journal of
Adolescent and Youth Psychological Studies
www.jayps.iranmehr.ac.ir

Fall (November) 2023, Volume 4, Issue 8, 41-52

# Identifying the antecedents and consequences of critical thinking with cognitive education method in students

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***ARTICLE INFORMATION***

**Article type**
Original research
Pages: 41-52

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**Article history:**
Received: 2023/05/03
Revised: 2023/06/24
Accepted: 2023/07/11
Published online: 2023/11/02

**Keywords:**
*Critical thinking, critical thinking in education, results of critical thinking.*

***ABSTRACT***

**Background and Aim:** Among the goals of contemporary education of students is openness to diversity, challenging their own beliefs and values, and learning from diversity so that citizens can be active and responsible and willing to accept challenges and have more comprehensive and complex views of the world and social relations. Have. This research was conducted with the aim of investigating the antecedents and factors influencing critical thinking and the consequences of students' critical thinking. **Methods:** The exploratory qualitative research method is a content analysis type with an interview tool. The statistical population of the research was based on valid articles of critical thinking literature and conducting interviews with 21 expert professors, experts, managers and teachers who are proficient in cognitive education and critical thinking until reaching theoretical saturation, and the method of data analysis was qualitative. And it was done by coding concepts, sub-category and main category in MAXQDA2020 software. **Results:** Antecedents affecting critical thinking include: cognitive education, cognitive conflict, questioning and problem solving, problem-based learning, and project-based learning. The consequences of critical thinking include: modifying measures for sustainable education, empowering students, cognitive learning and rational judgment. **Conclusion:** The results showed that cognitive training, cognitive conflict, questioning and problem solving, problem-based learning, and project-based learning are effective on critical thinking and cause the consequences of reforming measures for sustainable education, empowering students, cognitive learning, and rational judgment.



**How to Cite This Article:**
Farzinmajd, A., Naderibeni, N., Khanifar, H., & Fereidoun, S. (2023). Identifying the antecedents and consequences of critical thinking with cognitive education method in students. *jayps*, 4(8): 41-52.



[ DOR: 20.1001.1.28212525.1402.4.8.4.8 ]

## Introduction

For the development of human resources in the era of globalization and the development of human resources skills in facing the challenges of the 21st century, critical thinking skills are needed, which are acquired through formal and informal learning processes (Nisa et al., 2018). In the era of Socrates and Plato, students were taught critical thinking through questioning and searching in new situations (Neg et al., 2022). Dewey (1910) stated that in today's society, critical thinking is necessary to reduce or eliminate biased decisions and perform successfully (Van Pepen et al., 2021). Teaching critical thinking skills is one of the necessities of education because it causes solving various problems, thinking of solutions and finding solutions based on past experiences, during learning activities and throughout life. Students with critical thinking skills analyze their thoughts and get smart results by evaluating their choices, and by acquiring this skill, success in solving problems, making decisions, and expanding knowledge is created (Rahmtida et al., 2021). According to constructivist theory, students find and modify knowledge and make it their own. Therefore, students are not written on a white board and have presuppositions obtained from previous experience or learning (Wilujang and Hedayatullah, 2021). The purpose of teaching critical thinking in students is to develop students' skills, adding explanations to problems, criticizing the reliability of knowledge, analyzing and reasoning, scientific understanding by testing alternative ways. When challenging problems are given to students, their curiosity and inner motivation are stimulated, they offer different solutions by testing and logical reasoning, and then the intellectual power of the individual and critical thinking increases, and finally, quality learning is created. Characteristics such as fairness, humility, empathy, and honesty in social interaction and in personal development become possible by changing one's thinking, which becomes possible with proper education (Seror et al., 2021).

Meanwhile, it has been abundantly stated that there are many problems in teachers' teaching methods in traditional teaching methods. In the teacher-centered method, students cannot increase their thinking abilities and be aware of independent thinking, while in the face of new modern technology and communication, students must use critical thinking to react to information. Yuanshen (1998) called it "disease of lack of critical thinking" which means ignoring the ability of students in critical thinking, that is, students cannot be consciously trained, analyze and synthesize, abstract and generalize and other thinking abilities and the ability to innovate to find problems. and solve problems (Lu, 2021). Many aspects of critical thinking are rarely taught by teachers. As a result, the critical thinking skills of students who are able to identify, evaluate, argue and solve problems correctly have been neglected by the teacher who can train students for critical thinking in analysis and problem solving. (Supna et al., 2021). Many factors cause critical thinking to be created, such as students' interest in learning is a cognitive, emotional, and psychomotor activity, and creates a positive attitude and improves critical thinking (Alvarez-Horta et al., 2022). Also, the implementation of the learning inquiry model causes the development of critical thinking skills and improves analysis, the development of observation skills and the acquisition of skills in problem solving improves the critical thinking skills of students (Nisa et al., 2018). By developing critical thinking, the student gains the ability to reason and solve problems through the created information and knowledge. Students become authentic and reasonable by the critical thinking of self-reflective thinkers (Rogetti, 2021). Critical thinking leads to students making wise and independent choices, making independent judgments about their choices, preparing for competition and success in facing the increasing challenges and changes of the world, and empowering students (Tawapoti et al., 2021). Critical thinking causes openness to diversity and challenges to become active and responsible citizens. With critical thinking, students become more open-minded and have more comprehensive and complex views of the world (Abdollahi, Darbani, & Parsakia, 2022; Alvarez-Horta et al., 2022). Critical thinking causes assessment, problem solving, inference, thoughtful decision-making and analysis, and it is self-regulating and reasoning, and students can be thoughtful with the ability to decide what to do (Rogetti, 2021).

In the mentioned materials, the benefits of critical thinking were discussed, factors such as



[ DOR: 20.1001.1.28212525.1402.4.8.4.8 ]

cognitive education and questioning, if included in the education system and used by teachers, will cause critical thinking. Critical thinking leads to results such as having the ability to solve problems, having an open mind, the ability to challenge the obvious, and high-level thinking. Now the question is, what other factors cause critical thinking to occur? What are the results of the emergence of critical thinking so that positive results can be obtained by applying the factors affecting critical thinking and it can be included among the consequences of the critical thinking model in order to achieve useful results by using it in the education of students. Therefore, two questions were examined in this research, 1- What are the factors affecting critical thinking? 2- What are the consequences of critical thinking? In this research, the stated categories were identified.

## Method

The purpose of this research is to present the framework of the antecedents and consequences of critical thinking with the cognitive education method in students. According to the purpose, the research method is practical, and according to the type of data, it is qualitative, exploratory, according to the time of data collection, cross-sectional, and according to the method of data collection, or the nature and method of the research, it is qualitative content content analysis. According to the above material and for the purpose of in-depth investigation and better understanding of the subject, firstly, the related literature and background were studied. Then, the interview and thematic analysis method were used as a research technique to further understand and identify the main category, sub-category and concepts of antecedents and consequences of critical thinking. In this research, a non-random sampling method of a targeted type was used to select the interviewees based on the criteria for entering the research (which was mentioned in the study population section). In this basic method, the selection of sample cases by the researcher is based on the objectives of the study and the nature of the research. It should be noted that in this research, 19 interviewees were considered according to the principle of saturation, that is, interviewees number 20 and 21 did not add new codes to the interviews and the interview was stopped.

## Materials

**1. Semi-structured interview:** In the individual interviews with the interviewees, 4 main questions were used in the interview for preliminary investigation; Considering that after conducting 21 interviews, the main and secondary factors were repeated in the previous interviews and the data reached theoretical saturation, that is, the new data did not differ from the previously collected data and saturation was achieved, the interviews were stopped. The duration of the interview was between 30 and 90 minutes. In order to check the validity of the findings, in order to ensure the accuracy of the findings from the researcher's point of view, valuable opinions of professors familiar with this field and university experts who were experts and knowledgeable in this field were used. Also, at the same time, the participants were helped in analyzing and interpreting the data.

## Implementation

Two library methods based on theoretical and practical bases and field method were used to collect information. For qualitative analysis, the method of coding concepts, sub-category and main category was used. The method of data analysis in the qualitative part was theoretical coding derived from thematic analysis method with Maxqda software. Theoretical coding is an operation during which the data are analyzed, conceptualized and put together in a new way, and it is the main process during which the theory is developed based on the data. In this method, there are three main pillars: "concepts", "categories" and "issues". In this way, theories are formed based on "raw data". In any study as a whole, data collection, data organization, and data analysis are interdependent. Three types of coding were used to analyze the data obtained from the interview as well as theoretical bases, which are: concepts, sub-category and main category.

## Results

To collect qualitative data, 21 experts and experienced people were interviewed in the fields of cognitive education and critical thinking. Among the statistical sample of the research, 6 were women and 15 were men. Also, 5 people had master's degrees and 16 people had doctor's degrees. The antecedents affecting students' critical thinking include 5 main categories, 17 sub-categories and 83 concepts as described in Table 1, and the consequences of critical thinking include 4 main



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categories, 15 sub-categories and 90 concepts as described in Table 2.

**Table 1. Antecedents affecting students' critical thinking**

| Row | Main Category | Sub-categoy | Concepts | Codes |
|---|---|---|---|---|
| **1** | Cognitive training | remembering | Retrieving relevant knowledge from long-term memory<br>Purposeful and reasoned thinking<br>Focus<br>Obvious thinking, behaviors, or skills | q3q8q13q19<br>q2q4q6q9q11<br>q7q9q20<br>q9q11q12q17 |
| | | understanding | Determining the purpose of learning materials<br>Oral, written and graphic communication<br>logic<br>Mental processes resulting from disciplined, active, skillful, applied observation | q2q5q7q9q13<br>q4q6q15q17<br>q1q2q8q16<br>q1q8q9q12q13 |
| | | use | Performing and using procedures in specific situations<br>Summarizing and self-evaluation<br>Strategies and representations<br>Interpreting and compiling questions<br>Applying the right strategies and skills at the right time<br>Testing and connecting | q3q4q9q13q19<br>q2q4q8q14q21<br>q5q7q11<br>q10q12q16<br>q5q12q15q16<br>q2q16q18q20 |
| | | analyze | Breaking matter into its constituent parts<br>Identifying how these parts relate to each other<br>Clarity and overview | q1q4q7q9q11<br>q3q14q16q19<br>q2q16q19 |
| | | assessment | Decision making based on criteria and standards<br>Self-evaluation | q2q8q20<br>q1q12q14q19 |
| | | create or make | Inserting different information to create a new result<br>Clarity and overview<br>Making reflective decisions | q5q9q15<br>q12q13q19q21<br>q2q4q8q19 |
| **2** | Cognitive conflict | interest in learning | Emotional and psychomotor activity<br>Fairness, humility, empathy and honesty<br>A sense of satisfaction, clarity and understanding | q1q5q8q16<br>q5q12q15q17<br>q4q11q18q21 |
| | | understanding the new concept | Linking preconceptions with new knowledge<br>Overcoming misconceptions<br>Awareness of contradictions<br>Dissatisfaction with existing perceptions<br>Creating new concepts<br>The new idea is acceptable and consistent with the standard of knowledge | q3q13q14q19<br>q4q9q14q7q18<br>q1q5q3q15q16<br>q6q8q19q14<br>q12q14q17q18<br>q1q5q8q9q15<br>q3q7q21 |
| **3** | Questioning and problem solving | combining facts and evaluating tasks with why | The emergence of a problem or a questionable issue<br>Making connections between previous knowledge and new information and concepts<br>Learning by reason<br>Discovery and research in authentic environments | q3q8q10q13<br>q5q7q10q12<br>q4q7q11<br>q1q12q18q21 |



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| | | | | |
|---|---|---|---|---|
| | | compare | Assumptions, concepts, empirical or argumentative basis<br>Implications and consequences<br>Alternative views | q4q5q16q18<br>q1q5q9q11<br>q2q9q13q14<br>q11q14q18 |
| | | finding a solution to a problem | Conclusion<br>Thematic framework<br>Discussions and activities and problem solving skills<br>Finding solutions to a given problem<br>Finding a way to accomplish the goal | q4q7q13q20<br>q10q16q21<br>q2q5q14q18<br>q12q13q18<br>q3q6q13<br>q2q16q21 |
| | | problem solving skills | Questions for clarification<br>Questions about different perspectives<br>Questions to examine hypotheses and evidence<br>Agree or disagree questions | q8q10q11q20<br>q10q11q16q21<br>q2q6q9q13<br>q10q13q18 |
| | | analytical thinking | Defining the similarities and differences of variables and trends in the data<br>Use different sources to explain events<br>Prediction of results<br>The reason for changing a variable and the effect of a variable on other variables<br>Emphasis on building cognitive structures<br>Collaborate with peers<br>Learning how to deal with problems critically<br>Discover new information | q3q10q1718<br>q11q14q15<br>q5q10q12<br>q1q17q19<br>q11q13q20<br>q12q14q19q20<br>q1q5q13q15<br>q2q15q20 |
| **4** | Problem solving based learning | cognitive flexibility | Provide solutions to solve the problem<br>Increasing students' understanding of education<br>Improve learning outcomes<br>Development of innovation | q2q11q16<br>q8q14q17q18<br>q4q5q7q14<br>q5q9q13 |
| | | understanding the complexities of the field of knowledge | Student-centered model<br>Teacher Facilitator<br>Being more active<br>Encourage flexibility<br>Formation of study groups<br>Solving problems<br>Creative thinking in producing good work<br>Building scientific thinking<br>Improving academic abilities | q3q15q19<br>q7q12q15<br>q10q11q16<br>q13q16q17<br>q5q13q17q18<br>q2q3q7q14<br>q4q7q16q18<br>q1015q20q21<br>q1q4q7q12 |
| **5** | Project-based learning | exploratory | Intervening and guiding the thinking process<br>Transfer<br>Problem solving skills<br>Group question and answer<br>Academic ability<br>Information processing<br>Organizing<br>Acquisition and discovery of knowledge based on experiences<br>Better performance | q8q13q15<br>q1q2q8q16q19<br>q3q4q17q20<br>q2q4q6q7q17<br>q2q4q13q17q18<br>q11q13q16<br>q14q17q19<br>q2q3q15q17<br>q4q14q20q21 |
| | | collaborative | Independent, directed learning<br>Solve problems clearly and draw conclusions<br>Ability to respond to others<br>Gaining new knowledge<br>Improving the interaction of students with each other<br>Enhancing cognitive improvement potential | q8q11q15q16<br>q4q15<br>q10q12q17q21<br>q7q19q20<br>q12q14q18q20<br>q1q3q13q19 |



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Antecedents affecting students' critical thinking include the following main category codes:

1- Cognitive training that includes sub-categories: a) Remembering that includes concepts of getting relevant knowledge from long-term memory, purposeful and reasoned thinking, concentration and thinking, behaviors or obvious skills. b) Understanding, which includes concepts of determining the purpose of learning materials, oral, written and graphic communication, logic and mental processes resulting from disciplined, active, skillful, practical observation. c) Applying, which includes concepts of performing and using procedures in specific situations, summarizing and self-evaluation, strategies and representations, interpreting and formulating questions, applying strategies and appropriate skills at appropriate times, and testing and connecting. d) Analysis, which includes concepts of breaking the material into its constituent parts, identifying how these parts relate to each other, and clarity and overall review. e) Evaluation, which includes decision-making based on criteria and standards and self-evaluation. f) creating or constructing which involves putting together different information to create a new result, clarity and overview and making reflective decisions.

2-Cognitive conflict which includes the sub-category: a) interest in learning which includes concepts of emotional and psychomotor activity, fairness, humility, empathy and integrity and a sense of satisfaction, clarity and understanding. b) understanding the new concept, which includes concepts of linking presuppositions with new knowledge, overcoming false beliefs, awareness of contradictions, dissatisfaction with existing concepts, creating new concepts and new concepts that are acceptable and compatible with the standard of knowledge.

3- Questioning and problem solving which includes the subcategory: A) Combining facts and evaluating tasks with why, which includes concepts of the emergence of a problem or a questionable issue, establishing a connection between previous knowledge and new information and concepts, learning through cause and discovery, and research in authentic environments. b) Comparing, which includes concepts of assumptions, implications, empirical or argumentative basis, implications and implications, and alternative viewpoints. c) Finding a solution to the problem that includes concepts of conclusions, thematic framework, discussions and activities and problem solving skills, searching for solutions to a given problem and finding a way to achieve the goal. d) problem-solving skills that include concepts of questions for clarification, questions about different points of view, questions for examining hypotheses and evidence, and questions for or against. e) Analytical thinking that includes concepts of defining the similarities and differences of variables and trends in data, using different sources to explain events, predicting results, the reason for changing a variable and the effect of a variable on other variables, emphasizing the construction of cognitive structures; Collaborating with peers is learning how to critically approach issues and discover new information.

4- Learning based on problem solving, which includes the sub-category: a) Cognitive flexibility, which includes concepts of providing solutions to solve problems, increasing students' understanding of education, improving learning results, and developing innovation. b) Understanding the complexities of the field of knowledge, which includes concepts of student-centered model, facilitating teacher, being more active, encouraging flexibility, forming study groups, solving problems, creative thinking in producing good work, building scientific thinking and improving academic abilities.

5- Project-based learning that includes the subcategory: A) discovery that includes concepts of intervention and process guidance, thinking, transfer, problem solving skills, group question and answer, academic ability, information processing, organization, acquisition and discovery of knowledge based on experiences and better performance. b) Participation that includes concepts of independent, directed learning, clear problem solving and conclusions, the ability to respond to others, gain new knowledge, improve students' interaction with each other, and enhance the potential for cognitive improvement.



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**Table 2. Consequences of students' critical thinking**

| Row | Main Category | Sub-categoy | Concepts | Codes |
|---|---|---|---|---|
| 1 | Correcting measures for sustainable education | Change in behavior | Change in attitude | q10q12q13q19 |
| | | | Evaluating statements and presenting facts | q3q6q8q18 |
| | | | Active participation | q18q19q21 |
| | | | Commitment and interest | q1q6q10q16 |
| | | | Students become active and responsible citizens | q11q16q20q21 |
| | | | Living a rational life | q9q9q12q15 |
| | | | Cultivating people who are useful in the development of the country | q5q10q17 |
| | | Acceptance of diversity and challenges | Coherence of views | q4q7q10q15q18 |
| | | | Expressing contradictions and contradictions with facts and norms | q8q11q14q19 |
| | | | Preparation for competition and success in facing the increasing challenges and changes of the world | q1q5q7qq19<br>q3q6q7q15q18 |
| | | | Comprehensive and more complex views of the world and social relations | q2q3q6q11 |
| | | | Having thoughtful citizens for life and work | |
| 2 | Empowering students | Rational decisions | Ability to reason | q2q4q5q8q9q14q16 |
| | | | Make an opinion | q5q17q18q20 |
| | | | Problem formulation | q1q3q4q7q11q21 |
| | | | Organization and development of hypotheses | q10q19 |
| | | | Solving problems and drawing reasoned conclusions through the information and knowledge created | q6q17q19q21<br>q5q11q20 |
| | | Reflective decisions | Ability to make decisions with high-level thinking | q7q10q11q15q19q2 |
| | | | Creating new inventions and innovations | 0 |
| | | | Dealing with problems and finding solutions and new ideas | q2q5q7q8q11q12<br>q4q9q10q15q16 |
| | | | Generating ideas and innovations | q4q13q18q19 |
| | | | Responsible and favorable decision making for society | q8q11q15q18<br>q10q21 |
| | | | Solving environmental problems | q6q17q20 |
| | | | Leading the world towards sustainability | |
| | | Student autonomy | Self-centered thinkers | q3q7q19 |
| | | | Credible and reasonable students | q3q7q13q16q18 |
| | | | Wise and independent choices | q4q5q7q16q18 |
| | | | Having self-confidence | q7q13q16q19 |
| | | | Wise and independent choices | q1q5q15q19q20 |
| | | | Selective judgment | q3q4q7q14q18 |
| | | | Discovery and research in authentic environments | q5q16q17 |
| | | Increase one's intellectual power | Developing students' skills | q2q5q8q21 |
| | | | Developing students' abilities | q4q10q14q15 |
| | | | Access to advanced knowledge | q1q6q13 |
| | | | Reach higher thinking | Q6q9q14q18 |
| | | | Improve understanding of specific topics | q2q3q5q13 |
| | | | Improve analysis | q7q13q16q21 |
| | | Individual development | Fairness | q3q5q8q13 |
| | | | Modesty | q1q5q14q17q21 |
| | | | Sympathy | q1q3q7q9q15 |
| | | | Integrity in social interaction | q3q7q17 |
| | | | Self-reflection | q2q7q10q16q18 |
| | | | Valid and reasonable | q5q9q14q17 |
| | | | Strong open-minded people | q4q14q17 |
| | | | creative | q13q15q21 |



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| | | | | |
|---|---|---|---|---|
| | | Improving individual skills | Overcome problems | q5q12q17q20 |
| | | | Satisfactory results | q10q14q17 |
| | | | Giving convincing answers | q11q15q17q19 |
| | | | Developing observational skills | q17q19q20 |
| | | | Acquiring problem solving skills | q4q14q18 |
| | | | Acquire advanced knowledge | q5q16q18 |
| | | | Spreading useful information and knowledge | q7q13q19 |
| **3** | Cognitive learning | Learning to self-regulate | Self discipline | q8q12q17 |
| | | | Thinking in understanding | q4q6q19q20 |
| | | | Responsibility | q13q15q20q21 |
| | | | Interpretation and organization of content | q13q18q20 |
| | | | Understanding, identifying irrelevant information | q3q8q14 |
| | | | Creating knowledge | q6q13q15 |
| | | | Responsibility and improving the quality of learning | q1q3q13q16 |
| | | Analysis and reasoning | Identify irrelevant information | q4q7q18q21 |
| | | | Better understanding of concepts | q1q7q13q20 |
| | | | Intrinsic motivation | q5q17q13q19 |
| | | Lifelong learning | Reliability of knowledge | q6q9q12q17 |
| | | | Creating knowledge | q1q3q4q10q11q18 |
| | | | Quality learning | q5q11q16 |
| | | | Expanding knowledge | q10q16 |
| **4** | Rational judgment | Overcome complex problems | Becoming professional in the field of work | q12q15q18q20q21 |
| | | | Sharing ideas | q8q11q19 |
| | | | Presenting different solutions by testing and reasoning | q8q11q16q17q19 |
| | | | Solving various problems | q3q6q8q13q16 |
| | | | Thinking of a solution | q17q19 |
| | | | Finding solutions based on past experiences | q3q8q11q17 |
| | | Principled and reflective judgment | Having different views | q5q8q11q15 |
| | | | Provide structured opportunities for critique | q11q15q17 |
| | | | Independent judgment about choice | q5q11q15 |
| | | | Critical thinking | q1q10q14 |
| | | risk management | Understanding the challenges | q4q6q9q13q20 |
| | | | Accepting challenges | q4q6q8q9q14 |
| | | | Adapting to world changes | q1q3q7q8q18 |
| | | | Openness to diversity and challenge | q1q4q6q9q19 |
| | | | Dealing with all kinds of diversity and challenges | q14q18q19 |
| | | | Becoming active and responsible citizens | q1q4q5q17 |
| | | Value judgments | Ability to distinguish between real and fake data | q4q9q13q18 |
| | | | Ability to differentiate between facts and assumptions | q1q4q7q11 q9q10q11q16q20 |
| | | | Ability to recognize logical connections | q5q16q21 |
| | | | Ability to highlight specific topic links | q1q3q6q8 |
| | | | Ability to recognize real and logical fallacies in reasoning | q4q7q10q11q14 |
| | | | Ability to distinguish essential arguments from irrelevant ones | q6q10q15q16 |
| | | | Ability to differentiate reasonableness and unreasonableness of assessment | |

The consequences of critical thinking means the modification of actions towards sustainable education, which includes changes in behavior, acceptance of diversity and challenges. Empowering students includes rational decisions, reflective decisions, student autonomy, increasing one's intellectual power, individual development, and improving



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individual skills. Cognitive learning includes learning self-regulation, analysis and reasoning, lifelong learning, and rational judgment includes overcoming complex problems, principled and reflective judgment, risk management, and value judgments.

The consequences of critical thinking include the main category:

1- Modifying measures for sustainable education, including the sub-category: a) Change in behavior, which includes concepts of change in attitude, evaluation of statements and presentation of facts, active participation, commitment and interest, students becoming active and responsible citizens, living a rational life and cultivating people who are useful in the development of the country. b) acceptance of diversity and challenges including concepts of coherence of views, expression of contradictions, contradictions with facts and norms, preparation for competition and success in facing the increasing challenges and changes of the world, comprehensive and more complex views towards the world and social relations and having thoughtful citizens for life and work.

2- The empowerment of students includes the sub-category: a) Logical decision-making, which includes concepts of the ability to reason, formulate opinions, formulate problems, organize and develop hypotheses, solve problems and draw reasoned conclusions through information and knowledge. b) Reflective decisions include concepts of the ability to make decisions with high-level thinking, creating new inventions and innovations, dealing with problems and finding new solutions and ideas, generating ideas and innovations, making responsible and favorable decisions for society, solving environmental problems, leading the world towards sustainability. c) The autonomy of the student, which includes concepts of self-reflective thinkers, authentic and reasonable students, wise and independent choices, having self-confidence, wise and independent choices, selective judgment and discovery and research in authentic environments. d) Increasing a person's intellectual power, which includes concepts of developing students' skills, developing students' abilities, achieving advanced knowledge, achieving higher thinking, improving understanding of specific topics, and improving analysis. e) Personal development that includes the concepts of fairness, humility, empathy, honesty in social interaction, self-reflection, authentic and reasonable, strong and creative open-minded people. f) Improving individual skills that include concepts of overcoming problems, satisfactory results, giving convincing answers, developing observation skills, acquiring problem-solving skills, acquiring advanced knowledge, and expanding useful information and knowledge.

3- Cognitive learning includes the sub-category: a) self-regulation learning, which includes concepts of self-discipline, thinking in understanding, responsibility, interpreting and organizing content, understanding, identifying irrelevant information, creating knowledge and responsibility, and improving the quality of learning. b) Analysis and reasoning that includes concepts of identification of irrelevant information, better understanding of concepts and stimulation of internal motivation. c) Lifelong learning, which includes concepts of knowledge reliability, knowledge creation, quality learning, and knowledge expansion.

4- Rational judgment including the sub-category: a) Overcoming complex problems that include concepts of becoming professional in the field of work, sharing ideas, presenting different solutions by testing and reasoning, solving different problems, thinking of solutions and finding solutions based on past experiences. Is. b) Principled and reflective judgment that includes concepts of having different points of view, providing structured opportunities for criticism, independent judgment about choice and critical thinking. c) Risk management, which includes concepts of understanding challenges, accepting challenges, adapting to world changes, openness to diversity and challenges, interacting with all kinds of diversity and challenges, becoming active and responsible citizens. d) Value judgments that include concepts of the ability to distinguish between real and unreal data, the ability to distinguish between facts and assumptions, the ability to recognize logical links, the ability to highlight specific thematic links, the ability to recognize real and logical fallacies in reasoning, the ability to recognize essential arguments from Irrelevances and the ability to differentiate reasonableness and unreasonableness of evaluation. According to the content, it can be said that cognitive education includes remembering, understanding, applying, analyzing and creating. Cognitive conflict



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includes interest in learning, understanding new concepts. Questioning and problem solving include combining facts and evaluating tasks with why, comparing, finding solutions to problems, analytical thinking. Learning based on problem solving includes cognitive flexibility, understanding the complexities of the field of knowledge. Project-based learning includes exploratory and collaborative learning. Based on what was said, conceptual model 1, which is the antecedents and consequences of critical thinking, is presented.

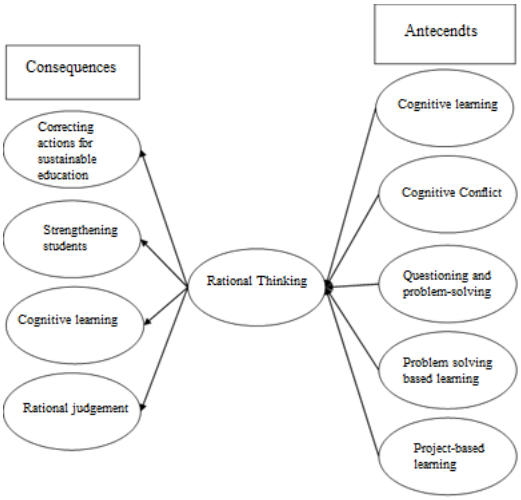


**Figure 1. Conceptual model of antecedents and consequences of critical thinking**

## Conclusion

The aim of the current research was to identify the antecedents and consequences of critical thinking in students with the cognitive education method. Cognitive education makes students connect their presuppositions with new knowledge and identify factors that cause more thinking to solve these problems (Makhros & Hedayatullah, 2021). When students experience the thought process and become aware of contradictions, the conceptual change of students' awareness of contradictions occurs. Cognitive conflicts cause dissatisfaction with existing concepts, understanding new concepts, new concepts that are acceptable and compatible with the standard of knowledge, and creating new concepts and lead to solving problems (Vilojang & Hedayatullah, 2021). Individual-social and academic characteristics of students in the four subscales of open attitude, analyticalism, confidence in reasoning and curiosity, which are factors related to cognitive skills, have a positive effect on improving students' thinking abilities for sustainable development (Su-Yi et al., 2022). Based on the obtained codings, cognitive education is aligned with what was studied in the research literature with the studies of Makhros and Hedayatullah (2021), Vilujang and Hedayatullah (2021) and (Su-Yi et al., 2022). Vilujang and Hedayatullah (2021) stated that students are not written blank slates and have presuppositions obtained from previous experience or learning. Questioning is an educational tool that students use critical skills (Rogetti, 2021). Implementation of the inquiry model of learning leads to the development of critical thinking skills, self-regulation and understanding of specific topics (Nisa et al., 2018). Question-based learning is effective in helping students develop critical thinking skills (Siborian et al., 2019). IBL (Inquiry-Based Learning and Problem Solving) is a way of asking questions and searching, and students learn using reason and are required to do science as a result of critical thinking (Duran & Button, 2016). Astra et al. (2021) to problem solving skills, which due to a specific purpose, the emergence of a problem or a questionable issue, assumptions, concepts, empirical basis or reasoning that lead to conclusions, implications and consequences. The implementation of the learning inquiry model leads to the development of critical thinking skills, self-regulation and understanding of specific issues (Syahrial et al., 2021). Based on the questioning category



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obtained from the analysis of the interviews, it is aligned with the research of Siyahrial et al. (2021), Rahmatida (2021) and Veno et al. (2021).

One of the limitations of the research was the time taken for the interview due to the busyness of teachers, managers and elites at the time of service, so the interview was postponed to non-working hours and in some cases to more limited times. Not accompanying some well-known experts with numerous researches and the dominant view of traditional education on the way of thinking of teachers, managers and people working in the education sector and not being familiar with critical thinking and how to create it in the field of cognitive education. Among the practical suggestions, providing a model of antecedents and consequences of critical thinking as a tool in evaluating teachers' performance and selecting excellent teachers can be effective. The individual growth of students and teachers is transformed into critical thinking, and the attention of managers and education officials to this issue creates positive changes according to the consequences. The method of teaching critical thinking should be included in the pre-service and in-service training of teachers. One of the research proposals is to identify intervening, strategic factors and platforms for critical thinking in order to provide a comprehensive model.

## Conflict of Interest

According to the authors, this article has no financial sponsor or conflict of interest.

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