Exploring Science Teacher's Perspective to Student Worksheets (Hard Scaffolding) to Improve Students' HOTS and Collaboration Skills

Desi Purwanti[1], Tri Jalmo[1*], Abdurrahman[1], Chansyanah Diawati[1]

[1] Postgraduate Science Education Department, University of Lampung, Jl. Prof. Dr. Sumantri Brojonegoro, Bandar Lampung 35145, Indonesia.

Abstract: This study aims to describe teachers' perceptions of the role of student worksheet (Hard Scaffolding) in improving HOTS and students' collaboration skills. The research was conducted in the province of Lampung, Indonesia, involving 56 science teacher respondents through the MGMP IPA forum (Science Subject Teacher Consultation). The research design is mixed methods. The mixed methods strategy used by Sequential Explanatory Design combines qualitative and quantitative data collection and data analysis. Data was taken using a questionnaire that was distributed using a Google form. The survey results show that teachers have a positive perception of student worksheet (hard scaffolding) to improve students' higher-order thinking skills and collaboration skills. Based on the results of an analysis of the use of student worksheet in schools, most teachers have not used student worksheets that are able to train students to achieve competence optimally. The scaffolding strategy in science learning can help the learning process where students are given some assistance during the early stages of learning and then reduce this assistance and provide opportunities for students or students to take over greater responsibility after being able to do it on their own so as to be able to involve students. actively in a learning process that is oriented to equip students with higher-order thinking skills and collaboration skills.

Keywords: Student Worksheet; Hard Scaffolding; HOTS; Collaboration Skills

Introduction

Higher-order thinking and collaboration skills are two important skills needed in the current and future job market. The fact shows that in any position in the world of work, one always needs the ability to analyze evidence, question assumptions, test hypotheses, observe and draw conclusions from all forms of data (Martel, 2021; NACE, 2020; Rokhman et al., 2014). Thus, the ability to think at a higher level will greatly assist someone in solving problems encountered in their respective fields. In daily life, a worker is always in the form of a team and everyone in the team has different skills (Bethlehem, 2016; Martel, 2021; NACE, 2020).

Therefore, the ability of collaboration and interaction between workers will achieve better results.

Based on the above, it is appropriate for education in schools to direct its attention to the development of the two abilities above, namely higher-order thinking skills and collaboration skills (Wijaya et al., 2016; Lu et al., 2021; Vasconcelos & Orion, 2021). However, the quality of education in Indonesia is still in the low category. This is based on the results of the 2018 PISA survey in the field of science, Indonesia is in the bottom 10 out of 79 participating countries. The students' average reading ability and science ability were respectively 42 points and 37 points below the student average (Pratiwi et al., 2020). The average ability of students to read and science is low, influenced by several factors, for example the situation and conditions of the learning process as well as the condition of teaching materials (Sutrisna, 2021).

The results of observations in a preliminary study conducted on junior high school students in Lampung showed that 84% of students stated that they used worksheets in learning science. However, 23% of the student worksheet contained questions whose answers were in textbooks/printed books, 20% and as many as 38% of students stated that the learning steps began with an explanation of the material after which students were asked to work on the student worksheet and finally collected it. This shows that the student worksheet used still uses low-level thinking skills questions and is only limited to actual abilities (Jalmo, 2010; Levrini et al., 2021). In addition, as many as 69% of students stated that when using student worksheet in learning science it was done individually not in groups, students were rarely trained to improve collaboration skills. Even though student worksheet functions as a study guide that contains a set of basic activities that must be carried out by students to maximize understanding in an effort to form basic abilities according to the achievement indicators taken (Jafarigohar & Mortazavi, 2017; Trianto, 2011).

Education needs to provide the best facilities so that the learning process follows the standard teacher process. Learning conducted by teachers generally does not use appropriate strategies and adequate teaching materials to train and develop these abilities. This explains that students experience difficulties in the learning process due to reduced academic recognition of knowledge and skills (Donnelly & Patrinos, 2021; Frederick et al., 2014; Kaffenberger, 2021). Therefore, it is necessary to have strategies and teaching materials that can support the development of students' potential level of ability, namely scaffolding. The term scaffolding was coined by Wood, Bruner, and Ross (1976), as a process of increasing students' ability to solve problems, achieve goals or complete tasks beyond their own abilities (Jalmo, 2010)

Scaffolding is a support process that allows students to successfully achieve goals or perform tasks that are beyond the capacity of students without assistance (potential ability) (Reiser, 2018; Umutlu & Kim, 2020). The scaffolding strategy does not only encourage actual knowledge, but stimulates students to increase potential abilities (Belland et al., 2015; Jalmo, 2010; Mustofa et al., 2008; Nurulsari, 2017). Scaffolding

is classified into 2, namely hard scaffolding and soft scaffolding. Hard scaffolding involves the use of computers as tools and paper-based materials, including student worksheet. One type of hard scaffolding is the "Process Worksheet", namely instructions on tasks in the form of questions that guide or encourage students so that students can complete each step that must be completed (Berenji et al., 2020; Großmann & Wilde, 2019; Mojarrabi Tabrizi et al., 2019).

This study aims to describe teachers' perceptions of the role of student worksheet (Hard Scaffolding) in improving HOTS and students' collaboration skills. These findings also provide an overview of the complexity of pedagogical work, which can inform the professional development of teachers to develop their teaching material preparation (student worksheet).

Method

The research design is mixed methods. The mixed methods strategy used by Sequential Explanatory Design combines qualitative and quantitative data collection and data analysis (Creswell, 2012). The sampling technique that we used to determine the sample was using random sampling (Sugiyono, 2016). We use the Google form to collect information that is disseminated online through the MGMP IPA forum (Science Teacher Deliberation) to describe teachers' perceptions of student worksheets being used in science lessons. Research activities were carried out at public/private junior high schools in Lampung Province, Indonesia. The research subjects used were 56 science teacher respondents based on long experience of teaching. The distribution of science teacher subjects based on past teaching experience can be detailed in Figure 1.

The survey instrument consists of 9 statements using the Guttman scale which has answer choices according to the contents of the question, namely: "Yes" and "No" with a score of "1" and "0" (Sudjana, 2005). The results of the questionnaire were analyzed using the percentage of responses from each item and the results of the interpretation of the presentation of the respondents' answers in a descriptive narrative form.
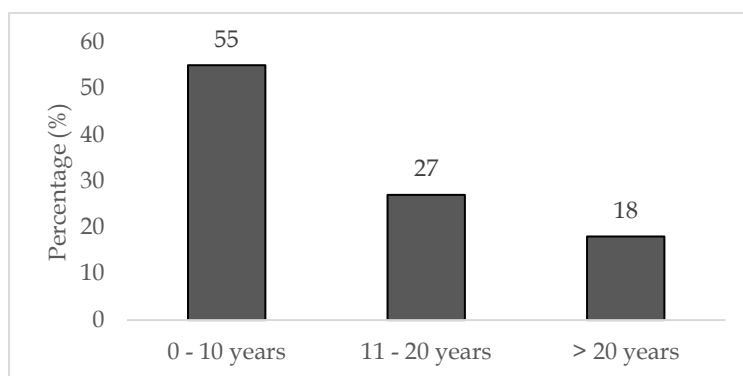
Figure 1. Percentage of teacher's teaching experience (n=56)

Results and Discussion

The results and discussion of the data obtained are in the form of a questionnaire. The results of distributing the questionnaire to 56 science teachers in Lampung Province can be seen in table 1.

Table 1. Interpretation of Teacher Perceptions Questionnaire Results (n=56)

Question	Percentage (%)	
	Yes	No
Do you use student worksheet in learning?	88	13
Did you make your own student worksheet to be used in the lesson?	39	61
Did you choose the student worksheet to be used in learning?	66	34
When using student worksheet is done through group learning?	57	43
When learning is done in groups are there rules that must be obeyed by students?	68	32
Have you ever seriously developed student worksheets that are able to train students to achieve competence optimally?	21	79
Do you need examples of student worksheet that are able to optimally develop student competencies?	100	0

The results showed that 88% of educators used student worksheet in learning, but only 39% of educators made student worksheet for learning. 66% chose the student worksheet to be used, 68% did it in groups, but only 21% of educators had seriously developed student worksheet and 100% of educators stated that they needed examples of student worksheet that were able to develop students' competencies optimally. The results of the teacher's questions and responses are in Table 2.

Table 2. Interpretation of Teacher's Statements and Responses

Question	Teacher Response
How to make student worksheet used in learning?	39% stated that they made their own student worksheet
	61% stated that they bought from publishers/ took from the internet
How to choose student worksheet to be used in learning?	34% stated that as long as it is in accordance with the subject matter and the price is affordable for students
	66% choose according to the competencies students will achieve
What are the characteristics of the student worksheet used?	23% stated that the student worksheet contains short answer questions that must be answered by students
	39% stated that the student worksheet contains questions that require students to do research/observations
	38% stated that the student worksheet contains questions that help students understand the material and think at a higher level
What is the learning scenario when carrying out learning using student worksheet?	16% stated that the student worksheet was started with a thorough explanation of the material after which students were asked to work on the student worksheet and finally it was collected
	16% stated that student worksheet begins with a thorough explanation of the material after which students are asked to work on the student worksheet and ends with class presentations and discussions

Question	Teacher Response
	30% stated that student worksheet begins with a brief material explanation by the teacher, then students work on the student worksheet individually/groups, presentations and class discussions
	38% stated that the student worksheet was started with a brief material explanation by the teacher, then students worked on the student worksheet in groups, presented and class discussions, and students were given student worksheet to work on independently/individually
How to use student worksheet done through group learning?	57% stated that they use group learning more often
	43% stated that it was more often done individually
What are the rules that must be obeyed by students in group discussions?	32% stated that there was none, the important thing was that the students were orderly and finished on time
	68% stated that there were, among others; there is a division of tasks for each member and all actively brainstorm
How to develop worksheets that are able to train students to achieve competence optimally?	21% stated that they had and the results were tested
	79% stated that they had never and wanted to be able to develop

Based on the data above, it can be seen that the learning carried out by educators in general has not used the right strategy and worksheets have not developed student competencies optimally. The results of teacher responses using worksheets based on long experience teaching science are shown in Figure 2.
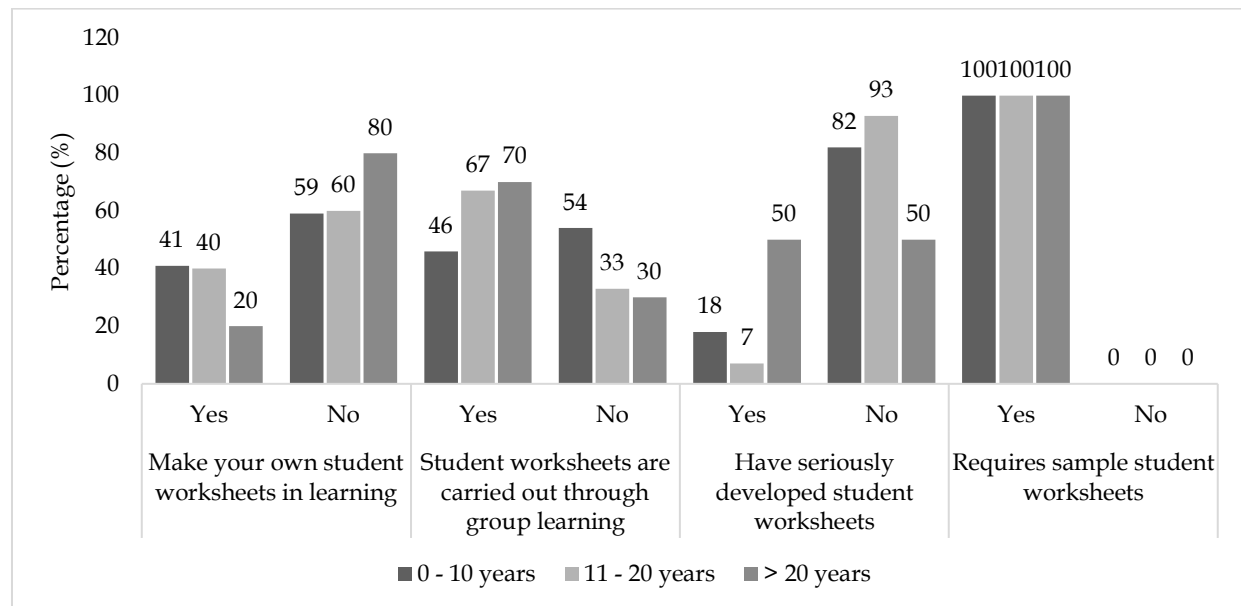

Figure 2. Percentage of teachers teaching experience using worksheets

Based on the figure above, it shows that more than 10 years of experience in teaching make their own student worksheet in learning compared to teaching experience of more than 10 years. This illustrates that a teacher's long experience of teaching is not necessarily seriously developing worksheets. This shows that individual teacher professional development is less effective and not optimal in developing student worksheet (Huda et al., 2023; Jalmo, 2010).

Based on the explanation above, it shows that educators use student worksheet in learning, but only as a form of giving assignments for actual knowledge, not yet stimulating to increase students' potential abilities

(Jalmo, 2010; Mustofa et al., 2008; Tiaradipa et al., 2020; Umutlu & Kim, 2020). Therefore, it is necessary for students to be trained in depth using student worksheet (hard scaffolding) to explore data, facts, and be given analytical questions, so that students' understanding increases and the level of development of students' abilities is at the level of potential ability (Choo et al., 2011; Jalmo, 2010; Nurulsari et al., 2017). The following is the scaffolding design in student worksheet teaching materials according to the results of observations and interviews:
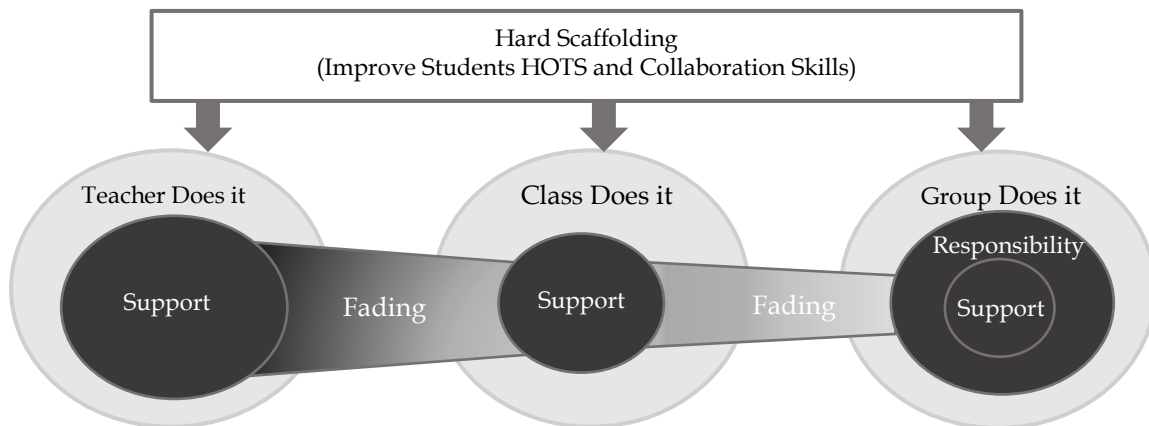
Figure 3. Hard scaffolding design in learning. source: Modified (Jalmo, 2010; Van de Pol et al., 2010)

Scaffolding was first coined by Wood, Bruner, and Ross (1976), is a process of increasing the ability of students or new people to solve problems, complete assignments, or achieve goals beyond their capabilities. Vygotsky defines scaffolding learning as "the role of the teacher and others in assisting student development and providing structured support to reach the next stage or level" (Stuyf, 2002).

Scaffolding is based on Vygotsky's sociocultural theory, namely that social interaction plays a fundamental role in the development of cognition. Learning occurs through student participation in deliberately instilled social and cultural experiences. Students develop their cultural and psychological functions through involvement in community cultural practices and interacting with more informed members of society (Vygotsky, 1978). In his work, Vygotsky has two main principles, namely the more knowledgeable other (MKO) and the zone of proximal development (ZPD). MKO is someone who has a better understanding or a higher level of ability than a student, for example a teacher, an adult, a child's peers or a child's parent. Vygotsky stated that there are two levels of student development, namely the level of actual development and the level of potential development, the distance between the level of actual development as the ability to solve problems independently and the level of potential development which is determined through problem solving under the guidance of adults or in collaboration with friends who are more capable called ZPD (Vygotsky, 1978). New skills emerge and can be developed with varying degrees of guidance if given the right ZPD. The following is a student worksheet design (hard scaffolding) to improve students' high-order thinking skills and collaboration skills.
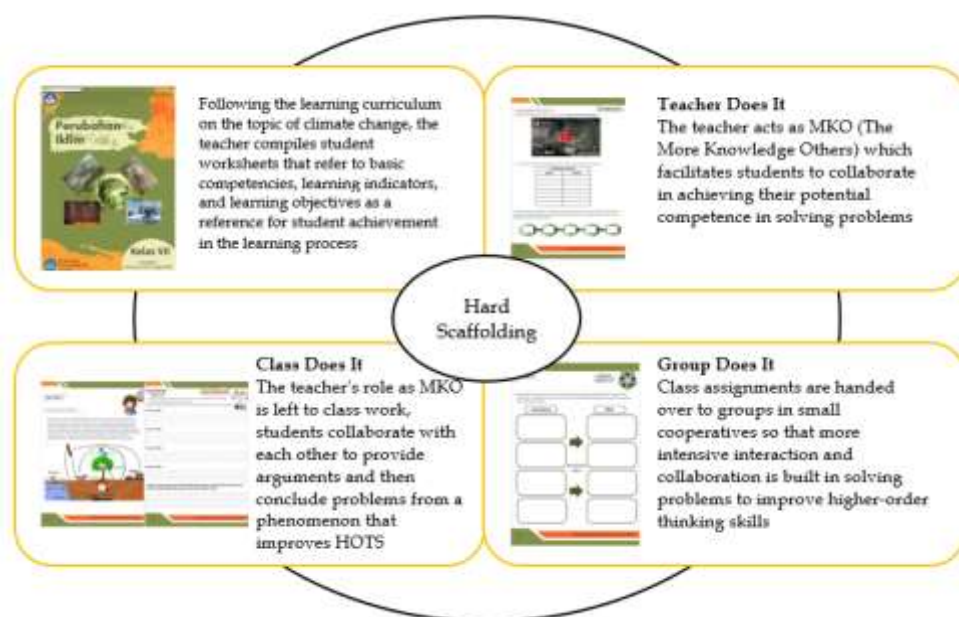

Figure 4. Student worksheet (hard scaffolding) design

Hard scaffolding in the form of worksheets is proven to improve learning performance (Morgan & Brooks, 2012; Suryaningsih et al., 2021). Providing assistance (scaffold) in the form of process worksheets is also capable of constructing knowledge (Choo et al., 2011). Scaffolding is a learning strategy in which students are given some assistance during the early stages of learning and then reduce this assistance and provide opportunities for these students or students to take over greater responsibility after being able to do it on their own (Nurulsari et al., 2017; Pirolli et al., 2021). This strategy will provide benefits to students by discovering concepts through the construction of knowledge they already have that can increase mastery of concepts and at the same time train important skills for facing the future and how to find concepts (Wakhidah et al., 2016).

Conclusion

The survey results show that teachers have a positive perception of student worksheet (hard scaffolding) to improve students' higher-order thinking skills and collaboration skills. Based on the results of an analysis of the use of student worksheet in schools, most teachers have not used student worksheet that are able to train students to achieve competence optimally. The scaffolding strategy in science learning can help the learning process where students are given some assistance during the early stages of learning and then reduce this assistance and provide opportunities for these students or students to take on greater responsibility after being able to do it on their own so as to be able to involve students. actively in a learning process that is oriented to equip students with higher-order thinking skills and collaboration skills.

Author Contributions
The lead author, Desi Purwanti, contributed to designing and conducting the research and writing the article. The second author, Tri Jalmo, contributed to assisting the research implementation process, designing research instruments and guiding the writing of the article to completion. The third and fourth author, Abdurrahman and Chansyanah Diawati, contributed to guiding the research. All authors have approved the version of the manuscript to be published.

Conflict of Interest
There is no conflict of interest in this research.

References

Belland, B. R., Burdo, R., & Gu, J. (2015). A Blended Professional Development Program to Help a Teacher Learn to Provide One-to-One Scaffolding. *Journal of Science Teacher Education*, 26(3), 263–289. https://doi.org/10.1007/s10972-015-9419-2

Berenji, S., Saeidi, M., & Ghafoori, N. (2020). The Effect of Problem-based Learning with Hard Scaffolds on Iranian EFL Learners' Reading Comprehension. *Journal of Language and Translation*, 10(2), 121–133. Retrieved from https://ttlt.stb.iau.ir/article_673895.html

Bethlehem, H. A. (2016). *Job Outlook 2016*. National Asscociation of Colleges and Employers.

Choo, S. S. Y., Rotgans, J. I., Yew, E. H. J., & Schmidt, H. G. (2011). Effect of worksheet scaffolds on student learning in problem-based learning. *Advances in Health Sciences Education*, 16(4), 517–528. https://doi.org/10.1007/s10459-011-9288-1

Creswell, J. W. (2012). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research*. Pearson Education, Inc.

Donnelly, R., & Patrinos, H. A. (2021). Learning loss during Covid-19: An early systematic review. *Prospects*, *0123456789*. https://doi.org/10.1007/s11125-021-09582-6

Frederick, M. L., Courtney, S., & Caniglia, J. (2014). With a Little Help from My Friends: Scaffolding Techniques in Problem Solving. *Investigations in Mathematics Learning*, 7(2), 21–32. https://doi.org/10.1080/24727466.2014.11790340

Großmann, N., & Wilde, M. (2019). Experimentation in biology lessons: guided discovery through incremental scaffolds. *International Journal of Science Education*, 41(6), 759–781. https://doi.org/10.1080/09500693.2019.1579392

Huda, T. A., Haenilah, E. Y., & ... (2023). Program For Developing Rural Area Elementary School Teachers Professionalism Based on TPACK: Review Empirical And Reflective. *Journal of Adaptive …*, 1(January), 29–44. Retrieved from https://journals.fkip.unila.ac.id/index.php/aej/article/view/73%0Ahttps://journals.fkip.unila.ac.id/index.php/aej/article/download/73/39

Jafarigohar, M., & Mortazavi, M. (2017). The Impact of Scaffolding Mechanisms on EFL Learners' Individual and Socially Shared Metacognition in Writing. *Reading and Writing Quarterly*, 33(3), 211–225. https://doi.org/10.1080/10573569.2016.1154488

Jalmo, T. (2010). Pengembangan Program Pelatihan

Peningkatan Kompetensi Guru IPA SMP. *Forum Pendidikan*, *30*(6), 79–88.

Kaffenberger, M. (2021). Modelling the long-run learning impact of the Covid-19 learning shock: Actions to (more than) mitigate loss. *International Journal of Educational Development*, *81*, 102326. https://doi.org/10.1016/j.ijedudev.2020.102326

Levrini, O., Tasquier, G., Barelli, E., Laherto, A., Palmgren, E., Branchetti, L., & Wilson, C. (2021). Recognition and operationalization of Future-Scaffolding Skills: Results from an empirical study of a teaching–learning module on climate change and futures thinking. *Science Education*, *105*(2), 281–308. https://doi.org/10.1002/sce.21612

Lu, K., Yang, H. H., Shi, Y., & Wang, X. (2021). Examining the key influencing factors on college students' higher-order thinking skills in the smart classroom environment. *International Journal of Educational Technology in Higher Education*, *18*(1), 1–13. https://doi.org/10.1186/s41239-020-00238-7

Martel, N. (2021). *The Class of 2021*. 1–6.

Mojarrabi Tabrizi, H., Behnam, B., Saeidi, M., & Lu, X. (2019). The effect of soft vs. hard scaffolding on reading comprehension skill of EFL learners in different experimental conditions. *Cogent Education*, *6*(1), 1–13. https://doi.org/10.1080/2331186X.2019.1631562

Morgan, K., & Brooks, D. W. (2012). Investigating a Method of Scaffolding Student-Designed Experiments. *Journal of Science Education and Technology*, *21*(4), 513–522. https://doi.org/10.1007/s10956-011-9343-y

Mustofa, H., Jazeri, M., Mu'awanah, E., Setyowati, E., Wijayanto, A., & Mamin, R. (2008). Strategi Pembelajaran Scaffolding Dalam Membentuk Kemandirian Belajar Siswa. *Jurnal Chemica*, *10*(April), 42–52. Retrieved from https://journal.an-nur.ac.id/index.php/ALF/article/view/29

NACE. (2020). *Job Outlook 2020 Survey*. National Asscociation of Colleges and Employers.

Nurulsari, N. (2017). *Pengembangan Strategi Soft Scaffolding dalam Pembelajaran Kooperatif untuk Meningkatkan Kemampuan Berpikir Kreatif Siswa pada Pembelajaran*. Doctoral dissertation, Fakultas Keguruan Dan Ilmu Pendidikan. Retrieved from http://digilib.unila.ac.id/29228/

Nurulsari, N., Abdurrahman, & Suyatna, A. (2017). Development of soft scaffolding strategy to improve student's creative thinking ability in physics. *Journal of Physics: Conference Series*, *909*(1). https://doi.org/10.1088/1742-6596/909/1/012053

Pirolli, P., Youngblood, G. M., Du, H., Konrad, A., Nelson, L., & Springer, A. (2021). Scaffolding the Mastery of Healthy Behaviors with Fittle+ Systems: Evidence-Based Interventions and Theory. *Human-Computer Interaction*, *36*(2), 73–106. https://doi.org/10.1080/07370024.2018.1512414

Pratiwi, I., Solihin, L., Atamadiredja, G., & Utama, B. (2020). Risalah kebijakan. *Pusat Penelitian Kebijakan, 3,* 1–8.

Reiser, B. J. (2018). Scaffolding Complex Learning: The Mechanisms of Structuring and Problematizing Student Work. *Scaffolding: A Special Issue of the Journal of the Learning Sciences*, 273–304. https://doi.org/10.4324/9780203764411-2

Rokhman, F., Hum, M., Syaifudin, A., & Yuliati. (2014). Character Education for Golden Generation 2045 (National Character Building for Indonesian Golden Years). *Procedia - Social and Behavioral Sciences*, *141*, 1161–1165. https://doi.org/10.1016/j.sbspro.2014.05.197

Stuyf, R. V. D. (2002). Scaffolding as a Teaching Strategy. *Adolescent learning and development, 52*(3), 5-18. Retrieved from https://pileidou.files.wordpress.com/2013/11/scaffolding-as-a-teaching-strategy.pdf

Sudjana, N. (2005). *Metode statistika*. Bandung: Tarsito.

Sugiyono. (2016). *Metode penelitian kuantitatif, kualitatif, dan R & D*. Bandung: Alfabeta.

Suryaningsih, H., Medriati, R., & Purwanto, A. (2021). Pengembangan lembar kerja peserta didik (LKPD) berbasis scaffolding berorientasi berpikir kritis pada materi Hukum Newton di SMA Negeri kota Bengkulu. *Amplitudo: Jurnal Ilmu dan Pembelajaran Fisika, 1*(1), 44-52. Retrieved from https://ejournal.unib.ac.id/jipf/article/view/17995

Sutrisna, N. (2021). Analisis Kemampuan Literasi Sains Peserta Didik SMA di Kota Sungai Penuh. *Jurnal Inovasi Penelitianitian*, *1*(12), 2683-2694. Retrieved from https://stp-mataram.e-journal.id/JIP/article/view/530

Tiaradipa, S., Lestari, I., Effendi, M. H., & Rusdi, M. (2020). The Development Scaffolding in Inquiry-Based Learning to Improve Students' Science Process Skills in The Concept of Acid and Base Solution. *JKPK (Jurnal Kimia Dan Pendidikan Kimia)*, *5*(2), 211–221. https://doi.org/10.20961/jkpk.v5i2.42420

Trianto, M. P. T. K. (2011). *Strategi Dan Implementasinya Dalam Kurikulum*. Jakarta: Prestasi Pustaka.

Umutlu, D., & Kim, C. M. (2020). Design guidelines for scaffolding pre-service teachers' reflection-in-action toward culturally responsive teaching. *Reflective Practice*, *21*(5), 587–603. https://doi.org/10.1080/14623943.2020.1779049

Van de Pol, J., Volman, M., & Beishuizen, J. (2010).

Scaffolding in teacher-student interaction: A decade of research. *Educational Psychology Review*, *22*(3), 271–296. https://doi.org/10.1007/s10648-010-9127-6

Vasconcelos, C., & Orion, N. (2021). Earth Science Education as a Key Component of Education for Sustainability. *Sustainability, 13*(3), 1316. https://doi.org/10.3390/su13031316

Vygotsky, L. (1978). *Interaction Between Learning and Development. From: Mind and Sociaty. Reprint in: Readngs on the Development of Children*. In New York: W.H. Freeman and Company, Linköpings universitet.

Wakhidah, N., Ibrahim, M., & Agustini, R. (2016). *Scaffolding Pendekatan Saintifik: Strategi Untuk Menerapkan Pendekatan Saintifik Dengan Mudah*. Jaudar Press Surabaya. http://repository.uinsa.ac.id/id/eprint/1599/

Wijaya, E. Y., Sudjimat, D. A., & Nyoto, A. (2016, September). Transformasi pendidikan abad 21 sebagai tuntutan pengembangan sumber daya manusia di era global. In *Prosiding Seminar Nasional Pendidikan Matematika, 1*(26), 263-278. Retrieved from https://repository.unikama.ac.id/840/32/263-278%20TRANSFORMASI%20PENDIDIKAN%20ABAD%2021%20SEBAGAI%20TUNTUTAN%20PENGEMBANGAN%20SUMBER%20DAYA%20MANUSIA%20DI%20ERA%20GLOBAL.pdf