

The Relationship Problem Solving Skills to Critical Thinking Skills in Aircraft Maintenance: A Conceptual Study

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ABSTRACT

Aircraft safety and security is a major factor in aviation. Therefore, ensure the aircraft maintenance and repairs carried out correctly, effectively, and efficiency needed to support these factors. This study aims to explain the importance of an aircraft mechanic to have critical thinking skills and the ability to solve the problems in aircraft maintenance. Aircraft mechanics are required to have critical thinking skills that are strictly related to problem-solving skills that are components in the 21st-century intelligence issue. The results of this study found an interrelated relationship between the critical thinking skill and problem-solving in carrying out aircraft maintenance which leads to the ability to think critically, laterally, and systemically, especially in the context of problem-solving and exploring various alternative ways or solutions.

Keywords: *Critical Thinking Skill, Problem-Solving Skill, Aircraft Maintenance*

1. INTRODUCTION

Aircraft maintenance is one of the essential elements of aviation. Maintenance is all activities carried out to maintain the aircraft, aircraft components, and equipment in an airworthy condition including inspection, repair, service, overhaul, and part replacement. Aircraft maintenance serves to ensure the proper operation of the aircraft in airworthy condition. Improper performance in aircraft maintenance, which is not appropriate with applicable standards and procedures, this will jeopardize flight safety. Airplane mechanics or aircraft technicians have a significant role in aviation. They are the people who act to support and ensure the safety of the aircraft. The aircraft mechanic profession has a pretty heavy responsibility to carry out aircraft maintenance and repairs to fly correctly and safely. In the aircraft maintenance activity, the roles and responsibilities of an aircraft mechanic, such as 1) Maintaining and repairing the system and mechanics of the aircraft 2) Maintaining the airworthiness status of the aircraft 3) Conducting inspection, maintenance, and double inspection of equipment (such as measuring instruments) and the fuselage 4) Write and keep records of repairs and document all preventive and corrective maintenance of the aircraft 5) Determine whether the aircraft is in a state

that meets the standards and ready to operate. Therefore, the critical thinking skills and problem-solving skills need to be optimized and explored for an aircraft mechanic.

Today, critical thinking and problem-solving skills are the abilities demanded of the working world. According to the Maine Department of Labor Career Center (2004), some individual characteristics desired by the working world are: (1) have self-confidence, (2) have a motivation to achievement, (3) mastering basic skills such as reading, writing, listening, speaking, and computer literacy, (4) mastering thinking skills, such as problem-solving, problem posing, critically, analytically, decision making, and creatively, and (5) mastering interpersonal skills, such as the ability to work in teams and negotiate. Creativity and problem solving are also abilities that are demanded by the business world as stated by Business in the Community / BITC as in [1] that the business world requires individuals with excellent communication skills, ability to work in teams, and problem-solving abilities. The ability to solve problems is a high-level cognitive ability. Reference [2] adds the problem-solving thinking stage after the evaluation stage, which is part of Bloom's cognitive stage. This stage shows that the ability to solve problems is a high-level cognitive ability.

The thinking ability to be studied is the ability to think critically, as in [3]. The researchers stated that critical thinking is the ability to give a reason and is reflective, which focused on what they believed and done. Critical thinking has to use a ratio (reason) and a strong belief to see things objectively, separating the problems of right and wrong as well as concluding an outcome that can be the basis to determine the steps to make changes. The strong critical thinking skills allow to evaluate arguments and be eligible for acceptance based on the thoughts. The ability to think critically is a higher-order thinking activity. This critical thinking can activate the skills of interpreting, analyzing, and evaluating evidence/ideas, identifying questions, arrange logical conclusions, and understanding the meaning of arguments.

In this decade, the development of the ability to think critically and solve problems is still relatively low attention in the field of aircraft maintenance, so there are still opportunities to explore critical thinking skills and their development. This paper explores the relationship between critical thinking and problem-solving—the results of this study used as a basis for subsequent research studies on critical thinking skills. Based on the background above, researchers conducted a conceptual study of the relationship of problem-solving to critical thinking skills in aircraft maintenance.

2. METHOD

This paper using qualitative inquiry in the field of aircraft maintenance and based on professional experience as an instructor and review by searching literature about critical thinking and problem solving. It synthesizes knowledge was iteratively and collaborative from previously reviewed articles on a particular topic and presents it in a new context to provide a springboard for new research that will fill knowledge gaps.

3. RESULT AND DISCUSSION

3.1. Critical Thinking

Reference [4] expressed that reasoning is a psychological action experienced by somebody when they confronted with an issue or circumstance that must be understood. Believing is controlling or overseeing and changing data in memory. This action is frequently done to frame ideas, reason, and think fundamentally, decide, think imaginatively, and take care of issues as in [5]. Reference [6] stated that characterizes thinking as a psychological movement to help define or take care of an issue, settle on a choice, or satisfy a longing to comprehend.

The critical thinking skill is an ability that must develop because it will have a good impact on prospective mechanics. Reference [7] stated that to

develop critical thinking skills. Eight steps should be performed, namely:

- 1) Recognize the problem.
- 2) Find the methods or clues to solve the problems.
- 3) Collect and compile the information needed.
- 4) Recognize the assumptions and the values that not stated.
- 5) Use appropriate, clear, and distinctive language in discussing a problem or a matter that it receives.
- 6) Evaluate and examine facts and statements.
- 7) Observe the existence of logical relationship problems and the answers given.
- 8) Draw the conclusions or opinions about the issue or problems discussed.

It agreed with [8] about the characteristics of people who think critically, they have a proper disposition and considering the opinions of others. Its processes carried out by asking questions to determine whether they are true or false, doubts, or partly correct.

Reference [9], in his research, stated that thinking is the ability to think at multiple levels and using the process of analysis and evaluation. Critical thinking, as a form of thinking ability, must be possessed by everyone, including students. Reference [10], a person who thinks critically can create significant questions, and problems then formulate them clearly and precisely. Critical thinking includes inductive reasoning aptitudes, for example, perceiving connections, breaking down open issues (with numerous potential arrangements), deciding circumstances and logical results, making ends, and ascertaining significant information. Reference [11] critical thinking is one of the aspects of being an analytical person. The mind must be open, bright, and based on facts. A critical thinker must be able to a) give reasons for the choices he made, b) answer the question why such decisions are taken, c) be open to differences in decisions and opinions of others, and d) be able to listen to the reasons why others have decision opinions different. To be a critical thinker, someone has to learn to ask questions about themselves, others, problems, and decisions taken by others.

Critical thinking is one of the forms of the skill of higher-order thinking. Reference [12] expressed critical thinking as (1) an attitude of thinking deeply about problems and things that are close enough for one's understanding, (2) knowledge of the logical investigation and reasoning methods, and (3) skills to apply these methods. Critical thinking requires a concerted effort to ensure any assumptive beliefs or knowledge based on supporting evidence and the conclusions that result. Furthermore, reference [13] stated that the components of critical thinking include: (1) drawing conclusions, (2)

assumptions, (3) deduction, (4) interpreting information, and (5) analyzing arguments—these critical thinking components used as benchmarks for one's critical thinking abilities. There are several vital elements in critical thinking that students must learn to have critical thinking skills, namely: (1) identifying problems; (2) identify relationships between components; (3) conclude the implications; (4) deducing motives; (5) combining independent elements to create new patterns created from thought (creativity); and (6) making original interpretations (creativity).

Reference [14] stated that there are several abilities associated with the concept of critical thinking. One of the statements, namely: "The abilities to understand problems, choosing information that is important to solve problems, understand assumptions, formulate and select relevant hypotheses, and draw valid conclusions and determine the validity of conclusions." Critical thinking is a complex process, and if done well, critical thinking will help us to systematically study complex ideas to better understand the problem or the consequences of practicing it as in [15].

The critical thinking skill is an ability that mostly needed in aircraft maintenance. This skill is essential because aircraft mechanics always have to be faced with problems (troubleshooting). Critical thinking emphasizes rational and reflective thinking so that it can reach the decision-making process. It means that when solving a problem, there needs to be reasonable and thoughtful consideration so that they can make decisions about which the correct solution used to solve the problem. Another opinion stated that critical thinking is the ability to make decisions rationally about something that has done or believed.

Today, education is in the age of knowledge, with the acceleration of an extraordinary increase in knowledge. It supported by the application of digital media and technology called the information superhighway Gates as in [16]. This case causes all fields must be ready to change with the times, including education. This change must follow so as not to be left behind by the times. Aircraft technology is progressing very rapidly. Therefore we need critical thinking skills and problem-solving that lead to the ability to think critically, laterally, and systemically, especially in the context of problem-solving in aircraft maintenance by following technological developments.

Therefore, Cahyono (2015), in his research, stated that indicators of critical thinking ability could be derived from the critical activities of prospective aircraft mechanics as follows:

- 1) Look for a clear statement of each question;
- 2) Considering reasons;
- 3) Trying to realize the data well;

- 4) Use sources that have validity and notice them;
- 5) Taking into account the circumstance and condition overall;
- 6) Trying to stay pertinent to the principle thought;
- 7) Considering unique and principal interests;
- 8) Looking for options;
- 9) Be receptive and think;
- 10) Taking positions when there is adequate proof to accomplish something;
- 11) Seek however much clarification as could reasonably be expected if conceivable;
- 12) Act efficiently and routinely with parts of the entire issue;
- 13) Based on some of the definitions of critical thinking before, it could be concluded that a person thinks critically with the characteristics of (1) solving a problem with a specific goal, (2) analyzing, generalizing, organizing ideas based on facts/information available, and (3) draw conclusions in solving the problem systematically with the correct arguments.

3.2. Problem Solving

Reference [17] defined the problem as a situation where a person or group confronted with a task which contains the nature of a conflict issue, or controversial, challenging, cannot be easily resolved by direct procedures, and individuals or groups have the desire to complete the task. Reference [18] stated that in the early 1900s, problem-solving shown as an activity that was mechanical, systematic, and often associated with an abstract concept. In this context, the problem solved is a problem that has an answer obtained through a process that involves a single method or (reasoning convex). As cognitive learning theory develops, problem-solving seen as a mental activity that involves complex cognitive skills. Its activity is also consistent with the opinion as in [19], which states that problem solving requires higher-order thinking skills such as visualization, association, abstraction, manipulation, reasoning, analysis, synthesis, and generalization.

Reference [20] that problem solving has a variety of roles, namely (1) problem solving as a context for doing mathematics, it means the issues have a function to motivate students to learn mathematics, (2) problem solving as a skill, which refers to the cognitive abilities of students in solving a problem, and (3) problem solving as an art, which sees problem-solving as the art of discovery. The purpose of learning mathematical problem-solving in this case is to develop the ability to be skillful and enthusiastic in solving problems,

becoming an independent thinker who can solve open-ended problems.

The experts have many opinions about activities to solve the problem. One of them, as stated by Polya. Reference [21] defines problem-solving as an attempt to discover a way out of difficulty, achieve a goal that is not immediately attainable. According to Polya, there are four steps in solving problems as in [22], namely:

1) Understand the problem

The problem must be truly understood, such as knowing what is not known things, what is already known, whether the conditions exist are sufficient or not enough to determine the unknown things. Is there an exaggeration, or is there a conflict. Determines a picture problem using the appropriate notation.

2) Make plans to solve the problems

Look for the relationship between existing information and the unknown things. While making this plan, a person should be paying attention to problems that can help if a relationship didn't immediately know, so that finally, a plan obtained from the solution.

3) Execute the plans

The plan implemented. Check and ensure that each step is correct and prove each step is correct.

4) Evaluation of the result of the solution

The proposed questions, such as: can check the results, can check the reasons stated, whether obtained different results, can see a glimpse of the solution, can use solutions that have obtained or methods that used for other similar problems.

3.3. Relationships Critical Thinking and Problem Solving in Aircraft Maintenance

The aircraft mechanics profession has quite heavy responsibilities. They are the people who act to support the safety of the aircraft. Aircraft mechanics is a problem solver. The ability to solve problems (troubleshooting) was performed by thinking analysis, analysis through research, accurate data, and others, so the maintenance resolved quickly and effectively. This skill must be support by the ability to master the concepts (theory) and experience gained from practical learning to find out the cause of the problem found and fix it with the right solution. Someone who has good problem-solving skills, he also has the competence in solving problems properly too. And vice versa, when a person has a low problem-solving ability, they perhaps will meet the obstacles in the learning process. The relationship between critical thinking and problem-solving skills is also important for a mechanic in the field to maintain the aircraft. With

better systemic thinking, as in [23], mechanics can develop critical thinking skills to encounter the rapid development of aviation as in [24]. Reference [25] was the first research classifies the techniques used in problem-solving and decision making into two groups roughly; it related to the critical/creativity division. The first group tends to be more direct and sequential, structured, rational and explanatory, and goal-oriented; this technique mostly part of the practice of critical thinking. The second group tends to be more holistic and parallel, emotional and intuitive, creative, and actual/kinesthetic; this technique is mostly as part of the practice of creative thinking.

Reference [21] as in [26], (2003) [27] and [28] offers a strategy for solving problems that consist of 4 steps: (a) understanding the problem, (b) making a plan, (c) carry out the plan, (d) evaluation. Understanding the problem is finding clearly what the problem is. It involves the act of finding information that is relevant to the problem and separating irrelevant elements. After aircraft mechanics can understand the problem correctly, then they must be able to draw up a problem-solving plan. The ability of the second phase is very dependent on the experience of students in solving problems. Making a plan or planning a solution is related to a general strategy for overcoming problems that are often referred to as heuristic strategies, for example, by solving problems into several small steps and then finding ways to carry out these steps. The third part deals with efforts to find an actual solution to the problem. In the heuristic strategy, we can create the correct plan concerning which algorithm. This step is direct and only involves the application of the chosen algorithm. The final step has to do with evaluating the results, which was an inspection of the work. Inspections carried out by other aircraft mechanics so that the level of accuracy in aircraft maintenance can be guaranteed. Based on some of the above understanding, it concluded that solving the problem in aircraft maintenance is an activity to find solutions to problems (troubleshooting) that faced by using integrally all the provisions of aircraft maintenance engineering knowledge that owned.

Furthermore, based on several definitions of critical thinking above, it can be concluded that a person thinks critically with the characteristics of (1) solving a problem with a specific goal, (2) analyzing, generalizing, organizing ideas dependent on realities/data available, and (3) draw conclusions to fix the problem systematically with the correct arguments. In this research, an analysis of the critical thinking skill of aircraft mechanics carried out by tracing the aircraft's essential mechanical thinking ability integrated into solving aircraft maintenance problems that actively involved mechanics and related them with critical thinking skills indicators.

The quality thinking of the candidate or real aircraft mechanics, and how they think, determines the quality of

their performance in the field of aircraft maintenance. Critical thinking involves articulating assumptions in problem-solving, choosing hypotheses and methods that are appropriate for experimentation, and composing open design problems as in [24], as well as developing, through the interaction of interpersonal disposition of

critical thinking. The indicators of each component of skill presented in Table 1.

Table 1. Indicators of the Critical Thinking Process in Solving Open Problems in Aircraft Maintenance (Polya-Based)

Polya Steps Problem Solving	Critical Thinking Ability Aspects	Critical Thinking's Indicators	Aircraft Maintenance activities
Understand the problems	Construct the simple reason	<ol style="list-style-type: none"> 1. Analyze the question by identifying the facts given clearly and logically 2. Focus the question to formulating the main points of the problem carefully 	Aircraft mechanics analyze and understand the problems (troubleshooting) that are faced based on manual maintenance and experience logically and carefully.
Make a plan for solving the problem	Build advanced skills	Determine methods that have ever studied accurately to solve problems	Aircraft mechanics plan to determine which one methods based on their experience to solve the problem accurately following the maintenance manual
Implement the problem-solving plan	Manage strategies and techniques	<ol style="list-style-type: none"> 1. Revealdata/definitions/theorems in solving problems correctly 2. Determine the solution of the problem and write down the solution or answer to the problem 	Aircraft mechanic execute the plan following the solution of the problem with the appropriate maintenance manual
Riview	Conclude and evaluate	<ol style="list-style-type: none"> 1. Determine the conclusion by evaluating the relevant arguments to fix the problem carefully. 2. Divide between conclusions based on valid/invalid rationable. 3. Determine alternative ways to solve problems. 	<ol style="list-style-type: none"> 1. The others of aircraft mechanics should carry out the double inspection to evaluate and ensure that the maintenance work was appropriate and following the maintenance manual 2. Aircraft mechanics should coordinate with senior mechanics or supervisor to determine alternative ways of solving problems if maintenance cannot be complete.

4. CONCLUSION

Aircraft maintenance activity is a very important factor in ensuring flight safety. Aircraft mechanics are required to have critical thinking skills that are closely related to problem-solving abilities that are components in the 21st-century insight issue. The ability to think critically and problem-solving leads to the ability to think fundamentally and systemically, particularly in the context of problem-solving. The requirements of problem-solving skills have required the ability to think critically in exploring various alternative ways or solutions in performing aircraft maintenance. While vice versa, the problem-solving activity provides triggers a problematic situation to develop the potential for critical thinking of an aircraft mechanic—both relationship variables need to be explored as a basis for developing each other capabilities. The problem-solving skill of

student aircraft mechanics, as well as real aircraft mechanics in the field, can be used as an indicator of the ability to think critically.

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