

The Effectiveness of the MIAP Learning Environment in Promoting Critical Thinking Among Students Enrolled in the Bachelor of Education Program in Computing: Applying the Watson and Glaser Concepts

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The objectives of this research are to develop a MIAP learning environment, devise tools to measure critical thinking ability, and assess the results, including whether there were any gender differences. The purposive sample comprised 12 students enrolled in the Bachelor of Education Program in Computing. The data were analyzed in percentages, and an Independent Samples t-test was conducted to identify gender differences in critical thinking abilities. The MIAP learning environment was divided into four stages and the measurement tools were included in the criteria used for evaluation. The results revealed that the overall critical thinking ability was high, with no significant difference between males and females.

Keywords: MIAP, learning environment, critical thinking, content validity index

INTRODUCTION

Due to international globalization, the 21st century is an era of rapid change (Disruption World), with many transformations in multiple domains, including disease, digital technology, daily life, the global economy, and society. As a result, social and cultural conditions significantly affect daily life. The need for educational development to keep pace with the current changes highlights the importance of enhancing the quality of the national workforce to prepare and strengthen educational capacity. Achieving this, along with a balance in various dimensions using interdisciplinary principles, will lead to integrating and creating new knowledge to promote excellence in various sciences (Wutthichai et al., 2021).

Such an approach aligns with education in the 21st century, which focuses on student learning outcomes (Outcome-based Education). Upon graduation, learners must possess the knowledge, skills, and characteristics the curriculum design requires. This results from a change through Education 4.0, which encourages students to be innovative and conduct research in science and technology, ultimately developing their abilities to engage in higher-order thinking to design, produce, develop, extend, and introduce new valuable and practical contributions to society. This includes independently integrating various sciences

and subjects (Nattaphol & Akhaphan, 2020). When the instructor has been assigned to create a piece of work.

The literature has revealed that 21st century learning skills include critical thinking, problem-solving, cooperative learning, creativity, leadership, implementation, and communication, which require students to learn through skills training, situational management, and applying knowledge to solve problems. These abilities are based on the process of critical thinking (Dararat, 2010). However, critical thinking encompasses a combination of attitudes related to the ability to recognize and understand existing problems, identify the need for evidence-based support, assess the accuracy of evidence, engage in logical reasoning for forming inferences, conclusions, evaluations, making decisions correctly and appropriately, and acquire the skills to apply attitudes and knowledge in practice (Sutinee, 2018). According to Watson & Glaser (1980), teachers can apply critical thinking in teaching and learning. This consists of five aspects: inference, recognition of assumptions, deduction, interpretation, and evaluation of arguments.

Studies have revealed that teaching and learning in Thailand at the undergraduate level have flaws regarding good human relations between teachers and classmates, a lack of creativity, and integrating knowledge with various subjects (Preedee, 2017). A permanent shift from old behavior to new behavior enable learners to practice, receive and transmit knowledge, and coordinate and build interpersonal relationships. Teachers can use the process of conveying ideas and an understanding of each individual through the MIAP learning process, which is divided into four steps: motivation, information, application, and progress (Nattaphol & Namon, 2018). Studies have shown that this process can enable learners to create new knowledge independently, resulting in better academic achievement and the capacity to integrate 21st century skills, more effective instructional design skills (Mervat, 2023), and use Information and Communication Technology for Education as a tool to support instructional management (Andriana et al., 2023). Therefore, the MIAP learning process and outcomes encourage students to think critically regarding the important goals of learning management in the System Analysis and Design for Education course. This will enable learners in the Bachelor of Education Program in Computing to gain knowledge, understanding, and practice regarding the use of information systems in educational organizations, identify people involved in information system development, understand the System Development Life Cycle (SDLC), Software Requirements, Software Analysis, Software Requirements Specification, use Data Flow Diagrams, design diagrams to display relationships in the data (Entity Relationship Diagram), create a data dictionary, engage in data input design, report design, display system output, complete documentation, and participate in small system design analysis practices related to the development of information systems within educational institutions (Chandrakasem Rajabhat University, 2019).

For these reasons, along with the importance of educational management in the 21st century, the researchers aimed to develop the MIAP learning environment and a critical thinking measurement tool by applying Watson and Glaser's concepts to develop further the higher-order thinking abilities of students enrolled in the Bachelor of Education Program in Computing at Rajabhat University.

RESEARCH QUESTIONS

1. According to Watson and Glaser's concepts, what is the MIAP Learning Environment for developing critical thinking?
2. By applying the concepts of Watson and Glaser, what does the instrument for measuring critical thinking look like?
3. Does the critical thinking of Computer Education Program students improve?

RESEARCH HYPOTHESIS

Male and female students enrolled in the Bachelor of Education Program in Computing will not differ in their critical thinking abilities.

RESEARCH METHODOLOGY

This research was divided into three phases:

1. *Developing a MIAP-based learning environment to develop critical thinking by applying the Watson and Glaser concepts.*

To develop the MIAP learning environment, the researcher analyzed documents, textbooks, academic papers, and related research articles using content analysis (Nattaphol & Namon, 2018). The results were summarized in the form of a diagram that was divided into four stages: motivation, information, application, and progress stage, along with the use of techniques for collaborative learning (Pimpan & Payao, 2020).

2. *Developing critical thinking measuring instruments by applying the concepts of Watson and Glaser.*

The researcher studied the concepts of Watson and Glaser (Watson & Glaser, 1980) to develop a critical thinking tool in the form of a multiple-choice knowledge test (Objective Test) containing 20 items divided into five fields, each measuring the learners ability to make inferences, recognize assumptions, deduce, interpret, and evaluate arguments, respectively. The researcher then assessed the quality of the developed tools using the following steps.

- a. Presenting the developed tools to 11 experts who were selected using purposive sampling. The experts were divided into two groups; education (five people) and computer education (six people). A person with at least three years of experience in the relevant field then assessed content validity using the Content Validity Index (CVI) with the following evaluation criteria (Yusoff, MSB, 2019): 1) an acceptable item-level CVI (I-CVI) index of 0.78 or higher. Data analysis revealed that this was between 0.91-1.00; 2) average validity value for the complete copy (Scale-level CVI/Average: S-CVI/Ave) must be at least 0.80 to be acceptable. Data analysis revealed a value of 0.98; 3) a validity value which all experts agree (Scale-level CVI/Universal Agreement: S-CVI/UA) must be 0.80. Data analysis revealed a value of 0.80, which can be displayed as follows:

FIGURE 1
THE RESULTS OF CONTENT VALIDITY ANALYSIS USING THE CONTENT VALIDITY INDEX (CVI)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Item	Experts											Experts in Agreement	I-CVI	UA	
	1	2	3	4	5	6	7	8	9	10	11				
1	1	1	1	1	1	1	1	1	1	1	1	1	11	1	1
2	1	1	0	1	1	1	1	1	1	1	1	1	10	0.91	0
3	1	1	1	1	1	1	1	1	1	1	1	1	11	1	1
4	1	1	1	1	1	1	1	1	1	1	1	1	11	1	1
5	1	0	1	1	1	1	1	1	1	1	1	1	10	0.91	0
6	1	0	1	1	1	1	1	1	1	1	1	1	10	0.91	0
7	1	1	1	1	1	1	1	1	1	1	1	1	11	1	1
8	1	1	1	1	1	1	1	1	1	1	1	1	11	1	1
9	1	0	1	1	1	1	1	1	1	1	1	1	10	0.91	0
10	1	1	1	1	1	1	1	1	1	1	1	1	11	1	1
11	1	1	1	1	1	1	1	1	1	1	1	1	11	1	1
12	1	1	1	1	1	1	1	1	1	1	1	1	11	1	1
13	1	1	1	1	1	1	1	1	1	1	1	1	11	1	1
14	1	1	1	1	1	1	1	1	1	1	1	1	11	1	1
15	1	1	1	1	1	1	1	1	1	1	1	1	11	1	1
16	1	1	1	1	1	1	1	1	1	1	1	1	11	1	1
17	1	1	1	1	1	1	1	1	1	1	1	1	11	1	1
18	1	1	1	1	1	1	1	1	1	1	1	1	11	1	1
19	1	1	1	1	1	1	1	1	1	1	1	1	11	1	1
20	1	1	1	1	1	1	1	1	1	1	1	1	11	1	1
21															
22													S-CVI/Ave	0.98	
23													S-CVI/UA		0.80
24															

- b. Testing the developed tools with 30 individuals who were not participants of the study (Tryout) to determine the difficulty by dividing them into strong and weak groups of 33%, with an acceptable value between 0.20-0.80 (Kanjanaawasee, 2009). Data analysis revealed that the difficulty value was between 0.43-0.71 for all 20 items. Next, the discriminating power was calculated (Discrimination) with an acceptable value of 0.20 or more (Kanjanaawasee, 2009). Analysis of the data revealed that the discriminating power was between 0.29-0.86 for the 20 items. Finally, the reliability of the entire instrument was determined using Kuder Richardson's KR-20 formula, with an acceptable value of 0.70 or higher (Kuder & Richardson, 1937). The overall reliability was very high, with a value of 0.83.
3. *Assessment of critical thinking by applying Watson and Glaser's concepts from the MIAP learning environment to students enrolled in the Bachelor of Education Program in Computing.*

The researcher experimented and collected data from a purposive sample of 12 students in the Bachelor of Education Program in Computing, Faculty of Science, Chandrakasem Rajabhat University. The students were enrolled in the COMP2029 System Analysis and Design for Education during the 2nd semester Academic Year 2022. This included a 16-week MIAP learning environment for developing critical thinking and assessing the ability of learners using a critical thinking measuring tool that applied the concepts of Watson and Glaser by analyzing percentages and interpreting the knowledge level according to the criteria. The results were as follows: 1) 80% or more is regarded as a high level, 2) 60 – 80% is regarded as moderate, and 3) less than 60% is regarded as low (Seree, 1994). The data were averaged from two groups independently using an independent samples t-test that applied the formula from Yuth (2015) to assess gender differences. Finally, the critical thinking results were summarized and discussed.

RESEARCH FINDINGS

The Effect of the MIAP Learning Environment on the Development of Critical Thinking Skills by Applying the Watson and Glaser's Concepts.

Based on the analysis and synthesis of relevant documents and research results, applying Watson and Glaser's concepts created a MIAP learning environment for the development of critical thinking (Figure 2).

FIGURE 2
MIAP LEARNING ENVIRONMENT FOR DEVELOPING CRITICAL THINKING BY APPLYING THE WATSON AND GLASER'S CONCEPTS

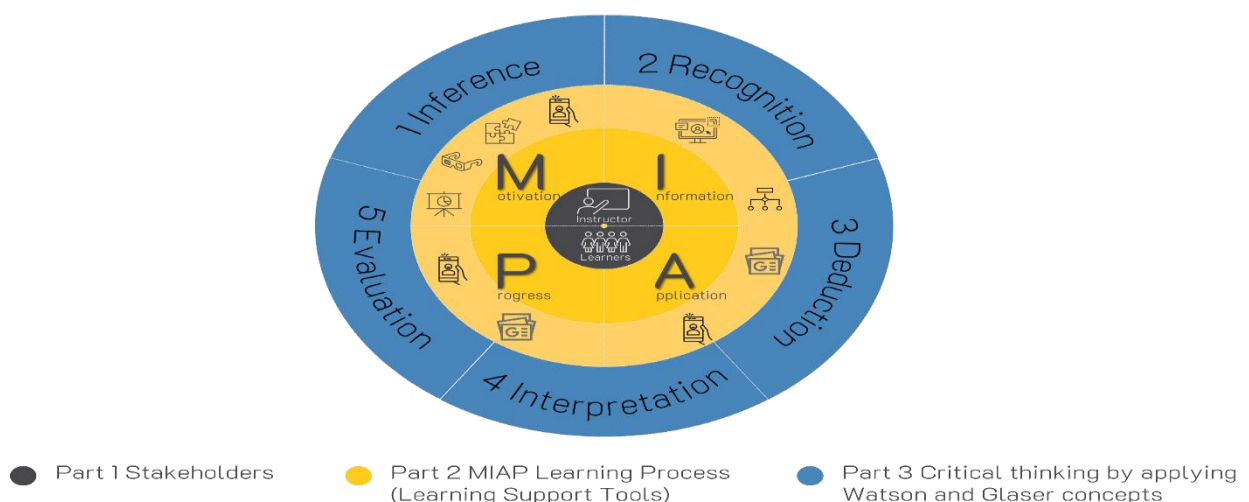


Figure 2 is divided into the following three parts: Part 1: Stakeholders were divided into two groups, namely instructors who transfer knowledge and support teaching and learning activities at Chandrakasem Rajabhat University, and learners who are undergraduate students enrolled in the Bachelor of Education Program in Computing and participated in the System Analysis and Design for Education course. Part 2: The MIAP Learning Process was divided into four steps, as listed in Table 1. Part 3: According to the MIAP learning process, critical thinking is a learning outcome, with contents and learning activities in the course of System Analysis and Design for Education divided into five aspects: the ability to make inferences, recognize assumptions, deduce, interpret, and evaluate arguments.

TABLE 1
THE MIAP LEARNING PROCESS

MIAP Learning Process	Instructor Role	Learner Role	Learning Activities	Learning Support Tools
Motivation	Import into the lesson. State the learning objectives for each week.	Answering questions and completing activities related to the lesson's introduction according to the scope of the material studied each week.	Asking questions according to the scope of the content studied each week, emphasizing critical thinking in real situations where students practice their professional experience during their studies in educational institutions.	<ul style="list-style-type: none"> – Information media – Multimedia – Games – Digital technology for education in organizing learning activities.
Information	Providing knowledge content according to course descriptions throughout the 16 weeks.	Study knowledge content and perform activities with teachers and classmates.	<ul style="list-style-type: none"> – Sharing knowledge – Collaborative Learning using the Think-Pair-Share technique. – Answer questions and jointly create workpieces according to the scope of the content learned each week. – Integrate content with COMP2278 	<ul style="list-style-type: none"> – Computer program – Program for designing diagrams for system analysis and design for education. – Google workspace for education. – Digital technology for education in organizing learning activities.

MIAP Learning Process	Instructor Role	Learner Role	Learning Activities	Learning Support Tools
			<ul style="list-style-type: none"> – Database Management System and EDUC2801 Teaching Practicum 2 courses. 	
Application	Assigned to prepare exercises and practical exercises on system analysis and design according to the scope of the content studied each week.	Prepare exercises and practical exercises on system analysis and design according to the scope of the content studied each week.	<ul style="list-style-type: none"> – Collaborative Learning using Team Pair-Solo and Pair-Discussion techniques. – Prepare assignments with critical thinking in real situations by integrating them with related subjects in educational institutions. 	
Progress	<ul style="list-style-type: none"> – Check the results of the written and practical exercises. – Check the results of the practice of the scope in the content learned each week. – Give feedback and suggestions from assignments. – Evaluate the success of the assigned tasks. 	<ul style="list-style-type: none"> – Present the results of the assigned work. – Exchange learning together with teachers and classmates. – Improve the results of the assigned work. 	<ul style="list-style-type: none"> – Presentation – Opinion exchange activities – Assessment of success from assignments 	<ul style="list-style-type: none"> – Google workspace for education – Digital technology for education in assessing learning outcomes.

The Results From Developing a Critical Thinking Measuring Instrument by Applying the Concepts of Watson and Glaser

The results were used to develop a tool for measuring critical thinking that comprised an objective test containing 20 items, (Table 2).

TABLE 2
THE RESULTS FROM DEVELOPING A CRITICAL THINKING MEASURING INSTRUMENT
BY APPLYING THE CONCEPTS OF WATSON AND GLASER

Critical Thinking	Definition of Terminology	Characteristics of Options
Part 1: The ability to make inferences. This comprises four items.	The ability to classify the probabilities of information or draw conclusions from a given situation.	<p>A. True means that when the conclusions are read, they are considered true according to the information in the given texts.</p> <p>B. Probably True means that when the conclusions are read, they are likely to be true according to the information in the texts.</p> <p>C. Information is insufficient if after reading the concluding passages, they are considered to have insufficient information to determine whether they are true or false.</p> <p>D. Likely to be False means that when the concluding statements are read, they are likely to be false according to the information in the given statement.</p> <p>E. False means that when the concluding statements are read, they are considered false based on the information shown in the given statement.</p>
Part 2: The ability to recognize assumptions. This comprises four items.	The ability to distinguish whether a statement does or does not satisfy a preliminary agreement in a given situation.	<p>A. The preliminary agreement is in accordance with the given circumstances.</p> <p>B. The preliminary agreement is not in accordance with the given circumstances.</p>
Part 3: The ability to deduce. This comprises four items.	The ability to distinguish whether conclusions are consistent or inconsistent with a given situation.	<p>A. The conclusion is consistent with the given circumstances.</p> <p>B. The conclusion is inconsistent with the given circumstances.</p>
Part 4: The ability to interpret. This comprises four items.	The ability to distinguish whether conclusions are reasonable or unreasonable in a given situation.	<p>A. The conclusion agrees with the main statement.</p> <p>B. The conclusion does not agree with the main statement.</p>
Part 5: The ability to evaluate arguments. This comprises four items.	The ability to distinguish which statements are strong, important, and relevant arguments.	<p>A. The argument is strong, significant, and relevant to the question.</p> <p>B. The argument is not strong, not important, and not related to the question.</p>

Critical Thinking Assessment by Applying Watson and Glaser’s Concepts From the MIAP Learning Environment to the Bachelor of Education Program in Computing Learning Management

The critical thinking results were assessed by applying the concepts of Watson and Glaser from the MIAP learning environment to 12 students enrolled in the System Analysis and Design course. The results regarding the ability of learners are listed in Table 3.

**TABLE 3
CRITICAL THINKING ASSESSMENT RESULTS AFTER APPLYING WATSON AND GLASER’S CONCEPTS**

Number	Part 1	Part 2	Part 3	Part 4	Part 5	Total (20)	Percentage (%)	Individual Results
1	4	4	5	4	5	17	85.0	High
2	4	4	4	5	4	16	80.0	High
3	4	4	4	5	5	17	85.0	High
4	4	5	4	3	5	16	80.0	High
5	4	4	4	4	5	16	80.0	High
6	5	4	5	4	5	18	90.0	High
7	3	5	3	5	5	16	80.0	High
8	5	3	4	5	5	17	85.0	High
9	4	4	4	5	4	17	85.0	High
10	4	5	4	5	5	18	90.0	High
11	5	4	4	5	5	18	90.0	High
12	4	3	5	4	5	16	80.0	High
Total	38	37	38	42	47	202		
Percentage	79.2	77.1	79.2	87.5	97.9	84.2		
Interpretation	Moderate	Moderate	Moderate	High	High	High		

As indicated in Table 3, the evaluation results revealed that overall, students have a high level of ability (84.2%). When classifying each aspect of critical thinking, the ability to evaluate arguments was highest at 97.9%, followed by the ability to interpret at 87.5%.

To determine whether there were any gender differences in the overall critical thinking ability of students in the Bachelor of Education Program in Computing, an independent t-test was performed and the result is displayed in Table 4.

**TABLE 4
COMPARISON OF OVERALL CRITICAL THINKING ABILITY BETWEEN MALES AND FEMALES**

Point of Comparison	Gender	Mean	SD	Levene’s Test for Equality of Variances		t	Sig.
				F	Sig.		
The ability to think critically	Males Females	15.67 13.00	1.37 2.90	4.21	0.07	2.04	0.07

SD: Standard deviation; Sig: Significance

The results of the Levene’s Test at a confidence level of 95% revealed a significance value of 0.07 (Table 4). This was higher than 0.05, which means that the variance in the overall critical thinking ability of males and females was the same. Therefore, equality variances were assumed. Thus, the main hypothesis

(H₀) was accepted, and the secondary hypothesis (H₁) was rejected as there were no differences between males and females in their critical thinking abilities.

CONCLUSION

The MIAP learning environment developed to enhance critical thinking is divided into three parts: part 1 - stakeholders divided into teachers and students; part 2 - the MIAP Learning Process, which consists of four steps: motivation, information, application, and progress; and part 3, critical thinking, which was divided into five aspects: inference, recognition of assumptions, deduction, interpretation, and evaluation of arguments. This aligns with the research from Nattaphol & Panita (2021) on the Development of a Learning Ecosystem Using Digital Knowledge Engineering Through MOOCs Knowledge Repository System. This research resulted in small and medium enterprise entrepreneurs in Bangkok, Thailand, being offered a learning environment consisting of learning processes and activities suitable for developing digital entrepreneurship. Similarly, a study by Sathiya et al. (2021) also used the basis for designing a MIAP learning environment. In their study, learning activities designed with digital technology for education in each step corresponds to the current research. Hence, for these authors, it was suitable for developing the digital intelligence of undergraduate students at Suan Sunandha Rajabhat University in the Introduction to Digital Economy course. However, developing a tool to measure critical thinking and assessing the consistency of the content (content validity) using the Content Validity Index (CVI) increased the accuracy of the developed tool by displaying I-CVI, S-CVI/Ave, and S-CVI/UA values. This is consistent with research by Yusoff (2019), who reported that the CVI is a systematic content validity check and a best practice that can be quantitatively explained by displaying various indices that accurately represent the measurement structure. Thunyakorn et al. (2013) developed a tool to measure the critical thinking process of university students through six real-life situations regarding electricity. It was found that such quality tools can be used to develop higher-order thinking skills through analytical, synthetic, and creative thinking. In the current study, applying Watson and Glaser's concepts from the MIAP learning environment to the Bachelor of Education Program in Computing on the System Analysis and Design course revealed high critical thinking. This is in line with the research of Siriporn (2019), who reported that the development of a critical thinking model was able to significantly improve the critical thinking abilities of learners.

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