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Higher Order Thinking Skill (HOTS) in Training Control Techniques Skill of Air Traffic Control Student Using Problem Based Learning Method

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A B S T R A C T

This research explores the use of Problem Based Learning (PBL) in air traffic control education to enhance students' control techniques skills through simulation. PBL encourages individual and group problem-solving, fostering contextual understanding. The study examines various simulation types and PBL characteristics aimed at improving these skills among air traffic control students. Results indicate that 750 students achieved an average score of 84.43, classified as very good. The research also discusses the advantages and challenges of implementing PBL in developing control techniques for air traffic control students.

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INTRODUCTION

Air traffic control guidance is an air traffic control service which provides clearance, instructions and information to aircraft whose purpose is to prevent collisions between aircraft, prevent collisions between aircraft and obstacles around the airport, maintain the smooth flow of air traffic control, provide advice and information that is useful for air safety and assist relief and search units in emergencies (ICAO Annex 11, 2001). In Air traffic control learning, students are educated to be able to carry out water traffic control guidance in their area of responsibility (ICAO PANS Doc 4444, 2016) and be able to provide separation and two-way communication to aircraft (ICAO Annex 10, 2001). Where students are trained to gain the ability to guide aircraft and have an air traffic control license (ICAO Annex 1, 2001).

Figure 1. Air Traffic Control Learning

Air traffic control learning program, students are given knowledge about air traffic control guidance (Procházka & Plos, 2013), airport knowledge (ICAO Annex 14, 2004), communication (ICAO Annex 10, 2001), aircraft characteristics (ICAO Annex 6, 2010), until handling emergency situation in the air (Eurocontrol, 2017). Air traffic control learning using the Problem based Learning (PBL) system method by providing and designing several exercises whose purpose of the exercise is to train students' cognitive and behavioral development towards the completion of various simulations given (Arya et al., 2021), In the simulation there are also exercises that require student creativity in finding solutions (Fauzia, 2018), of course, each air communication student has techniques and solutions different in handling each case which of course remains based on safety factors (Boustras et al., 2017) Yadaf and nikmaz mentioned that safety is a top priority in the air and reducing a risk at an acceptable level is the main goal. (Yadav & Nikraz, 2012).

Air traffic control learning uses the PBL learning method (Wood, 2008) where students are introduced to a case to be solved related to guiding air traffic control so that students can further develop their mindset to solve a problem (Glenn et al., 1999). When conducting research at air vocational education schools in Indonesia where there are 5 (five) schools that educate air traffic control

students and around 800 air traffic control students, it can be found that PBL-based learning methods are applied in air traffic control learning where students are required to actively guide air traffic control by being given several problems or cases designed by lecturers or teachers in practicum simulations and students must solving the case by developing his mindset it aims to train the control techniques skill of air traffic control students(Lindenfeld et al., 2020) . In training to train control techniques skill of air traffic control, students are trained to have control techniques, namely the application of separation (Krozel et al., 2016), traffic information, communication (Krivonos, 2007), weather mastery (Kulesa, 2003), coordinating with other units and airports (Krivonos, 2007) and implementing safety management systems in air traffic control (Lee, 2006).

Aviation schools in Indonesia use the ATC Simulator laboratory as a means of practicum air traffic control where the ATC Simulator laboratory is a laboratory that can design several problems that will be given to students such as departure aircraft, arrival aircraft to a more complex level such as communication failure (Dayton & Henriksen, 2007), Engine on fire (Foo, 2000), Landing gear problem, etc. where the lecturer will provide problems in the middle of the practicum which is adjusted to the exercises given and will be a facilitator to supervise every thought and decision made by students and provide advice to students if they experience difficulties in solving problems. This is in accordance with the quotes kalev martens and jaak umborg which say students are given the opportunity to design their own learning activities and to achieve their own learning goals to take experience and analyze student knowledge and practice control techniques skill in air traffic control (Martens & Umborg, 2012). In other studies on PBL learning, it is stated that the application of PBL can train and develop critical thinking skills in students, this is because students can identify, analyze, solve problems, think logically and make decisions appropriately and can draw their own conclusions (Fakhriyah, 2014).

There has been no or lack of discussion about PBL in learning in the Aviation, especially in the safety aviation, making the author want to analyze problem based learning and describe the relationship of PBL learning to train control techniques skill of air traffic control student

THEORETICAL REVIEW

Problem Based Learning (PBL)

The problem based learning (PBL) model is a learning that uses students' thinking abilities both individually and in groups to solve problems so that they can have relevant and contextual meanings. (Kilroy, 2004). The purpose of PBL-based learning is to be able to train students' ability to apply concepts to a new or real problem so that it can be integrated with the concept of Higher Order Thinking Skills (HOTS), willingness and desire in learning, directing independent learning, and training a skill in students (Jailani et al., 2017). According to Nurhadi (2004) in (Hayati et al., 2020) "Problem based learning (PBL) is an interaction between stimulus and response, where there is a relationship between the two directions of learning and the environment". The environment provides input in the form of help and problems to students, and the nervous system of the brain functions to

interpret and interpret assistance effectively so that the problems given to students can be investigated, studied, assessed and can find solutions to a problem. PBL is a learning technique or approach designed to present a contextual problem so that it can stimulate students to learn to solve a given problem. PBL is also a learning model that requires students to learn both individually and in groups to find solutions to real-world problems where the problem can be used to bind students to the desire to know a learning in question (Dewi, 2016).

Benefits of Problem Based Learning (PBL) Model

Aris Shoimin (2014) in (Febrianingtyas, 2013) argues that the advantages of the PBL model include:

1. Students are encouraged to be able to have the ability to solve a problem in a real situation.
2. Students have the ability to build their own knowledge through work and learning activities.
3. Learning only focuses on problems related to so that students do not need to study material that has nothing to do so that this can reduce the burden on students in storing information.
4. Scientific activity will be realized in students through group work.
5. Students will be familiar with using sources of knowledge from various sources whether from the internet, documents, libraries, interviews, etc.
6. Students have the ability to assess the progress of knowledge and learn on their own.
7. Students can communicate scientifically in discussion activities or present the results of their work.
8. Difficulties in learning can be more easily overcome by group work or peer teaching

METHODOLOGY

The method used in analyzing for this study is descriptive analysis experiments (Suardi, 2020). Descriptive analysis techniques analysis experiments are methods of collecting data that appear in the form of words or symbols, obtained through observation, documentation, and experiments carried out on students arranged into expanded texts (Muri Yusuf, 2017). The descriptive method of analysis experiments emphasizes the description naturally and as it is, so with this nature it is required to be directly involved in the field in making observations (Anggito, 2018). The data taken in this study came from experiments, observations, documentation, interviews with lecturers and students of air traffic control vocational education in 5 (five) aviation schools in Indonesia that educate air traffic control students under the auspices of the Indonesian Ministry of Transportation as well as from various sources and research results related to the topics investigated, namely PBL learning in air traffic control learning in aviation schools in Indonesia. The interview instruments conducted in this study include operational activities of air traffic control learning to train student control techniques skill by explaining the characteristics and syntax of PBL-based learning methods in learning air traffic control.

RESULTS

Air Traffic Control Learning Methods Based on PBL Syntax

Referring to the learning syntax of PBL, several air traffic control learning activities can be described by providing problems that are adjusted to the stages of learning. The following is a problem exercise developed to train control techniques skill of air traffic control student in aviation schools in Indonesia.

Table 1. Exercise Simulation of Air Traffic Control Practicum Using Problem-Based Learning Method

No	Traffic	Status	Expected Performance
1	DEP	VFR	Taxi, Takeoff (Pistone Engine)
2	DEP	IFR	Startup, Taxi, Takeoff (Pistone Engine dan Turbo Engine)
3	ARR	VFR	Landing Instruction, Sequence Arrangement
4	DEP/ARR	IFR, VFR	Departure and Arrival Procedure, Traffic Information
5	DEP/ARR	IFR, VFR	Problem 4, Ground Vehicle, Helicopter Operation
EXAMINATION 1			**All item which has been exercised**
6	DEP/ARR	IFR, VFR	Problem 5, Local flight, Unexpected Traffic, Overflying
7	DEP/ARR	IFR, VFR	Problem 6, Communication Failure
8	DEP/ARR	IFR, VFR	Problem 7, Multirunways Operation
9	DEP/ARR	IFR	Departure and Arrival Instrumen approach
EXAMINATION 2			**All item which has been exercised**
10	DEP/ARR	IFR	Problem 9, Missed Approach + Special VFR Operation
11	DEP/ARR	IFR, VFR	General Procedures
12	DEP/ARR	IFR, VFR	Change of Runway
13	DEP/ARR	IFR, VFR	Urgency Situation
14	DEP/ARR	IFR, VFR	Emergancy Situation
FINAL EXAMINATION			**All item which has been exercised**

Exercise 1 is an initial exercise in learning air traffic control, students are trained to be able to provide air traffic control services to VFR (Visual Flight Rules)

departure aircraft, understanding of aerodrome layouts, and jurisdiction of air traffic control responsibilities.

Exercise 2 is the next stage of exercise 1 where students are trained to be able to provide air traffic control services to IFR (Instrument Flight Rules) Departure aircraft and provide knowledge about ATC Clearance, Release Time, Standard Instrument Departure.

Exercise 3 is a training to guide VFR Arrival aircraft. Students are trained to be able to provide sequence arrival, understanding circuit patterns, aircraft arrangements in the vicinity of aerodrome and procedures for aircraft arrival.

Exercise 4 is a combined simulation of departure and arrival. Students are trained to be able to provide air traffic control services so that collisions between aircraft do not occur. Students are also trained to provide traffic information, separation between departures and arrival aircraft.

Exercise 5 is a continuation of the simulation in exercise 4 but there is additional traffic, namely helicopter procedures and ground vehicle activities such as the transfer of aircraft parking stands, checking runway conditions by AMC (Apron Movement Control) units, etc.

Examination 1 after completing 5 exercises students are asked to carry out examination 1 whose purpose is to repeat and analyze the ability control techniques skill of air traffic control student before proceeding to the next exercise. Students will be asked to re-simulate examination 1 if they do not meet the standard passing score.

Exercise 6 is the first phase 2 continuation after student complete examination 1. Exercise 6 there is an increase in traffic, namely unexpected traffic which can be in the form of local traffic, Hospital or medical aircraft, etc. and the addition of traffic overfly where the ability of students to provide traffic info and separation will grow and increase.

Exercise 7 is an abnormal situation that malatific the ability of air traffic control students in providing air traffic control services to aircraft experiencing communication failure. Students are given knowledge about the use of signal lights and air traffic control service procedures to aircraft that experience communication failure.

Exercise 8 can be used as an alternative to simulation if there are 2 or more runways where air traffic control students are given training in providing air traffic control services if the airport has 2 or more runways. Direction after takeoff, separation between departure and arrival aircraft will be a very important capability in this exercise.

Exercise 9 is a training on IFR approach aircraft. In this simulation, we are trained on Instrument approach, concequitive and non concequtive approach, Arrival segment, holding, etc.

Examination 2 after completing 9 exercises, students are asked to carry out examination 2 which is the same purpose as examination 1, namely repeating and analyzing the ability control techniques skill of air traffic control student before proceeding to the next exercise. Students will be asked to re-simulate examination 2 if they do not meet the standard passing score.

Exercise 10 is the first phase 3 continuation where students are trained to be able to provide air traffic control services to aircraft that have missed approach, bad weather.

Exercise 11 is a combined exercise before entering an abnormal situation with a more complex simulation where exercise 11 starts from exercise 1 to 10.

Exercise 12 is a simulation of the change runway. In this simulation, students are trained to be able to provide air traffic control services when there is a significant change in weather direction so that it can result in a change in the direction of the runway. Of course, in this simulation, the regulation of traffic in the air and on the ground has changed and requires good air traffic control services by air traffic control.

Exercise 13 is a simulation of urgency situation. In this simulation, students are trained to be able to provide air traffic control services when the aircraft has an event that requires assistance from a landed unit such as ambulances, technicians, etc. an urgency situation event can be the condition of a sick passenger on the plane, or the condition of an aircraft that has minor damage and needs assistance from a ground unit at the airport.

Exercise 14 is the most extreme simulation in flight, namely Emergency situation. In this simulation, students are trained to be able to provide air traffic control services when the aircraft has an event that requires assistance from a ground unit such as firefighters, technicians, search and rescue, etc. emergency situation events can be in the form of engine failure, engine fire, unstable cabin pressure, aircraft hijacking, etc. so that they need help from ground units at the airport.

Examination 3 is the final examination after completing 14 exercises, students are asked to carry out examination 3 which is to repeat and analyze the development of student control technique skills air traffic control before continuing the next lesson, namely carrying out On the Job training (OJT) at the real airport with a duration of approximately 150 days. When carrying out OJT, students can practice the air traffic control skills that have been obtained during the simulation and carried out at the real airport. This is expected to increase the control technique skills of Air Traffic Control students and gain experience that can be useful in the continuation of their careers.

The amount of traffic in each air traffic control exercise can be adjusted according to the students' abilities and airport conditions. But usually in each simulation there is 10-20 traffic in each exercise and each simulation takes 30-60 minutes. Cooperation between controllers, pilots and the role of the teacher will be very important in the smooth running of air traffic control simulations.

The control techniques skill of air traffic control students who are trained are the ability and skills of air traffic control in guiding aircraft under their responsibility to create efficient, orderly and safe traffic. Here are the control technique abilities of students trained using the PBL learning system.

Table 2. Indicators Control Techniques Skill of Air Traffic Control Student

Apect's	**Indicators**
Separation	Selection of providing separation
	Application of separation
	Separation is maintained/ensured
	Efficiency
Control technique/ judgement	Analysis and problem solving
	Planning abilities
	Priorities/ sequence
	Traffic flow/ efficiency
	Familiarization with pattern/confliction Point(s)
Communication/clearance/instruction	Use of Standard phraseologies
	Phonetic alphabet/voice quality
	Clarity of expressions
	Timeliness of issuance
Flight Data	Completeness/correctness of FPS
	Neatness and legibility of FPS
	Correct Use of abbreaviation/symbol
	Sequence in handling FPS
Co-Ordination	Clarity of expressions
	Promptness/priorities
	Adherence to LOCA
	Adherence to the directives
Abnormal Situation	Anticipation/ reaction
	Judgement
Work Habit	Deporment/ attitude

Apect's	Indicators
	Initiative
	Attention to detail
	Appearance
	Field observation

Aviation schools in Indonesia in the practicum of air traffic control use PBL learning in solving a problem given to students. The learning of air traffic control uses the ATC Simulator laboratory which is adapted to the syntax of PBL learning according to Warsono & Hariyanto (2013, p. 151) in (Herzon et al., 2018) to train student control technique skills, as follows:

1. Orient students to a problem.

   In the previous air traffic control learning activities, students will be given explanations and explanations about exercises or problems that will be given to students. The stages of the problem are adjusted to the exercise that will be used in the air traffic control practicum using the ATC Simulator laboratory. There are 15 problem scenarios that are usually given to students in stages including departure aircraft (Malik et al., 2010), arrival aircraft (Dong & Du, 2010), departure+arrival (Patterson et al., 2012), traffic information, communication failure and emergency situation (Daidzic, 2017). After the lecturer or teacher provides an explanation regarding the problem that will be given to students, the teacher will conduct a question and answer session before carrying out practicum activities in the ATC Simulator laboratory. This is in accordance with a statement from the air traffic lecturer who stated:

   "*We provide orientation to students regarding the problems or exercises that will be given, so that students can find learning resources and references about the problems to be given apart from the material provided by the lecturer*".

2. Organizing students to learn

   After giving an explanation of the exercise or problem that will be given to the student. The lecturer or teacher will ask students to simulate air traffic control activities by organizing students into several parts, namely controllers, assistants, approaches, and pilots.during the simulation, lecturers will provide problems to students and help students if they experience difficulties in solving the problem (Madang et al., 2019).

   "*During the simulation, we were divided into several roles, namely controller, pilot, assistant and approach and we worked together in solving the problems given*" *(Interview with ATC students)*

3. Guiding students in analyzing individual and group problems

   After carrying out the simulation, the teacher will repeat the problem given to the student for further discussion together and the teacher will encourage students to find information relevant to the problem given when conducting the air traffic control simulation. Students will search for information through aerial documents, articles, the internet, the web, etc. regarding the problems given to be further elaborated broadly to other students.
4. Develop and present a work of the problems given

   Lecturers or teachers will assist students in developing findings from problem solving that are given to both individuals and groups. students will provide a report on the findings of the problems given during the practicum at the ATC Simulator Laboratory in front of other students whose purpose is to provide an overview and knowledge to other participants. Teachers also provide suggestions and images that can be used as a reference for students when facing similar problems or other problems.
5. Analyze and evaluate the process of solving a problem.

   The lecturer will assist students in conducting a final evaluation of the problem-solving process carried out by the student. After evaluating the results of the group, the lecturer will conduct a similar simulation to other groups with the intention of the next group applying the solutions that have been described by the lecturer or lecturer or the previous group.

Characteristics of PBL in Air traffic control learning

Based on Barrow's theory, Min Liu (2005) there are PBL characteristics that are applied in learning air traffic control to train control techniques skill of air traffic control student, namely:

1. Learning is Student-Centered

   In Air traffic control learning to train control techniques skill student, it focuses more on students as a learning resource in solving a problem. Therefore, PBL learning is strongly supported by the theory of constructivism where students are encouraged to build and construct to develop their own knowledge (Saguni, 2019). By emphasizing on the student's thinking pattern in solving a problem, it is hoped that it can train the control techniques skill of the student in dealing with problems that arise in the future.
2. Authentic Problem from the organizing focus for learning.

   Giving problems to students is an authentic or original problem so that students can and are able to understand the problems given and can be applied in their professional life or the world of work later.

   "We give our students exercises according to the conditions and problems that arise at the airport, so that they can find their own solutions in solving problems" (interview with air traffic control lecturers)

3. New Information is acquired through self-directed learning.

   In carrying out the water traffic control practicum in the ATC Simulator laboratory, students sometimes do not understand and know about the process of solving a problem so that students try to find the problem themselves more broadly either from books, journals, Aviation documents or others source information.

   "If we have difficulties, we usually look for references or sources from Aviation documents or the internet and also ask the previous batch (seniors)"

4. Learning occurs in small group

   In the discussion of a problem in learning air traffic control using the ATC Simulator laboratory. Students will be grouped into controllers, assistants, approaches, pilots and there will be scientific interactions and exchanges of opinions or thoughts for the purpose of solving problems. And it is not uncommon for them to try the air traffic control practicum again outside of class hours in the ATC Simulator laboratory to try to solve the problems that have been discussed previously with this matter students can be concluded to have good intentions to try to develop their respective control techniques.

5. Teacher act as Fasilitator

   In the implementation of air traffic control learning in the ATC Simulator laboratory, the teacher or lecturer acts as a facilitator. Even so, the teacher or lecturer must always monitor the development of student activities and encourage them to achieve the targets to be achieved.

The Higher Order Thinking Skill (HOTS) Method in Air Traffic Control learning

Air traffic control learning aims to hone students' skills and knowledge in guiding air traffic control safely and efficiently. Problem based learning simulation in air traffic control learning refers to the HOTS learning model where students must be able to do a high level of reasoning so that students are not fixated on one problem solving pattern given. Students must think critically, creatively, collaboratively and communicatively in solving problems given in air traffic control simulations.

According to Bloom's taxonomy in (Ahmad & Sukiman, 2019) at the C4-C6 level, Higher order thinking skill (HOTS) is a high-level ability that is at the level of analyzing, evaluating, and creating. The following is the HOTS learning method in air traffic control learning

Figure 1. Air Traffic Control Learning

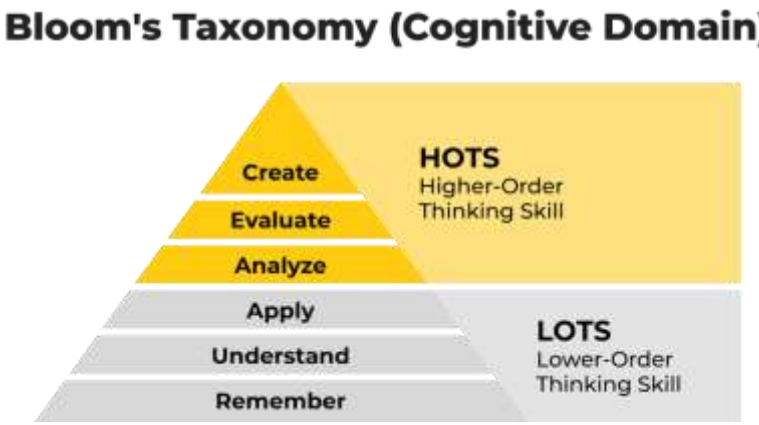

Table 3. HOTS on Air Traffic Control Learning

Analize	1. Air traffic control students are trained to be able to analyze the movement of aircraft that are in their responsibility. 2. Air traffic control students are trained to solve given problems by developing each student's planning ahead to create aviation safety. 3. Air traffic control students are trained to be able to detect potential accidents between aircraft and provide separation to aircraft to prevent collisions between aircraft.
Evaluate	1. Air traffic control students are trained to be able to decide appropriately in providing separation to aircraft so that there are no accidents between aircraft 2. Air traffic control students should reevaluate the steps that have been taken in providing air traffic control services and evaluate errors in guiding the aircraft so that they do not occur in the next learning.
Create	1. Air traffic control students should develop their control techniques skill in guiding aircraft safely and efficiently. 2. Air traffic control students should find and reformulate things that are wrong regarding their control techniques skill in conducting air traffic control practicums and look for sources related to air traffic control services such as flight documents, journals or the internet.

Air traffic control students are required to analyze, evaluate and create a guide plan Air traffic control that is safe and efficient and in accordance with the established rules. The role of teachers in learning air traffic control is also very important where teachers must plan and manage effective air traffic control learning and provide simulations or appropriate problems in providing learning to students. Teachers must prepare for the implementation of learning

systematically and designed in learning tools. Learning tools such as practicum equipment, learning modules, learning tools are very important in learning success and can create learning that is interactive, inspiring, challenging, efficient and can motivate students to think critically, actively and find solutions in solving air traffic control problems provided so as to create creativity and physical and psychological independence in students

The Higher Order Thinking Skill (HOTS) Method in Air Traffic Control Learning

Control techniques skill air traffic control student are taken from the student learning practicum scores of air traffic control and from these scores the lecturer provides an evaluation of student control techniques skill in solving exercise problems that are given to be used as a reference for students to be able to develop their control techniques skill in the next exercise. Students can provide guidance to lecturers or search for sources such as documents, the internet, literature or articles related to the shortcomings of the evaluation results that have been described by the lecturer. The following is the average score of air traffic students taken from 5 (five) aviation schools in Indonesia under the auspices of the Indonesian Ministry of Transportation including Civil Aviation Polytechnic of Indonesia, Civil Aviation Polytechnic of Surabaya, Civil Aviation Polytechnic of Makassar, Civil Aviation Polytechnic of Medan, and Civil Aviation Polytechnic of Jayapura by taking a total number of 750 air traffic control students

Table 3. Average Score of Air Traffic Control Practicum Simulation at Indonesian Aviation School

Exercise and School	Average Simulated value of practicum Air traffic control				
	PPI Curug	Poltekbang Surabaya	Poltekbang Makassar	Poltekbang Medan	Poltekbang Jayapura
1	88.46	89.41	81.15	82.12	81.94
2	86.98	84.13	82.85	81.1	79.09
3	84.04	89.43	86.6	81.24	85.13
4	84.93	81.1	80.03	79	79.07
5	91.02	86.77	89.3	86.48	85.45
Exam 1	80.32	82.28	80.12	76.24	80.26
6	88.4	83.76	79.05	84.68	77.92
7	87.27	85	82.55	82.32	84.91
8	86.24	85	84.53	89.12	83.48
9	86.45	89.43	84.08	83.84	80.69
Exam 2	88.88	86.01	85.15	86.54	85.59
10	87.38	86.36	83.03	86.36	87.52
11	90.07	85.52	85.08	83.54	82.4
12	88.46	88.93	86.8	85.28	84.32
13	83.82	83.48	80.08	79.50	82.02
14	86.75	84.2	86.35	84.32	81.1
Final Exam	85.56	88.12	83.45	86.24	83.71

Average	86,77	85,81	83,54	83,40	82,62
Average total grades			84,428		

From the average results of air traffic control students in 5 (five) Aviation schools in Indonesia, it was found that the average score of air traffic control students is very good where the average score of cross pestle students in Indonesia is 84,428 which means that the air traffic control learning system using the PBL learning method can form and improve student control techniques skill which are expected to be useful for the progress of air traffic control students when carrying out on the job training at the airport as well as being a very important capital to continue to improve the ability of air traffic control students to a higher career path.

DISCUSSION

The Advantages and Weaknesses of PBL in Air Traffic Control Learning

Air traffic control learning using the PBL learning method has advantages and weaknesses in it. When making observations and conducting interviews with lecturers and when conducting air traffic control simulation experiments for students, several aspects were found, including.

Advantages of PBL on Air Traffic Control learning

1. Students are encouraged to be able to have an air traffic control ability in solving a problem given by the lecturer or teacher when carrying out simulations and training control techniques skill so that it can train students' abilities and train students' mindset independently in solving problems and train control techniques skill of air traffic control student.
2. Students can develop and build air traffic control skills and train individual air traffic control skills through learning activities.
3. Learning is focused on a material about learning air traffic control and in it there are supporting learnings about water traffic control guidance such as: aerodrome, air traffic service, traffic info, etc. so that students' mindset abilities can develop and can train students' abilities and knowledge about air traffic control procedures.
4. There is information sharing about the problem or problems given to students and analyzed together in groups to get problem solving so that there is a discussion or scientific activity in the practicum air traffic control using the ATC simulator laboratory.
5. Students are actively looking for other learning resources to figure out how to solve a problem. It can be through the internet, libraries, interviews with lecturers or teachers and even seniors.
6. Students can assess their own learning progress.
7. Through the guidance of teachers who repeatedly encourage and direct them to ask questions and seek solutions to real problems by themselves, students will indirectly learn to complete those tasks independently in their later life.

Weaknesses of Problem based learning in Air Traffic Control learning

In addition to the advantages found, there are also weaknesses in PBL learning in air traffic control practicum to train control techniques skill obtained when carrying out simulation experiments, observations and interviews, including:

1. There is a diversity of students' abilities and learning abilities, so that in the distribution of tasks or problems given by lecturers or teachers, they find difficulties in dividing tasks.
2. Students' ability to solve problems is very diverse and diverse, it is not uncommon to find differences in problem solving between students in solving given problems, causing differences in control technique abilities between students.
3. Students' lack of understanding of the problem given is a problem for students in solving a problem. For example, giving communication failure problems, students must previously have a theory or understanding of aircraft procedures when experiencing communication failure. Sometimes students are found who are lazy to read reference documents or find sources of information about the problems that will be given to students

CONCLUSIONS AND RECOMMENDATIONS

Based on the above view, it can be concluded that in learning air traffic control is learning "Problem centered approach" where lecturers and students are bound in solving a problem regarding air traffic control that is adapted to real conditions at airports and aims to train and educate students to have control techniques skill good at air traffic control. And in the ATC Simulator laboratory it can simulate problems that can be solved by students. In the ATC Simulator there are also theories or knowledge regarding air traffic control procedures and when carrying out practicum in the ATC Simulator laboratory the lecturer or teacher will provide problems to train and develop students' control engineering skills regarding air traffic control in the air traffic control unit.

PBL learning is a learning process that actively trains mentally, builds knowledge based on the students' own cognitive abilities. The role of lecturers and teachers in air traffic control learning in improving control techniques skill of air traffic control student is as a facilitator and mediator in learning. The results of learning air traffic control using PBL learning are looking at the learning process and students' success in presenting problems and encouraging students to find their own ideas in solving and solving problems given to these students as well as training control techniques skill of air traffic control student so that they can provide services to the aircraft in a safe, secure and efficient manner. However, to get good results and learning processes in learning air traffic control using the PBL learning system, it requires the interest and desire of students to actively participate in solving problems regarding air traffic control procedures. Through continuous guidance from lecturers or instructors to encourage and direct them to ask questions and seek a solution to a problem, indirectly students will learn to complete assignments independently in their future careers. In air traffic control learning and to train control techniques skill using PBL learning students can be

realized through giving exercises or problems, completing exercises, studying and discussing individually and in groups about problems or exercises that "usually" occur during air traffic control practicum. From some of the opinions above and from the results of simulation testing on air traffic control students, it can be concluded that the application of the PBL learning method was very successful in shaping and improving control techniques skill of air traffic control student where seen from the results it shows the average value of air traffic control students in Indonesia get a very good score with a value of 84.428 which is in accordance with the objectives of PBL in air traffic control learning, namely to improve and shape control techniques skill of air traffic control student so that students can develop air traffic control skills by thinking critically, solving problems, independent in learning, and have high social skills in life**.**

FURTHER STUDY

To provide deeper insights and wider applications, more study is invited to explore this area further, addressing any potential limits and broadening the scope of analysis.

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