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Bloom's Taxonomy Revision-Oriented Learning Activities to Improve Procedural Capabilities and Learning Outcomes

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Abstract: The implementation of learning activities in schools has not provided opportunities or encouragement for students in developing their procedural knowledge. This research aimed to test the effectiveness of developing Bloom's Taxonomy revision-oriented learning activities to grade IV elementary learners' procedural knowledge capabilities and learning outcomes. This research used quasi-experiment with a quasi-experimental design which consisted of a posttest-only control design. The population of this study was sixth-grade students of 9 schools with an overall number of 229 students. The sample in the study was 50 students, there were 26 students from the experimental class and 24 students from the control class. A test method with 10 question items was used as a data collection method. The data analysis methods and techniques used were quantitative descriptive analysis and inferential statistical analysis. Then the data were analyzed using the MANOVA test assisted by the IBM SPSS Statistics 21.0 program. The hypothesis test results showed a significance value of .000 (Sig<.05). It can be concluded in procedural capabilities and learning outcomes between groups of students there is a significant difference from following learning by implementing Bloom's Taxonomy Revision oriented learning activities with the experimental and control group.

Keywords: *Bloom's taxonomy revision, learning outcomes, procedural capabilities.*

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Introduction

Learning is an interactive process between learners with teachers, learners with learners, learners with the subject matter, and learning environments (Dolong, 2016; Hanafy, 2014; Pane & Dasopang, 2017; Zhu et al., 2021). Increased interaction between these components, especially students, requires innovations in learning so that learning qualifies good learning. Learning is successful if it can engage students or be student-centered and able to motivate students to be able to find for themselves and associate the information they have obtained with information that is already in the student's memory (Andrian & Rusman, 2019). Learning processes like this will make learning more meaningful. Meaningful learning will provide emotional and social experiences (Bressington et al., 2018; Kostiainen et al., 2018). One of the teacher's main roles is creating meaningful learning. The teacher should create a learning atmosphere that makes students active in learning. If students are invited to move into learning, then students interest and motivation in learning will increase. Increasing learning activities is an effort made by teachers so that students' behavior in the learning process changes better (Emda, 2018; Lubis, 2011; Suharni & Purwanti, 2018). In carrying out learning activities, students should also follow learning procedures to develop the procedural knowledge they have (Badjeber & Mailili, 2018; Fakhrurrazi, 2018).

Procedural knowledge is knowledge related to how to do something that includes knowledge of skills and algorithms, techniques and methods, and criteria that are used as a reference in determining the time to do something in a particular discipline (Armanza & Asyhar, 2020; Astuti et al., 2019; Ioannou & Ioannou, 2020). Procedural knowledge is a scientific step generally studied through laboratory activities or practices (Fadilah et al., 2020). The improvement of procedural knowledge aims to assist students in developing a more systematic and structured mindset. A better and more systematic mindset will affect students' problem-solving (Burais et al., 2016; Khuzaeva, 2014). Developing students' procedural

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knowledge is inseparable from teachers' responsibility in creating an interesting and fun learning atmosphere, then being able to motivate students to be active and take a part in the learning process. It is because creating a fun learning atmosphere will affect the learners' interest and motivation in the following learning. High motivation and interest in the learning process will positively impact student learning outcomes (Berutu & Tambunan, 2018; Febriyanti & Seruni, 2014). The acquisition of student learning outcomes should match the cut score determined. High learning outcomes show that learning is achieved well and optimally.

The reality that occurs in the field shows that the learning activities implemented by the teacher lack innovation and varied creations, therefore, the learning becomes teacher-centered. The approach used is still a conventional approach without realizing the involvement of students in the learning process. Teachers explain more in theory than students do their activities. Students cannot participate actively during learning. In addition, students do not get the opportunity to develop thinking skills during learning. The lack of learning activity resulted in low student learning outcomes (Mahlianurrahman, 2017). So far, learning activities in schools have not provided opportunities or encouragement for students to develop their procedural knowledge (Hutagaol, 2013; Siregar et al., 2011). Procedural knowledge has not been emphasized in the learning implementation. Therefore, this causes students to be more able to memorize than just understand the subject matter delivered by the teacher. This also causes students to be less able to solve problems properly and systematically. Other problems during learning activities include the lack of attention and student responses to the teacher's explanation. Students get bored following lessons and tend to be passive in learning activities (Syahrir & Susilawati, 2015). This will have an impact on the students' low learning outcomes.

In solving the problems, the opportunity to improve procedural knowledge skills can be done by developing Bloom's Taxonomy Revision-oriented learning activities. Learning activities must encourage students to participate in learning actively. The learning activity can be interpreted as an activity in the learning process that encourages students to achieve learning goals (Gugssa & Kabeta, 2021; Lubis, 2011; Machin, 2012; Rawa et al., 2016; Sailer et al., 2021). The learning activities implementation with Bloom's Taxonomy Revision in the teaching and learning process has a massive influence on improving students' knowledge, especially procedural knowledge because learning activities are designed to be more innovative and varied. There are two dimensions in Bloom's Taxonomy Revision, namely the dimension of cognitive processes consisting of remembering, understanding, applying, analyzing, evaluating, and creating, while the knowledge dimension consists of factual, conceptual, procedural, and metacognitive knowledge (Gunawan & Palupi, 2012).

Several previous studies have become references in supporting this research, namely research which states that student learning activities have a significant influence on improving learning outcomes and the construction of students' cognitive processes in elementary schools (Agung et al., 2017; Rahmadani & Anugraheni, 2017). Other research also states that learning activities are feasible to be developed to improve students' thinking skills (Bartik et al., 2013). Furthermore, there is research stating that innovative learning models in learning can improve students' procedural skills (Mufliva & Herman, 2016). In addition, the use of revised bloom taxonomy-oriented learning activities can improve scientific literacy and creative thinking skills (Pujawan et al., 2022). Based on these studies, it can be seen that there has been no research that examines the use of Bloom's Taxonomy revision-oriented learning activities to increase procedural knowledge and student learning outcomes. Therefore, the novelty of this study is applying revised bloom taxonomy-oriented learning activities to improve procedural knowledge and student learning outcomes in elementary schools.

This research aimed to test the effectiveness of developing Bloom's Taxonomy revision-oriented learning activities to grade IV elementary learners' procedural knowledge capabilities and learning outcomes. The learning activity consists of 6 activities: procedural recall, understanding procedural, applying procedural, analyzing procedurals, evaluating procedurals, and creating procedurals. This is expected to be able to support the teachers create more innovative learning activities and emphasize students' procedural knowledge to actively participate in the process of learning and become centers in learning.

Methodology

Research Design

This research was a study with a quasi-experiment and a quasi-experimental as the research design which consisted of a post-test-only control design. The experimental group was the group that applied the treatment. The teacher organized a learning process that provided opportunities for students to carry out learning activities following the revised bloom taxonomy. The learning activities consisted of 6 activities: procedural recall, understanding procedural, applying procedural, analyzing procedurals, evaluating procedurals, and creating procedurals. In contrast, control classes were not given treatment, or students followed learning without applying Bloom's Taxonomy Revision-oriented learning activities. After the application of learning activities was completed, both classes are given a post-test in the kinds of a description problem.

Sample and Data Collection

The population used in this study was grade IV students in Cluster II of Buleleng regency consisting of 9 schools with an overall number of 229 students who then conducted an equality test against all grade IV using One Way-ANOVA using the SPSS 22.0 application for windows. The study's population was the entire object consisting of similar elements (Asbari et al., 2019; Kokoç & Kara, 2021). At the same time, the determination of research samples was done by random sampling technique. The sample in this study was 50 students, with characteristics presented in Table 1.

Table 1. The Characteristics of Sample

Characteristics	Sub-Characteristics	N
Group	Experimental (SD Negeri 1 Tukadmungga)	26
	Control (SD Negeri 2 Banjar Tegal)	24
	Total	50
Gender	Male	22
	Female	28
	Total	50
Learning Achievement	High	14
	Medium	26
	Low	10
	Total	50

The test method was used as a data collection method in this study. The test method was one method implemented to determine the level of ability and knowledge of a person by providing some questions or stimuli to be given a response or answer by the individual (Evayanti & Sumantri, 2017). Test methods were used to determine how the effectiveness of Bloom's Taxonomy Revision oriented in students learning activities procedural knowledge abilities and learning outcomes. The research instrument used was a test in the form of essay questions. The instrument was developed by the researcher by following several stages, namely: 1) preparation for the instrument grid, 2) preparation for the instrument, and 3) instrument validation. The instrument used must go through several tests, namely: validity and reliability test. The research instrument grids are presented in Table 2 and Table 3.

Table 2. The Grid of Procedural Knowledge Instrument

Basic Competency		Indicators	Cognitive Level	Item Number	Number of Items
3.4	Knows the relations of force to motion in occurrence in the surrounding environment.	Presented with the question, students can appropriately mention the steps of playing with the catapult.	C1	1,2	2
3.3	Explains the benefits of the diversity of individual characteristics in everyday life.	Presented with questions, students can explain the stages carried out in compiling observational reports about the diversity of individual characteristics appropriately.	C2	3,4	2
4.4	Presents experimental results on the relationship between force and motion.	Presented with images, students can arrange to kick and stop the ball appropriately.	C3	5,6	2
3.1	Knows three-dimensional images and shapes.	Presented with the questions, students can appropriately distinguish the stages of three-dimensional images.	C4	7,8	2
3.9	Observe the characters contained in the fictional text.	Presented with questions, students can assess the steps of making fiction stories appropriately.	C5	9,10	2
4.1	Creates a story picture	Presented with a question, students can arrange the steps to take a picture of the story appropriately.	C6	11,12	2

The procedural knowledge instrument test had been tested for the validity and reliability of the instrument. To test the validity of the procedural knowledge, test the CVR formula was used. The results obtained from calculating each instrument item with the CVR formula were 1.00. The acquisition of the CVR value indicated valid criteria. It was used to test the content validity of the procedural knowledge test instrument. The results obtained from calculations using the CVI formula are 1.00. Acquisition of CVI scores indicated very good validity criteria. To test the reliability of the procedural knowledge test with polytomous data, the Alpha-Cronbach formula was used. The results obtained from these calculations were 0.71 and were in the criteria of high reliability.

Table 3. The Grid of Learning Outcomes Instrument

Basic Competency		Indicators	Cognitive Level	Question Type	Number of Items	Items Number
3.4	Knows the relation of force to motion in occurrence in the surrounding environment	Explain the difference between force and motion	C2	Essay	1	1
4.4	Presents experimental results on the relationship between force and motion	Determine the effect of force on the motion of an object	C3	Essay	1	2
		Determine the force used in an activity	C3	Essay	1	3
3.3	Explains the advantages of individual diversity of characteristics in everyday life	Describes differences in characteristics of the individual in their family	C4	Essay	1	4
		Explain the benefits of the diversity of individual characteristics in everyday life	C2	Essay	1	5
3.1	Knows three-dimensional images and shapes	Specify images included in three-dimensional images	C3	Essay	1	6
		Describe the characteristics of a three-dimensional image	C2	Essay	1	7
3.9	Observe the characters contained in the fictional text.	Mention the characters contained in the story	C1	Essay	1	8
		Explaining the nature of each character in a story	C2	Essay	1	9
4.1	Creates a story picture	Create a story picture	C6	Essay	1	10

The learning outcomes instrument test had gone through validity and reliability testing. Then the CVR formula was used to measure the validity of the item learning outcomes. The results obtained from calculating each instrument item with the CVR formula were 1.00. The acquisition of the CVR value indicated valid criteria for all items. The CVI formula was used to test the content validity of the learning outcomes test instrument. The results obtained from calculations using the CVI formula were 1.00 with very good validity criteria. Test the reliability of learning outcomes with data in the form of polytomy using the Alpha-Cronbach formula. The results obtained from these calculations were 0.71 with high-reliability criteria.

Analyzing of Data

The analysis data methods used in this research were quantitative descriptive analysis methods and inferential statistics. Prerequisite analysis tests include data distribution normality tests, variance homogeneity tests, multivariate homogeneity tests, and bound variable linearity tests. The first initial test was the Kolmogorov-Smirnov normality test. Next was the homogeneity test which was carried out with two analyses: the variant homogeneity test with Levene's Test of Equality and the multivariate homogeneity test with Box's Test of Equality of Covariance Matrices. The next prerequisite test was a linearity test purpose to find out the absence of linear relationships in each bound variable analyzed by Deviation from Linearity.

Prerequisite analysis tests include data distribution of normality tests, variance homogeneity tests, multivariate homogeneity tests, and bound variable linearity tests. The first initial test was the Kolmogorov-Smirnov normality test. The result of the analysis showed all of the data came from a normally distributed data group. A Sig value can show. > 0.05. The normality prerequisite fulfilled the criteria, the next test was the homogeneity test. The homogeneity test was carried out with two analyses in this study, namely the variant homogeneity test with Levene's Test of Equality and the multivariate homogeneity test with Box's Test of Equality of Covariance Matrices. The outcomes of homogeneity analysis showed the same meaning that the data of the study come from homogeneous data groups' results. This can be observed from sig values. Each of the tests showed a value of more than 0.05. Sig value. Levene's Test of Equality is 0.285 for procedural capability while sig scores. Study results of 0.672. Moreover, the homogeneity test obtained a Sig value. 0.671.

The next prerequisite test is a linearity test to define the absence of linear relationships in each bound variable analyzed. The analysis results showed that the sig value in Linearity Deviation was .032 (<.05). It meant there was no linear relation between procedural capability data and learning outcomes.

Findings / Results

Descriptive Analysis Results

Bloom's Taxonomy Revision oriented learning activities that were tested for validity applying in SD N 1 Tukadmungga, which was selected as an experimental class. After the learning activities implementation was completed, then continued with the provision of tests to experimental and control class students. The tests were given to students to take procedural knowledge data and the outcomes of students' learning. Furthermore, data were analyzed inferentially and descriptively. The descriptive analysis of data in control groups and experimental is presented in Table 4.

Table 4. Descriptive Analysis Results

	Grade	Mean	Std. Deviation	N
Procedural Capabilities	Experimental	78.0546	9.23712	36
	Control	51.5394	7.94016	34
	Total	65.1716	15.86353	70
Learning Outcomes	Experimental	75.6000	8.00546	36
	Control	48.8834	7.51873	34
	Total	62.5724	15.46350	70

MANOVA Test Results

After the initial test, which included the data distribution normality test, the variance of homogeneity test, the test of multivariate homogeneity, and the test of bound variable linearity, it continued with the hypothesis testing using the Manova test. The outcomes of the MANOVA test analysis are presented in Table 5 and Table 6.

Based on MANOVA analysis in Table 5 and Table 6, it was obtained that the significance values on Pillai's Trace, Hotelling's Trace, Wilks' Lambda, and Roy's Largest Root amounted to .000 (<.05). Therefore, it found that there was a simultaneous difference in procedural knowledgeability and outcomes of learning between groups of students who follow learning by applying Bloom Revision Taxonomy-oriented activities of learning with groups of students who follow learning without the implementation. The test effects analysis between subjects showed a significance value of .000 (<.05) for the procedural knowledge variable. This meant that found a significant influence on learning by implementing Bloom's Taxonomy revision-oriented learning activities to the procedural knowledge skills of grade IV elementary students. And the last tests of effects analysis between subjects found a significance value of .000 (<.05) for the Learning Outcomes variable. That showed a significant influence on learning by applying Bloom's Taxonomy revision-oriented learning activities to the learning outcomes of grade IV elementary students.

Table 5. Multivariate Analysis Test

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Intercept	Pillai's Trace	0.980	2234.717	2.000	67.000	0.000	0.985
	Wilks' Lambda	0.020	2234.717	2.000	67.000	0.000	0.985
	Hotelling's Trace	66.668	2234.717	2.000	67.000	0.000	0.985
	Roy's Largest Root	66.668	2234.717	2.000	67.000	0.000	0.985
Grade	Pillai's Trace	0.750	101.084	2.000	67.000	0.000	0.751
	Wilks' Lambda	0.250	101.084	2.000	67.000	0.000	0.751
	Hotelling's Trace	3.018	101.084	2.000	67.000	0.000	0.751
	Roy's Largest Root	3.018	101.084	2.000	67.000	0.000	0.751

Table 6.Effects Analysis Test Between-Subjects

Source	Dependent Variable	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	Procedural Capabilities	12326.583	1	12303.583	165.333	0.000	0.709
	Learning Outcomes	12358.613	1	12388.613	205.043	0.000	0.751
Intercept	Procedural Capabilities	293634.726	1	293624.726	3945.665	0.000	0.983
	Learning Outcomes	270520.956	1	270520.956	4477.375	0.000	0.985
Grade	Procedural Capabilities	12303.583	1	12303.583	165.333	0.000	0.709
	Learning Outcomes	12388.613	1	12388.613	205.043	0.000	0.751
Error	Procedural Capabilities	5061.299	68	74.417			
	Learning Outcomes	4109.529	68	60.420			
Total	Procedural Capabilities	31467.000	70				
	Learning Outcomes	290559.000	70				
Corrected Total	Procedural Capabilities	17365.943	69				
	Learning Outcomes	16487.143	69				

Discussion

The study results showed a simultaneous difference in procedural knowledgeability and learning outcomes between groups of learners who followed the learning by applying Bloom's Taxonomy revision oriented in learning activities and groups of students who followed the learning without applying. In addition, based on further tests conducted, it was found that there was a significant influence of learning by applying Bloom's Taxonomy revision oriented in learning activities to procedural knowledgeability and learning results of grade IV elementary students. The analysis results showed that applying Bloom's Taxonomy revision in learning activities effectively improved the ability of procedural knowledge and students' learning outcomes. It proved by several changes in students' behavior in a better direction. The increasing student's activeness in learning and teaching activities. Bloom's Taxonomy revision oriented in learning activities allowed learners to go through, experience, or perform and relate their experiences and knowledge to new experiences and views on learning materials. It would not be easily forgotten by providing opportunities for students to do real activities that involve the physical and overall senses, seek, and discover new knowledge themselves (Kulsum & Hindarto, 2011). Providing opportunities for students to learn actively will provide a learning experience used in their daily lives (Angela, 2014; Bressington et al., 2018).

Following the activity, students' learning process is more to the learning process that can develop procedural skills. Students will have better procedural knowledge than those defended without Bloom's Taxonomy revision-oriented learning activities. In addition, activities that support knowledge development are problem-solving processes carried out in the process of learning. This statement is following the opinion that state procedural knowledge will increase if learners are accustomed to the problem-solving process (Ratu & Erfan, 2018). Problem-solving activities enable students to improve their understanding and solutions offered more interactively (Chang et al., 2017). Problem-solving ability is the ability to use skills already possessed to answer unanswered questions or difficult situations (Septina et al., 2018). Problem-solving is the ability of learners to solve challenging questions that cannot be solved by routine procedures that learners already know (Nomleni & Manu, 2018). Therefore, students' activity in the learning process can increase procedural knowledge.

Procedural knowledge means knowledge related to how to do something that includes knowledge of ability and algorithms, methods, techniques, and criteria that are used as a reference in determining the time to do something in a particular discipline (Armanza & Asyhar, 2020; Astuti et al., 2019; Ioannou & Ioannou, 2020). Procedural knowledge is a scientific step generally studied through laboratory activities or practices (Fadilah et al., 2020). The improvement of procedural knowledge aims to assist students in developing a more systematic and structured mindset. A better and more systematic mindset will affect how students solve a problem (Burais et al., 2016; Khuzaeva, 2014). Good procedural knowledge will certainly greatly impact student learning outcomes. Because the learning atmosphere produced will be more interesting and active, which will impact learning outcomes. Learning interest is needed in the learning process. Interest encourages children to actively participate in the learning process to change or increase knowledge and experience (Nasution et al., 2020). Learning interest is an important factor in success in all fields, such as studies, work, hobbies, and activities (Chen et al., 2020). Interest is not just a liking for something or an activity (Utomo et al., 2018). The interest in learning in students functions as a force that encourages students to learn. The higher the student's interest in the activity will improve the learning process, achieving the desired goals (Pambudi, 2018). Thus, more fun learning will grow students' interest in learning, improving students' learning outcomes.

Bloom's Taxonomy revision-oriented learning activities use a basic framework in thinking that makes it easier for the learner to understand, organize, and implement the goals of learning (Gunawan & Palupi, 2012). Students' procedural knowledge can be increased by applying Bloom's Taxonomy revision in learning activities. This is because Bloom's Taxonomy revision-oriented learning activities have the following advantages. 1) can improve students' activeness in learning, 2) can create students' learning experiences, 3) enable students to go through, experience, or perform as well as be able to relate their experiences and knowledge with new experiences and views on learning materials 4) produce deliberate changes in knowledge and attitude values, 5) increase students' interest and motivation in learning, and 6) provide opportunities for students to develop procedural knowledge, 7) can increase students' independence in learning through discovery activities that are following existing procedures, 8) can allow for social interaction that makes learning more enjoyable. Teachers should create Bloom's Taxonomy revision-oriented learning activities with these advantages. Therefore, the student's behavior in the learning process changes in a better direction and allows learners to take a part in the process of learning actively (Emda, 2018; Lubis, 2011; Suharni & Purwanti, 2018). Then, teachers can apply this learning activity to lower and higher classes to help students develop their knowledge.

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Conclusion

Bloom's Revised Taxonomy-oriented learning activities were developed effectively to enhance procedural knowledge capabilities and learning results of grade IV elementary students. This is because Bloom's Taxonomy revision-oriented learning activities have the following advantages: can improve students' activeness in learning; can create students' learning experiences; enable students to go through, experience, or perform as well as be able to relate their experiences and knowledge with new experiences and views on learning materials; produce deliberate changes in knowledge and attitude values; increase students' interest and motivation in learning; provide opportunities for students to develop procedural knowledge; can increase students' independence in learning through discovery activities that are following existing procedures; can allow for social interaction that makes learning more enjoyable.

Recommendations

Implementing Bloom's Taxonomy revision-oriented learning activities can encourage learners to participate actively and become centers in learning. The researcher recommends that practitioners create and implement learning activities based on Bloom's Revised Taxonomy in lower and higher classes to help students develop their procedural capabilities and learning outcomes. In addition, this research is expected to utilize as input for other future researchers to carry out similar research or even elaborate on other research methods.

Limitations

The limitations of this study lie in the limitations of the population and sample, the other limitation is in the dependent variable studied. Therefore, further research is expected to be able to conduct deeper research that can involve a larger population, and measure other variables.

Authorship Contribution Statement

Adijaya: Conceptualization, design. Agung Parwata: Analysis. Suwela Antara: writing/drafting manuscript. Widiana: Editing/reviewing, supervision.

References

Agung, A. A. G., Widiana, I. W., & Indrasuari, N. K. S. (2017). Pengembangan aktivitas pembelajaran mengasosiasi berbasis media gambar berseri dalam meningkatkan proses kognitif siswa [Development of association learning activities based on serial picture media in improving students' cognitive processes]. *Jurnal Ilmiah Sekolah Dasar*, *1*(3), 138-146. https://doi.org/10.23887/jisd.v1i3.10323

Andrian, Y., & Rusman, R. (2019). Implementasi pembelajaran abad 21 dalam kurikulum 2013 [Implementation of 21st century learning in the 2013 curriculum]. *Jurnal Penelitian Ilmu Pendidikan*, *12*(1), 14–23. https://doi.org/10.21831/jpipfip.v12i1.20116

Angela, T. (2014). Challenges to meaningful learning in social studies – the key competencies as an opportunity to students' active participation. *Procedia - Social and Behavioral Sciences*, *128*, 192–197. https://doi.org/10.1016/j.sbspro.2014.03.142

Armanza, R., & Asyhar, B. (2020). Pemahaman konseptual dan prosedural siswa sma / ma dalam menyelesaikan soal program linier berdasarkan tipe kepribadian [Conceptual and procedural understanding of high school students in solving linear program problems based on personality type]. *Jurnal Tadris Matematika*, *3*(2), 163–176. https://doi.org/10.21274/jtm.2020.3.2.163-176

Asbari, M., Santoso, P. B., & Purwanto, A. (2019). Pengaruh kepemimpinan dan budaya organisasi terhadap perilaku kerja inovatif pada industri 4.0 [The influence of leadership and organizational culture on innovative work behavior in industry 4.0]. *JIM UPB: Jurnal Ilmiah Manajemen*, *8*(1), 7–15. https://doi.org/10.33884/jimupb.v8i1.1562

Astuti, P., Qohar, A., & Hidayanto, E. (2019). Proses berpikir siswa dalam menyelesaikan soal higher order thinking skills berdasarkan pemahaman konseptual dan prosedural [Students' thinking process in solving higher order thinking skills problems based on conceptual and procedural understanding]. *Jurnal Pendidikan: Teori Dan Praktik*, *4*(1), 117–123. https://doi.org/10.17977/jptpp.v4i1.11910

Badjeber, R., & Mailili, W. H. (2018). Analisis pengetahuan prosedural siswa kelas smp pada materi sistem persamaan linier dua variabel ditinjau dari gaya kognitif [Analysis of the procedural knowledge of junior high school students on the material of a two variable linear equation system viewed from cognitive style]. *JPPM: Jurnal Penelitian dan Pembelajaran Matematika*, *11*(2), 41-54. http://doi.org/10.30870/jppm.v11i2.3753

Bartik, A., Abdussamad, & Rosnita. (2013). Peningkatan aktivitas pembelajaran matematika dengan penerapan metode demontrasi di kelas iii sdn 11 sungai kunyit [Increasing mathematics learning activities by applying demonstration methods in class iii sdn 11 sungai kunyit]. *Jurnal Pendidikan Dan Pembelajaran Khatulistiwa*, *2*(7), 1-12. http://bit.ly/3HUbl0N

Berutu, M. H. A., & Tambunan, M. I. H. (2018). Pengaruh minat dan kebiasaan belajar terhadap hasil belajar biologi siswa sma se-kota stabat [The influence of interests and study habits on biology learning outcomes of high school students in stabat city]. *Jurnal Biolokus: Jurnal Penelitian Pendidikan Biologi dan Biologi*, *1*(2), 109-116. https://doi.org/10.30821/biolokus.v1i2.351

Bressington, D. T., Wong, W. K., Lam, K. K. C., & Chien, W. T. (2018). Concept mapping to promote meaningful learning, help relate theory to practice and improve learning self-efficacy in Asian mental health nursing students: A mixed-methods pilot study. *Nurse education today*, *60*, 47-55. https://doi.org/10.1016/j.nedt.2017.09.019

Burais, L., Ikhsan, M., & Duskri, M. (2016). Peningkatan kemampuan penalaran matematis siswa melalui model discovery learning [Improving students' mathematical reasoning ability through the discovery learning model]. *Jurnal Didaktik Matematika*, *3*(1), 77–86. http://bit.ly/3YuK0YP

Chang, C. J., Chang, M. H., Chiu, B. C., Liu, C. C., Fan Chiang, S. H., Wen, C. T., Hwang, F. K., Wu, Y. T., Chao, P. Y., Lai, C. H., Wu, S. W., Chang, C. K., & Chen, W. (2017). An analysis of student collaborative problem solving activities mediated by collaborative simulations. *Computers and Education*, *114*, 222–235. https://doi.org/10.1016/j.compedu.2017.07.008

Chen, D., Putri, N. D., Meliza, W., Astuti, Y., Wicaksono, L. Y., & Putri, W. A. (2020). Identifikasi minat siswa sma kelas x terhadap mata pelajaran fisika [Identification of class x high school students' interests in physics subjects]. *PENDIPA Journal of Science Education*, *5*(1), 36–39. https://doi.org/10.33369/pendipa.5.1.36-39

Dolong, H. M. J. (2016). Teknik analisis dalam komponen pembelajaran [Analysis techniques in the learning component]. *Jurnal Inspiratif Pendidikan*, *5*(2), 293–300. https://cutt.ly/Y3Q8DK0

Emda, A. (2018). Kedudukan motivasi belajar siswa dalam pembelajaran [The position of student learning motivation in learning]. *Lantanida Journal*, *5*(2), 172-182. https://doi.org/10.22373/lj.v5i2.2838

Evayanti, A. M. D., & Sumantri, M. (2017). Penerapan metode mind mapping untuk meningkatkan keterampilan menulis surat pribadi siswa kelas IIIA [Application of mind mapping method to improve students' personal letter writing skills in class IIIA]. *Jurnal Ilmiah Sekolah Dasar*, *1*(1), 42–50. https://doi.org/10.23887/jisd.v1i1.10124

Fadilah, M., Permanasari, A., Riandi, R., & Maryani, E. (2020). Analisis karakteristik kemampuan literasi sains konteks bencana gempa bumi mahasiswa pendidikan ipa pada domain pengetahuan prosedural dan epistemik [Analysis of the characteristics of science literacy ability context of earthquake disasters of science education students in the domain of procedural and epistemic knowledge]. *Jurnal IPA Dan Pembelajaran IPA*, *4*(1), 103–119. https://doi.org/10.24815/jipi.v4i1.16651

Fakhrurrazi, F. (2018). Hakikat pembelajaran yang efektif [The nature of effective learning]. *At-Tafkir*, *11*(1), 85-99. https://doi.org/10.32505/at.v11i1.529

Febriyanti, C., & Seruni, S. (2014). Peran minat dan interaksi siswa dengan guru dalam meningkatkan hasil belajar matematika [The role of student interest and interaction with teachers in improving mathematics learning outcomes]. *Formatif: Jurnal Ilmiah Pendidikan MIPA*, *4*(3), 245–254. https://doi.org/10.30998/formatif.v4i3.161

Gugssa, M. A., & Kabeta, G. G. (2021). Instructors' workplace learning activities and inhibitors in Ethiopian higher learning institutions: Bahir Dar University in focus. *Social Sciences & Humanities Open*, *3*(1), Article 100106. https://doi.org/10.1016/j.ssaho.2021.100106

Gunawan, I., & Palupi, A. R. (2012). Taksonomi bloom - revisi ranah kognitif: kerangka landasan untuk pembelajaran, pengajaran, dan penilaian [Bloom's taxonomy - revision of the cognitive domain: a foundational framework for learning, teaching, and assessment]. *Premiere Educandum: Jurnal Pendidikan Dasar Dan Pembelajaran*, *2*(2), 98-117. http://doi.org/10.25273/pe.v2i02.50

Hanafy, M. S. (2014). Konsep belajar dan pembelajaran [The concept of learning and learning]. *Lentera Pendidikan: Jurnal Ilmu Tarbiyah dan Keguruan*, *17*(1), 66-79. https://doi.org/10.24252/lp.2014v17n1a5

Hutagaol, K. (2013). Pembelajaran kontekstual untuk meningkatkan kemampuan representasi matematis siswa sekolah menengah pertama [Contextual learning to improve the mathematical representation ability of junior high school students]. *Infinity Journal*, *2*(1), 85-99. https://doi.org/10.22460/infinity.v2i1.27

Ioannou, M., & Ioannou, A. (2020). Technology-enhanced embodied learning: Designing and evaluating a new classroom experience. *Educational Technology and Society*, *23*(3), 81–94. https://www.jstor.org/stable/26926428

Khuzaeva, E. S. (2014). Mengembangkan pola pikir cerdas, kreatif dan mandiri melalui telematika. *Jurnal Lingkar Widyaiswara*, *1*(4), 138-148. https://bit.ly/3JDPqMt

Kokoç, M., & Kara, M. (2021). A multiple study investigation of the evaluation framework for learning analytics: instrument validation and the impact on learner performance. *Educational Technology and Society*, *24*(1), 16–28. https://www.jstor.org/stable/26977854

Kostiainen, E., Ukskoski, T., Ruohotie-Lyhty, M., Kauppinen, M., Kainulainen, J., & Mäkinen, T. (2018). Meaningful learning in teacher education. *Teaching and Teacher Education*, *71*, 66–77. https://doi.org/10.1016/j.tate.2017.12.009

Kulsum, U., & Hindarto, N. (2011). Penerapan model learning cycle pada sub pokok bahasan kalor untuk meningkatkan keaktifan dan hasil belajar siswa kelas VII SMP [The application of the learning cycle model in the sub-topic of heat to increase the activity and learning outcomes of class VII junior high school students]. *Jurnal Pendidikan Fisika Indonesia*, *7*(2), 128–133. https://bit.ly/3HZ6ICA

Lubis, K. M. (2011). Peningkatan aktivitas pembelajaran hidrosfer dan dampaknya terhadap kehidupan melalui tindakan guru inovatif pada kelas x di sma negeri 1 semarang [Improving hydrosphere learning activities and its impact on life through innovative teacher actions in class x at sma negeri 1 semarang]. *Jurnal Geografi: Media Informasi Pengembangan dan Profesi Kegeografian*, *8*(1), 21-32. https://bit.ly/3RwNNSU

Machin, A. (2012). Pengaruh permainan call cards terhadap hasil belajar dan aktivitas pembelajaran biologi [The effect of call cards game on learning outcomes and biology learning activities]. *Jurnal Pendidikan IPA Indonesia*, *1*(2), 163–167. https://bit.ly/3jFBMOl

Mahlianurrahman, M. (2017). Peningkatan Motivasi Belajar IPA Melalui Implementasi Metode Inquiry Kelas V Sekolah Dasar [Increasing Motivation to Learn Science Through the Implementation Inquiry Methods in Class V Elementary School]. *Jurnal Ilmiah Sekolah Dasar*, *1*(4), 252-259. https://doi.org/10.23887/jisd.v1i4.12509

Mufliva, R., & Herman, T. (2016). Penggunaan bar model untuk meningkatkan kemampuan membuat model matematis dan keterampilan prosedural serta ketekunan belajar siswa sekolah dasar [The use of model bars to improve mathematical modeling ability and procedural skills and learning diligence of elementary school students]. *Jurnal Penelitian Pendidikan*, *16*(2), 147–159. https://doi.org/10.17509/jpp.v16i2.4236

Nasution, R. H., Hapidin, H., & Fridani, L. (2020). Pengaruh pembelajaran ict dan minat belajar terhadap kesiapan membaca anak usia dini [The influence of ict learning and learning interest on early childhood reading readiness]. *Jurnal Obsesi : Jurnal Pendidikan Anak Usia Dini*, *4*(2), 733-746. https://doi.org/10.31004/obsesi.v4i2.411

Nomleni, F. T., & Manu, T. S. N. (2018). Pengembangan media audio visual dan alat peraga dalam meningkatkan pemahaman konsep dan pemecahan masalah [Development of audio visual media and teaching aids in improving concept understanding and problem solving]. *Scholaria: Jurnal Pendidikan Dan Kebudayaan*, *8*(3), 219–230. https://doi.org/10.24246/j.js.2018.v8.i3.p219-230

Pambudi, B. A. (2018). Hubungan penggunaan jaringan internet, pelayanan administratif, minat dan motivasi belajar dengan prestasi mahasiswa [Relationship between internet network usage, administrative services, interests and learning motivation with student achievement]. *JMSP: Jurnal Manajemen Dan Supervisi Pendidikan*, *2*(3), 159–168. https://doi.org/10.17977/um025v2i32018p159

Pane, A., & Dasopang, M. D. (2017). Belajar dan pembelajaran [Lesson and learning]. *FITRAH: Jurnal Kajian Ilmu-Ilmu Keislaman, 3*(2), 333-352. https://doi.org/10.24952/fitrah.v3i2.945

Pujawan, I. G. N., Rediani, N. N., Antara, I. G. W. S., Putri, N. N. C. A., & Bayu, G. W. (2022). Revised bloom taxonomy-oriented learning activities to develop scientific literacy and creative thinking skills. *Jurnal Pendidikan IPA Indonesia (Indonesian Journal of Science Education)*, *11*(1), 47-60. https://doi.org/10.15294/jpii.v11i1.34628

Rahmadani, N., & Anugraheni, I. (2017). Peningkatan aktivitas belajar matematika melalui pendekatan problem based learning bagi siswa kelas 4 sd [Improving mathematics learning activities through problem based learning approach for grade 4 elementary school students]. *Scholaria: Jurnal Pendidikan Dan Kebudayaan*, *7*(3), 241-250. https://doi.org/jwf7

Ratu, T., & Erfan, M. (2018). Meningkatkan keterampilan procedural dan keterampilan berpikir tinggi mahasiswa melalui model pemecahan masalah pada perkuliahan elektronika dasar [Improving students' procedural skills and higher order thinking skills of students through problem-solving]. *Jurnal Pendidikan Fisika Dan Keilmuan*, *4*(1), 30–35. https://bit.ly/3JIbxRW

Rawa, N., Sutawidjaja, A., & Sudirman, S. (2016). Pengembangan perangkat pembelajaran berbasis model learning cycle 7e pada materi trigonometri untuk meningkatkan kemampuan koneksi matematis siswa [Development of learning tools based on the 7e learning cycle model on trigonometry materials to improve students' mathematical connection ability]. *Jurnal Pendidikan - Teori, Penelitian, Dan Pengembangan*, *1*(6), 1042–1055. http://bit.ly/3lcLbxt

Sailer, M., Schultz-pernice, F., & Fischer, F. (2021). Contextual facilitators for learning activities involving technology in higher education: The C♭-model. *Computers in Human Behavior*, *121*, Article 106794. https://doi.org/10.1016/j.chb.2021.106794

Septina, N., Farida, F., & Komarudin, K. (2018). Pengembangan lembar kerja siswa dengan pendekatan saintifik berbasis kemampuan pemecahan masalah [Development of student worksheets with a scientific approach based on problem solving ability]. *Jurnal TATSQIF: Jurnal Pemikiran & Penelitian Pendidian*, *16*(2), 160–171. https://doi.org/10.20414/jtq.v16i2.200

Siregar, N., Armanto, D., & Saragih, S. (2011). Penerapan pembelajaran berbasis masalah untuk meningkatkan pemahaman konsep dan pengetahuan prosedural matematika siswa smp [Application of problem-based learning to improve concept understanding and procedural knowledge of mathematics for junior high school students]. *PARADIKMA: Jurnal Pendidikan Matematika*, *3*(1), 104–208. http://bit.ly/3Ytbdei

Suharni, & Purwanti. (2018). Upaya meningkatkan motivasi belajar siswa [Efforts to increase student motivation]. *G-Couns: Jurnal Bimbingan Dan Konseling*, *3*(1), 131–145. https://doi.org/10.31316/g.couns.v3i1.89

Syahrir, S., & Susilawati, S. (2015). Pengembangan modul pembelajaran matematika siswa SMP [Development of mathematics learning modules for junior high school students]. *Jurnal Ilmiah Mandala Education*, *1*(2), 162-171. http://bit.ly/3Y870N5

Utomo, H. N., Arifin, I., & Timan, A. (2018). Latar minat & animo peserta didik dalam pembelajaran berbasis proyek di sekolah menengah kejuruan 4 tahun [Students' interests & interests in project-based learning in 4-year vocational high schools]. *Jurnal Administrasi Dan Manajemen Pendidikan*, *1*(1), 45–51. https://doi.org/10.17977/um027v1i12018p45

Zhu, R., Qiu, T., Wang, J., Sui, S., Hao, C., Liu, T., Li, Y., Feng, M., Zhang, A., Qiu, C., & Qu, S. (2021). Phase-to-pattern inverse design paradigm for fast realization of functional metasurfaces via transfer learning. *Nature communications*, *12*, Article 2974. https://doi.org/10.1038/s41467-021-23087-y