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Abstract

This article reviews empirical research on applying the Attention, Relevance, Confidence, and Satisfaction (ARCS) model in real educational settings, including computer-based learning approaches. This review focuses on three aspects: (1) how the ARCS model was applied to what specific educational settings; (2) what research methods were used; and (3) what outcomes were reported in these studies. Our findings indicate that the ARCS model was applied in a variety of countries and educational settings. The course component(s) in which the ARCS model was incorporated included single course component (e.g. course email), multiple course components, and other programs (e.g. specific software or game). Quantitative methods were used more than qualitative and mixed methods in these reviewed studies. Four major research outcomes were found in regard to participants' affective domain, cognitive domain, psychological traits, and retention/completion rates. We also summarized the studies in this review and provided future research directions. The latter include application of design-based research to educational problems that the ARCS Model might address, especially in the context of computer-based learning.

Keywords: literature review, motivation, the ARCS model

Use of the ARCS Model in Education: A Literature Review

1. Introduction

Motivation is an important concept in human behaviors, and it plays a key role in student learning and in how educators can help students learn better (Pintrich, 2003). Motivation is "the study of why people think and behave as they do" (Graham & Weiner, 1996, p. 63). Motivation is tied closely to student learning achievement and is often considered one of the main factors that keep students learning (Paas, Tuovinen, Merriënboer, & Darabi, 2005). Students with different levels of motivation tend to behave differently in learning. For example, students with high motivation showed more exploratory learning behaviors (Martens, Gulikers, & Bastiaens, 2004). Besides the fact that motivation is connected with learning achievement, the effects of motivation on students' positive emotional experience during learning was also a critical component (Schiefele, 1991).

One important question that motivational research should be able to answer is how to motivate students in learning (Weiner, 1990). Motivational design, seeking to answer this question, is defined as "the process of arranging resources and procedures to bring about changes in people's motivation" (Keller, 2010, p. 22). It is a systematic process based on motivational theories and principles (Keller, 2010). One commonly used motivational design model is the attention, relevance, confidence, and satisfaction (ARCS) model. The ARCS model is rooted in a theoretical foundation: the expectancy-value theory (Keller, 1987a). In order to motivate students, the instructor or instructional materials need to (1) catch and sustain students' attention; (2) state why the students need to learn the content; (3) make students believe that they are able to succeed if they exert effort; and (4) help students feel a sense of reward and pride (Keller, 1987a). The ARCS model utilizes a systematic process which can be specified into four steps:

define, design, develop, and evaluate (Keller, 1987a). Furthermore, many of the other motivational literature's recommended strategies to improve students' motivation fall under the four components of the ARCS model (Hodges, 2004).

The ARCS model was well-developed and validated more than 30 years ago (Keller, 1987), and thus it is not surprising that the model has been used in widely different contexts (e.g. face-to-face classes as well as online environments) by researchers from many different countries. Motivational materials and strategies designed from the model vary (e.g. embedding strategies into videos or instructional texts), and the results of the study are not always consistent (e.g. whether students' motivations are increased). In addition, the student body in terms of their demographics, cultural beliefs and learning strategies as well the learning technologies differ significantly from when the ARCS model was first created. Thus, some ARCS strategies may not be effective for certain student population or in a particular learning environment. From all the points discussed above, a comprehensive review of empirical studies of applying the ARCS model is much needed to build a holistic view of how the model is applied in educational settings and what the outcomes are. Such is the purpose of this review which has research questions: (1) what are the educational settings in which the ARCS model has been applied? (2) what research designs have been used in past empirical studies? and (3) what are the reported outcomes after applying the ARCS model?

The structure of this article is as follows. Section 2 introduces the search and selection process as well as analysis method. Section 3 presents the results and discussions of the research questions. Section 4 concludes the article and provides directions for future research on the ARCS model.

2. Method

2.1 Selection Criteria

Based on the purposes introduced in section 1, the following selection criteria were used to select relevant articles:

1. The articles must be published in peer-reviewed journals in English. Conference proceedings and book chapters are excluded from this review.
2. The studies must be conducted in actual educational settings because we are interested in how the ARCS model has been used to address real educational issues. Educational settings can include face-to-face instruction, blended courses, or online courses, and not limited to learners of certain ages.
3. The studies must apply the ARCS model in designing instruction and/or instructional materials. Studies that used only surveys to measure the four components of the ARCS or studies only examined course materials for ARCS components without designing ARCS strategies are excluded from the review.
4. The articles must report empirical qualitative or quantitative data, analyze the data and interpret the results. Conceptual papers are excluded from the review.

2.2 Search and Selection Procedures

The electronic databases searched in this review included Academic Search Complete (ASC), Education Resources Information Center (ERIC) and Education Full Text (EFT). The key words used to search for relevant articles were (1) *ARCS model*, (2) *ARCS*, (3) *motivational design*, (4) *motivation design,* and (5) *attention, relevance, confidence, satisfaction*. These searches uncovered a total of 99, 1128, 59, 41, and 66 peer-reviewed journal articles published in English, respectively. After a careful examination of these articles, 23 met the four criteria presented above. Google Scholar was then used to identify additional articles, which yielded

6000+ results, an examination of the first 10 pages produced four additional articles. A scan of the articles' references produced no additional articles. As of February 22, 2018, a total of 27 articles were included in the final review.

2.3 Data Analysis

The basic unit of analysis was each individual article. Since our research questions are descriptive in nature and most articles did not report enough statistical results for a meta-analysis, content analysis was used in this review. We used the summative approach of content analysis in that we compared and contrasted all the articles based on the three research questions (Hsieh & Shannon, 2005). The analysis was achieved by four phases of analysis. In each phase, the first author coded the articles, classified them, and created summary charts. Then the second author reviewed the summary charts and discussed details with the first author. Both of them revised the chart and synthesized the results, and finally reported the results in different sections.

The first phase involved categorizing the educational contexts and how the ARCS model was applied in these contexts. In this phase, the first author created a summary chart with information of (1) which component(s) of the ARCS model were addressed, (2) in what countries these studies were carried out, (3) in what subject areas these studies were conducted, (4) what delivery methods the courses used, and (5) what course components were included in the motivational design. The results were reported in section 3.1. In the second and third phases, we analyzed the research design and research outcomes respectively. The studies were classified into quantitative, qualitative, and other methods. How these studies measured the relevant variables was also presented. The results were reported in section 3.2. The research outcomes were categorized into areas (i.e., cognitive domain, affective domain, psychological traits, and retention rates) and into whether the study found significant differences in the variables they

measured. The results were included in section 3.3. In the fourth phase, we synthesized the results from the first three phases, analyzed them critically with advantages and problematic areas, recognized the study limitations and provided future directions. This part was outlined in section 4.

3. Results and Discussions

3.1 ARCS Model Applications

We discuss how researchers applied the ARCS model from the following three perspectives: (1) the component(s) of the ARCS model, (2) the context/environment in which the studies were conducted and (3) how learning materials involving the ARCS motivational strategies were designed.

3.1.1 Component of the ARCS. Most studies (22 out of 27) in this literature review used all four components of the ARCS. The remaining five involve only relevance (M.-M. Chang & Lehman, 2002; Means, Jonassen, & Dwyer, 1997), only confidence (Huett, Moller, Young, Bray, & Huett, 2008; Moller & Russell, 1994), and attention, relevance and confidence (Song & Keller, 2001).

3.1.2 Study context. To understand the specific educational environments under which these studies were conducted, we summarized their countries, participants, and fields. As indicated in Table 1, the studies represent many different cultures and geographical areas including North America, Europe, Africa, the Middle East, and the Far East. This provides a solid basis for the generalizability of any results that emerge from the data.

Table 1
Countries/Areas of Studies

Countries	Studies
Austria	Astleitner & Hufnagl (2003), Astleitner & Lintner (2004)
China	Zhang (2017)
Malaysia	Annamalai (2016), Wah (2015)

Mozambique	J. Visser & Keller (1990)
Taiwan	C. Chang, Chang, & Shih (2016), M.-M. Chang & Lehman (2002), ChanLin (2009), Chen (2014), Feng & Tuan (2005), Hung, Chao, Lee, & Chen (2013), Liao & Wang (2008), Wu, Tsai, Yang, Huang, & Lin (2012)
Turkey	Aşıksoy & Özdamlı (2016), Karakis et al. (2016), Kurt & Keçik (2017), Ocak & Akçayır (2013)
U.K.	L. Visser, Plomp, Amirault, & Kuiper (2002)
U.S.A.	Doering, Scharber, Riedel, & Miller (2010), Hodges & Kim (2013), Huett, Kalinowski, Moller, & Huett (2008), Huett, Moller, et al. (2008), Kim & Keller (2008), Means et al. (1997), Moller & Russell (1994), Song & Keller (2001)

The broad variety of participants includes K-12 students and teachers, higher education students, vocational students, and employed adults provides another basis for the generalizability of the results (Table 2). Additional samples in some categories, such as employed adults, would be desirable.

Table 2
Participants of Studies

Participants	Studies
K-12 students	Feng & Tuan (2005), Karakis et al. (2016), Ocak & Akçayır (2013), Song & Keller (2001), Wah (2015)
K-12 teachers	Doering et al. (2010)
Technological and vocational students	Annamalai (2016), Liao & Wang (2008), Wu et al. (2012)
College students	Aşıksoy & Özdamlı (2016), Astleitner & Lintner (2004), Astleitner & Hufnagl (2003), C. Chang et al. (2016), M.-M. Chang & Lehman (2002), ChanLin (2009), Chen (2014), Hodges & Kim (2013), Huett, Kalinowski, et al. (2008), Huett, Moller, et al. (2008), Kim & Keller (2008), Kurt & Keçik (2017), Means et al. (1997), Zhang (2017)
Graduate students	L. Visser et al. (2002)
Both college and graduate students	Hung et al. (2013), Moller & Russell (1994)
In service learners	J. Visser & Keller (1990)

Most academic and vocational areas are represented in the various samples (Table 3). The study falls under the multiple subject areas recruited participants who were educators teaching various subjects (Doering et al., 2010). It would be desirable to have samples from the arts, but they did not exist at the time of this review.

Table 3
Subject Areas of Studies

Subject Area	Studies
Business	Moller & Russell (1994)
English as second language	Annamalai (2016), C. Chang et al. (2016), M.-M. Chang & Lehman (2002), Hung et al. (2013), Kurt & Keçik (2017),
Social science	Astleitner & Lintner (2004), L. Visser et al. (2002)
STEM	Aşıksoy & Özdamlı (2016),ChanLin (2009),Feng & Tuan (2005), Hodges & Kim (2013), Karakis et al. (2016), Kim & Keller (2008), Song & Keller (2001), Means et al. (1997), Wah (2015), Zhang (2017)
Technical, professional and vocational	Astleitner & Hufnagl (2003), Chen (2014), Huett, Kalinowski, et al. (2008), Huett, Moller, et al. (2008), Liao & Wang (2008), Ocak & Akçayır (2013), J. Visser & Keller (1990), Wu et al. (2012)
Multiple	Doering et al. (2010)

The types of courses or instructional sessions in which the ARCS model was applied also vary, including instructions that was face-to-face or self-driven printed texts, blended instructions, online courses, instructions that was supported by computer software or games, and mobile learning environments, as shown in Table 4.

Table 4
Course Delivery Methods

Delivery method	Studies
No computer or Internet supported instruction	Astleitner & Lintner (2004), Kim & Keller (2008), Liao & Wang (2008), Means et al. (1997), Moller & Russell (1994), Kurt & Keçik (2017), J. Visser & Keller (1990), L. Visser et al. (2002)
Blended instruction	Aşıksoy & Özdamlı (2016), Hodges & Kim (2013), Ocak & Akçayır (2013)
Web-based instruction	Astleitner & Hufnagl (2003), M.-M. Chang & Lehman (2002), ChanLin (2009), Chen (2014), Doering et al. (2010), Feng & Tuan (2005), Huett, Moller, et al. (2008), Huett, Kalinowski, et al. (2008)
Computer assisted instruction	Annamalai (2016), Hung et al. (2013), Karakis et al. (2016), Song & Keller (2001), Wah (2015), Wu et al. (2012)
Mobile learning	C. Chang et al. (2016), Zhang (2017)

3.1.3 Course component. In this review, we divided course components, in which the ARCS strategies were applied, into six categories: (1) course emails or messages, (2) face-to-face instructions, (3) instructional texts, (4) course video lectures, (5) the entire course including various activities and instructional materials, and (6) other programs. Table 5 shows the

categories and studies.

Table 5
Course Components with ARCS Strategies

Course Components	Studies
Email/Message	Huett, Kalinowski, et al. (2008), Kim & Keller (2008), J. Visser & Keller (1990), L. Visser et al. (2002)
Face-to-face instruction	Kurt & Keçik (2017)
Instructional texts	Astleitner & Lintner (2004), Means et al. (1997), Moller & Russell (1994)
Video	Astleitner & Hufnagl (2003), Hodges & Kim (2013),
Different course components	Aşıksoy & Özdamlı (2016), M.-M. Chang & Lehman (2002), ChanLin (2009), Chen (2014), Feng & Tuan (2005), Liao & Wang (2008), Ocak & Akçayır (2013), Wu et al. (2012)
Other programs	Annamalai (2016), C. Chang et al. (2016), Doering et al. (2010), Huett, Moller, et al. (2008), Hung et al. (2013), Karakis et al. (2016), Song & Keller (2001), Wah (2015), Zhang (2017)

Some studies selected a single course component and integrated the ARCS motivational strategies, while some studies used multiple course components and/or instructional activities to embed the strategies. Other studies used technologies or programs other than the standard course components to design the strategies. Email/message, instructional text and video were chosen the most frequently to embed the ARCS strategies. Verbal instructions (Ocak & Akçayır, 2013), quiz questions with feedback (ChanLin, 2009), and lab activities (Feng & Tuan, 2005) were some examples when designing and integrating strategies into more than one course component. Other researchers designed ARCS strategies in external programs, such as multi-media e-books (Annamalai, 2016), an adventure learning program (Doering et al., 2010), a computer-assisted adaptive program (Song & Keller, 2001), computer-based educational games (Karakis et al., 2016), computer software (Huett, Moller, et al., 2008; Wah, 2015), mobile learning environments (C. Chang et al., 2016; Zhang, 2017), and computer-based teaching robot program (Hung et al., 2013).

3.2 Research Method

We categorized these studies based on their study methods, and we examined measurements of the major variables. The most frequently used research method was quantitative method with 19 out of the 27 articles. Appendix A lists the research design for each of the reviewed articles.

3.2.1 Research design. One type of quantitative method is factorial design, which investigates the effects of each of the factors as well as their interactions. In the study by Means et al. (1997), one factor was intrinsic relevance: whether students had intrinsic or extrinsic relevance toward a given topic; the other factor was extrinsic relevance strategy: students who received learning materials with embedded relevance strategies or without those strategies. In Kim and Keller's (2008) study, the two factors were satisfaction: whether students were satisfied with their previous scores, and motivational messages with personalized information: whether students received personalized messages or not. Participants' intrinsic motivation in the subject area was one factor while the motivational-enhanced learning materials was another factor (M.-M. Chang & Lehman, 2002) study.

The other type that is widely used is experimental or quasi-experimental design method. Researchers manipulate the independent variable(s) and measure the outcomes associated with each manipulated condition (Bhattacherjee, 2012). The difference between experimental and quasi-experimental design is that participants are randomly assigned into each of the conditions in experimental design studies while randomness does not occur in quasi-experimental design studies. In both experimental and quasi-experimental studies, one group was usually provided with learning materials or classroom instructions with ARCS strategies while the other group received materials or instructions without those strategies. Sometimes a third group was included

to serve as another level of comparison. For example, Song and Keller (2001) conducted a three-group experimental design with a non-motivation strategy group, a motivational static group, and a motivational adaptive group. Single group pre- and post-test experimental design is also used (e.g. Karakis et al. (2016)), in which the authors compared the pre- and post-test scores of motivation and/or achievements of the same participants to find out the differences in these variables. A variety of data collection methods were adopted in those studies, including questionnaires, performance tests, and single questions measuring specific variables that the researchers cared about, such as time-on-task or continuing motivation.

Experimental research is useful in drawing causal relationships between independent and dependent variables because of "its internal validity (causality) due to its ability to link cause and effect through treatment manipulation, while controlling for the spurious effect of extraneous variable" (Bhattacherjee, 2012, p. 83). In the (factorial) experimental and quasi-experimental studies discussed above, the researchers attempted to examine the causal relationship between using the ARCS model in teaching and students' motivation, achievement, and/or other variables. These types of research provided researchers and practitioners with confirmations of whether the ARCS model is effective in increasing participants' motivation and achievement (and other measures) under a specific educational environment. It needs to be noted that different research studies might reach different conclusions because of varied research settings, participants, data collection methods, intervention designs, and measurement instruments, etc., which we will discuss in section 3.3. However, since there is no control group to rule out the alternative possibilities, single group design is considered weak and no causal relationship can be drawn from the results.

In contrast, there are several studies utilizing non-experimental design such as case study,

qualitative or mixed method study. Qualitative studies in general "provide results that are usually rich and detailed, offering ideas and concepts to inform your research" (Macdonald & Headlam, 2008, p. 35). These non-experimental studies seek deeper understandings of students' motivational problems, the applications of the ARCS model, and how integrating ARCS strategies affect students' motivation and achievement. Multiple data collection methods were used in these studies, including discussion forum posts (ChanLin, 2009), students' assignments and self-reflections (ChanLin, 2009), questionnaires (Annamalai, 2016; Aşıksoy & Özdamlı, 2016; Doering et al., 2010; J. Visser & Keller, 1990; L. Visser et al., 2002; Wah, 2015), round table discussions (J. Visser & Keller, 1990), classroom observations (J. Visser & Keller, 1990; L. Visser et al., 2002), instructor log books (L. Visser et al., 2002), interviews (Aşıksoy & Özdamlı, 2016; Doering et al., 2010; L. Visser et al., 2002; Wah, 2015), and previous years' course record (L. Visser et al., 2002).

Case studies investigate a phenomenon in a natural setting in great detail over a period of time and provide rich descriptions by analyzing data from multiple data collection methods (Bhattacherjee, 2012). A case study design article is reviewed here in detail as an illustration of the non-experimental designs. Fifteen staff members in the Ministry of Education in Mozambique who were taking an instructional design course participated in the study by J. Visser and Keller (1990). Using students' self-reported feelings and perceptions of the course, as well as their course performance, the authors frequently identified students' motivational needs and distributed motivational messages after the diagnoses. These motivational messages were designed to increase students' attention to the course and assignments; enable learners to relate the course content to their careers especially in longer time; make them believe they could succeed in the course after putting in effort; and encourage learners to feel proud and gratitude to

the learning experience. Besides the self-reported feelings and perceptions that were used to diagnosis students' motivational conditions, questionnaires measuring students' perceived importance of the motivational strategies, class observation notes recording students' reactions to the messages, and students' performance data were used to assess the effects of the motivation messages.

Quantitative studies are useful in evaluating the effectiveness of the model statistically, but qualitative and mixed method studies can help researchers and practitioners understand the design process, why the model is applied in this format, and how certain ARCS strategies are selected. For example, J. Visser and Keller (1990) described the educational conditions in Mozambique, analyzed participants' motivational conditions, explained why motivational messages could be effective, and specified how the motivational messages were designed based on these considerations.

3.2.2 Measurement. One criterion for selecting articles in this review was whether the study reported empirical data measuring the effects of ARCS model applications. A variety of methods were used to measure the dependent variables in quantitative studies and to evaluate the model application in non-quantitative studies. Outcome variables that were measured the most often were motivation and achievement. Being a construct that cannot be observed directly, motivation is always measured indirectly. Touré-Tillery and Fishbach (2014) stated that researchers need to understand clearly what types of motivation they are capturing in order to measure it. In studies of the ARCS model application, the Course Interest Survey (CIS) (Keller, 2010) and the Instructional Material Motivation Survey (IMMS) (Keller, 2010), designed specifically for the ARCS model, were used to measure participants' motivation frequently. The major difference between CIS and IMMS is that CIS is designed for teacher-led classrooms

while IMMS is mainly for self-directed learning. Eleven studies in this review used the IMMS or its modified version and five studies used CIS or its modified version to measure students' motivation in regard to the ARCS components. Some studies used other instruments to measure motivation, such as the Science Motivation Questionnaire by Aşıksoy and Özdamlı (2016). Self-designed instrument measuring motivation was used in Astleitner and Hufnagl (2003).

Educational achievement is a critical piece in educational research because achievement can have a deterministic effect on educational system and its policy (Hanushek, 1979). In the reviewed ARCS application articles, achievement was normally measured by instructor-designed tests/exams. Some studies used pre- and post-test method to examine the achievement increase before and after the motivational intervention. For example, Moller and Russell (1994) administered equivalent tests before and after the experiment and the difference between them was treated as a measure of learning achievement.

Besides motivation and achievement, researchers also cared about other variables that might be affected by the motivational interventions. These variables included time spent on learning tasks (Feng & Tuan, 2005; Kim & Keller, 2008; Means et al., 1997), course retention rate (Huett, Kalinowski, et al., 2008; L. Visser et al., 2002), continuing motivation (Hung et al., 2013; Song & Keller, 2001), self-sufficiency (Aşıksoy & Özdamlı, 2016), student behaviors by system logs (Chen, 2014) and learning efficiency (Song & Keller, 2001). For example, Kim and Keller (2008) used time spent on tasks partly as a diagnostic variable to design personal messages. Time-on-task was also considered as an indicator of students' study habits in this study. Feng and Tuan (2005) measured students' time spent on tasks as an indication of their engagement. Song and Keller (2001) treated the ratio of performance and study time as a measure for learning efficiency. The authors also asked participants if they were willing to learn

similar topics in the future to imply continuing motivation. Huett, Kalinowski, et al. (2008) compared course retention rates between the experimental and control group.

3.3 Research Outcome

Although examining the influences of the ARCS model on students' motivation and achievement was an emphasis in these reviewed papers, other variables and other research outcomes were involved in some articles. We categorized the reported research results into four different domains: affective domain (26 studies), cognitive domain (20 studies), other psychological traits (five studies), and retention/completion rates (two studies).

3.3.1 Affective domain. Affective domain includes such things as students' motivation, feelings and attitudes toward the course, and continuing motivation. It is one of the major outcomes that researchers in the ARCS literature reported. One group of studies suggests that participants in the ARCS-enhanced group showed higher motivation or higher in at least one of the four ARCS components than the control group. Quantitative studies found that participants who were exposed to the ARCS-enhanced learning materials showed better attitudes toward the subject area (e.g. Hodges & Kim, 2013). Non-quantitative studies reported outcomes related to positive attitudes and feelings toward the ARCS strategies (e.g. ChanLin, 2009; L. Visser et al., 2002). Feng and Tuan (2005) reported that students spent longer study time on the ARCS-enhanced materials.

Another group of studies reported no significant differences in motivation or other affective domain outcomes between the experimental and the control group. For example, Wu et al. (2012) highlighted that there were no significant differences in motivation as well as all the four components in the ARCS. Three studies arrived at the results that there was no significant difference in participants' confidence between the experimental and the control group (Huett,

Moller, et al., 2008; Moller & Russell, 1994; Song & Keller, 2001). One study reported no significant difference in relevance (Huett, Kalinowski, et al., 2008) and one in satisfaction (Song & Keller, 2001). Hodges and Kim (2013) found no significant difference in interest in the course between the ARCS experimental and control group. Two studies reported no difference in self-reported study time between groups (Kim & Keller, 2008; Means et al., 1997).

It is important to note that different studies can reach different results even though they all involved using the ARCS model in an educational setting. As discussed in section 4.1.1, the educational settings in which the model was applied varied; participants differed in terms of ages, nationalities, educational levels, majors, etc.; the ARCS-enhanced material design was also different on many levels even though the same model was used. Due to all those factors, it is almost unavoidable to see different results drawn from these studies. This is also why researchers have been advocating design-based research (DBR) in the educational technology field because DBR usually describes a potential solution to a particular educational problem in great detail (Reeves, 2000). Then readers will understand better how a program or a particular intervention was designed and implemented. In fact, a DBR approach was introduced by Keller (1987c) during the development of the ARCS model. However, people tended to use the theoretical model (Keller, 1987b) without utilizing the DBR process.

3.3.2 Cognitive domain. Students' performance in tests was the main cognitive domain outcome reported in these articles. Similar to the affective domain, there were also two groups of studies that reported either higher/increased achievement or no significant difference in achievement. As Wu et al. (2012) assumed, the specific educational setting and participants was one possible reason for the insignificance in achievement. The relatively short period of experiment time was another assumption that might affect the study results. Astleitner and

Lintner (2004) found that the experimental group performed worse in the first achievement test than the control group and then outperformed the control group in the second test. Their results could be considered evidence of the importance of experiment time. It is also possible that the specific ARCS tactics that the researchers selected might not be effective under certain conditions. Thus, these authors encouraged further research to continue explore the effects of the ARCS model under different settings.

3.3.3 Psychological traits. Researchers believed that students' other psychological traits might also be affected by the ARCS model or students with certain psychological traits would have different motivation, so some studies included these psychological traits. Astleitner and Lintner (2004) claimed that ARCS strategies both positively and negatively influenced participants' several psychological traits related to self-regulated learning. Astleitner and Hufnagl (2003) found that participants who had lower situation-outcome-expectancies (SOE) scores had increased motivation and achievement after learning the ARCS-enhanced texts, but not participants with higher SOE scores. Participants' intrinsic motivation was another trait that was considered by some researchers. For example, M.-M. Chang and Lehman (2002) discovered that participants who had higher intrinsic motivation and were included in the ARCS group had the highest score on both motivation and performance.

3.3.4 Retention/completion rate. Studies in this category reported higher retention/completion rates in the ARCS group or class than the control group or class without the ARCS interventions. Huett, Kalinowski, et al. (2008) found that the experimental group in which students received emails based on the ARCS model had higher retention rate and lower failure rate. L. Visser et al. (2002) designed and distributed messages that were ARCS-based to students in a case study. They compared the completion rates of this course with previous courses without

the ARCS strategies and found that the completion rate in the ARCS course was higher.

4. Conclusion

We reviewed empirical studies that were published in peer-reviewed journals until February 22, 2018 to summarize research on applying the ARCS model in real educational settings. The findings of this review provided insights for researchers and practitioners into (1) how the ARCS model was applied and under what educational contexts; (2) what types of research design and methods were used; and (3) what major outcomes were reported.

4.1 Summary

In this review, we found that the ARCS model has been applied in a variety of educational settings, such as K-12 education, higher education, and technical school, in different subject areas and many countries. Most studies included strategies of all the four factors in the ARCS model. Researchers either selected a specific course component, like videos or course emails, to incorporate ARCS strategies in, or designed the strategies into multiple course components. This variety of contexts provides evidences that the ARCS model can be applied into different learning environments, to different levels of students, and in different countries. However, these studies provided various levels of detail of the ARCS design process from barely mentioning the strategies to lengthy analysis of the educational situation, resources, and how the decisions were made based on those conditions.

The most often used research method was quantitative: experimental, quasi-experimental, and factorial design. We speculated that the reason for this quantitative domination was because the ARCS model was a well-developed model with clear steps and guidelines, as Keller (1987a) pointed out : “the ARCS Model appears to provide useful assistance to designers and teachers, and warrants more controlled studies of its critical attributes and areas of effectiveness” (p. 2).

Researchers could design ARCS strategies based on those guidelines and test their effects in an experiment. In addition, the ARCS model was designed to improve students' motivation, so it was reasonable for researchers to conduct experimental design to examine the effects of the model on motivation.

Another important finding was that past empirical research focused mainly on four types of outcomes: affective domain, cognitive domain, psychological traits, and retention/completion rate. Motivation is an important element under the affective domain. Almost every study in the review reported motivation as one of the research outcomes, but the outcomes differed in these studies. As a widely used indirect measure of motivation, time-on-task also showed different patterns as well. Keller pointed out although the ARCS model had been applied in different countries, there should be differences in the motivational tactics usage among students of different cultures (Simsek, 2014). Thus, the seemingly contradictory results of motivation and time-on-task were probably due to the varied educational settings, designs, and ARCS strategy selections, and so on. Overall, the students showed positive attitudes toward the ARCS strategies and learning materials in which those strategies were integrated.

Similarly, the major variable in the cognitive domain was inconsistent in these studies – some studies found that students who received the ARCS instruction obtained higher achievement score and/or better learning gains while other studies reported no difference. Compared with the affective and cognitive domain, fewer articles reported psychological traits and retention/completion rate as research outcomes or variables that could affect outcomes. How the ARCS model affected students' other psychological traits was not clear based on the studies in this review. However, researchers seemed to consider that intrinsic motivation or intrinsic feelings of some sub-scales of the ARCS model would affect learners' motivation and

achievement. Retention/completion rates were reported as improved by the ARCS model in two studies, which was easy to understand because motivation was considered a critical factor that influences retention rate (Hart, 2012).

5.2 Practitioner Guidelines

When applying the ARCS model, practitioners should consider the special culture or other context situations because these situations may shape specific learner characters, which then leads to certain unique motivational strategies (Simsek, 2014). For example, J. Visser and Keller (1990) used strategies to remind students of their social responsibilities because people in Mozambique usually set priorities to the society rather than themselves. In addition, practitioners can design motivational strategies creatively and embed them into external learning systems or materials such as e-books or educational games. Lastly, what outcomes to measure and how to measure depend on the goals of the motivational project. But practitioners could consider using multiple methods like surveys, self-reported time-on-task and system logs as the indirect measures for motivation.

5.3 Limitations and Future Research Directions

The current review focuses only on empirical studies published in peer-reviewed journals, which is a small subset of studies on this topic. Thus, the reviewed studies may not reflect research on ARCS application in general. Another limitation of this review is that most studies used self-reported data such as questionnaires, interviews and students' reflective writings to measure motivation and/or other outcomes like attitudes. Although Gonyea (2005) acknowledged the value of self-reported data in educational research, the author suggests that researchers use multiple data sources to measure an educational outcome.

There are several future ARCS model application research directions. First, a large

number of studies only applied the ARCS model for a short period of time, such as several hours of experimentation. The ARCS model may need longer time to have a real effect on students' motivation and achievement. Second, the motivational strategies in some articles seemed isolated from the entire course, such as embedding several ARCS strategies into one course component like the course email. Keller (2010) suggested that the ARCS model be integrated with the instructional design process instead of using an isolated strategy. Third, very few studies pointed out that any motivational design decisions were based on the specific conditions or cultures in which the studies were conducted. Pintrich (2003) mentioned that there might be differences in motivational beliefs in learning among learners of different cultures and this would most likely influence the relevance category of design in the ARCS model (Keller, 2010). Thus, ignoring the particularity of a specific group of learners might result in imprecise motivational problem diagnosis or inappropriate strategy usage. Fourth, more studies on applying the ARCS model in computer-supported or purely online learning environments should be conducted because of the prevalence of online learning and the potential differences of learners' characteristics in online and face-to-face learning (e.g. online students are less satisfied with the course than face-to-face students in a statistics course (Summers, Waigandt, & Whittaker, 2005)).

Fifth, human motivation is a complex construct which involves many psychological concepts. Future research on motivating students by the ARCS model could investigate other cognitive or psychological factors which influence motivation. Astleitner and Lintner (2004) found that the ARCS design positively affected some psychological traits but not the others. How and why did this happen? Are there more such traits or attributes that could have an effect on motivational design research? This is a dynamic area of research and future examinations of motivation literature should investigate these questions.

Sixth, another area for further exploration is design-based research (DBR) that was introduced for motivational design (Keller, 1987c) and formalized in a more generalized process by Collins (1992) and Reeves (2000, 2006). Educational DBR starts with an educational problem, designs a solution based on past literature, implements the solution in a real setting, and evaluates the solution (The Design-Based Research Collective, 2003). In this way, readers can easily tell what the motivational problems are, how certain ARCS strategies are designed, and whether these strategies are effective in solving the particular motivational problem. In addition, by describing the contexts in detail, researchers will understand better the rationale for the whole design under a specific situation, especially in a context that is not familiar to many researchers, like the educational system in Mozambique (J. Visser & Keller, 1990). Practitioners will also learn better when applying the ARCS model in their own educational settings.

Last, motivation is usually not in a static status during a process, which makes adaptively diagnosing motivational issues and adaptively motivating students an important topic in ARCS application literature. Song and Keller (2001) created a motivational adaptive group in their experiment by diagnosing students' motivation intermittently and then providing different combinations of motivational strategies. The authors suggested that even more adaptive designs could be made for the motivational adaptive group. Other researchers emphasized that adaptively examining motivation and implementing motivational strategies would be a good future research direction (Astleitner & Lintner, 2004). With the prevalence of learning analytics research, there will be more methods to diagnose learning problems in real time in order to react pedagogically and policy-wise (Vatrapu, Teplovs, Fujita, & Bull, 2011). Baker and Inventado (2014) stressed that learning analytics could be used to identify students in particular needs and then personalize learning experiences for these students. Identifying motivation needs using these analytic

techniques and adaptively designing motivational strategies based on the data and the ARCS model can be a very useful and promising topic for future researchers to pursue.

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