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Improving the Skills of Critical Information Retrieval for Research through Learning Activities ARCS Model

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Abstract

The research aimed to report the ARCS model for promoting pre-service mathematics teachers' critical information retrieval skills for research. The purposes of the study on ARCS for critical information retrieval skills were to (1) investigate the conditions of critical information retrieval skills for research of pre-service mathematics teachers on the ARCS model in learning activities, (2) evaluate the development of critical information retrieval skill for research of pre-service mathematics teachers after using the ARCS model, and (3) evaluate the pre-service mathematics teachers' satisfaction. Forty-nine pre-service mathematics teachers who enrolled in the subject of research for learning development were purposefully selected as the research cohort. The research tools were a questionnaire that could be used to measure critical information retrieval skills for research with contextual accuracy and confidence (IOC = 0.66-1.00, α = .834). The research found that the critical information retrieval skill for the research samples prior to using the ARCS model in learning activities was extremely high; evaluating the development of the research cohort's critical information retrieval skills after using the ARCS model in learning activities with relative gain scores, overall, the average was very high; and pre-service mathematics teachers' satisfaction is high. The result revealed that pre-service mathematics teachers could explain the method of searching, extracting, and selecting information, evaluating the quality of information, and effectively making decisions in accepting information.

Keywords: Critical information retrieval skills, ARCS model, Motivation

1. Introduction

Data searching is looking for information for a particular purpose, such as research, study, or daily use. It also describes how sentences are put together (Thunberg & Arnell, 2022; Zamani, Trippas, Dalton, & Radlinski, 2022). The information, news, and technology era are currently in full swing (Basilotta-Gómez-Pablos, Matarranz, Casado-Aranda, & Otto, 2022). Much knowledge is being exchanged. Learner-centeredness is crucial in both administration and teaching and learning. Instead of studying information or pre-made topic content, learners must learn how to learn and search for knowledge. No one will teach or research all disciplines due to their richness. Therefore, the learner's quality of the pursuit of information must come first instruction must be geared toward developing the learner. It is crucial to have the resources necessary to pursue self-knowledge.

To get the material that best suits your needs conduct a search that includes the author's name and more straightforward queries that use a single word or a combination of phrases. Titles, headings, or keywords, as well as sophisticated or advanced searches, frequently incorporate strategies or search patterns that enable users to focus their investigations so that they can choose the one that best suits their needs (Koesten, Kacprzak, Tennison, & Simperl, 2017).

Information is retrieved from a variety of sources, including books, newspapers, journals, and websites. It is important for problem-based learning (PBL) (Macklin, 2001). Accessing information, evaluating it, and using it effectively and critically are all examples of information retrieval skills. The data is accurate and creative. People with information retrieval skills can usually determine the scope of the information they need to evaluate the required information effectively and efficiently. Information and its sources are material and include selected information and prior knowledge; apply information effectively (Webber & Johnston, 2000). Understand how to achieve a specific goal and use it. Access information and use it ethically and legally. According to the review, one strategy for cultivating critical thinking abilities is to use motivation, as the learner's solid academic success is influenced by the desire to learn (Pu et al., 2019; Stavredes, 2011). Sun and Gao (2020) explain that motivation has to do with how likely or interested a student is to learn, which is a very important factor in how hard a student tries to learn.

Make sure that students have the knowledge, skills, and abilities they need for the 21st century, such as a basic understanding of information, the ability to solve problems, and the ability to think critically and creatively. How should you handle the huge amounts of information that are easy to find on the Internet, access, screen, choose, and determine which information is trustworthy? Being unreliable is a vital skill for getting by in the fast-paced, information-filled world we live in today, such as when doing research for a class. Instead of listening to knowledgeable people who might not be doing the right thing, students and teachers should study, research, or evaluate peer-reviewed academic papers (Nezvalová, 2011); according to Chou (2011), discussions of the value of good and quality research for improving or improving work, according to a study by Boonphadung (2013), should focus on doing search operations, as this is necessary for students to be effective as professional instructors.

Motivation is the force that initiates, guides, and maintains goal-oriented behaviors (Sejdija, 2016). According to Skinner (1995), a response need not be due to a single stimulus. This stimulus would have elicited the same reaction if the right conditions had been met. By applying behavioral group learning theory to this educational technology, we design classes that meet the following characteristics: 1) Step-by-step learning; 2) Participation of learners in learning; 3) Immediate recognition of learning outcomes (feedback); 4) Gaining reinforcement (reinforcement). Expectation (confidence in one's own ability), value (thinking that something is worthwhile), and emotion make up motivation (the emotional effect). Furthermore, extrinsic and intrinsic motivation can also be used to categorize motivation (Prabhu, Sutton, & Sauser, 2008). Even though there have been differences of opinion between intrinsic and extrinsic motivation, both can help learners learn to meet expectations. Niemiec and Ryan (2009) are motivated by providing learning objectives and opportunities for students to draw on their preliminary knowledge to build new knowledge. Furthermore, it allows the instructor to collect and inform students about a suitable design method. Learning environments and teaching strategies for learners (Waite & Davis, 2006). Additionally, it allows the instructor to gather data about students to create teaching methods and environments that are acceptable to the students (Ustun, Karaoglan Yilmaz, & Yilmaz, 2021).

Keller (1987) presents the ARCS motivation model which stands for Attention (A), Relevance (R), Confidence (C), and Satisfaction (S). The ARCS motivation model is regarded as one of the most successful methods for improving undergraduates' ability to access material critically (Tsai et al., 2022). This is the case because it is based on the following: 1) The expectation-value theory, developed by Tolman and Levin, emphasizes that people can be motivated to engage in an activity if it is valued and linked to satisfaction. 2) The theory of self-efficacy developed by Bandura refers to the belief in one's capabilities to achieve a goal. 3) The self-esteem theory, developed by Carl Roger, focuses on how a person matches self-ideals with the abilities of the world (Huett, Moller, Young, Bray, & Huett, 2008). This combination results in the ARCS model's four phases: attention, relevance, confidence, and satisfaction (Suherman, Zaman, & Farida, 2021). The advancement examines how common it has become for student teachers to develop and change as a step up to the level of critical inquiry. A teaching strategy for sustainability in a social science discipline, where students frequently lack or have significantly different degrees of core understanding, is inspired by Vygotsky's (1978) Zone of Proximal Development (ZPD) (Vygotsky & Cole, 1978). To identify the students' crucial information retrieval skills, data were analyzed and interpreted using the Zone of Proximal Development (ZPD) and ARCS methods (Figure 1).

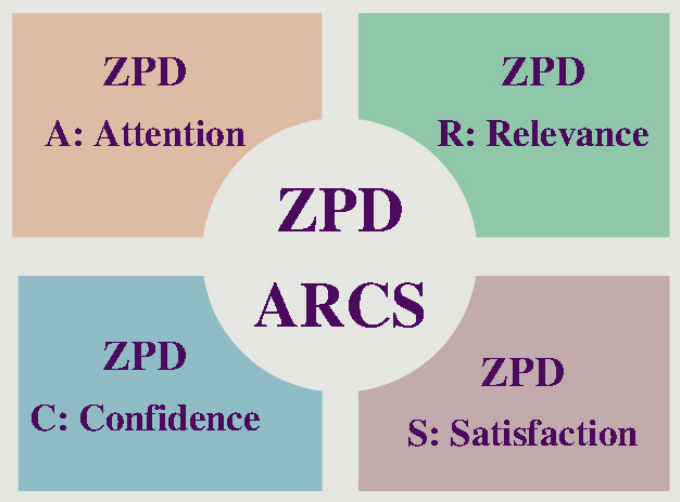

Figure 1. Conceptual framework

How easy is it to explain each step and draw connections within and outside the educational system? Research, knowledge seeking, and information seeking from various sources are crucial to the learning process. Most undergraduates need more accuracy in their querying abilities. Lack of understanding of the significance of data discovery, sometimes, people use sources that are wrong or don't have enough information. Students should be aware of the ethical principle of not continue using the same source without attribution or citation. They might also use references or organize bibliographies that are consistently wrong. Would 21st-century needs be met if educators and students were to study critical search techniques?

The problem researchers will utilize in this study to create a clear picture of the process of gaining such skills is how and if introducing activities of ARCS learning as a guideline or framework for critical inquiry by students will change.

This research aims to improve the skills of critical information retrieval in pre-service mathematics teachers using the ARCS model, which trains data search skills, summarizing, and referencing documents. First, a questionnaire will be used to assess the pre-service mathematics teachers' actual development. Then, information on the pre-service mathematics teachers' conditions for crucial knowledge retrieval skills was gathered. The learning exercise used the ARCS paradigm to raise pre-service mathematics teachers to the highest achievable growth level. The findings of the pre-service mathematics teachers' information selection, filtering, and appropriate evaluation methods were then examined to ascertain the pre-service mathematics teachers' potential development levels. Finally, focus groups were used to evaluate learning satisfaction.

2. Method

2.1 Population

Based on purposive sampling, this study's target population was 49 pre-service mathematics teachers who had signed up to be research subjects to help improve learning.

2.2 Research Instrument

In this study, we made a questionnaire that could be used to measure critical information retrieval skills for research with contextual accuracy and confidence (IOC index of 0.66-1.00, $\alpha = 0.834$).

2.3 Data Collection

The researchers followed procedures when collecting data. The researchers collected the data for the research as follows: 1. Study, analyze, and compare the critical data retrieval skills of pre-service mathematics teachers using questionnaires on the practice of querying data before learning management using the ARCS Model. 2. Organize learning activities using the ARCS Model, as detailed in Table 1, five times per six hours to develop critical information retrieval skills using the strengths and weaknesses analysis of pre-service mathematics teachers' critical information retrieval skills. Through their research and work, the researchers used discussions and comments on the learning materials obtained from the joint investigation, which are shown in Tables 1 and 2.

Table 1. Using the ARCS model as a framework for learning activities

Organization	Learning Activities
Attention: A	Stimulate interest or raise awareness among students by comparing the research report's content with the material that appears in the author's books and journals and the research report with the material that appears in the author's books, journals, and dissertations.
Relevance: R	Suggest the goals of the studied topics: innovations used to solve problems, independents, and variables learned: innovations used to solve problems, independents, and variables used in the research. The plot of each chapter's search, such as Chapter 1, quotes the background. Chapter 2 is about independent variables studied, researched, and written according to APA (American Psychological Association) 6th edition. Chapter 3: Statistics are used to determine tool quality, and statistics are used to analyze data. Chapter 5 talks about the results of the research and the findings, and the theory that is mentioned comes from Chapter 2.
Confidence: C	Set up groups of four to five students, ask them to work together to assist one another, and then have them present their work in front of the class along with the criteria they had to meet for that type of educational activity, which includes evaluation of operational work and assessment of academic performance.
Satisfaction: S	Assessment of material understanding and knowledge among students is done with each set of students' work and presentations; comments and thoughts are shared, as are criticism and justice, in-depth interviews, and group conversations with students if needed.

Table 2. Some examples of learning activities that use the ARCS model as a guide

Organization	Some examples of learning activities
Attention: A	First and foremost, the history and significance of writing are linked to reliable books and documents. Third, search for early factors based on variables. Fourth, related research. Fifth debate outcome
Relevance: R	Suggest goals for the topic being studied, such as content accuracy, query modernization, citation data accuracy, search source reliability, and data valuation.
Confidence: C	1) Summarize the work and provide feedback to each group of students and discuss it with the students. 2) Use compliments, awards, and points to instill confidence in students' work.
Satisfaction: S	Give out assessments and feedback on learning activities.

2.4 Data Analysis

The data were examined in this study. We discussed the following information:

(1) Data obtained from questionnaires related to query skills for critical research, which is a 4-level estimation scale, using frequency statistics, mean (M), and standard deviations (SD) in describing the results of the data analysis.

(2) The average threshold for interpreting the level of critical information retrieval skill for research comes from pre-service mathematics teachers' self-assessments (Srisa-ard, 2003).

$$\text{Interval} = \frac{\text{High score} - \text{Low score}}{\text{Number of levels}} = \frac{4-1}{6} = 0.50 \quad (1)$$

We used the concept of dividing the average gauge in the research into six average score ranges in order to achieve the highest resolution and match the practices of mathematics teachers, as shown in Table 3.

Table 3. Mean criteria for interpreting critical information retrieval skills for research and satisfaction levels.

Mean rating	Level of skills and satisfaction
3.51-4.00	Extremely high
3.01-3.50	Very high
2.51-3.00	High
2.01-2.50	Moderate
1.51-2.00	Low
1.00-1.50	very low

(3) Use formulas to figure out the percentage of change in search skill development scores. This can be done by comparing the level of critical information retrieval skills for research before and after learning activities using the ARCS model and comparing the level of critical research query skills before and after learning activities (Kanjanawasee, 2009).

$$\text{Relative Growth Score} = \frac{\text{Posttest score} - \text{Pretest score}}{\text{Full score} - \text{Pretest score}} \times 100 \quad (2)$$

Relative growth score criteria compared to growth level are shown in Table 4.

Table 4. Developmental score criteria compared to growth level.

Relative growth score	Growth level
76-100	Very high
51-75	High
26-50	Intermediate
0-25	Early

3. Results

(1) The results of the critical retrieval skills of mathematics teacher students after the use of the ARCS model are shown in Table 5.

Table 5. critical information retrieval skills for research of pre-service mathematics teachers before and after using ARCS learning activities.

Items	Pre-service mathematics teachers					
	Before using ARCS learning activities		Level of Skills	After using ARCS learning activities		Level of Skills
	M	SD		M	SD	
1. Examine the main ideas, secondary ideas, and inconsistencies in the information from the sources.	1.65	0.48	Low	3.12	0.60	very high
2. Creating questions to use as a framework for finding the information you need.	1.67	0.47	Low	3.43	0.61	very high
3. Take into account the legality and morality of collecting and using information.	1.51	0.51	Low	3.78	0.47	Extremely high
4. Decision-making using current information is not behind schedule.	1.41	0.50	Very low	3.55	0.50	Extremely high
5. Studying information with others to gain a better and broader understanding.	1.55	0.50	Low	3.71	0.50	Extremely high
6. Citations from scholarly sources.	1.55	0.50	Low	3.57	0.58	Extremely high
7. The process of selecting researchable data by using theoretical reasoning.	1.53	0.50	Low	3.45	0.50	very high
8. Evaluating sources for reliability.	1.47	0.50	Very low	3.65	0.48	Extremely high
9. Evaluating and using data based on accuracy.	1.61	0.49	Low	3.61	0.49	Extremely high
10. Exchanging information and ideas with instructors and friends to learn.	1.65	0.48	Low	3.78	0.51	Extremely high
11. Considering a variety of perspectives in the search for information.	1.63	0.49	Low	3.41	0.50	very high
12. Collect data from a variety of sources before drawing conclusions.	1.45	0.50	Very low	3.43	0.50	very high
13. Data selection when using technology	1.63	0.49	Low	3.49	0.54	very high
14. Data screening from research	1.55	0.50	Low	3.45	0.50	very high
15. Choose the appropriate data source for gathering information.	1.59	0.50	Low	3.53	0.50	Extremely high
Overall	1.56	0.50	Low	3.53	0.54	Extremely high

Table 5 shows that after the extremely high level of ARCS learning activities (M = 3.53, SD = 0.54), overall data search and critical information retrieval skills for research among

pre-service mathematics teachers were at a low level (M = 1.56, SD = 0.5).

(2) Figure out the growth score of pre-service math teachers' critical information retrieval skills before and after they use ARCS learning activities, as shown in Table 6.

Table 6. Number and percentage of pre-service mathematics students with growth score

Relative growth score criteria	Growth level	The number of pre-service mathematics students	Percentage
76-100	Very high	20	40.82
51-75	High	29	59.18

Table 6 shows how pre-service mathematics students who managed to learn activities with the ARCS model scored on academic development in research courses to improve learning. According to pre-test and post-test assessments, 20 students accounted for 40.82% of the total students, and 29 students accounted for 59.18% of the total students, a very high level of growth. This means that students who were organized with ARCS learning activities greatly improved their growth scores.

(3) Pre-service mathematics teachers are generally high with their critical research skills after using the ARCS model (mean = 2.98, SD = 0.83).

4. Discussion

(1) Based on the data collection from pre-service mathematics teachers who took part in this study project, it was discovered that both students and teachers maintained their knowledge and had strong information-querying abilities. In other words, students have strategies and techniques for choosing, analyzing, synthesizing, screening, and evaluating the correctness and trustworthiness of the information gleaned from multiple sources. Effectively search through websites, online e-journals, books, and textbooks from national journal bases such as the Thai Journal Citation Index Center (TCI) through the ThaiJo system and an online library of education research and information such as ERIC (Education Resources Information Center). In accordance with Bandura's instructions, instructors have made it a priority to help students and teachers acquire crucial search skills for creating research reports and professional citations, as seen by the APA Style 6 Edition citations for accurate citations utilizing Zotero (Mubaroq, Abdullah, & Setiawan, 2020). According to Straková and Cimermanová (2018) advice that was developing student-teachers with permanence in their learning and appreciation of their value and effectiveness, instructors have given high priority to teaching students how to conduct critical searches and writing research reports and professional references. Practice and a focus on practice are both necessary.

(2) Adopting the ARCS model, which involves the integration of the concepts of motivation

and learning, serves as a framework for learning management. It was found that the pre-service mathematics teacher students had a change in the knowledge and practice they wanted and expected regarding information search, i.e., that pre-service mathematics teacher students had a high level of critical information retrieval skills for research, which signifies a change in the knowledge and practice of information queries. Additionally, students' degree of critical information retrieval skills and growth score has altered significantly, demonstrating that they are aware of the value of critical questions. Know how to effectively select, synthesize, screen, and assess the reliability and accuracy of data obtained from an online library of education research and information such as ERIC, books, and textbooks. These national journal bases include the Thai Journal Citation Index Center, or TCI (Thai-Journal Citation Index Center), through the ThaiJo system. Additionally, actual data supports the use of the ARCS model as a framework for learning management to help students improve critical search abilities. It is appropriate to acquire these abilities. This is consistent with research by Ucar and Kumtepe (2020) that found that groups of learners studying according to ARCS procedures had a higher motivation to study than those who followed standard procedures. It is also consistent with research by Machalow et al. (2020) that found that groups of learners studying according to ARCS procedures had higher academic or performance achievement than learners who did not study using the ARCS model. Additionally, it has been found that teaching with the ARCS incentive model fosters student motivation, which leads to better learning outcomes. This finding is consistent with research by Ma and Lee (2021), which found that students who study with the ARCS model outperform those who study without it in terms of academic achievement.

(3) In line with Bovermann and Bastiaens (2020), who stated that motivation is a factor that should be taken into account in the design of teaching and learning activities, and in line with Machalow et al. (2020), the use of ARCS-based activities as a framework for developing critical search skills in teaching students is a productive form of learning activity. The ARCS model, which is reflected in the ARCS model, guides learning activities starting at the highest levels. It fosters the growth and encouragement of students' critical search abilities and improves student-teacher satisfaction. This is due to the fact that the ARCS model includes a satisfaction stage in which professors offer encouraging comments during each stage of the critical search operation and are impartial when evaluating the work of teacher students using criteria that have already been acknowledged and acknowledged by teacher students.

5. Conclusion

a study of how incentive concepts based on arcs affect the growth of query skills. A survey of the opinions and satisfactions of teacher students involved in the research project on the activities for developing pre-service mathematics teachers' critical search skills using the ARCS model was done utilizing data from the necessary research undertaken by teacher students. Learn how to search for information in documents, books, textbooks, sources, and websites; select, screen, and judge accuracy before accepting reliable information; and, most importantly, choose which information and data should be trusted or accepted by having criteria for evaluating and making important decisions on the data and information studied. This shows how using the ARCS model as a framework for learning management can help

pre-service mathematics teachers get better at asking critical questions.

6. Limitations

An essential and significant talent is the development of critical search abilities. Because there is a lot of information in the digital world that needs evaluation, acceptance, or trust, this skill should be consistently taught to students. Therefore, this broad message should be constructed in line with theory. By including them in all areas taught, adult education promotes the continued development of these skills in teaching students.

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