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The effect of linguistic intelligence and memory on air traffic control performance of field aviation polytechnic

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ABSTRACT

Some research has been conducted to understand how general knowledge and short-term memory affect academic achievement. However, research that links these two predictors with air traffic control performance in a laboratory has not been found. Twenty-four ATC cadets participated in this research. This is associative research with multiple correlation analysis that aims to find the correlation between linguistic intelligence and short-term memory toward cadets' air traffic control performance in Aerodrome Control Tower (TWR) Laboratory. The research instruments used are oral proficiency interview, Intelligence Structure Test (IST), and air traffic control simulation. Data obtained, then, are analyzed by using the product-moment method of correlation. The results show that there is a positive correlation among the three variables with the level of closeness that falls in the high category that can be seen from the correlation coefficient value. In fact, linguistic intelligence and short-term memory both contribute to air traffic control performance during simulations. These findings offer several implications for the training program to promote success in learning air traffic control, especially in the laboratory.

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INTRODUCTION

In the last several decades, many aviation accidents had occurred every day and resulting in fatalities in many aspects, not only aircrew and passengers but also people and property on the ground when the crashed aircraft falls into dense urban areas (Li et al., 2022). According to International Civil Aviation Organization (2001), one of the factors that cause incidents and accidents is the use of non-standard procedures and phraseology. Proper and efficient communication between flight personnel and ATC is a crucial determinant of aviation safety in the commercial aviation industry (Clark & Williams, 2020; Yen, 2014).

The Air Traffic Controller (ATC) profession requires an extremely high level of knowledge and expertise, as well as the practical application of specific skills related to the cognitive domains (e.g., spatial perception, information processing, logical reasoning, decision making), aspects of communication, and human relations (Costa, 1996). Air Traffic Controller, abbreviated as ATC or controller, is generally considered one of the many professions requiring a high mental load (Budiman et al., 2013; Costa, 1996; Fathimahhayati et al., 2018). Various studies related to this profession have also been conducted (Agustini, 2019; Rachmadina & Puspitadewi, 2019; Rahmati & Izadpanah, 2021; Rakas & Yang, 2007; Suarez, 2007; Yen, 2014). In this field of work, decisions

need to be made within seconds. This requires a high mental load, such as thinking, making decisions, calculating, remembering, observing, and monitoring things quickly in a short time while working.

When carrying out their duties, ATCs always have to communicate. In terms of communicating, ATC and pilots are required to master the communication procedure called Radiotelephone (RTF), which is a means of communication used by ATC in giving orders (e.g., GIA 212 runway 23 cleared to land), as well as information to pilots (e.g., GIA 212 runway is wet) (International Civil Aviation Organization, 2001). Yen (2014) added that communication barriers between pilots and ATC could cause problems and even fatal flight accidents. Furthermore, a review conducted on 340 accidents over nine months in 1988 by Morrison and Wright, Yen (2014) found that 42% of the total accidents could be attributed to communication errors.

Earlier, Rakas and Yang (2007) reiterated that communication problems caused 70% of operational errors and pilot deviations. It could be seen in several accidents, including the fall of a Boeing cargo plane on a hill on February 19, 1989, in Malaysia. The instruction "… descend two four zero zero" from the ATC, which the pilot misinterpreted as "… to 400," was the cause of this accident (retrieved from http://aviation-safety.net/database). In this case, the message receiver (pilot) received the message incorrectly because the message sender (controller) uttered an incomplete message. Unclear communication can affect flight traffic's smooth flow and even lead to incidents or accidents.

The effective performance of the ATM (Air Traffic Management) system depends on competent and qualified air traffic management professionals. Air Traffic Controllers (ATCs) managing and operating this system must have a shared understanding of what is expected of them in terms of performance wherever they may work to support a globally interoperable system and achieve optimum capacity within acceptable safety limits (International Civil Aviation Organization, 2007). This shared understanding becomes critical when considering the increasing traffic and the growing complexity and interconnectedness of the systems involved. Then, it must be separate from the initial process, namely training which is essential for performing control duties at operational units and supports qualified air traffic controllers in maintaining their competence.

ATC training is competency-based training characterized by a performance orientation, emphasis on standards of performance and their measurement, and the development of training to the specified performance standards (International Civil Aviation Organization, 2007). Competencies allow people to formulate solutions for complex and challenging situations, including those they are experiencing for the first time (International Civil Aviation Organization, 2007). Air traffic controllers must be able to deal with these situations effectively and simultaneously ensure that they are done safely and securely, even when they perform air traffic simulations in the laboratory.

In aviation safety, clear and effective communications are as important as technical skills (Tajima, 2004). Communication is also related to linguistic intelligence. In general, intelligence is defined as a person's ability to acquire knowledge, then master it and put it into practice when facing problems. Gardner (1993) an expert known in the theory of multiple intelligences, defines intelligence as the ability to solve problems and produce products in various circumstances and real situations. Furthermore, Gardner (1993) defines linguistic intelligence as the ability to use and process words effectively, both oral (verbal) and written (nonverbal).

Besides verbal intelligence, memory is another factor traditionally associated with academic achievement (Bayliss et al., 2003; Bull et al., 2008). Memory is the awareness of one or more experiences in the past that come back to life. Memory is also defined as the spiritual ability to receive (keep in mind), store, and raise awareness (reproduce) of things that have been stored (Umainingsih et al., 2017). From a psycholinguistic point of view, the memory contains an impulse to a claim through a network regarding an event or events in the past, which is called the reconstruction process (Ridwan, 2006).

There are three systems in memory: sensory, short-term, and long-term (Hilgard et al., 1979). Furthermore, the memory that plays a significant role and is needed in the completion of most cognitive tasks is short-term memory. This memory is also often associated with performance in reading and mathematics (Bayliss et al., 2005; Bull et al., 2008; del Valle & Urquijo, 2015; Hulme et al., 2007; Swanson & Kim, 2007). Additionally, the correlation between memory and academic

performance was found among children, adolescents, and adults (Bull et al., 2008; Engle et al., 1999; Swanson & Kim, 2007).

In ATC training, cadets have to decide or quickly choose phraseologies that are in accordance with the conditions experienced when providing air traffic services at the Aerodrome Control Tower (TWR) Laboratory. They need to communicate with radio transmission as the primary way to exchange information between controllers and others. In this situation, cadets are required to recall phrases to establish communication. Furthermore, the phraseologies that have been memorized will be conveyed through verbal instructions or information. Using non-standard phraseology can lead to misunderstanding, breakdown of the communication process, or eventually to loss of separation.

As stated above, due to their correlation with academics, linguistic intelligence, and memory, either individually or simultaneously, both appear to affect the performance of adolescents when performing learning activities which in this case are simulations in the laboratory. Therefore, this study was designed to analyze the correlation and influence of linguistic intelligence and short-term memory on the performance of adolescents in the laboratory during air traffic control simulations.

RESEARCH METHOD

According to the level of explanation, this type of research is classified as associative or relationship research aiming to reveal the relationship between two or more variables (Siregar, 2013). This research is also a study with multiple correlation analysis, namely the analysis used to determine the strength of the relationship between three or more variables and to determine the contribution given partially or simultaneously by the independent variables to the value of the dependent variable (Siregar, 2013).

The population used in this study were level II ATC candidates at the Politeknik Penerbangan Medan's Diploma III Air Traffic Control Study Program. There were 24 cadets, categorized as a saturated sampling method because all population members were the samples. This technique is often used when the population is small and less than thirty people (Sugiyono, 2011). The data collection technique chosen in this study was a test. The test is a set of stimuli given to the sample to get an answer which is then used as the basis for determining a numerical score. In the test, research instruments are used, also known as research measuring instruments, in the form of intelligence tests and air traffic control simulations. Before testing the hypothesis, it is necessary to test the normality and linearity of the data first as a prerequisite test. These tests were carried out to obtain the data distribution and determine the linear nature of the distribution of the variable data. From the normality test, data is usually distributed if the probability value or significance level of the data is more significant than 0.05 ($p > 0.05$), while data with a significance level less than 0.05 ($p < 0.05$) is not normally distributed. After then, the data was analyzed using the product-moment correlation technique.

RESULT AND DISCUSSION

Result

The measuring instrument used to obtain data on linguistic intelligence and short-term memory abilities of cadets are the Intelligence Structure Test (IST). The subtests conducted to measure linguistic intelligence include SE/completing sentences subtest, WA/finding synonyms subtest, the AN/finding word relationships subtest, and GE/finding homonyms test. The ME/Aufgaben/memorizing words subtest is conducted to measure short-term memory. From the test results, the scoring is then carried out based on the scoring provisions that have been set for each question item. The test results showed in Table 1.

Table 1. Test Result

No.	Data	X1	X2	Y
1	Lowest score	86	85	62
2	Highest score	108	109	81
3	Mean	99.25	98.79	73.96
4	Median	101	99	75
5	Modus	103	99	75

Based on the data results, categorization is divided into low, medium, and high categories, as presented in Table 2 and Table 3.

Table 2. Categorization of Linguistic Intelligence Score

No.	Interval	Frequency	Percentage	Details
1	$X \leq 94$	4	17%	Low
2	$94 < X \leq 104$	18	75%	Medium
3	$104 < X$	2	8%	High
	Total	24	100%	

It can be seen from the data presented in Table 2 that 4% of the total cadets are in a low category, 75% are in the medium category, and 2% are in the high category. From this categorization, the level II cadets of the Diploma III Air Traffic Control Program at the Politeknik Penerbangan Medan have relatively average linguistic intelligence with a percentage of 75%.

Table 3. Memory Score Categorization

No.	Interval	Freqeuncy	Percentage	Details
1	$X \leq 75$	0	0%	Low
2	$65 < X \leq 89$	2	8,3%	Medium
3	$89 < X$	12	91,7%	High
	Total	24	100%	

Furthermore, Table 3 shows that level II ATC cadets in the Diploma III Air Traffic Control Study Program at the Politeknik Penerbangan Medan have a relatively high short-term memory (high category) with a percentage of 91.7%. Then, an Air Traffic Control simulation was used as the research instrument to obtain data on the Y variable or air traffic control performance. Each item of expected performance is scored according to the existing scoring guidelines.

Additionally, the simula-tion results are as follows the lowest value of 62, the highest value of 81, and an average value of 73.96. Based on the result data, the simulation result score data were then categorized in the TWR Laboratory to place respondents in tiered categories: low, medium, and high. The categorization of the results of the simulation of air traffic control performance in the TWR Laboratory is presented in Table 4.

Table 4. Air Traffic Control Performance Score Categorization

No.	Interval	Frequency	Percentage	Details
1	$X \leq 65$	2	8,3%	Low
2	$65 < X \leq 75$	13	54,2%	Medium
3	$75 < X$	9	37,5%	High
	Total	24	100%	

Table 4 shows that 54.2% of level II cadets' air traffic control performance results in the Diploma Study Program in Air Traffic Control of Politeknik Penerbangan Medan are in the medium category. In the prerequisite test, the Kolmogorov-Smirnov Tes of Normality is used as the normality test, which is analyzed by statistical applications. From the normality test, it is concluded that the three variables tested, namely linguistic intelligence, short-term memory, and air traffic control

performance of cadets, have Asymp. Sig, which is greater than 0.05 (Table 5). Hence, the three variables are normally distributed.

Table 5. Normality Test

Data	Kolmogorf-Smirnov Asymp. Sig.
X1	
X2	0.162
Y	

The following prerequisite test is a linearity test with a significance level (α) of 5%. Two variables will be said to have a linear relationship if the deviation from linearity sig. is more significant than 0.05. From the results of the linearity test, it is concluded that there is a linear and significant relationship between the variables X1 and Y as well as variables X2 and Y, as evidenced by the deviation from linearity sig. > α or Fcount < Ftable value as shown in Table 6 and Table 7.

Table 6. X1 and Y Linearity Test

Linearity Test	
Deviation from Linearity Sig.	0,941
α	0,05
F_{count}	0,388
F_{table}	3,47

Table 7. X2 and Y Linearity Test

Linearity Test	
Deviation from Linearity Sig.	0,869
α	0,05
F_{count}	0,454
F_{table}	3,47

Linguistic Intelligence Correlation with Air Traffic Control Performance

Pearson product-moment correlation coefficient is a correlation analysis used to see the effect between variables. With the help of statistical applications, the results of the correlation analysis of linguistic intelligence with air traffic control performance are presented in Table 8.

Table 8. Linguistic Intelligence Correlation with Air Traffic Control Performance

Effect of X1 on Y	
Constant number	17,448
Reaction coefficient number	0,921
R	0,881
R2	0,776
Sig	0,000
α	0,05
r_{count}	8,726
r_{table}	0,404

Value of Sig. < α can be seen in Table 8 shows that linguistic intelligence is related to air traffic control performance. Furthermore, the significance test also displayed the value of rcount > rtable, which means that linguistic intelligence significantly influences cadets' air traffic control performance in the TWR Laboratory.

Correlation between Memory and Air Traffic Control Performance

The results of the correlation analysis between memory and air traffic control performance are presented in Table 9.

Table 9. Correlation between Memory and Air Traffic Control Performance

Effect of X2 on Y	
Constant number	12,871
Reaction coefficient number	0,618
R	0,763
R2	0,582
Sig	0,000
α	0,05
r_{count}	5,540
r_{table}	0,404

From Table 9, it can be seen that the value of Sig. < α. Hence, it can be determined that the short-term memory variable is related to the air traffic control performance variable. Furthermore, based on the significance test, the rcount value is 5.540 while the rtable is 0.404. If rcount > rtable, it means that short-term memory ability also has a significant effect on cadets' air traffic control performance.

Linguistic Intelligence and Memory Double Regression of Air Traffic Control Performance

Multiple regression tests can be carried out to see the correlation between the three variables, as presented in Table 10.

Table 10. Double Regression

Effect of X1, X2 on Y	
R	0,881
R2	0,777
Sig	0,000
F	0,05
F_{count}	36,528
F_{table}	3,47

The value of Fcount > Ftable shown in Table 10 indicates a significant influence between linguistic intelligence and short-term memory on cadets' air traffic control performance when conducting simulations in the laboratory.

Discussion

Cadets with a good level of linguistic intelligence can process words and have a satisfactory form of speech. Instructions, information, or permissions are written in English when the cadets perform air traffic control simulations. Providing precise and efficient information, instructions, and permissions is influential in the safety of aviation traffic. The data from the intelligence structure test in this study showed that 75% of the cadets had medium linguistic intelligence.

Gardner (1993) defines intelligence as the ability to solve problems or create value products in one or more cultural and societal settings. In the theory of multiple intelligences (multiple intelligences or MI), Gardner refers to intelligence as a collection of mental abilities, talents, or skills. Gardner's theory offers a broader view of intelligence and suggests that intelligence is a continuum that can be developed throughout life. According to Gardner in Jasmine (2016), most people can adequately develop this type of intelligence.

Someone with linguistic intelligence can organize thoughts clearly and use the ability competently through words to express his/her thoughts orally. This speaking skill is the central and most visible aspect of this intelligence. However, this intelligence is used for communication skills and, more importantly, the ability to express one's thoughts, desires, and opinions.

In the implementation of air traffic control simulations, cadets were required to be able to receive or input the information received from several of their co-workers, including pilots, to then

store it and then reproduce the information when needed. With the re-emergence of information in aviation traffic services, cadets must continue to comply with the rules of in-flight communication. This is, of course, the basis that memory is also closely related to cadets' air traffic control performance.

In English, contextually, the word memory or remembrance refers to remember, remind, and recollection (Ridwan, 2006). The word memory also includes meanings: keeping facts and recalling facts back to the mind, succeeding in remembering, and the time over which the memory goes back. From the point of view of psycholinguistics studies, memory contains an impetus for claims regarding past events through a network called the reconstruction process (Ridwan, 2006). Furthermore, Ridwan (2006) stated that this includes demands, incentives, or claims.

In terms of structure, memory in its reconstruction process goes through three stages, namely: (1) The input stage refers to making notes about the message/content someone hears or reads from a discourse. Furthermore, one can carry out an interpretation of the content and then store it in memory. It should be noted that memory is different from rote. If memorization focuses on the outer form, memory is more concerned with content, message, and meaning (internal form); (2) Storage stage pertains to memorizing and storing several words or phrases. In this stage, storage can be classified into short-term or long-term memory. Short-term memory covers a short period and is relatively easy to remember, e.g., a number sequence of no more than 7 or 8 digits. As for long-term memory, it takes a longer time and differs in the limitations of ability between one person and another. Remembering phrases with long word sequences, let alone unrelated ones, requires high skill and memory; and (3) In The output stage, in this stage, someone recalls and reuses the stored information so that it can produce something.

Memory as a process refers to the dynamics of the mechanisms associated with acquiring and recalling information from the past (Crowder, 1993). This process is divided into three stages: recalling information that has been learned in the past, recognizing information, remembering, and connecting various other information so that it becomes a complex concept or story (Hilgard et al., 1979; Khodijah, 2014). Someone who can remember a thing or event indicates that the person has experienced it or has stored the relevant information in his consciousness and will bring it back at some time.

All information received will go through sensory memory in the memory system and last for a brief period. Furthermore, the information will be sent to short-term memory and stored for only about 15-30 seconds. If the information is still memorized, the short-term memory then forwards it to the long-term memory, which is a permanent storage place for information.

From the results of the intelligence structure test, which measures memory ability, it can be seen that 91.7% of the cadets have high short-term memory abilities. Moreover, from the calculation of the regression equation between short-term memory and air traffic control performance, the formula $Y = 12.871 + 0.618X$ is obtained. If $X = 0$, then the equation $Y = 12.871$ is obtained. Thus, if the cadets do not have good short-term memory, it is estimated that they will get a 12.871 score due to air traffic control performance in the TWR Laboratory.

Concerning the positive X coefficient, the relationship between short-term memory and air traffic control performance is also positive. Hence, the greater the short-term memory ability possessed by the cadets, the more excellent the opportunity for better results of the cadets' air traffic control performance in the laboratory TWR. According to the value of $r = 0.763$, it can also be concluded that the short-term memory of the cadets contributes to 58.2% of the impact on air traffic control performance. According to Ling and Catling (2012), short-term memory is one-factor affecting individual intelligence. Therefore, a good memory is expected to positively impact cadets' performance during air traffic control simulations.

According to the results of air traffic control performance obtained from the simulations, 8.3% or two cadets have simulation results in the low category, 54.2% or 13 cadets in the medium category, and 37.5% or nine cadets are in the high category. The performance itself is defined as the result of an implementation or treatment. In the study of Psycholinguistics, Chomsky in Chaer (2009) defines performance as linguistic treatment or language implementation in the form of producing sentences in actual or real conditions. Moving forward from this definition, performance in air traffic control can also be defined as the implementation of communication (verbal and nonverbal) between

the controller and the pilot or other related parties in terms of air traffic control. This communication is carried out in average and emergencies by providing instructions and information needed during the flight, such as weather information, flight navigation, and flight traffic conditions.

In carrying out the duties of a controller, there are five objectives of air traffic services or known as objectives of the air traffic services, that must be followed, namely:

> *Prevent collisions between aircraft; prevent collisions between aircraft in the maneuvering area and obstructions in that area; expedite and maintain an orderly flow of air traffic; provide advice and helpful information for the safe and efficient conduct of flights; notify appropriate organizations regarding aircraft in need of search and rescue aid, and assist such organizations as required.* (International Civil Aviation Organization, 2001)

From all these objectives, it is clear that the controller is an important part of the aviation traffic service because preventing collisions between aircraft with obstacles in the vicinity is the main task of this profession.

During the learning period at the TWR Laboratory, prospective ATC cadets also carry out the same roles, tasks, and goals as a controller, i.e., conducting air traffic control simulations which, of course, must be safe, secure, and efficient. The implementation of this simulation is based on a predetermined expected performance, from now on referred to as air traffic control performance. Air traffic control performance consists of several aspects, one of which is the communication/clearance/instruction/information provided by prospective ATC students who act as controllers. This becomes incredibly important because all services an ATC provides are stated in permissions, instructions, and information.

From the analysis results, linguistic intelligence and short-term memory ability, either individually or together, have a significant relationship with air traffic control performance. This is based on the significance test results, each of which shows that the rcount values are 8.726 and 5.540 > rtable value = 0.404.

Interestingly, this study's findings align with a recent study by Robres et al. (2021), who suggested that better short-term memory is associated with better academic achievement and will remain stable for the next level, even with higher academic demands. Suppose these findings are related to this research, then, of course. In that case, part of the success of air traffic control performance which is part of the academic achievement of ATC cadets, will be determined by short-term memory abilities. In this case, research by Robres et al. (2021) above strengthens the results of this study. Hence, good short-term memory is important for ATC prospective cadets to provide satisfactory air traffic control performance results in the TWR Laboratory.

Furthermore, to improve the cadets' air traffic control performance during simulations at the TWR Laboratory, teachers at the Politeknik Penerbangan Medan should support cadets in developing abilities and skills based on short-term memory abilities. Several studies have found various ways to develop or improve a person's short-term memory skills. This increase in ability is also supported by the latest research that proved the continuous production of new neurons or neurogenesis in the brain until adulthood. As a result, abilities, and intelligence can still be developed (Boldrini et al., 2018; Cope & Gould, 2019; Kempermann et al., 2018). This research also shows that even from entering adulthood until reaching adulthood, it is still possible to develop the abilities of each individual.

CONCLUSION

This study's results indicate a positive relationship and a significant effect, as indicated by a correlation value of 0.881 (powerful correlation) between linguistic intelligence and air traffic control performance and 0.763 (strong correlation) between memory and air traffic control performance. Furthermore, the level of proximity of the relationship between the three variables is considered extremely strong due to the correlation coefficient value being 0.881, which means that the two predictors in this study contributed 77.7% to cadets' performance in the TWR Laboratory. However, this study did not consider linguistic factors affecting memory, such as language type, input, time (period, time), and results (output). Furthermore, due to the limitations of this research, it is hoped that future studies will develop this research with a wider sample or add other variables that are

thought to affect air traffic control performance to meet a higher level of contribution in the field of air traffic control.

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REFERENCES

Agustini, E. D. (2019). Pengkajian Phraseology (Bahasa) pemanduan lalu lintas penerbangan Makassar Advanced Air Traffic Services di Bandara Internasional Sultan Hasanuddin-Makassar. *Warta Penelitian Perhubungan*, *24*(1), 70–88. https://doi.org/10.25104/warlit.v24i1.985

Bayliss, D. M., Jarrold, C., Baddeley, A. D., & Gunn, D. M. (2005). The relationship between short-term memory and working memory: Complex span made simple? *Memory*, *13*(3–4), 414–421. https://doi.org/10.1080/09658210344000332

Bayliss, D. M., Jarrold, C., Gunn, D. M., & Baddeley, A. D. (2003). The complexities of complex span: Explaining individual differences in working memory in children and adults. *Journal of Experimental Psychology: General*, *132*(1), 71–92. https://doi.org/10.1037/0096-3445.132.1.71

Boldrini, M., Fulmore, C. A., Tartt, A. N., Dwork, A. J., Mann, J. J., Boldrini, M., Fulmore, C. A., Tartt, A. N., Simeon, L. R., Pavlova, I., & Poposka, V. (2018). Human hippocampal neurogenesis persists throughout aging. *Cell Stem Cell*, *22*(4), 589-599.e5. https://doi.org/10.1016/j.stem.2018.03.015

Budiman, J., Pujangkoro, S. A., & Anizar. (2013). Analisis beban kerja operator air traffic control bandara XYZ dengan menggunakan metode NASA-TLX. *Jurnal Teknik Industri FT USU*, *3*(3), 15–20. https://www.neliti.com/publications/219430/analisis-beban-kerja-operator-air-traffic-control-bandara-xyz-dengan-menggunakan

Bull, R., Espy, K. A., & Wiebe, S. A. (2008). Short-term memory, working memory, and executive functioning in preschoolers: Longitudinal predictors of mathematical achievement at age 7 years. *Developmental Neuropsychology*, *33*(3), 205–228. https://doi.org/10.1080/87565640801982312

Chaer, A. (2009). *Psikolinguistik: Kajian teoretik*. Rineka Cipta.

Clark, L., & Williams, G. J. (2020). English Language proficiency in radiotelephony: A survey about its effect on the safety and efficiency of aviation. *The ESPecialist*, *41*(4), 1–21. https://doi.org/10.23925/2318-7115.2020v41i4a9

Cope, E. C., & Gould, E. (2019). Adult neurogenesis, glia, and the extracellular matrix. *Cell Stem Cell*, *24*(5), 690–705. https://doi.org/10.1016/j.stem.2019.03.023

Costa, G. (1996). *Occupational stress and stress prevention in air traffic control*. https://www.ilo.org/wcmsp5/groups/public/---ed_protect/---protrav/---safework/documents/publication/wcms_250120.pdf

Crowder, R. G. (1993). Short-term memory: Where do we stand? *Memory & Cognition*, *21*(2), 142–145. https://doi.org/10.3758/BF03202725

del Valle, M. V., & Urquijo, S. (2015). Relaciones de las estrategias de codificación mnésica y la capacidad de aprendizaje con el desempeño académico de estudiantes universitarios. *Psicología Educativa*, *21*(1), 27–37. https://doi.org/10.1016/j.pse.2015.02.004

Engle, R. W., Tuholski, S. W., Laughlin, J. E., & Conway, A. R. A. (1999). Working memory, short-term memory, and general fluid intelligence: A latent-variable approach. *Journal of Experimental Psychology: General*, *128*(3), 309–331. https://doi.org/10.1037/0096-3445.128.3.309

Fathimahhayati, L. D., Tambunan, W., & Putri, R. A. (2018). Analisis beban kerja mental pada operator Air Traffic Controller (ATC) dengan metode subjektif dan objektif (Studi kasus: Airnav Bandar Udara XYZ). *Angkasa: Jurnal Ilmiah Bidang Teknologi*, *10*(1), 69–76. https://doi.org/10.28989/angkasa.v10i1.205

Gardner, H. (1993). *Multiple Intelligences (kecerdasan majemuk) teori dalam praktik* (L. Saputra (ed.)). Interaksara.

Hilgard, E. R., Atkinson, R. C., & Atkinson, R. L. (1979). *Introduction to psychology* (Seventh Ed). Harcourt Brace Jovanovich.

Hulme, C., Goetz, K., Gooch, D., Adams, J., & Snowling, M. J. (2007). Paired-associate learning, phoneme awareness, and learning to read. *Journal of Experimental Child Psychology*, *96*(2), 150–166. https://doi.org/10.1016/j.jecp.2006.09.002

International Civil Aviation Organization. (2001). *Annex 11 - Air Traffic Services* (13th ed.). International Civil Aviation Organization. https://skyrise.aero/wp-content/uploads/2017/03/ICAO-Annex-11-Air-traffic-services.pdf

International Civil Aviation Organization. (2007). *Manual of radiotelephony* (4th ed.). https://www.ealts.com/documents/ICAO Doc 9432 Manual of Radiotelephony (4th ed. 2007).pdf

Jasmine, J. (2016). *Metode mengajar multipple intelligences* (A. Salim (ed.); P. Purwanto (trans.)). Nuansa Cendekia.

Kempermann, G., Gage, F. H., Aigner, L., Song, H., Curtis, M. A., Thuret, S., Kuhn, H. G., Jessberger, S., Frankland, P. W., Cameron, H. A., Gould, E., & Hen, R. (2018). Human adult neurogenesis: Evidence and remaining questions. *Cell Stem Cell*, *23*(1), 25–30. https://doi.org/10.1016/j.stem.2018.04.004

Khodijah, N. (2014). *Psikologi belajar*. Remaja Rosdakarya.

Li, Y., Zhang, Y., Wang, L., & Guan, X. (2022). Research on potential ground risk regions of aircraft crashes based on ADS-B flight tracking data and GIS. *Journal of Transportation Safety & Security*, *14*(1), 152–176. https://doi.org/10.1080/19439962.2020.1754981

Ling, J., & Catling, J. (2012). *Psikologi kognitif*. Erlangga.

Rachmadina, K. M., & Puspitadewi, N. W. S. (2019). Hubungan antara fatigue dengan safety performances pada pekerja ATC (Air Traffic Controller). *Character: Jurnal Penelitian Psikologi*, *6*(4), 1–6. https://jurnalmahasiswa.unesa.ac.id/index.php/40/article/view/29853

Rahmati, M., & Izadpanah, S. (2021). A study of the proficiency and performance of Iranian Air Traffic Controllers: Attitude, work experience and specific aviation English courses. *Asian-Pacific Journal of Second and Foreign Language Education*, *6*(1), 1–22. https://doi.org/10.1186/s40862-020-00105-y

Rakas, J., & Yang, S. (2007). Analysis of multiple open message transactions and controller-pilot miscommunications. *7th USA/Europe Air Traffic Management R&D Seminar*, 1–11. https://www.researchgate.net/profile/Jasenka-Rakas/publication/228678418_Analysis_of_Multiple_Open_Message_Transactions_and_Controller-Pilot_Miscommunications/links/00463520ee19c2ce1e000000/Analysis-of-Multiple-Open-Message-Transactions-and-Controller-Pil

Ridwan, T. A. (2006). *Bahasa dan linguistik*. PT. Mestika.

Robres, A. Q., Andrade, A. G., Ortega, Z., & Ramajo, S. S. (2021). Intelligence quotient, short-term memory and study habits as academic achievement predictors of elementary school: A follow-up study. *Studies in Educational Evaluation*, *70*, 101020. https://doi.org/10.1016/j.stueduc.2021.101020

Siregar, S. (2013). *Metode penelitian kuantitatif: Dilengkapi dengan perhitungan manual & SPSS*. Kencana.

Suarez, R. (2007). *The effects of foreign accent and language on reaction time and accuracy in an Air Traffic Control task* [Embry-Riddle Aeronautical University]. https://commons.erau.edu/cgi/viewcontent.cgi?article=1278&context=db-theses

Sugiyono, S. (2011). *Metode penelitian administrasi*. Alfabeta.

Swanson, H. L., & Kim, K. (2007). Working memory, short-term memory, and naming speed as predictors of children's mathematical performance. *Intelligence*, *35*(2), 151–168. https://doi.org/10.1016/j.intell.2006.07.001

Tajima, A. (2004). Fatal miscommunication: English in aviation safety. *World Englishes*, *23*(3), 451–470. https://doi.org/10.1111/j.0883-2919.2004.00368.x

Umainingsih, M. B., Alexon, & Kurniah, N. (2017). Penerapan model pembelajaran untuk meningkatkan daya ingat dan prestasi belajar matematika. *Diadik : Jurnal Ilmiah Teknologi Pendidikan*, *7*(2), 87–97. https://doi.org/10.33369/diadik.v7i2.3687

Yen, J.-R. (2014). Modelling the oral communication performance of Air Traffic Control. *Journal of Air Transport Studies*, *5*(1), 39–54. https://doi.org/10.38008/jats.v5i1.72