

The Effect of Teachers' Training, Areas of Expertise, and Education Type on the Achievement of Multiple-choice HOTS Questions in Vocational High School

Sutrisno, Antelas Eka Winahyo, Boedi Rahardjo

Universitas Negeri Malang, Indonesia

E-mail: sutrisno.ft@um.ac.id

Abstract. This research aimed to find the impact of teachers' training, areas of expertise, and education type on the achievement of multiple-choice HOTS questions. The design of this research was experimental. The independent variable was training provision, the moderator variables were teachers' areas of expertise and education level, and the dependent variable was the achievement of multiple-choice HOTS questions. The subjects in this research were 28 teachers of Public Vocational High School 2 Turen consisting of teachers in productive and non-productive areas of expertise. The data collection used documentation and assignments. The data analysis technique used descriptive statistics with a paired t-test and factorial f-test. The significance level in this research was $p = 0.05$. Results showed that training provision significantly improved teacher's skills in making multiple-choice HOTS questions, improvement tendency of productive teachers after training compared to non-productive teachers, albeit insignificant, and improvement tendency shown by teachers from the non-teaching institutions after training compared to teachers from teaching institution, although also insignificant.

Keywords: training, question, hots, teachers

INTRODUCTION

Vocational high school graduates are required not only to perform routine work but also problem-solving. However, in reality, their competency has not reached the expectation, signed by low graduates' absorption in the workplace (Central Bureau of Statistics, February 2020). The situation signaled that learning activity in vocational high school has low relevancy with workplace needs.

Low relevancy could be caused by low target achievement from students and, in turn, less pushing for them to think more creatively. The condition is marked by many kinds of research that showed that most teacher-made questions are parts of the lower order of thinking (Saïdo et al., 2015; Putri, 2017; Rohmi et al., 2018; Maghviroh & Sutrisno, 2016; Sofiana et al., 2018; & Sari et al., 2018).

Higher-order thinking encourages students to learn previously unencountered problem-solving, analyze phenomena to find answers, respond to the phenomenon, and solve problems in new ways. Students are ready to solve the issues, not only from the learned material but also by creating ways to solve upcoming ones through HOTS (Higher Order Thinking Skill) questions.

HOTS questions require higher-order thinking, not only knowledge, comprehension, or application, but contextual, analytical, evaluative, and creative. Anderson and Krathwohl detailed the HOTS that consists of (1) application, using formula, model, and provisions in new condition; (2) analysis: distinguish, center, select, organize, find relationships, integrate, describe, describe, organize, relate, deconstruct; (3) evaluate, such as to verify, coordinate, detect, observe, test, criticize, and assess; and (4) creating, namely generate, hypothesize, plan, design, produce, or construct (Anderson & Krathwohl, 2001).

Experts have different opinions in placing whether an area is in lower- or higher-order thinking. According to Bronk (2009), the cognitive area has six levels divided into lower- and higher-order thinking skills. Knowledge, comprehensions, and application are lower-order thinking skills, whereas analysis, synthesis, and evaluation are higher-order thinking skills. Other experts, Ulmer and Torres (2007) grouped knowledge and comprehension as lower-order thinking skills (LOTS) and application, analysis, synthesis, and evaluation as HOTS. Thompson (2008) stated that lower-order thinking is

signaled by information or concepts or knowledge application in situations familiar to students. Higher-order thinking involves solving assignments that have yet to be taught or known in a new context or case. Some researchers use Bloom's Taxonomy as the standard in assessing whether some questions are in LOTS or HOTS category. In Bloom's Taxonomy, LOTS questions cover knowledge and comprehension, while questions containing analysis, synthesis and evaluation are in the HOTS category. According to Thompson (2008), the application is often found in LOTS and HOTS. Application can be included in the HOTS category when used in new situations.

Based on the above description, HOTS questions mean higher-order thinking questions consisting of application in new situations, analysis, synthesis, and evaluation. Or, according to the revised Bloom's Taxonomy, consists of applying in new condition, analysis, evaluation, and creating.

Training helps improve the skill in creating HOTS questions. Analysis showed that training provision significantly enhanced the workers' ability (Al Naqbi et al., 2018). Training also improved society's workability (Yudianto et al., 2020) substantially.

Variables that possibly influenced HOTS achievement in making multiple-choice questions were teachers' areas of expertise and education origin type. As commonly known, vocational high school teachers are divided into productive and non-productive and teachers who come from teaching and non-teaching institutions. Effective teachers teach practice and drawing subjects and rarely use multiple-choice questions, whereas non-productive teachers in theory subjects always use multiple-choice questions. Similarly, teachers from teaching institutions mainly receive materials on creating multiple-choice questions in HOTS; therefore, their skills in creating HOTS questions are better. Meanwhile, teachers from non-teaching institutions did not receive the material, reflecting poorly on their abilities. Thus, it could be said that teachers' areas of expertise and education origin type possibly influence the HOTS achievement in multiple-choice questions. This research aimed to find the influence of teachers' training, areas of expertise, and education type on the achievement of multiple-choice HOTS questions.

METHODS

This research was experimental design. The independent variable was training provision, the moderator variables were teachers' areas of expertise and education level, and the dependent variable was the achievement of multiple-choice HOTS questions. Hence, the control group was before training, and the experimental group was after training.

The subjects in this research were 28 teachers from Public Vocational High School 2 Turen, consisting of teachers in productive and non-productive areas of expertise. Data collection technique used documentation and assignments. Each subject made ten questions of HOTS before and after training on making multiple-choice questions HOTS. HOTS achievement was assessed using the six-level indicators of the revised edition of Bloom's Taxonomy. The research was conducted online and offline due to the pandemic.

The procedure was performed in eight stages. The first stage was creating and collecting data on multiple-choice HOTS questions that teachers made following their ability. The second stage was the evaluation of the questions. The third stage was sharing the material on how to create multiple-choice questions of HOTS. The fourth stage was an assignment on making multiple-choice HOTS questions. The fifth stage was the evaluation of the newest assignment. The sixth stage was comparing the initial questions with the after-training results. The seventh stage was comparing the HOTS achievement between productive and non-productive teachers and between teachers from teaching institutions and non-teaching institutions. The eighth stage found the interaction between training provision with areas of expertise and teachers' type of education institution and HOTS achievement.

The data analysis technique used descriptive statistics with paired t-test and factorial f-test. The descriptive analysis was utilized to find the central tendency of data before and after treatment. The mean difference analysis was used to see the difference and improvement from the before and after

treatment, while factorial analysis of variance was utilized to obtain the interaction between areas of expertise and type of education with HOTS achievement. The requirements test is carried out before analyzing differences and interactions, resulting in a significance level of $p = 0.05$.

RESULT AND DISCUSSIONS

Training Influence on HOTS Achievement

Before teachers’ training, the mean value of HOTS was 55.57 and improved to 65.04 after training. Descriptively, there was a 9.47 points improvement or 17.04% from the initial value. The results of the data normality test showed that before training, data were not distributed normally with the value of Asymp. Sig. (2-tailed) $0.013 < 0.05$. Meanwhile, after training, the data were distributed normally with the value of Asymp. Sig. (2-tailed) $0.200 > 0.05$. This shows that there are data weaknesses in generalizing to the population.

The experimental analysis results showed a significant improvement in teachers' skills when creating multiple-choice questions of HOTS before and after training, obtaining the mean value of 55.57 before training and 65.04 after training. The factorial analysis of variance received $F = 16.641$ with significance $0.00 < 0.05$ as written in Table 1.

Table 1. Analysis of Variant Score Improvement

Tests of Within-Subjects					
Source	Sum of Squares	df	Mean Square	F	Sig.
Y	1318.867	1	1318.867	16.641	.000
Error (Y)	2060.615	26	79.254		

These results stated that training provision improved teachers' ability to create HOTS questions by 17.04%, similar to the previous research indicating that training provision improved teachers' ability to implement HOTS-based lessons by 4.23%. The improvement was significant (Sudan et al., 2020). Thus, the increase in the teacher's ability to make multiple choice HOTS questions after the training was significant. However, the ability has yet been optimized, with only scoring for 65.04%. This situation means that training needs to be done continuously to improve teachers' ability because HOTS questions making skill is essential in preparing exams.

Training and Areas of Expertise Influence on HOTS Achievement

The achievement of multiple-choice HOTS questions that teachers made is explained below. Descriptively, training improved teachers' ability in creating multiple-choice questions. However, there was a score difference between productive and non-productive teachers. Before training, the ability of productive teachers was lower than non-productive teachers. After training, they were better than non-productive teachers, as seen in Table 2 with 13.46 points improvement or 25.03%, whereas the improved ability of non-productive teachers was 6.00 points or 10.50%.

Table 2. Crosstab of Time and Teachers' Areas of Expertise

	Productive	Non-Productive
Before Training	53.77	57.13
After Training	67.23	63.13
Improvement	13.46	6.00

The t-test was performed to find the significant improvement after conducting the requirement test. Based on the normality test, both groups were not normally distributed. Based on the One-Sample Kolmogrov-Smirnov test, the Asymp. Sig. (2-tailed) < 0.05. These results indicated a weakness in the results of the analysis in generalization.

Mean difference analysis results showed no difference in teachers' ability in making HOTS questions between productive and non-productive. Results obtained non-homogenous t-test = 1.524 and significance of (2-tailed) = 0.143 > 0.05 as stated in Table 3. Hence, this research admitted that although productive teachers' ability in making HOTS questions was better than non-productive, the improvement was insignificant.

Table 3. T-test Results from Productive dan Non-productive Teachers

	Levene's Test		t-test for Equality of Means		
	F	Sig.	t	df	Sig. (2-tailed)
Equal variances assumed	6.088	.021	1.564	26	.130
Equal variances not assumed			1.524	20.928	.143

Although, after training, productive teachers could create better results compared to prior training (Table 2), the interaction was insignificant. The interaction analysis between training provision and teachers' areas of expertise obtained the value of $F = 2.446$ and significance of $0.130 > 0.05$, as shown in Table 4. Results implied that the interaction was limited and tended to be insignificant.

Table 4. Interaction Between Training Provision and Areas of Expertise

Tests of Within-Subjects					
Source	Sum of Squares	df	Mean Square	F	Sig.
Y * X	193.867	1	193.867	2.446	.130
Error (Y)	2060.615	26	79.254		

Figure 1 displays the interaction diagram of multiple-choice HOTS questions from before and after training those productive and non-productive teachers made. Before training, productive teachers made lower score questions than non-productive teachers, whereas, after training, they were better, although the interaction was insignificant.

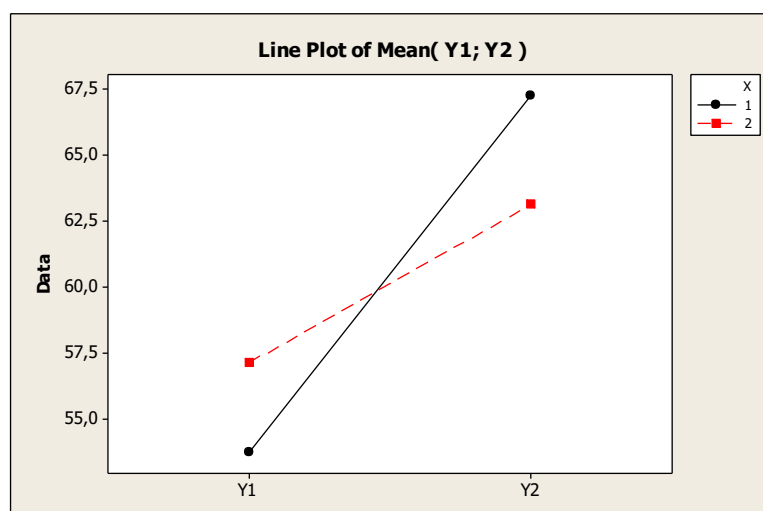


Figure 1. Interaction Between Training Provision and Areas of Expertise

The insignificant interaction results could be caused by the sample of each cell that did not meet the total number; hence, even if interaction occurred descriptively, inferentially, it was insignificant. It can be explained that productive teachers with a lack of ability to create HOTS questions, marked by the low score (53.77), needed to improve themselves to become more confident. It became a motivation for those teachers to improve and better themselves. This situation followed previous analysis and research that stated a significant correlation between the need for self-actualization and work motivation, with $r = 0.602$ and $p = 0.00 < 0.05$. Higher need for self-actualization resulting in higher work motivation (Syauta & Yuniasanti, 2015). However, performance motivation and quality are also influenced by incentives. Different incentives might create different motivations and performances. Previous research showed that stimulus had a significant and positive effect on work motivation with $p = 0.028 < 0.05$ (Spanjaards, 2016; Graha, 2005). Likewise, according to Graha (2005), incentives positively and significantly impacted performance with $p = 0.000 < 0.05$. Therefore, based on previous researches, it can be concluded that they tended to have improvement on productive teachers after training, although insignificant.

Training and Education Origin Influence on HOTS Achievement

Before training, teachers from teaching institutions made higher HOTS questions than teachers from non-teaching institutions. After training, their skills were on par. The improvement, however, was higher on teachers from non-teaching institutions, as exhibited in Table 5. The improvement for teachers from teaching institutions was 7.10 points or 12.25%, while for teachers from non-teaching institutions was 14.44 points or 28.56%.

Table 5. Crosstab of Time and Education Type

	Teaching	Non-teaching
Before training	57.95	50.56
After training	65.05	65.00
Improvement	7.10	14.44

These results showed that teachers from non-teaching teaching institutions adapted to HOTS questions making after training. Their initial lower skill in making HOTS questions became similar with the teachers from teaching institutions. The t-test was performed to find whether the improvement was significant or not after conducting the requirement test. The results of the normality test of data based on the type of education show that a group is normally distributed with significance (2-tailed) = $0.120 > 0.05$, whereas another is not normally distributed with Asymp. Significance (2-tailed) = $0.001 < 0.05$.

The mean difference analysis results showed no difference in teachers' ability in making HOTS questions between teaching institutions and non-teaching institutions. Results obtained non-homogenous t-test = 1.430 and significance of (2-tailed) = $0.165 > 0.05$ as stated in Table 6. Hence, this research admitted that although non-teaching institution-origin teachers' ability to make HOTS questions better than teachers from teaching institutions, the improvement was insignificant.

Table 6. T-test Result Teaching Institution and Non-teaching Institution

	Levene's Test		t-test for Equality of Means		
	F	Sig.	t	Df	Sig. (2-tailed)
Equal variances assumed	2.577	.121	1.430	26	.165
Equal variances not assumed			1.319	13.077	.210

As mentioned before training, teachers from non-teaching institutions had lower HOTS questions than teachers from teaching institutions. After training, they were on the same level as seen in Table 5. The interaction analysis between training provision and teachers' areas of expertise obtained the value of $F = 2.046$ and significance of $0.165 > 0.05$, as shown in Table 7. Results implied that the interaction was insignificant.

Table 7. Interaction Between Training Provision and Education Type

Tests of Within-Subjects					
Source	Sum of Squares	df	Mean Square	F	Sig.
Y * Z	164.476	1	164.476	2.046	.165
Error(Y)	2090.006	26	80.385		

Figure 2 displays the interaction diagram of multiple-choice HOTS questions from before and after training made by teachers from non-teaching institutions and teaching institutions. Before training, teachers from non-teaching institutions made lower score questions than teachers from teaching institutions, whereas, after training, they were almost the same.

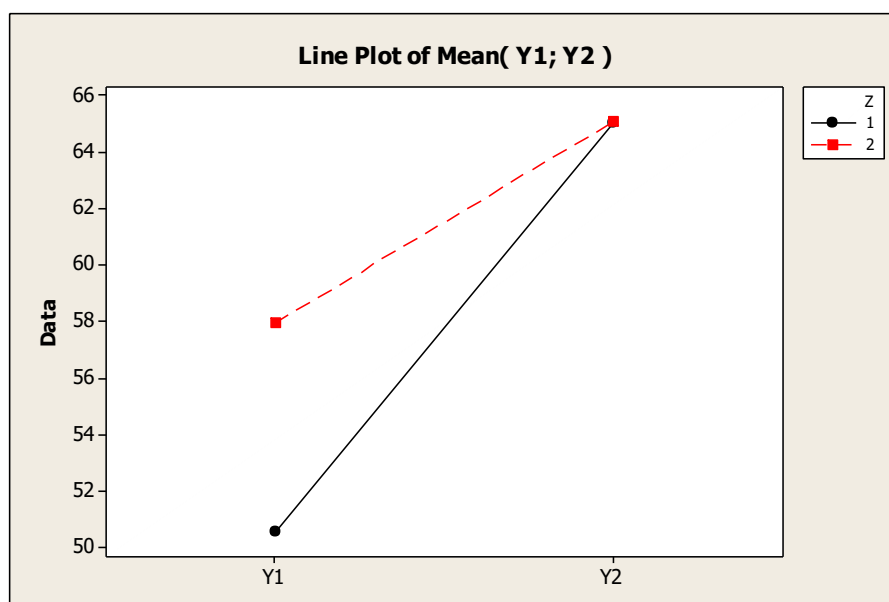


Figure 2. Interaction Between Training Provision and Educational Type

The results can be explained as teachers who came from non-teaching institutions did not receive learning evaluation knowledge, and they felt the need to obtain that. The training material was needed to give good assessment during learning, and they could be more confident in making HOTS questions so that before training, they gained lower scores; after training, the score was balanced with teachers from teaching institutions. This condition followed previous research where self-esteem, self-actualization, and social needs affected motivation significantly. Social needs affected motivation by = 0.165 with $p = 0.012$, self-esteem needs affected motivation by = 0.321 with $p = 0.000$, and self-actualization needs affected motivation by = 0.243 with $p = 0.001$ (Taslimet al, 2018). Likewise, there was a significant positive relationship between self-actualization needs and work motivation, with $r = 0.602$ and $p = 0.00 < 0.05$ (Syauta & Yuniasanti, 2015). However, the results showed that incentives influenced the quality of the performance. The provision of compensation or incentives had a positive and significant effect on employee performance (Oluigbo & Anyiam, 2014). There was a positive and significant effect between incentives on teacher performance (Maulana & Thohari, 2019 & Pasaribu & Irsutami, 2015). Likewise, the study results found that partially material incentives affected motivation

but had no effect on performance. This showed that if the incentives are not different, the quality of motivation and performance may also be similar. Therefore, based on previous researches, it can be concluded that they tended to have improvement on teachers from non-teaching institutions better than teacher institutions, although insignificant.

CONCLUSION

Based on the analysis and discussion, the conclusions were as below. First, the achievement in developing multiple-choice HOTS questions was 65.04, a 17.04% improvement from the initial score. Training provision on creating multiple-choice HOTS questions improved the level of the question significantly. Second, a tendency that the HOTS questions from productive teachers were better than non-productive teachers, although the improvement was insignificant. Descriptively, there was interaction in HOTS achievement with training provision in teachers' areas of expertise, although insignificant. Third, teachers from non-teaching institutions tend to improve better than teachers from teaching institutions, although minor. Likewise, there was no significant interaction between training provision and teachers' origin institution.

REFERENCES

- Al Naqbi, R.A.K., Yusoff, R.B.M., & Ismail, F.B. (2018). The Effect of Incentive System on Job Performance Motivation as Mediator for Public Sector Organization in Uae. *International Journal of Engineering & Technology*, 7 (4.7), 380-388.
- Anderson, L.W. & Krathwohl, D.R. (2001). *A Taxonomy for Learning, Teaching and Assessing: A Revision of Bloom's Taxonomy*. Retrieved from: <http://www.kurwongbss.qld.edu.au/thinking/Bloom/blooms.htm>
- Central Bureau of Statistics. (2020). The Open Unemployment Rate (TPT) is 4.99 percent. Retrieved from: <https://www.bps.go.id/pressrelease/2020/05/05/1672/februari-2020--tingkat-pengangguran-terbuka--tpt--sebesar-4-99-persen.html>
- Bronk, R. (2009). *Bloom's Taxonomy*. Retrieved from: http://etec.ctlt.ubc.ca/510wiki/index.php?title=Bloom%27s_Taxonomy&oldid=62298
- Gómez-Carrasco, C. J., Monteagudo-Fernández, J., Moreno-Vera, J. R., & Sainz-Gómez, M. (2019). Effects of a Gamification and Flipped-Classroom Program for Teachers in Training on Motivation and Learning Perception. *Education Sciences*, 9(4), 1-15. Doi: <https://doi.org/10.3390/educsci9040299>. Retrieved from: <https://www.mdpi.com/2227-7102/9/4/299>
- Govaerts, N., Kyndt, E., & Dochy, F. (2018). The Influence of Specific Supervisor Support Types on Transfer of Training: Examining the Mediating Effect of Training Retention. *Vocations and Learning*, 11(2), 265-288. Doi: 10.1007/s12186-017-9190-y
- Graha, A.N. (2005). The Effect of Training on Employee Ability and Its Impact on Employee Performance. *Modernisasi*, 1 (2), 75-93.
- Scaradozzi, D., Screpanti, L., Cesaretti, L., Storti, M., & Mazzieri, E. (2019). Implementation and Assessment Methodologies of Teachers' Training Courses for STEM Activities. *Technology, Knowledge and Learning*, 24(2), 247-268. Doi: <https://doi.org/10.1007/s10758-018-9356-1>
- Maghviroh, L. dan Sutrisno, S. (2016). Analysis of Multiple Choice Questions Made by Teachers Competency in Drawing Engineering Skills for Vocational High Schools. *Teknologi dan Kejuruan*, 39(1), 21-32.
- Maulana, S.R., & Thohari, F. (2019). The Effect of Incentives on Teacher and Employee Performance at Madrasah Aliyah Darul Muttaqien Bogor. *Jurnal Ekonomi Efektif*, 1 (2), 122-134.

- Misliya, M., Alim, A., Usuf, E., Tamsah, H. & Yusriadi, Y. (2021). The Effect of Training and Education and Teacher Certification Allowances on Teachers. *Cypriot Journal of Educational Science*. 16(4), 1368-1383. Doi: <https://doi.org/10.18844/cjes.v16i4.5986>
- Ödalen, J., Brommesson, D., Erlingsson, G. Ó., Schaffer, J. K., & Fogelgren, M. (2019). Teaching University Teachers to Become Better Teachers: The Effects of Pedagogical Training Courses at Six Swedish Universities. *Higher Education Research & Development*, 38(2), 339-353. <https://doi.org/10.1080/07294360.2018.1512955>
- Oluigbo, I., & Anyiam, K. (2014). The Role of Compensation on Employee Performance in an Information Technology Organization. *International Journal of Research in Information Technology*, 2(4), 548-558.
- Pasaribu, C., & Irsutami. (2015). The Effect of Incentives on Teacher Performance in State Senior High Schools with Motivation as an Intervening Variable. *Jurnal Akuntansi, Ekonomi dan Manajemen Bisnis*, 3(1), 69-73.
- Putri, A. N. (2017). Students' Cognitive Thinking Level Based on Question Forms in General Biology Course. *Proceedings of the National Seminar on Science Education, Science Research and Learning Development Strategies to Sharpen 21st Century Skills*, Universitas Sebelas Maret Surakarta, 136-140.
- Rohmi, N. Z. Sutrisno, S., Kuncoro, T. (2018). *Conformity of Thinking Level on Exam Questions and Subject Assignments with Basic Competency Indicators of DPIB Islamic Vocational School 1 Blitar City*. Research Report. Malang: State University of Malang.
- Saido, G. M., Siraj, S., Nordin, A. B., & Al_Amedy, O. S. (2015). Higher Order Thinking Skills Among Secondary School Students in Science Learning. *The Malaysian Online Journal of Education Science*, 3(3), 13-20.
- Sari, P.N., Sutrisno,S., Wena, M. (2018). *Differences in Forms of Assessment of Achievements in the Cognitive Level of DPIB State Vocational High School 6 Malang*. <http://karya-ilmiah.um.ac.id/index.php/TS/article/view/80453/0>.
- Smith, T. E., & Sheridan, S. M. (2019). The Effects of Teacher Training on Teachers' Family-Engagement Practices, Attitudes, and Knowledge: A Meta-Analysis. *Journal of Educational and Psychological Consultation*, 29(2), 128-157. doi: <https://doi.org/10.1080/10474412.2018.1460725>
- Sofiana, I., Sutrisno, S., & Winahyo, A. E. (2018). Teacher's Understanding of the Level of Questions Arranged in the Technical Skills of Vocational High Schools. *Teknologi dan Kejuruan*, 4(1), 45-54.
- Spanjaards, H. (2016). *The relation between incentives and job motivation, and the influence of gender*. Thesis, Faculty of Economics and Business, University of Amsterdam.
- Sudana, I. M., Oktarinab, N., Apriyanic, D., & Achmadid, T. A. (2020). An Implementation of HOTS Based Learning Strategy in Vocational High Schools. *International Journal of Innovation, Creativity and Change*. 13(12), 1327-1340.
- Syauta, B. A., & Yuniasanti, R. (2015). The relationship between needs of self-actualization and working motivation in career women in PT Kusuma Sandang Mekarjaya. *InSight*, 17(1), 49-55.
- Taslim, N. Y. M., Ishak, N. A., & Abdullah, A. (2018). The Relationship between Needs Accomplishment and Motivation. *Journal of Administrative Science*, 15(2), 91-98.
- Thompson, T. (2008). Mathematics Teachers' Interpretation of Higher-Order Thinking in Bloom's Taxonomy. *International Electronic Journal of Mathematics Education*. 3(2), 96–111.
- Ulmer, J. D., & Torres, R. M. (2007). A Comparison of The Cognitive Behaviors Exhibited by Secondary Agriculture and Science Teachers. *Journal of Agricultural Education*. 48(4), 106–116.

- Ward, R. J., Bristow, S. J., Kovshoff, H., Cortese, S., & Kreppner, J. (2022). The Effects of ADHD Teacher Training Programs on Teachers and Pupils: A Systematic Review and Meta-Analysis. *Journal of Attention Disorders*, 26(2), 225-244. Doi: <https://doi.org/10.1177/1087054720972801>
- Widiyawati, Y., Nurwahidah, I., Sari, D. S., Masykuri, M., & Budiyanto, C. W. (2021). The 21st Century Science Learning: HOTS and Digital Literacy Among Junior High School Students in Semarang, Indonesia. *Journal of Physics: Conference Series*. 1842(1), 1-13. Doi: 10.1088/1742-6596/1842/1/012081
- Yudianto, R, Zulaiha, & Diana, H. (2020). The Effect of Training on Improving Community Work Ability at the Pagaralam City Job Training Center. *Ekonomia*, 11(1), 56-70.
- Zahid, M., & Khanam, A. (2019). Effect of Reflective Teaching Practices on the Performance of Prospective Teachers. *Turkish Online Journal of Educational Technology-TOJET*, 18(1), 32-43. Retrieved from: <https://eric.ed.gov/?id=EJ1201647>