



Contents lists available at ScienceDirect

Computers & Education

journal homepage: www.elsevier.com/locate/compedu

Use of the ARCS model in education: A literature review

Kun Li^{a,*}, John M. Keller^b^a Doctor of Physical Therapy, Duke University, 2200 West Main Street, Suite B-230, Durham, NC 27705, United States^b Florida State University, 9705 Waters Meet Drive, Tallahassee, FL 32312, United States

ARTICLE INFO

Keywords:

Literature review
Motivation
The ARCS model

ABSTRACT

This article reviews empirical research on applying the Attention, Relevance, Confidence, and Satisfaction (ARCS) model to 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 to 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, learning behaviors, and psychological traits. We also summarized the studies in this review and provided future research directions. The latter includes applications of design-based research to educational problems that the ARCS model might address, especially in the context of computer-based learning.

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 tied closely to student learning achievement and is often considered one of the main factors that keep students learning (Paas, Tuovinen, Merriënboer, van and 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 is also a critical component (Schiefele, 1991).

One important question that motivational research should 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). 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). The model states that, 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).

* Corresponding author.

E-mail address: kl195@duke.edu (K. Li).

The ARCS model was well-developed and validated more than 30 years ago (Keller, 1987a), 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 to educational settings and what the outcomes are. Such is the purpose of this review which has research questions: (1) what are the educational settings to 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 future research directions.

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, which 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 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, a summary chart was created with information of study contexts and the ARCS strategies implemented. The results were reported in section 3.1. In the second and third phases, we analyzed the research design and research outcomes respectively. Relevant variables measurement was also presented. The results were reported in section 3.2. The research outcomes were categorized into areas (i.e., cognitive domain, affective domain, learner behaviors, and psychological traits) 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.

Table 1
Countries/areas of studies.

Countries	Studies
Austria	Astleitner and Hufnagl (2003), Astleitner and Lintner (2004)
China	Zhang (2017)
Malaysia	Annamalai (2016), Wah (2015)
Mozambique	J. Visser and Keller (1990)
Taiwan	C. Chang, Chang, and Shih (2016), M.-M. Chang and Lehman (2002), ChanLin (2009), Chen (2014), Feng and Tuan (2005), Hung, Chao, Lee, and Chen (2013), Liao and Wang (2008), Wu, Tsai, Yang, Huang, and Lin (2012)
Turkey	Aşıksoy and Özdamlı (2016), Karakis, Karamete, and Okçu (2016), Kurt and Keçik (2017), Ocak and Akçayır (2013)
U.K.	L. Visser, Plomp, Amirault, and Kuiper (2002)
U.S.A.	Doering, Scharber, Riedel, and Miller (2010), Hodges and Kim (2013), Huett, Kalinowski, Moller, and Huett (2008a), Huett, Kalinowski, et al. (2008a) and Huett, Moller, et al. (2008), Kim and Keller (2008), Means et al. (1997), Moller and Russell (1994), Song and Keller (2001)

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) which component(s) of the course the ARCS strategies were embedded.

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 involved only relevance (M.-M. Chang & Lehman, 2002; Means, Jonassen, & Dwyer, 1997), only confidence (Huett, Moller, Young, Bray, & Huett, 2008b; 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, course delivery methods, 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.

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.

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.

The types of courses or instructional sessions to which the ARCS model was applied also varied based on the technology of the learning environment as shown in Table 4.

3.1.3. Course component

In this review, we divided course components, into which the ARCS strategies were incorporated, 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.

Email/message, instructional text and video were chosen the most frequently to embed the ARCS strategies as a single course

Table 2
Participants of studies.

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

Table 3
Subject areas of studies.

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

Table 4
Course delivery methods

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

Table 5
Course components with ARCS strategies.

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

component. 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., 2008b; Wah, 2015), mobile learning environments (C. Chang et al., 2016; Zhang, 2017), and a 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 20 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 (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).

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 (Bhattacharjee, 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.

In contrast, there are several studies utilizing other designs such as case study, qualitative or mixed method study. These studies seek deeper understandings of students' motivational problems, the applications of the ARCS model, and students' perceptions and attitudes toward the instructions/learning materials. 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 (Bhattacharjee, 2012). A case study design article is reviewed here in detail as an illustration of the other 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 students 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 students to feel proud and gratitude to the learning experience. 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.

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" (Bhattacharjee, 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. 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.

On the other hand, qualitative, mixed method and case 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. In both quantitative and qualitative (including mixed-method and case study) 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). A 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 the educational system and its policy (Hanushek, 1979). In the reviewed 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 gain.

Besides motivation and achievement, other variables were measured in some studies. This can be achieved by some questions in the survey to participants (e.g. Kim and Keller (2008) measured students' study time using several questions in a survey), an entire survey measuring certain construct (e.g. Zhang (2017) deployed a survey measuring students' learning experiences), or other data collection methods which were frequently occurred in qualitative and case studies, including discussion forum posts (ChanLin, 2009), students' assignments (ChanLin, 2009), questionnaires (Annalalai, 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/system logs (Chen, 2014; 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).

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), learner behaviors (eight studies), and other psychological traits (five 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).

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., 2008b; Moller & Russell, 1994; Song & Keller, 2001). One study reported no significant difference in relevance (Huett, Kalinowski, et al., 2008a) 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.

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 3.1.1, the educational settings to which the model was applied varied; participants differed in terms of ages, nationalities, educational levels, majors, etc.; the ARCS-enhanced materials were also designed differently 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 exploring the effects of the ARCS model under different settings.

3.3.3. Learner behavior

This category includes variables like time spent on task, numbers of forum post, numbers of assignment submission, and course retention rate. Though these variables were meant to measure engagement or attitudes in some studies, we categorized them as learner behaviors in this review. Feng and Tuan (2005) reported that students spent longer study time on the ARCS-enhanced materials. Two studies reported no difference in self-reported study time between groups (Kim & Keller, 2008; Means et al., 1997). Song and Keller (2001) introduced an efficiency concept which was the ratio of the amount of learning and time on learning. They found that the motivationally adaptive and the non-motivation groups had higher efficiency than the motivationally static group. Chen (2014) suggested that students demonstrated improved active learning behaviors because their forum post and assignment submission numbers increased significantly after taking the ARCS-enhanced computer-based instruction. J. Visser and Keller (1990) reported that students actively participated in class which incorporated ARCS strategies. Studies 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. (2008a) and Huett, Moller, 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.

3.3.4. Psychological trait

Researchers believed that students' other psychological traits might also be affected by the ARCS model or students with certain psychological traits would have differences in 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. [Aşıksoy and Özdamlı \(2016\)](#) measured participants' self-sufficiency and found it increased after the ARCS-enhanced instruction. Intrinsic motivation is another such trait that two studies measured. Both studies reported findings that students who were intrinsically motivated and were assigned to the extrinsic motivational group scored the highest on motivation and performance ([M.-M. Chang & Lehman, 2002](#); [Means et al., 1997](#)).

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 to 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, designed the strategies into multiple course components or embed the strategies into some external programs. 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, learner behaviors, and psychological traits. 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. 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 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 learner behaviors and psychological traits as research outcomes or variables that could affect outcomes. Learner behaviors also varied in that some found improved time-on-task or participation while others found no differences in time. 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](#)). 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.

4.2. 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 mobile learning systems 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 to triangulate data sources.

4.3. 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 increase the study validity.

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 only one course component. 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 may 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 to 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.

Appendix A. Supplementary data

Supplementary data related to this article can be found at <http://dx.doi.org/10.1016/j.compedu.2018.03.019>.

References

- Annamalai, S. (2016). Implementing ARCS model to design a motivating multimedia e-book for polytechnic esl classroom. *Journal of Telecommunication, Electronic and Computer Engineering*, 8(8), 57–60.
- Astleitner, H., & Hufnagl, M. (2003). The effects of situation-outcome-expectancies and of arcs-strategies on self-regulated learning with web-lectures. *Journal of Educational Multimedia and Hypermedia*, 12(4), 361–376.
- Astleitner, H., & Lintner, P. (2004). The effects of ARCS-strategies on self-regulated learning with instructional texts. *E-Journal of Instructional Science and Technology*, 7(1). Retrieved from <http://eric.ed.gov/?id=EJ850349>.
- Aşıksoy, G., & Özdamlı, F. (2016). Flipped classroom adapted to the ARCS model of motivation and applied to a physics course. *Eurasia Journal of Mathematics, Science and Technology Education*, 12(6), 1589–1603. <https://doi.org/10.12973/eurasia.2016.1251a>.
- Baker, R. S., & Inventado, P. S. (2014). Educational data mining and learning analytics. In J. A. Larusson, & B. White (Eds.). *Learning Analytics: From research to practice* (pp. 61–75). New York: Springer. https://doi.org/10.1007/978-1-4614-3305-7_4.
- Bhattacharjee, A. (2012). Social science research: Principles, methods, and practices. Textbooks Collection. Retrieved from http://scholarcommons.usf.edu/oa_textbooks/3.
- Chang, C., Chang, C.-K., & Shih, J.-L. (2016). Motivational strategies in a mobile inquiry-based language learning setting. *System*, 59, 100–115. <https://doi.org/10.1016/j.system.2016.04.013>.

- Chang, M.-M., & Lehman, J. D. (2002). Learning foreign language through an interactive multimedia program: An experimental study on the effects of the relevance component of the ARCS model. *Calico Journal*, 20(1), 81–98.
- ChanLin, L.-J. (2009). Applying motivational analysis in a Web-based course. *Innovations in Education & Teaching International*, 46(1), 91–103. <https://doi.org/10.1080/14703290802646123>.
- Chen, Y.-T. (2014). A study to explore the effects of self-regulated learning environment for hearing-impaired students. *Journal of Computer Assisted Learning*, 30(2), 97–109. <https://doi.org/10.1111/jcal.12023>.
- Collins, A. (1992). Toward a design science of education. In E. Scanlon, & T. O'Shea (Eds.). *New directions in educational technology* (pp. 15–22). Berlin: Springer-Verlag. Retrieved from http://link.springer.com/chapter/10.1007/978-3-642-77750-9_2.
- Doering, A., Scharber, C., Riedel, E., & Miller, C. (2010). "Timber for president": Adventure learning and motivation. *Journal of Interactive Learning Research*, 21(4), 221–251.
- Feng, S.-L., & Tuan, H.-L. (2005). Using ARCS model to promote 11th graders' motivation and achievement in learning about acids and bases. *International Journal of Science and Mathematics Education*, 3(3), 463–484. <https://doi.org/10.1007/s10763-004-6828-7>.
- Gonyea, R. M. (2005). Self-reported data in institutional research: Review and recommendations. *New Directions for Institutional Research*, 2005(127), 73–89. <https://doi.org/10.1002/ir.156>.
- Hanushek, E. A. (1979). Conceptual and empirical issues in the estimation of educational production functions. *Journal of Human Resources*, 14(3), 351–388.
- Hart, C. (2012). Factors associated with student persistence in an online program of study: A review of the literature. *The Journal of Interactive Online Learning*, 11(1), 19–42.
- Hodges, C. B. (2004). Designing to motivate: Motivational techniques to incorporate in e-learning experiences. *The Journal of Interactive Online Learning*, 2(3), 1–7.
- Hodges, C. B., & Kim, C. (2013). Improving college students' attitudes toward mathematics. *TechTrends*, 57(4), 59–66. <https://doi.org/10.1007/s11528-013-0679-4>.
- Hsieh, H.-F., & Shannon, S. E. (2005). Three approaches to qualitative content analysis. *Qualitative Health Research*, 15(9), 1277–1288. <https://doi.org/10.1177/1049732305276687>.
- Huett, J. B., Kalinowski, K. E., Moller, L., & Huett, K. C. (2008a). Improving the motivation and retention of online students through the use of ARCS-based e-mails. *American Journal of Distance Education*, 22(3), 159–176. <https://doi.org/10.1080/08923640802224451>.
- Huett, J. B., Moller, L., Young, J., Bray, M., & Huett, K. C. (2008b). Supporting the distant student: The effect of arcs-based strategies on confidence and performance. *Quarterly Review of Distance Education*, 9(2), 113–126.
- Hung, I.-C., Chao, K.-J., Lee, L., & Chen, N.-S. (2013). Designing a robot teaching assistant for enhancing and sustaining learning motivation. *Interactive Learning Environments*, 21(2), 156–171. <https://doi.org/10.1080/10494820.2012.705855>.
- Karakis, H., Karamete, A., & Okçu, A. (2016). The effects of a computer-assisted teaching material, designed according to the ASSURE instructional design and the ARCS model of motivation, on students' achievement levels in a mathematics lesson and their resulting attitudes. *European Journal of Contemporary Education*, 15(1), 105–113.
- Keller, J. M. (1987a). Development and use of the ARCS model of instructional design. *Journal of Instructional Development*, 10(3), 2–10. <https://doi.org/10.1007/BF02905780>.
- Keller, J. M. (1987b). Strategies for stimulating the motivation to learn. *Performance and Instruction*, 26(8), 1–7.
- Keller, J. M. (1987c). The systematic process of motivational design. *Performance & Instruction*, 26(9–10), 1–8.
- Keller, J. M. (2010). *Motivational design for learning and performance: The ARCS model approach* (1st ed.). New York: Springer.
- Kim, C., & Keller, J. M. (2008). Effects of motivational and volitional email messages (MVEM) with personal messages on undergraduate students' motivation, study habits and achievement. *British Journal of Educational Technology*, 39(1), 36–51. <https://doi.org/10.1111/j.1467-8535.2007.00701.x>.
- Kurt, P. Y., & Keçik, İ. (2017). The effects of ARCS motivational model on student motivation to learn English. *European Journal of Foreign Language Teaching*, 0(0), Retrieved from <https://oapub.org/edu/index.php/ejfl/article/view/478>.
- Liao, H.-C., & Wang, Y. (2008). Applying the ARCS motivation model in technological and vocational education. *Contemporary Issues In Education Research*, 1(2), 53–58.
- Martens, R., Gulikers, J., & Bastiaens, T. (2004). The impact of intrinsic motivation on e-learning in authentic computer tasks. *Journal of Computer Assisted Learning*, 20(5), 368–376. <https://doi.org/10.1111/j.1365-2729.2004.00096.x>.
- Means, T. B., Jonassen, D. H., & Dwyer, F. M. (1997). Enhancing relevance: Embedded ARCS strategies vs. purpose. *Educational Technology Research & Development*, 45(1), 5–17. <https://doi.org/10.2307/30220166>.
- Moller, L., & Russell, J. D. (1994). An application of the ARCS model design process and confidence-building strategies. *Performance Improvement Quarterly*, 7(4), 54–69. <https://doi.org/10.1111/j.1937-8327.1994.tb00650.x>.
- Ocak, M. A., & Akçayır, M. (2013). Do motivation tactics work in blended learning environments?: the ARCS model approach. *International Journal of Social Sciences and Education*, 3(4), 1058–1070.
- Paas, F., Tuovinen, J. E., Merriënboer, J. J. G., & van and Darabi, A. A. (2005). A motivational perspective on the relation between mental effort and performance: Optimizing learner involvement in instruction. *Educational Technology Research & Development*, 53(3), 25–34. <https://doi.org/10.2307/30220439>.
- Pintrich, P. R. (2003). A motivational science perspective on the role of student motivation in learning and teaching contexts. *Journal of Educational Psychology*, 95(4), 667–686. <https://doi.org/10.1037/0022-0663.95.4.667>.
- Reeves, T. C. (2000). Enhancing the worth of instructional technology research through "design experiments" and other development research strategies. *Presented at the annual meeting of the american educational research association*. LA, USA: New Orleans.
- Reeves, T. C. (2006). Design research from a technology perspective. In J. V. den Akker, K. Gravemeijer, S. McKenney, & N. Nieveen (Eds.). *Educational design research* (pp. 52–66). London: Routledge.
- Schiefele, U. (1991). Interest, learning, and motivation. *Educational Psychologist*, 26(3–4), 299–323. <https://doi.org/10.1080/00461520.1991.9653136>.
- Simsek, A. (2014). Interview with John M. Keller on motivational design of instruction. *Contemporary Educational Technology*, 5(1), 90–95.
- Song, S. H., & Keller, J. M. (2001). Effectiveness of motivationally adaptive computer-assisted instruction on the dynamic aspects of motivation. *Educational Technology Research & Development*, 49(2), 5–22. <https://doi.org/10.2307/30220308>.
- Summers, J. J., Waigandt, A., & Whittaker, T. A. (2005). A comparison of student achievement and satisfaction in an online versus a traditional face-to-face statistics class. *Innovative Higher Education*, 29(3), 233–250. <https://doi.org/10.1007/s10755-005-1938-x>.
- The Design-Based Research Collective (2003). Design-based research: An emerging paradigm for educational inquiry. *Educational Researcher*, 32(1), 5–8. <https://doi.org/10.2307/3699927>.
- Touré-Tillery, M., & Fishbach, A. (2014). How to measure motivation: A guide for the experimental social psychologist. *Social and Personality Psychology Compass*, 8(7), 328–341.
- Vatrapu, R., Teplov, C., Fujita, N., & Bull, S. (2011). Towards visual analytics for teachers' dynamic diagnostic pedagogical decision-making. *Proceedings of the 1st international conference on learning analytics and knowledge* (pp. 93–98). New York, NY, USA: ACM. <https://doi.org/10.1145/2090116.2090129>.
- Visser, J., & Keller, J. M. (1990). The clinical use of motivational messages: An inquiry into the validity of the ARCS model of motivational design. *Instructional Science*, 19(6), 467–500. <https://doi.org/10.1007/BF02504998>.
- Visser, L., Plomp, T., Amirault, R. J., & Kuiper, W. (2002). Motivating students at a distance: The case of an international audience. *Educational Technology Research & Development*, 50(2), 94–110.
- Wah, L. K. (2015). The effects of instruction using the arcs model and Geogebra on upper secondary students' motivation and achievement in learning combined transformation. *Asia Pacific Journal of Educators and Education*, 30, 141–158.
- Weiner, B. (1990). History of motivational research in education. *Journal of Educational Psychology*, 82(4), 616–622.
- Wu, P.-L., Tsai, C.-H., Yang, T.-H., Huang, S.-H., & Lin, C.-H. (2012). Using ARCS model to promote technical and vocational college students' motivation and achievement. *International Journal of Learning*, 18(4), 79–91.
- Zhang, W. (2017). Design a civil engineering micro-lecture platform based on the ARCS model perspective. *International Journal of Emerging Technologies in Learning (IJET)*, 12(01), 107–118.