Biosfer: Jurnal Pendidikan Biologi

Dynamic assessment on high school biology students' reasoning skills

Murni Ramli*, Mayasari Mahfudhotul Khasanah, Sri Dwiastuti

Biology Education, Faculty of Teacher Training and Education, Universitas Sebelas Maret, Indonesia

* Corresponding author: mramlim@staff.uns.ac.id

A B S T R A C T

Reasoning skills of students may be improved through a sort of feedback constructed in the dynamic assessment. The research aims to analyze the effect of dynamic assessment on high school biology students' reasoning skills. The research employs a quasi-experimental method with a pretest-posttest control group design. The participants were students of the grade X Science Program (N=61), which were selected purposively. Data on reasoning skills were collected by pretest and posttest focused on the concepts of bacteria. with the dynamic assessment method. The data analysis technique employs an Independent sample t-test. The research result indicates that Dynamic Assessment provides a better effect on students' reasoning skills in Bacteria material.

INTRODUCTION

Thinking skills which consist of information processing, reasoning, inquiries, creative thinking, and evaluation are the skills demanded as 21st-century skills. As part of thinking skills, reasoning skills are important for making meaningful understanding in the scientific domain and supporting scientific paradigms and methodologies. Reasoning skills become the basis for critical thinking skills to help the students to get the relevant knowledge and achieve proper conclusions (Dowd, Thompson, Schiff, & Reynolds, 2018; Perta, Ansori, & Karyadi, 2017).

Reasoning skills are related to science literacy. Individuals who master science literacy can realize the concepts and theories, use and develop reasoning in accepting the facts or theories, ask the right questions, think analytically, and answer questions using deductive reasoning (Genç, 2015). Reasoning skills as part of thinking skill is a mental process that includes the knowledge application to make decisions, solve problems, and achieve goals (Remingo, Yangco, & Espinosa, 2018). Reasoning skills allows individual to build new representation from previous knowledge (Teig & Scherer, 2016). Aspects of reasoning skills have been determined as conservation reasoning, proportional reasoning, control of variables, correlational reasoning, combinatorial reasoning, and probabilistic reasoning, which was well known as the six dimensions of reasoning, and measured through the Lawson Classroom Test of Scientific Reasoning or LCTSR (Lawson, 2000; Lawson, 1978). LCTSR is a more popular instrument to test reasoning skills (Bello, 2014). Initially, the LCTSR was a multiple-choice test, but the newer version used the two-tier design assessment (Bao et al., 2009).

To nurture the reasoning skills of students, assessment for learning (AfL) is one of the approaches that should be introduced. AFL supports learning improvement by providing a sort of feedback on the students' tasks and helps them to achieve the learning goals (Leong & Tan, 2014). Students thinking process, including the reasoning skills and the way they solve the problem logically can be promoted through the assessment which sets up as dynamic as possible. The principles of AfL are exactly similar to the concepts of dynamic assessment. There are two types of assessment that can be applied as dynamic assessment is diagnostic and formative assessment (Byrne, 2009). Formative assessment has followed the rules of AfL in a way that teachers can identify students' achievement, and soon after giving the feedback and make a switch on the teaching method or approach (Fornaguera, 2014). While diagnostic assessment is a test to detect students' incapability or misconceptions (Zulfia, Susilo, & Listyorini, 2019; Yunanda, Susilo & Ghofur, 2019).

Dynamic Assessment (DA) is an assessment focused on the learning process and provides interactions or assistance during the assessment process. The dynamic assessment has core values, the arrangement of feedback, and mediation assistance. The main difference between Dynamic Assessment (DA) and Static Assessment (SA) lies in the provided feedback and the relationship between the researchers and the research subjects (Hessamy & Ghaderi, 2014). Dynamic assessment is process-oriented and seeks to identify students' skills and learning potential. Dynamic assessment can be carried out dynamically, i.e., changes on what must be recorded, and there are interventions. It is contrary to the static assessment, which no changes for what must be recorded, and there are no interventions given during the assessment (Cotrus & Stanciu, 2014).

Adults can provide substantial assistance at the beginning of the learning process of students, and help will be gradually reduced when students' abilities become better (Clarà, 2017). This idea is along with the Vygotsky theory on Zone Proximal Development (ZPD), in which there is part in cognitive processing that students need to be assisted to understand the concepts learned (Lightfoot, Cole, & Cole, 2013)

Static assessment can only measure individual achievement levels without interventions carried out during tests and learning, so it cannot measure students' cognitive change abilities

(Passig, Tzuriel, & Eshel-kedmi, 2016). DA has the potential to train and improve the change abilities of students, including the progress of reasoning skills. Repeated evaluations in DA provide the opportunities to assess learning at the micro-level and provide information and advice for learning at the macro level in terms of assessing the reasoning skills. It allows the teachers to facilitate learning with feedback to students and improve learning efficiency. It because they can recognize the difficulties experienced by the students and help to solve these problems (Stevenson, Bergwerff, Heiser, & Resing, 2013).

The most dominant approached used in DA were the "sandwich format" and "cake format". The sandwich format has the steps started with the pretest, mediation phase, and posttest. While the cake format is the intervention or assistance is administered in the assessment format and learners will receive assistance per item of question that they found difficult. The form of assistance in the cake format is usually script or often a menu of hints prompts or clues (Grigorenko, 2009; Grigorenko & Sternberg, 1998). The "cake format" was adopted in this research. In this approach, DA was implemented using the prompts, hints, or cues given when students accomplish the assessment process. The researcher mediated the students to identify and handle errors on each test or the question (Shabani, 2016).

Research on DA mostly aims to improve cognitive abilities (Kovalčíková, 2015), language abilities of children, reading skills, and some research done in mathematics as well (Stevenson, Heiser, & Resing, 2016; Tzuriel & Caspi, 2017). While DA research on biology topics is rare. Some prominent works on biology concepts, such as web-based dynamic assessment focusing on photosynthesis which was done consecutively by Wang from National Tsing Hua University, Taiwan (Lin & Wang, 2017; Wang, Wu, Yu, & Lin, 2015; Wang, 2011, 2018; Wang, Wang, & Huang, 2008), and ecology did by Taiwanese scholars as well (Hung, Hwang, Su, & Lin, 2012). Therefore, there is still a wide challenge to develop DA on other topics in biology.

This research focused on the two aspects of reasoning skills: correlational reasoning and combinatorial reasoning. Correlational reasoning is the ability to recognize causal relationships between variables. Meanwhile, combinatorial reasoning is the ability to consider several factors or combinations to conclude (Shofiyah & Wulandari, 2018). The effect of dynamic assessment on reasoning skills has not been studied widely. There is one research on this topic done by van der Graaf and team on the scientific reasoning of kindergarten students

There are four methods to implement dynamic assessment: clinical interviews, testing the limits, graduated prompting, and pre-test-train-post-test (Kovalčíková, 2015). Clinical interviews, testing the limits, and pre-test-train-post-test are the common approaches used for language and mathematics. And graduated prompting is used by Wang in his web-based dynamic assessment on the photosynthesis

Novitasari, Ramli, & Karyanto (2018) have developed the basis of DA, called The Facts and Proofs Diagnostic Test (FPD) and Structural Communication Grid Test (SCG) on the concepts of bacteria. The result showed the FPD and SCG can be used to detect students' conceptual understanding, misconceptions, and argumentation abilities. However, The Facts and Proofs Diagnostic Test and the Structural Communication Grid Test are still categorized as static assessments. We adopt some questions regarding bacteria from these instruments, and some modified from the Khan Academy to develop a dynamic assessment on bacteria, and further checked the effectiveness of this DA instrument to the reasoning skills of students.

METHODS
Research Design
The research was quasi-experimental. The research learning design is illustrated in Table 1. The research design used was pretest and posttest control group design. The research independent variable was dynamic assessment, whereas the dependent variable was reasoning skills.

Table 1
Constellation of Pretest-Posttest Control Group Design

Class	Pretest	Treatment	Posttest
Experiment	O_1	X	O_2
Control	O_1	-	O_2

Note: O_1 = Pretest of Reasoning Skills, X = Treatment, O_2 = Posttest of Reasoning Skills

Population and Samples

The research was conducted at one of the public senior high schools in Surakarta in grade X of the Science Program of the academic year 2018/2019 with a population of 220 students. Samples were selected purposively, i.e., the grade who were learning the topic of bacteria at the time research was done. Two classes of grade X science courses were randomly selected as the experiment (N = 30) and control class (N=31). All students of both classes had agreed to join the research as participants.

Instrument

The research instrument was employed to measure the reasoning skills of students which covered the concepts learned on the topic of bacteria. The test was focused to train correlational and combinational reasoning. The instrument consists of 53 items with multiple choices and there are prompts for every item which treated to the experimental class, which can be accomplished within 45 minutes. A construct and content validity test by an expert was conducted in advance. An empirical validity test of the instrument items done by the Pearson Product Moment formula resulted from r > r_{table} with a minimum range of 0.89. It indicated that the items were valid. Further, a reliability test was conducted using that generated value of 0.25 > 0.21 which means that the instrument was reliable (Khasanah, Ramli, & Dwiastuti, 2020).

Procedure

In the first stage, students in both classes were asked to work on the pre-test questions which are formatted in Google form. Next, the experiment class students were invited to work on the same problem as in the pre-test stage. Students who have answered all the questions were able to click the view score button to see the given feedback whether they gave correct answers or incorrect ones.

If students choose the correct answers, then there was feedback to confirm that their answers were correct. If students make mistakes, feedback was given as the graduated prompting. The prompts were the questions about bacteria given once to direct the students towards the correct answer.

After two weeks, the students of both classes were asked to work on the post-test questions. Experimental class students get prompting as shown in Figures 4 and 5 to help students gave the correct answer, while the control class students did not get prompting. The pretest and post-test questions were the same items. Pre-test results from the experimental class were used to classify students' reasoning skills into high, mediocre, and low categories.

Data Analysis Techniques

Three types of data analysis were applied, i.e., normality test with Shapiro-Wilk Test, homogeneity test with Levene Test, and hypothesis testing used one-way ANCOVA. The normality test suggested that the data were normally distributed in the experimental and the control class (Table 2). The significance value of the experimental class versus the control class in the pretest shows that the score of the pretest is bigger than 0.05. Furthermore, the significance value of the experimental class versus the control class in the posttest indicates that the significance probability value of the pretest is bigger than 0.05. The significance

probability value > 0.05 means H_0 is accepted. The result of the normality test (Table 2) suggests that the p-value or significance of pretest and post-test in the experimental and control class was more significant than $\alpha = 0.05$; thus, the reasoning skills data were normally distributed.

Table 2
Normality test of reasoning skills pretest and posttest.

No	Class	Sample	Reasoning Skills		Significance	Conclusion
			Sig. Pretest	Sig. Posttest		
1	Experiment	30	0.354	0.194	0.05	Normal
2	Control	31	0.957	0.106	0.05	Normal

Table 3
Homogeneity of reasoning skills.

Levene Statistic	df1	df2	Sig.
0.054	1	59	0.0816

Based on Table 3, the statistic test showed a significance of 0.0816 > 0.05, or H_0 was accepted. Therefore, it could be interpreted that the pretest in the experimental and the control class were homogenous.

RESULTS AND DISCUSSION

Table 4 shows the average pretest score of the control class was 31.77, while the experiment class was 29.43. The initial ability of both classes was tested using the independent sample t-test. T-test results showed the sig. value of 0.148 > 0.05, which means no significant differences in reasoning skills between the control class pretest and the experiment class.

Table 4
Correlation of pretest and posttest scores of reasoning skills.

No	Class	N	r	Sig.	Description
1	Experiment	30	0.342	0.032	Significant
2	Control	31	0.741	0.00	Significant

According to data of the experiment and control classes in Table 4, the pretest score, which is a covariate, had a significant correlation with the post-test score after treatment since the p-value or significance was smaller than $\alpha = 0.05$. It can be concluded that H0 (dynamic assessment does not affect or increase students' reasoning skills) was rejected and H1 (dynamic assessment affects students' reasoning skills) was accepted. Thus, dynamic assessment significantly affected high school students' reasoning skills.

Table 5
ANCOVA test of reasoning skills.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1172.573[a]	2	586.286	42.255	.000
Intercept	1817.302	1	1817.302	130.979	.000
Pretest	325.776	1	325.776	23.480	.000
Assessment	1021.883	1	1021.883	73.650	.000
Error	804.739	58	13.875		
Total	95932.000	61			
Corrected Total	1977.311	60			

The hypothesis test was One-Way ANCOVA with $\alpha = 0.05$. Table 5 indicates that the p-value is $0.000 < 0.05$, thus H_0 was rejected. It means at a confidence level of 95%, there was an influence of dynamic assessment and non-dynamic assessment (static assessment) on reasoning skill post-test scores. It suggested that the post-test scores were indeed due to the influence of implemented the DA, instead of student experience or because of their prior knowledge. Thus, dynamic assessment influenced the increase in students' reasoning skills.

This research showed the intervention of dynamic assessment helps students to answer questions about the concepts of bacteria by including correlational reasoning and combinatorial reasoning indicators. DA provides the opportunity to give intervention to students and lead them to the correct answer. In this study, the interventions were given as several prompts for each question. The first prompt provides little information about the solution to the question. The subsequent prompts bring more information, and finally, students can answer correctly. Prompts were given gradually from the general to the more specific ones for the subsequent prompts. It helps and guides students to achieve the correct answer (Wang, 2010).

The dynamic assessment also applies Vygotsky's theory of the Zone of Proximal Development (ZPD). It was assumed that the students can be helped to gain achievement by providing them with assistance. Also, prompting in dynamic assessment help students develop their conceptual understanding and answer the questions correctly (Khaghaninejad, 2015; Poehner & Infante, 2016).

The following were examples of questions accompanied with a discussion of concept indicators and prompting given to the experimental class:

Q4: Bacteria differ from viruses, protists, and Animalia. Based on the level of the organism, which one of the following statements describes the level of the correct organism?
  A. Bacteria > Virus > Protist > Animalia
  B. Virus > Bacteria > Protist > Animalia
  C. Virus > Protist > Bacteria > Animalia
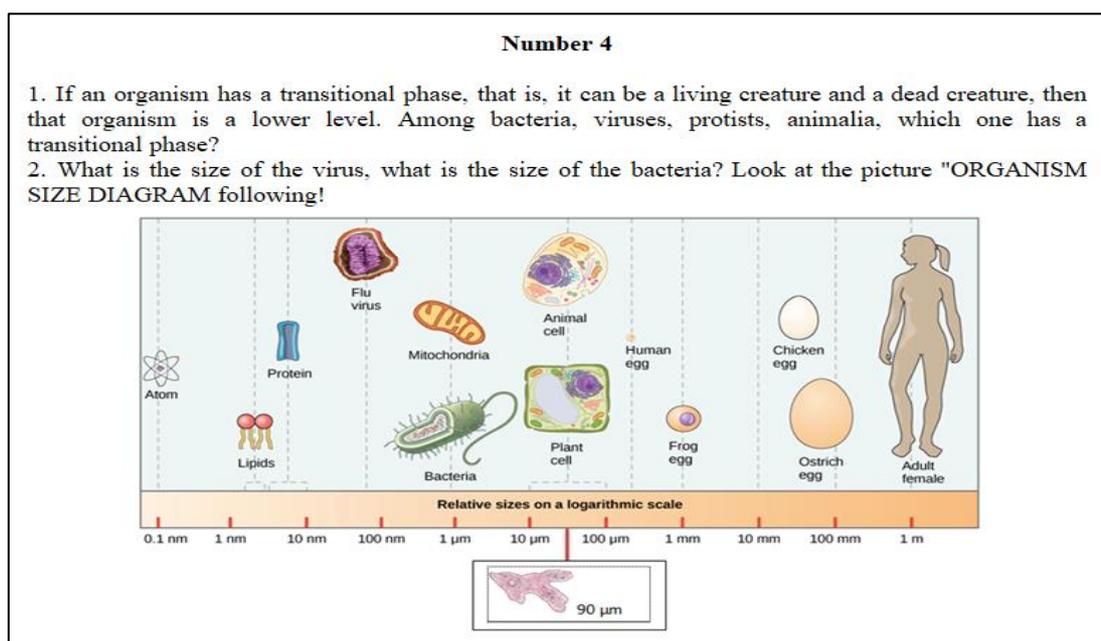 D. Bacteria > Protist > Virus > Animalia
    Prompting:

Figure 1. Prompting for Q4

Q7a: As living things, bacteria need nutrition. Based on how to obtain their food, bacteria are divided into two types: heterotrophs and autotrophs. A species of bacteria has the characteristics of behaving as parasites, saprophytes, and symbionts. Do those bacteria are classified as heterotrophic bacteria or autotrophic bacteria?

A. Heterotrophs

B. Autotrophs

Prompting:

1. What is the meaning of the concept of actively obtaining food?
2. What is in the plant cells so they can make their own food? or do photosynthesis?
3. What is needed in the photosynthesis process?
4. What is the meaning of the concept of obtaining food passively?
5. What are the concepts of the interaction of organisms with the host?
6. Where are the Autotroph bacteria located, and where are heterotrophic bacteria located?

Figure 2. Prompting for Q7a

Q8e: Bacteria have many unique ways to reproduce. There are several ways of bacterial reproduction, such as binary division, budding, fragmentation, and DNA recombination (transformation, conjugation, and transduction). One of the bacterial propagation processes is that the tip of the bacterial cell develops into a bud and is then followed by genomic replication in the bud. Buds develop and release new bacteria. What is the breeding method described in those statements?

A. Binary cleavage

B. Budding

C. Fragmentation

D. Transformation

E. Conjugation

F. Transduction

G. Endospore

Prompting:

Number 8e
1. What is the meaning of vegetative, asexual, and sexual reproduction?
2. What is the meaning of binary fission?
    -> What is the meaning of budding?
    -> What is the meaning of fragmentation?
    -> What is the meaning of transformation?
    -> What is the meaning of conjugation?
    -> What is the meaning of transduction?

Figure 3. Prompting for Q8e

For Q4, six students from the low achievement (LA) group of the experimental class answered correctly after getting prompts. Before the treatment of DA, only one out of those six gave the correct answers. While, for Q7a, six students from the LA group of the experimental class answered correctly after getting prompts. Previously, only five out of those six gave the correct answers. Moreover, six students from the LA group of the experimental class answered correctly after getting prompts for Q8e. Before DA treatment, none gave the correct answers.

Changes because of prompting were appeared in students who gave the incorrect answer

in the pre-test, they gave the correct answers at the post-test stage. Some students who have given a correct answer during pre-tests can still give the correct answers after prompts were given. Some students were unable to give the correct answers even after prompts were provided.

Prompting for Q4 helped the students to develop a conceptual understanding of distinguishing between bacteria, viruses, and protists based on their structure. Prompting for Q7a helped the students to develop an understanding to distinguish between heterotrophic and autotrophic bacteria. While prompting for Q8e helped students to construct the concept of differentiating the bacteria reproduction methods. Students can give the correct answers because the prompt helped them to remember the previous concepts and reconstruct their concepts.

An example of changes that occurred in one student of the lower-class experimental class is Student Number 10 (S10). S10 got a score of 19 during the pre-test. Prompting resulted in S10 got a higher score during the post-test (48). S10 initially gave wrong answers to some items during the pretest (such as Q3g, Q3h, Q4, Q5c, Q5f, Q6a, Q6d, Q6e, Q7e, Q7h, Q8a, Q8b, Q8e, Q8f, Q8g, Q9, Q10, Q12b, Q12c, Q12d, Q12e, Q12f, Q12g, Q13a, Q13c, Q13d, Q13e, Q13i, and Q13k). Prompting helped S10 to give the correct answers during the post-test. Changes in students' answers showed that dynamic assessment with prompting is effective to help students improve their achievement. The effective prompt should be matched with ZPD. It means the prompt can guide students to reach their optimal potential abilities (Navarro & Mourgues, 2018).

The control class was not provided with the dynamic assessment and was only asked to study the topic of bacteria independently. Due to the absence of scaffolding or assistance, the students at the control class did not experience feedback to bring them into the correct answer, they had lower post-test scores than the experimental class. Feedback is an important part of AFL, especially for some students who are categorized as ones who need scaffolding or assistance to understand the concepts comprehensively (Eremina & Reginald, 2016). The dynamic assessment had advocated as an assessment that can differentiate students' proficiency (Feng & Heffernan, 2010).

The results showed that there was a difference between reasoning skills between students provided with the dynamic assessment and the ones without the dynamic assessment. The experimental class has a higher reasoning skills score and differs significantly from the control class. The reasoning skills of students also improved through the DA or the prompting of DA is actually as feedback for students in the concept of assessment for learning. By controlling the abilities of students on scientific reasoning in the format of the experiment design, Graaf and the team also found the effectiveness of assistance on students' upgrading skills (van der Graaf, Segers, & Verhoeven, 2015). It also conveyed the theory of Vigotsky on zone proximal development (Clarà, 2017; Poehner, 2017).

CONCLUSION

The research revealed that dynamic assessment with graduated prompting affects students' reasoning skills and also their understandings of the concepts about bacteria. Thus, it is promising to do the same research on other levels of schooling, biology topics, and types of thinking skills as well. However, there are some limitations of the dynamic assessment instrument which is developed in the platform of google form quiz, i.e., the non-flexibility of providing the various prompting as assistance for students, and students can only access the prompt after accomplishment all of the questions. Therefore, a more appropriate platform should be developed or compared in future research, and a large-scale test is also advised to confirm the effectiveness of the graduated prompting DA instrument.

REFERENCES

Bao, L., Cai, T., Koenig, K., Fang, K., Han, J., Wang, J., … Wu, N. (2009). Learning and Scientific Reasoning. *Science*, *323*, 1–9. https://doi.org/10.1126/science.1167740

Bello, A. (2014). The acquisition of the six formal reasoning abilities by students in Kaduna State, Nigeria. *International Journal of Education and Research*, *2*(6), 613–628. https://doi.org/10.18848/2327-7971/CGP/v21i01/49044

Byrne, B. O. (2009). Knowing more than words can say: using multimodal assessment tools to excavate and construct knowledge about wolves. *International Journal of Science Education*, *31*(4), 523–539. https://doi.org/10.1080/09500690701730479

Clarà, M. (2017). How Instruction Influences Conceptual Development: Vygotsky's Theory Revisited. *Educational Psychologist*, *52*(1), 50–62. https://doi.org/10.1080/00461520.2016.1221765

Cotrus, A., & Stanciu, C. (2014). A Study on Dynamic Assessment Techniques, as a Method of Obtaining a High Level of Learning Potential, Untapped by Conventional Assessment. *Procedia - Social and Behavioral Sciences*, *116*, 2616–2619. https://doi.org/10.1016/j.sbspro.2014.01.622

Dowd, J. E., Thompson, R. J., Schiff, L. A., & Reynolds, J. A. (2018). Understanding the complex relationship between critical thinking and science reasoning among undergraduate thesis writers. *CBE—Life Sciences Education*, *17*(ar4), 1–10. https://doi.org/10.1187/cbe.17-03-0052

Eremina, A. H. A., & Reginald, U. (2016). Effect of Assessment for Learning (AFL) on Biology academic achievement of senior secondary students in Rivers State. *European Journal of Educational and Development Psychology*, *4*(2), 12–24. Retrieved from https://www.eajournals.org/wp-content/uploads/Effect-of-Assessment-for-Learning-AFL-On-Biology-Academic-Achievement-of-Senior-Secondary-Students-in-Rivers-State.pdf

Feng, M., & Heffernan, N. (2010). Can we get better assessment from a tutoring system compared to traditional paper testing? can we have our cake (better assessment) and eat it too (student learning during the test)? *Educational Data Mining 2010 - 3rd International Conference on Educational Data Mining*, 41–50. https://doi.org/10.1007/978-3-642-13437-1_54

Fornaguera, C. C. (2014). *Assessment for Learning in Inquiry Based Science Education: From Individualistic to Socio-cultural Perspectives*. Aalborg University. https://doi.org/10.5278/vbn.phd.engsci.00066

Genç, M. (2015). The effect of scientific studies on students' scientific literacy and attitude. *Ondokuz Mayis University Journal of Faculty of Education*, *34*(1), 141–152. https://doi.org/10.7822/omuefd.34.1.8

Grigorenko, E. L. (2009). Dynamic assessment and response to intervention: Two sides of one coin. *Journal of Learning Disabilities*, *42*, 111–132. https://doi.org/10.1177/0022219408326207

Grigorenko, E. L., & Sternberg, R. J. (1998). Dynamic Testing. *Psychological Bulletin*, *124*(1), 75–111. https://doi.org/10.1037/0033-2909.124.1.75

Hessamy, G., & Ghaderi, E. (2014). The role of dynamic assessment in the vocabulary learning of Iranian EFL learners. *Procedia - Social and Behavioral Sciences*, *98*(1990), 645–652. https://doi.org/10.1016/j.sbspro.2014.03.463

Hung, P. H., Hwang, G. J., Su, I. H., & Lin, I. H. (2012). A concept-map integrated dynamic assessment system for improving ecology observation competences in mobile learning activities. *Turkish Online Journal of Educational Technology*, *11*(1), 10–19. Retrieved from https://www.learntechlib.org/p/55803/

Khaghaninejad, M. S. (2015). *Dynamic assessment: From theory to practice*. Germany: Lambert Academic Publishing.

Khasanah, M. M., Ramli, M., & Dwiastuti, S. (2020). Developing a dynamic assessment instrument to assess reasoning skills about bacteria. *Jurnal Penelitian Dan Evaluasi Pendidikan*, *24*(1), 62–75. https://doi.org/10.21831/pep.v24i1.28815

Kovalčíková, I. (2015). From dynamic assessment of cognitive abilities to educational interventions: Trends in cognitive education. *Journal of Pedagogy*, *6*(1), 5–21. https://doi.org/10.1515/jped-2015-0001

Lawson, A E. (2000). Classroom Test of Scientific Reasoning. *Revised Edition Journal of Research in Science Teaching*, *15*(1), 11–24. Retrieved from http://www.public.asu.edu/~anton1/AssessArticles/Assessments/Mathematics Assessments/Scientific Reasoning Test.pdf

Lawson, Anton E. (1978). The development and validation of a classroom test of formal reasoning. *Journal of Research in Science Teaching*, *15*(1), 11–24. https://doi.org/10.1002/tea.3660150103

Leong, W. S., & Tan, K. (2014). What (more) can, and should, assessment do for learning? Observations from 'successful learning context' in Singapore. *The Curriculum Journal*, *25*(4), 593–619. https://doi.org/10.1080/09585176.2014.970207

Lightfoot, C., Cole, M., & Cole, S. R. (2013). *Physical and Cognitive Development in Early Childhood. The Development of Children* . New York: Worth Publishers.

Lin, C. Y., & Wang, T. H. (2017). Implementation of personalized e-assessment for remedial teaching in an e-learning environment. *Eurasia Journal of Mathematics, Science and Technology Education*, *13*(4), 1045–1058. https://doi.org/10.12973/eurasia.2017.00657a

Navarro, J., & Mourgues, C. (2018). Dynamic assessment and computerized adaptive tests in

reading processes. *Journal of Cognitive Education and Psychology*, *17*(1), 70–96. https://doi.org/10.1891/1945-8959.17.1.70

Novitasari, C., Ramli, M., & Karyanto, P. (2018). Facts And Proofs Diagnostic Test And Structural Communication Grid Test on The Topic of Bacteria: A quantitative analysis. *Jurnal Pendidikan Biologi Indonesia*, *4*(3), 195–202. https://doi.org/10.22219/jpbi.v4i3.6166

Passig, D., Tzuriel, D., & Eshel-kedmi, G. (2016). Improving children's cognitive modifiability by dynamic assessment in 3D immersive virtual reality environments. *Computers & Education*, *95*, 296–308. https://doi.org/10.1016/j.compedu.2016.01.009

Perta, P. A., Ansori, I., & Karyadi, B. (2017). Peningkatan aktivitas dan kemampuan menalar siswa melalui model pembelajaran siklus belajar 5e. *Diklabio: Jurnal Pendidikan Dan Pembelajaran Biologi*, *1*(1), 72–82. https://doi.org/https://doi.org/10.33369/diklabio.1.1.72-81

Poehner, M. E., & Infante, P. (2016). Mediated development: A Vygotskian language learner abilities, *0*(0), 1–26. https://doi.org/10.1002/tesq.308

Remingo, K., Yangco, R., & Espinosa, A. (2018). Analogy-enhanced instruction: Effects on reasoning skills in science. *The Malaysian Online Journal of Educational Science*, *2*(2), 1–9. https://files.eric.ed.gov/fulltext/EJ1086234.pdf

Shabani, K. (2016). Implications of Vygotsky's sociocultural theory for second language (L2) assessment. *Cogent Education*, *3*(1), 1–16. https://doi.org/https://doi.org/10.1080/2331186X.2016.1242459

Shofiyah, N., & Wulandari, F. E. (2018). Model problem-based learning (PBL) dalam melatih scientific reasoning siswa. *Jurnal Penelitian Pendidikan IPA*, *3*(1), 33–38. http://dx.doi.org/10.26740/jppipa.v3n1.p33-38

Stevenson, C. E., Bergwerff, C. E., Heiser, W. J., & Resing, W. C. M. (2013). Working memory and dynamic measures of analogical reasoning as predictors of children's math and reading achievement. *Infant and Child Development*, *23*(1), 1–16. https://doi.org/10.1002/icd.1833

Stevenson, C. E., Heiser, W. J., & Resing, W. C. M. (2016). Dynamic testing: Assessing cognitive potential of children with culturally diverse backgrounds. *Learning and Individual Differences*, *47*, 27–36. https://doi.org/10.1016/j.lindif.2015.12.025

Teig, N., & Scherer, R. (2016). Bringing formal and informal reasoning together — a new era of assessment? *Front. Psycol*, *7*(1097), 1–5. https://doi.org/10.3389/fpsyg.2016.01097

Tzuriel, D., & Caspi, R. (2017). Intervention for peer mediation and mother-child interaction: The effects on children's mediated learning strategies and cognitive modifiability. *Contemporary Educational Psychology*, *49*, 302–323. https://doi.org/10.1016/j.cedpsych.2017.03.005

Van der Graaf, J., Segers, E., & Verhoeven, L. (2015). Scientific reasoning abilities in kindergarten: dynamic assessment of the control of variables strategy. *Instructional*

Science, 43(3), 381-400. https://doi.org/10.1007/s11251-015-9344-y

Wang, P.-H., Wu, P.-L., Yu, K.-W., & Lin, Y.-X. (2015). Influence of Implementing Inquiry-based Instruction on Science Learning Motivation and Interest: A Perspective of Comparison. *Procedia - Social and Behavioral Sciences*, *174*(July), 1292–1299. https://doi.org/10.1016/j.sbspro.2015.01.750

Wang, T.-H. (2010). Web-based dynamic assessment: Taking assessment as teaching and learning strategy for improving students' e-Learning effectiveness. *Computers and Education*, *54*(4), 1157–1166. https://doi.org/10.1016/j.compedu.2009.11.001

Wang, T. H. (2011). Implementation of Web-based dynamic assessment in facilitating junior high school students to learn mathematics. *Computers and Education*, *56*(4), 1062–1071. https://doi.org/10.1016/j.compedu.2010.09.014

Wang, T. H. (2018). Developing a web-based assessment system for evaluating examinee's understanding of the procedure of scientific experiments. *Eurasia Journal of Mathematics, Science and Technology Education*, *14*(5), 1791–1801. https://doi.org/10.29333/ejmste/85170

Wang, T. H., Wang, K. H., & Huang, S. C. (2008). Designing a Web-based assessment environment for improving pre-service teacher assessment literacy. *Computers and Education*, *51*(1), 448–462. https://doi.org/10.1016/j.compedu.2007.06.010

Yunanda, I., Susilo, H., & Ghofur, A. (2019). Misconceptions identification on biodiversity and protist using multiple choice open reason (mcor). *Biosfer: Jurnal Pendidikan Biologi, 12*(2), 170 - 181. https://doi.org/10.21009/biosferjpb.v12n2.170-181

Zulfia, F. A., Susilo, H., & Listyorini, D. (2019). Virus-bacteria diagnostic test (vbd-test) in identifying biology teacher's misconception. *Biosfer: Jurnal Pendidikan Biologi, 12*(2), 144-156. https://doi.org/10.21009/biosferjpb.v12n2.144-156