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UNDERSTANDING OF SOIL THROUGH META-AFFECTIVE AND META-COGNITIVE TRAINING

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Abstract

Living things play a significant function in the soil. As members of the younger generation, students lack knowledge of healthy soil. This Static-Group Pretest-Posttest Design provides integrated and separate meta-affective and meta-cognitive training in science learning, especially for topics on the science of soil. There are 36 students of ninth grade involve where each 18 students in integrated and separate training. The research instrument is 20 multiple-choice based on cognitive process dimensions in four sub-topics, namely the role of soil, the role of soil organisms, the process of soil formation, and soil components. The Normalized Gain (g) is testing the effectiveness of the two pieces of training. The results show that integrated training has a positive effect compared to separate training because it shows a positive average value of Normalized Gain (g). Furthermore, based on the sub-topics, two pieces of training did not help students in understanding the sub-topics "process of soil formation" and "soil components" because the average value of Normalized Gain (g) was negative. The fact that these two subtopics are less common than the other two in daily life is one of the contributing causes. The research's practical application is how to tie science to the mind (meta-cognitive) and emotions (meta-affective) in daily living.

Keywords: Integrated training, Meta-affective, Meta-cognitive, Separate training, Soil.

1. Introduction

The soil is a crucial part of the food chain that connects all living creatures. Deteriorating soil conditions may be impacted by pollution created by humans. Science instruction can use research-based learning techniques to better understand this, such as looking at soil micro-plastic pollution, analysing it in a lab, and looking into how it might affect the sustainability of the food chain in the polluted soil area [1]. Furthermore, today's biggest issue is climate change. As a result, it is vital to examine students' perceptions of how polar ice melts, how it occurs, and the repercussions. These findings may have ramifications for science curricula, which are used in the learning process. To avert future social confrontations, the community's growing awareness and critical attitude must be accommodated [2].

Investigating soil is a subject that social studies majors can also study. Their concept that soil is a source of productivity and life is evident from the analysis's findings. Additionally, there are connections between the concept of soil and economic, national, and spiritual values. The importance of soil concerning life, living things, humanity, and the motherland emerges from social studies students' perceptions [3]. Plants use the process of photosynthesis to create oxygen, and they see the soil as a source of life. Water is taken up by plants as they grow in the soil, where it is then used as one of the raw materials for photosynthesis. Alternative conceptions must be present alongside the main conception in science education. Students can use experimental activities to create conceptual changes or increase their understanding [4].

Students' conceptions must be disclosed at a young age because they are closely connected to nature at this age and have heightened awareness of environmental challenges. Direct interviews or student-created images and narrations might convey pupils' perceptions. The findings of the study demonstrate that they employ relevant knowledge to explain environmental phenomena, but that they also confront misconceptions and strongly claim that people are to blame for environmental difficulties. Children's and adults' perceptions of the world can also study by asking them to explain the earth's structure. In general, both children and adults consider soil and water to be the most important elements on the earth. They are unaware that the concentric layers are the earth's structure, leading to the possibility of life in the planet's deepest structures [5]. To engage students in comprehending global concerns related to soil conditions, it is essential for students who have taken scientific courses to learn the concept of soil. This concept analysis is being done utilizing the soil-related subtopics and the cognitive process dimension.

This study is innovative in that it combines meta-affective and meta-cognitive processes into a single unit to help students understand science. Previous research has solely emphasized the one that is employed in learning. In truth, thoughts and emotions can interact. For instance, students may have studied for tests and stored the information in their cognitive memory, but due to anxiety and nervousness, some of the information may have been forgotten. In this study, students in two groups that got single or combined meta-cognitive and meta-affective training in science learning are compared. The lesson plans the teacher employs to teach are including meta-affective and meta-cognitive methods.

Information regarding thinking is known as metacognitive knowledge or knowledge about thinking. The word "meta" implies "beyond" or "on top of," whereas "cognitive or cognition" refers to learning new things and developing existing knowledge through mental processes including thought, experience, and sense. The psychology of students is linked to this process in education, which makes use of students' capacity to plan, monitor, and assess their studies. As a result, this action is the result of a smart learner or thinker. Many studies in the field of education have raised concerns regarding meta-cognitive or metacognitive abilities [6]. In science education, meta-cognitive or metacognitive skills play a function as a research input [7, 8], or output [9].

Students' thoughts and feelings regarding their learning are inextricably linked. Meta-affective refers to the process of feeling or emotion, whereas meta-cognitive or metacognitive refers to the process of thinking. A meta-affective component helps one monitor and manage emotional responses, while metacognition enhances one's capacity to monitor and control one's thinking and learning. Meta-affective learning was an important aspect of physics learning for students during their studies [10]. Furthermore, the connection between metaconceptual and affective regulation and science accomplishment was partially mediated by science self-efficacy [11].

2. Method

This study uses The Static-Group Pretest-Posttest Design. The main difference between the static-group pretest-posttest design and the static-group comparison design is both groups receive a pretest. These are the static groups and are known as a non-equivalent control group design [12]. The number of 9th-grade students who involve are 18 students in both integrated and separate training. Students are regularly assisted by teachers in using meta-affective and meta-cognitive strategies during the science learning process in integrated training, whereas students are trained by researchers in interpreting meta-affective and meta-cognitive strategies and applying them independently during science learning in separate training. Figure 1 depicts a diagram of this design.

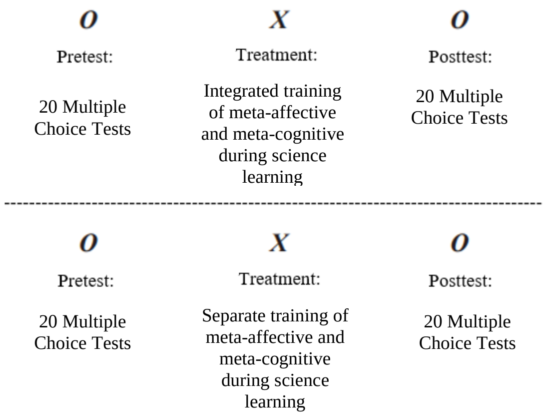

Fig. 1. The static-group pretest-posttest design for comparing integrated and separate training of meta-affective and meta-cognitive during science learning [12].

10 meta-affective strategies can be applied by students during science learning, namely: (1) Students identify their feelings, (2) Students must examine themselves objectively to manage compliments, feedback, and criticism, (3) Students embrace

their strengths and acknowledge their weaknesses, (4) Students understand that self-work and growth are positive activities, (5) Students write a list of the things they like about themselves, (6) Discuss how thoughts lead to actions and actions to feelings, which lead once again to thoughts, (7) Students are to construct a personal emotion journal and discuss it, (8) Clarifying the personal emotion journal, (9) Students fortify their belief in themselves, and (10) Students set a realistic goal and write down steps they can take to meet that goal.

10 meta-cognitive strategies can be applied by students during science learning, namely: (1) Discuss how students live a happy life, (2) Discuss how students become respected human beings, (3) Discuss how students feel good about themselves, (4) Give a few tips about active listening, (5) Students write down three key ideas from the lecture, (6) Students construct a personal learning journal, (7) Clarifying the personal learning journal, (8) Students do combine the test by using short or long essay questions, (9) Students reflect on coursework, and (10) Students learn to recognize what they do not understand.

The research tool is a multiple-choice test with up to 20 questions on the topic of soil that provide via an online test (Google form). This cognitive process dimension follows the Bloom Taxonomy revision, namely understanding (C2), applying (C3), analysing (C4), and evaluating (C5). Referring to the curriculum, the topic of soil consists of four sub-topics, namely the role of soil, the role of soil organisms, the process of soil formation, and soil components. Cognitive processes in the category of understanding (C2) include interpreting, exemplifying, classifying, summarizing, inferring, comparing, and explaining the role of soil, the role of soil organisms, the process of soil formation, and soil components. Two cognitive processes make up the applying (C3) category, namely executing (when the task is an exercise, which is familiar) and implementing (when the task is a problem, which is unfamiliar) the role of soil, the role of soil organisms, the process of soil formation, and soil components. Each sub-topic is represented by five multiple-choice questions. The blueprint of test items is presented in Table 1.

Table 1. The blueprint of test items.

Sub-topics	**The Cognitive Process Dimension**				**Total**
	C2	**C3**	**C4**	**C5**	
1. Role of Soil	1	5, 6	11	17	5
2. Role of Soil Organisms	2	7	12, 13	18	5
3. Process of Soil Formation	3	8	14, 15	19	5
4. Soil Components	4	9, 10	16	20	5
Total	4	6	6	4	20

These test items have tested on 33 10^{th}-grade students and then statistically tested using IBM SPSS Statistics 25. Cronbach's Alpha is 0.824 means that this test package has high reliability. Table 1 shows that the 20 test items are arranged according to the normal curve principle where C3 and C4 have more numbers than C2 and C5. Test items on C3, C4, and C5 provide contextual information related to daily life about the concept of soil. The information cites the latest news sources or articles. The learning objectives for the analysing (C4) category include figuring out how to distinguish between the relevant and important parts of a message (differentiating), how the message's components are grouped (organizing), and what the message's fundamental goal is (attributing) the role of soil, the role of soil organisms, the process of soil formation, and soil components. The cognitive processes of evaluating (C5) judgments based on external standards and examining judgments for internal consistency include the role of soil, the role of soil organisms, the process of soil formation, and soil components

3. Results and Discussion

This study presents results from the perspective of the science of soil, namely the role of soil, the role of soil organisms, the process of soil formation, and soil components. Between the integrated and separate training, the four soil sub-topics are compared. Even if minerals and nutrients are abstract, they may be grasped using nanoparticle technology and learning media in the form of interactive simulations, increasing the View of the Nature of Science and Technology (VNOST) [13].

The cognitive process dimension follows the Bloom Taxonomy revision, namely, C2 is understanding, C3 is applying, C4 is analysing and C5 is evaluating. Students at Level C2 can make sense of information regarding questions or learning narratives by talking vocally or using visual visuals. Students are required to use procedures in both routine and unique situations at Level C3. Students are requesting to collect elements of the content and connect them to form a comprehensive and logical structure at level C4. Students in the C5 level, on the other hand, are allowed to evaluate or criticize a phenomenon using criteria and standards [14], national examination and summative tests [15], as a diagnostic test [16], students’ perception [17], and students’ overconfidence bias [18].

3.1. Role of soil

The sub-topic of “role of the soil” was measured by question number 1 concerning the role of soil which is specifically needed by legumes, and question number 5 is about the principles that underlie the use of clay. Question number 6 is about the principle of terracing which implement as a soil conservation effort and water on plantations, question number 11 is about provisions for making infiltration wells, and question number 17 is about immature manure.

The Normalized gain or N-gain (g) analysis can be used to examine the effectiveness of integrated and separate meta-affective and meta-cognitive training with science learning. The difference between the initial condition value (before training) and the end condition value is calculated in the N-gain score test (after training). Table 2 summarizes the results of the N-gain test on the subtopic of “role of the soil".

Table 2. The normalized gain of the sub-topic of “role of the soil” on integrated and separate training.

Normalized Gain (g)	Integrated Training	Separate Training
Mean	0.09	-0.15
Minimum	-1.00	-4.00
Maximum	1.00	0.50

One of the numbers that show an increase in student understanding after receiving learning with meta-affective and meta-cognitive training is question number 6 about terracing. Large-scale vegetation plantation and diverse terracing measures have been widely used as the most powerful ecological restoration tools in water-restricted erosive mountain environments to control water erosion. The presence of several plant communities might add to the ambiguity and complexity of soil water status [19]. Soil loss had a high correlation with growth and biomass. Bench terracing is the best soil and water conservation strategy for repairing heavily degraded ravines [20].

The ability of soil to store clean water reserves for use by plants, animals, and people is one of its primary functions. The gravimetrical method is used to determine the amount of water in the soil by measuring other characteristics from which soil water can be inferred, or by directly calculating the amount of water lost when the soil dries up. The dielectric approach has been successfully used to calculate the quantity of water required by palm oil nurseries produced in media with varied levels of soil organic matter and to evaluate the water balance in vegetated soils [21].

Furthermore, question number 5 on principles that underlie the use of clay shows a very high increase in understanding of the group that received meta-affective and meta-cognitive training in an integrated manner. This question is completed with an article on clay crafts for home decoration. Moreover, the test item is relating to the characteristics of clay that underlie the making of these handicrafts.

3.2. Role of soil organisms

The sub-topic of “role of soil organisms” was measured by question number 2 on what soil microorganisms are capable of breaking down pesticides and herbicides, and number 7 on the production of Kascing compost (used with worms). Number 12 on the role of worms in increasing soil fertility, number 13 on how rotting fungi work, and number 18 on the most effective strategies for producing compost. The Normalized gain (g) analysis test on the subtopic of “role of soil organisms" is illustrated in Table 3.

Table 3. The normalized gain of the sub-topic of “role of soil organisms” on integrated and separate training.

Normalized Gain (g)	Integrated Training	Separate Training
Mean	0.08	-0.18
Minimum	-1.00	-1.00
Maximum	1.00	0.50

Question 12 about the role of worms in promoting soil fertility is one of the statistics that shows an increase in student knowledge after receiving learning with integrated meta-affective and meta-cognitive training. The soil serves as an ecosystem supplier for earthworms, which is a biological function. The synthesis of earthworm nanoparticles can improve these worm products. Moreover, question number 13 on how rotting fungi work shows a very high increase in understanding of the group that received meta-affective and meta-cognitive training in an integrated manner. This question is completed with an article on *P. chrysosporium* fungus for a semi-mechanical pulp processing environment friendly. Furthermore, the test item is relating to the principle of how rotting fungi work.

Vermicomposting is a low-impact method of converting organic waste into a profitable agricultural product. Vermicomposting has many positive effects on soil health and plant development. However, there are still a lot of unknown effects of vermicomposting on soil-plant systems. Vermicomposting is essential for the sustainability of agriculture. Chemical fertilizers are less effective than vermicomposting fertilizers at increasing soil fertility. It is a low-cost technological approach to processing or treating organic waste. Earthworms can reduce several types of sludge from municipal garbage. The use of earthworms and aquatic worms to reduce sludge is a promising and somewhat popular technology, especially in small-scale communities in poor nations [22].

3.3. Process of soil formation

The sub-topic of "process of soil formation" was measured by question number 3 concerning examples of mechanical processes in soil formation, and number 8 concerning the underlying principles for removing moss adhering to rock statues. Number 14 concerning stalactites and stalagmites associated with soil formation processes, number 15 about the layer of soil that must be excavated so that the roots of the mango tree are not cut, and number 19 regarding effective procedures for perfect weathering. The Normalized gain (g) analysis test on the subtopic of "process of soil formation" is shown in Table 4.

Table 4. The normalized gain of the sub-topic of "process of soil formation" on integrated and separate training.

Normalized Gain (g)	Integrated Training	Separate Training
Mean	-0.14	-0.13
Minimum	-1.00	-2.00
Maximum	0.40	0.67

Although both pieces of training show a negative mean of Normalized gain (g), the separate training is smaller than the integrated training. Question 14 about stalactites and stalagmites associated with soil formation processes is one of the statistics that shows an increase in student knowledge after receiving learning with separate meta-affective and meta-cognitive training.

Much is known about microbes discovered in caves, but less is known about microbes (bacteria) trapping in stalactites and their likely environmental origins. The metataxonomic examination of stalactite core material revealed an ecological spectrum of bacteria that was unusually extensive [23]. Low-magnesium calcite with small amounts of contaminants like clays formed the stalagmites. Lamination, which mostly comprises aspartic and micritic growth layers, is a component of all stalagmites [24].

The sub-topic of "process of soil formation" also discusses weathering. The test item that contains the weathering process that occurs on the bark is presented in question number 19. This test item is completed with information that a group of students is doing a practicum to prove the weathering process occurs on the bark. Furthermore, questions are directed to assess the effectiveness of the procedures carried out by the group of students.

3.4. Soil components

The sub-topic of “soil components” was measured by question number 4 about the soil layer that is inhabited by organisms. Number 9 is about the principles underlying the business of selling hummus. Number 10 concerns the soil components that underlie the construction of artesian wells. Number 16 concerns the nutrients used in large quantities and needed by plants, and number 20 is about the most effective design so that plants can thrive for a long time. The Normalized gain (g) analysis test on the subtopic of “soil components" is shown in Table 5.

Table 5. The normalized gain of sub-topic of “soil components” on integrated and separate training.

Normalized Gain (g)	Integrated Training	Separate Training
Mean	-0.08	-0.02
Minimum	-3.00	-1.50
Maximum	1.00	0.75

One of the questions to assess students' understanding of the sub-topic of “soil components" is question number 20. This test item is about the most effective design so that plants can thrive for a long time. There are two designs offered by two different groups, the question is directed to evaluate the most effective design. Although both pieces of training show a negative mean of Normalized gain (g), the separate training is smaller than the integrated training. Question 10 about soil components that underlie the construction of artesian wells is one of the statistics that shows an increase in student knowledge after receiving learning with separate meta-affective and meta-cognitive training. Saline water has percolated down for many meters and has saturated the soil. High-resolution electrical resistivity tomography (HERT) scans using the pole-dipole method were used to determine the groundwater potential of the paleochannels [25].

People are also fascinated by the historical and cultural history, as well as the biodiversity linked with the springs, and many of them have the potential to become distinctive tourism destinations with tremendous visual impact. There are relationships between the properties of springs, self-flowing artesian wells, and underground cave lakes [26]. The purpose of the radon monitoring in the artesian wells was to learn more about how mud eruption works and how the eruption cycle is affected by radon fluctuations. During the eruption, the opposite radon tendencies were seen. The unusual behavior of wells could be explained by the movement of gas fluxes during the eruption [27].

At the drilling site, artesian wells are being found at a depth of 108 meters, rising to 2 meters above the surrounding soil. Since the majority of wells in this area smell and contain iron, locals take advantage of the discovery of artesian wells to meet their needs for clean water. Modifications to artesian good design that enables outflow regulation can assist water-saving, sustainable paddy growing techniques. With rats as a primary yield-reducing problem, solutions will most likely rely on more synchronized planting dates and, as a result, collective action for scale efficacy. Currently, interventions based on this design are being tested [28].

Meta-cognitive strategy in this training acts as an independent variable and then analysed its impact on students' understanding of soil in daily life, therefore meta-cognitive serves as input [7]. Meta-cognitive is divided into knowledge and regulation, where the indicators are implemented by students with the help of teachers (integrated training) and independently after receiving training from researchers (separate training). Meanwhile, meta-affective which is divided into awareness and regulation dimensions, is applied with the same principle as meta-cognitive. Therefore, at the same time, students manage their thoughts and emotions to better understand the soil material [11].

As the number of sample sizes is very small, it must be a consideration for generalization in this study. This aspect is a limitation of this study so that implications for further research with a larger number of samples and proportionally distributed representing a particular area. In addition, it also ensures that science teachers who carry out meta-affective and meta-cognitive training in an integrated manner with science lessons are understood and flexible in implementing meta-affective and meta-cognitive indicators. Training that combines meta-affective and meta-affective is new, teachers are not familiar with integrating indicators for emotional and thought management, whereas in general teachers only focus on cognitive aspects or science content. Within the framework of five essential vital functions of a person: individually-organic, family-tribal, cognitive-practical, social, and transcendental, the required regions are related to the formation and satisfaction of educational demands [29].

Metacognition is a construct and process that may explain how students can enhance and manage their thinking and learning. It is simply "thinking about thinking." The metacognitive knowledge, abilities, and awareness to alleviate or mitigate some of the challenges associated with some youth's low academic accomplishment [30]. Furthermore, metacognitive knowledge, abilities, and awareness alleviate or mitigate some of the challenges associated with some youth's low academic accomplishment [31]. Students who had active learning with embedded metacognition training had better metacognitive skills after the semester than classmates who had lecture-based instruction with no metacognition education. Including metacognition instruction and practice in the context of active learning is one technique to improve student metacognitive skills, especially by shifting students away from their weakest skills and toward stronger ones [32].

Over a semester, some students improve their prediction accuracy. Low-performing students, on the other hand, are less accurate at predicting exam grades and do not increase their metacognitive calibration during the semester. Furthermore, offering calibration feedback to low-performing pupils may lead to increased overconfidence [33]. Furthermore, learners in the High Goals and Values and Mastery-Driven groups outperformed those in other groups, and those who engaged in planning, self-evaluation, and monitoring performance outperformed those who did not engage in much metacognitive activity [34]. Students showed increased self-assurance in their ability to comprehend the material, indicated more interest, and improved their metacognitive skills. Reflective writing not only helps students enhance their metacognitive skills but also shows the instructor how a student grows from a novice to a more seasoned learner [35].

The benefits of flipped classrooms are well-documented, and they emphasize the improvement in students' educational outcomes. Affective, interpersonal, and cognitive domains scored higher than effect sizes in the results. However, students who studied chemistry, engineering, mathematics, and physics benefited less from flipped classrooms than students who studied other courses, according to the findings

[36]. Continued interdisciplinary collaboration is required to understand the emotional effects of undergraduate field trips and how to convert those results into inclusive practice [37]. Science teachers promoted the notion of "mineral" as the highest concept, while pre-service science teachers preferred the concepts of "mineral" and "earth," and high school students preferred the concept of "plants" [38].

4. Conclusion

Since it has a positive average value of Normalized Gain (g), the data demonstrate that integrated training has a beneficial effect when compared to separate training. Meanwhile, because the average value of Normalized Gain (g) was negative, the two pieces of training did not assist students in learning on sub-topics "process of soil formation" and "soil components”. In contrast to the other two sub-topics, "role of the soil" and "role of soil organisms," these two are rarely experienced in daily life by students. The results of this study suggest that more/further research should be conducted on how to blend emotional (meta-affective) and cognitive (meta-cognitive) regulation in science learning.

References

1. Rowe, L.; Kubalewski, M.; Clark, R.; Statza, E.; Goyne, T.; Leach, K.; and Peller, J. (2018). Detecting microplastics in soil and sediment in an undergraduate environmental chemistry laboratory experiment that promotes skill building and encourages environmental awareness. *Journal of Chemical Education*, 96(2), 323-328.
2. Yanto, I.T.R., Apriani, A., Hidayat, R., Deris, M.M., and Senan, N. (2021). Fast clustering environment impact using multi soft set based on multivariate distribution. *JOIV: International Journal on Informatics Visualization*, 5(3), 291-297.
3. Yazici, S. (2020). Metaphorical perceptions of the secondary school students regarding the concept of soil. *African Educational Research Journal*, 8(3), 566-574.
4. Messig, D.; and Groß, J. (2018). Understanding plant nutrition—the genesis of students’ conceptions and the implications for teaching photosynthesis. *Education Sciences*, 8(3), 132.
5. Cardoso, A.; Ribeiro, T.; and Vasconcelos, C. (2018). What is inside the earth?. *Science & Education*, 27(7), 715-736.
6. Azevedo, R. (2020). Reflections on the field of metacognition: issues, challenges, and opportunities. *Metacognition and Learning*, 15(2), 91-98.
7. Muhali, M.; Yuanita, L.; and Ibrahim, M. (2019). The validity and effectiveness of the reflective-metacognitive learning model to improve students’ metacognition ability in Indonesia. *Malaysian Journal of Learning and Instruction*, 16(2), 33-74.
8. Kleitman, S.; and Narciss, S. (2019). Introduction to the special Issue “applied metacognition: real-world applications beyond learning”. *Metacognition and Learning*, 14(3), 335-342.
9. Asy'ari, M.; and Ikhsan, M. (2019). The effectiveness of inquiry learning model in improving prospective teachers' metacognition knowledge and metacognition awareness. *International Journal of Instruction*, 12(2), 455-470.

10. Radoff, J.; Jaber, L.Z.; and Hammer, D. (2019). "It's scary but it's also exciting": evidence of meta-affective learning in science. *Cognition and Instruction*, 37(1), 73-92.
11. Kirbulut, Z.D.; and Uzuntiryaki-Kondakci, E. (2019). Examining the mediating effect of science self-efficacy on the relationship between metavariables and science achievement. *International Journal of Science Education*, 41(8), 995-1014.
12. Fraenkel, J.R.; Wallen, N.E.; and Hyun, H. H. *How to Design and Evaluate Research in Education*, Eighth Edi. New York: McGraw-Hill, 2012, pp. 269-270.
13. Priyand, E.R.P.; Sukmafitri, A.; Mudzakir, A.; Nandiyanto, A.B.D.; Nugraha, W.C.; and Ramdhani, W. (2020). Zinc oxide nanoparticles for enhancing students' view of the nature of science and technology. *Indonesian Journal of Science and Technology*, 5(1), 1-10.
14. Zorluoglu, S.L.; Bagriyanik, K.E.; and Sahintürk, A. (2019). Analyze of the science and technology course TEOG questions based on the revised Bloom taxonomy and their relation between the learning outcomes of the curriculum. *International Journal of Progressive Education*, 15(2), 104-117.
15. Prihastuti, I.; and Widodo, A. (2020). Cognitive level analysis of science item tests on secondary school assessment. *Journal of Physics: Conference Series*, 1521(4), 1-6.
16. Anwar, A.H.; Rustaman, N.Y.; and Purwianingsih, W. (2019). Development of three-tier diagnostic test instruments for detecting students' conception. *Journal of Physics: Conference Series*, 1318(1), 1-6.
17. Pratami, A.R.; Riza, L.S.; and Rusyati, L. (2021). Investigating junior high school students' perception of global warming topic using semantic network analysis. *Journal of Physics: Conference Series*, 1806(1), 1-6.
18. Rusmana, A.N.; Roshayanti, F.; and Ha, M. (2020). Debiasing overconfidence among Indonesian undergraduate students in the biology classroom: An intervention study of the KAAR model. *Asia-Pacific Science Education*, 6(1), 228-254.
19. Wei, W.; Feng, X.; Yang, L.; Chen, L.; Feng, T.; and Chen, D. (2019). The effects of terracing and vegetation on soil moisture retention in a dry hilly catchment in China. *Science of the Total Environment*, 647(1), 1323-1332.
20. Kumar, R.; Bhardwaj, A.K.; Rao, B.K.; Vishwakarma, A.K.; Bhatnagar, P.R.; Patra, S.; and Sharma, N.K. (2021). Development of degraded ravine lands of Western India using Sapota (*Achras zapota*) plantation with terracing vs. trenching-on-slope-based conservation measures. *Land Degradation & Development*, 32(1), 101-111.
21. Hermawan, B.; Suparjo, E.; Hindarto, K.S.; Silalahi, R.; and Barchia, F. (2017). A quick dielectric method to determine insitu soil water content for precision water use under sustainable agricultural practices. *International Journal of Advanced Science Engineering Information Technology*, 7(3), 910-915.
22. Emamjomeh, M.M.; Tahergorabi, M.; Farzadkia, M.; and Bazrafshan, E. (2018). A review of the use of earthworms and aquatic worms for reducing sludge produced: An innovative ecotechnology. *Waste and biomass valorization*, 9(9), 1543-1557.

23. Michail, G.; Karapetsi, L.; Madesis, P.; Reizopoulou, A.; and Vagelas, I. (2021). Metataxonomic analysis of bacteria entrapped in a stalactite's core and their possible environmental origins. *Microorganisms*, 9(12), 1-12.
24. Eren, M.; Akgöz, M.; Kadir, S.; and Kapur, S. (2021). Primary characteristics of selected stalagmites from four caves located between Erdemli and Silifke (Mersin), southern Turkey—implications on their formation. *Carbonates and Evaporites*, 36(2), 1-17.
25. Bhadra, B.K.; Gor, N.; Jain, A.K.; Meena, H.; and Rao, S.S. (2021). Groundwater investigation of the artesian wells on the palaeochannels in parts of the Great Rann of Kachchh, Gujarat, India, using remote sensing and geophysical techniques. *Hydrogeology Journal*, 29(8), 2705-2724.
26. Akhmedenov, K.M.; and Idrisova, G.Z. (2021). The importance of springs, self-flowing artesian wells, underground cave lakes of western Kazakhstan in tourism. *Geo Journal of Tourism and Geosites*, 37(3), 747-756.
27. Kumar, A.; Walia, V.; Lin, S.J.; and Fu, C.C. (2021). Radon monitoring in artesian wells at Mato-san area of South Taiwan for mud eruption studies. *Journal of the Geological Society of India*, 97(12), 1590-1592.
28. Khasanah, N.M.; Tanika, L.; Pratama, L.D.Y.; Leimona, B.; Prasetiyo, E.; Marulani, F.; and Van Noordwijk, M. (2021). Groundwater-extracting rice production in the rejoso water-shed (Indonesia) reducing urban water availability: characterisation and intervention priorities. *Land*, 10(6), 586-596.
29. Rustamova, N.R. (2020). Training of students of cognitive processes based on vitagen educational situations. *International Journal of Advanced Science and Technology*, 29(8), 869-872.
30. Smith, A.K.; Black, S.; and Hooper, L.M. (2020). Metacognitive knowledge, skills, and awareness: A possible solution to enhancing academic achievement in African American adolescents. *Urban Education*, 55(4), 625-639.
31. Alt, D.; and Raichel, N. (2020). Reflective journaling and metacognitive awareness: Insights from a longitudinal study in higher education. *Reflective Practice*, 21(2), 145-158.
32. Santangelo, J.; and Cadieux, M.; and Zapata, S. (2021). Developing student metacognitive skills using active learning with embedded metacognition instruction. *Journal of STEM Education: Innovations and Research*, 22(2), 75-87.
33. Morphew, J.W. (2021). Changes in metacognitive monitoring accuracy in an introductory physics course. *Metacognition and Learning*, 16(1), 89-111.
34. Hong, W.; Bernacki, M.L.; and Perera, H.N. (2020). A latent profile analysis of undergraduates' achievement motivations and metacognitive behaviors, and their relations to achievement in science. *Journal of Educational Psychology*, 112(7), 1409-1430.
35. O'Loughlin, V.D.; and Griffith, L.M. (2020). Developing student metacognition through reflective writing in an upper level undergraduate anatomy course. *Anatomical Sciences Education*, 13(6), 680-693.
36. Jang, H.Y.; and Kim, H.J. (2020). A meta-analysis of the cognitive, affective, and interpersonal outcomes of flipped classrooms in higher education. *Education Sciences*, 10(4), 1-16.

37. Ward, E.G.; O'Connell, K.B.; Race, A.; Alwin, A.; Alwin, A.; Cortijo-Robles, K.; and Sea, W. (2021). Affective learning outcomes in the field. *Bulletin of the Ecological Society of America*, 102(4), 1-12.
38. Rusyati, L.; Rustaman, N. Y.; Widodo, A.; and Ha, M. (2021). The conception of soils: a cross-sectional study based on the school's perspective. *Journal of Engineering Science and Technology*, Special Issue on ICMScE(1), 34-41.