

Journal of Science Education Research

Journal homepage: www.journal.uny.ac.id/jserr



Development of E-worksheet based on Problem Based Learning to Improve Student's Metacognitive Ability

R. A. Mitasari¹, R. Hidayah^{2*}

^{1,2}Study Program of Chemistry Education, Faculty of Mathematics and Natural Sciences, Universitas Negeri Surabaya

Corresponding Author. Email: ruslyhidayah@unesa.ac.id

Keywords

E-worksheet,
Problem Based
Learning,
Metacognitive

Abstract

The study aimed to determine the validity, practicality, and effectiveness of electronic student worksheets (e-worksheets) based on problem based learning (PBL) to improve students' metacognitive abilities on stoichiometric material. The research was used a research and development (R&D). The sample of the study was 30 students from SMAN 19 Surabaya. The instruments were validation sheets, student observation sheets, cognitive test sheets, and MAI questionnaires. The metacognition ability was tested using MAI questionnaire on the aspects of planning, monitoring, and evaluating. Then, it was strengthened again with a cognitive test consisting of 6 cognitive questions. The results showed that the developed e-worksheet has 89.76%; 86.67%; 83.33%; and 86.67% of content; graphics; presentation; and language validities, respectively. All components were in the very high category. The results of the practicality of the e-worksheet were 94.64%; 99.29%; 95.24%; 97.62%; and 94.05% for the PBL strategy; metacognitive; graphics; presentation; and language components, respectively. All components were in the very practical category. Based on the t-test, the sig.2-tailed of the planning, monitoring, and evaluating aspects were less than 0.05 so H_a is accepted, which means that the e-worksheet can improve students' metacognitive abilities in those aspects. This is supported by the t-test of students' cognitive abilities where the sig.2-tailed is 0.000 so H_a is accepted, which means that the developed e-worksheet can improve students' cognitive abilities.

INTRODUCTION

The 2013 Curriculum is the curriculum used in Indonesia today and it is a substitute for the KTSP curriculum. The curriculum focuses more on the student, not the teacher. In addition, in the learning process, the approach used is the scientific approach, which consists of observing, asking, reasoning, trying, and creating networking. The 2013 curriculum is a product of educational change and is designed to meet the needs of the 21st century (Widodo, 2016).

The 21st century is not just an expression of time because of the development of science, technological innovation, new thinking, and different perspectives experienced by humans. 21st century skills in the learning curriculum are not only useful for students in their life but also can prepare students for their future lives (Alismail & McGuire, 2015).

According to Jonassen (2011) there are several types of problems. These problems are divided into

two, i.e.: well-structured and ill-structured problems. A well-structured problem is a problem whose solution applies fixed concepts, rules, and principles in chemistry, whereas ill-structured problem is a problem concerning the resolution of unknown elements, the relationship among concepts, rules, and principles that are not mutually consistent (Jonassen, 2011). The two types of problem have different levels of completion so different characteristics of metacognitive abilities will be produced. Students are better at solving existing problems based on good metacognitive characteristics.

Chemical stoichiometry is a broad concept that is taught in chemistry lessons, e.g.: the relationship between the moles of reactants and products in an equilibrium reaction. This allows students to solve problems related to chemical reactions, amounts of substances, concentrations, and chemical equilibrium. The stoichiometric concepts mentioned above are fundamental in quantitative chemistry.

Failure to understand and make connections between these concepts creates conceptual problems for students (Jonassen, 2011).

The habits of mind can help students to prepare information choices related to complexities in personal, professional, and civil life. Learning is needed to develop integrative and metacognitive abilities (Huber & Hutchings, 2008).

Metacognitive skills are needed to overcome various types of problems, including well-structured and ill-structured in stoichiometric material. Metacognitive skill is one of the higher-order thinking skills (HOTS) of humans in their thinking processes (Greenstein, 2012). Metacognition occurs in the use of prior knowledge to plan strategies in carrying out tasks, as well as taking the necessary steps to solve problems, reflect, and evaluate the results (Teal, 2010). Metacognitive skills refer to students' ability to plan in order to achieve goals and to manage, monitor, and modify problem-solving processes. Therefore, the study of metacognitive skills in the problem-solving process is important. Skills that need to be learned include planning, monitoring, and evaluation (Livingston, 1997).

In improving metacognitive skills, learning strategies are needed to follow the goals desired by the teacher. One of the effective learning strategies that can increase the sensitivity, creativity, independence, and problem-solving of students is the problem-based learning (PBL) (Mustofa & Hidayah, 2020). In PBL, students are given real-life problems that occur in the community, so that students get an innovative and creative learning process in their problem-solving approach, hence students become interested and want to solve the problem (Dasna *et al.*, 2007). The main goal of the PBL approach is to show students the relevance of the subject matter by conveying an appropriate, realistic, and practical context (Alrahlah, 2016).

Based on the results of the pre-research, it is found that the metacognitive ability of the students in SMAN 19 Surabaya was measured using an MAI questionnaire. The percentage of the planning aspect is 67.24% in the good category. The percentage of the monitoring aspect is 64.38% in the sufficient category. Lastly, the percentage of the evaluating aspect is 61.44% in the sufficient category. Based on these results, the metacognitive ability of students at SMAN 19 Surabaya is 64.35%, which is in a sufficient category.

In the learning activities, media is needed to support the learning process. One example of the media in chemistry learning is the e-worksheet. E-worksheet is an electronic-based worksheet that contains assignments and work instructions for a given task. E-worksheet is easy and effective to be used because it can be accessed at any time and does not need much space to store. Student worksheets

are student's guides in conducting investigations or problem-solving activities (Trianto, 2010).

Based on the above description, the study aims to determine the validity, practicality, and effectiveness of the e-worksheet based on PBL in improving students' metacognitive abilities.

RESEARCH METHOD

This was a research on the development of learning media using a design that refers to the research and development (R&D) method by Sugiyono. The R&D method was a research method used to produce certain products and to test the validity, practicality, and effectiveness of the product. The R&D method has 10 stages, namely (1) potencies and problems, (2) data collection, (3) product design, (4) design validation, (5) design revision, (6) product trial, (7) product revision, (8) usage trial, (9) product revision, and (10) mass production. Here, this research was conducted only until the product trials (Sugiyono, 2016).

This study used a sample of 30 students in the XII grade of MIPA 8 from SMAN 19 Surabaya. This research used questionnaires, observation, and test methods. The instruments used were e-worksheets study sheets, MAI questionnaire sheets to measure metacognitive ability, e-worksheet validation sheets, test sheets to measure students' cognitive abilities, and student response sheets to see the practicality of the e-worksheet.

The measurement of the validity of the e-worksheet used a validated questionnaire, which was then filled out by 2 lecturers of the Universitas Negeri Surabaya and 1 teacher of SMAN 19 Surabaya. The percentage of the questionnaire data was obtained based on the Likert scale calculation in Table 1.

Table 1. Likert Scale

Score	Description
1	Very Less
2	Less
3	Enough
4	Good
5	Very good

Table 2. Score Conversion

Score (%)	Category
0.00 – 20.0	Very low validity
20.1 – 40.0	Low validity
40.1 – 60.0	Medium validity
60.1 – 80.0	High validity
80.1 – 100.0	Very high validity

The score results obtained were percentages and converted to obtain the quality of the developed

products. The score conversion is presented in Table 2.

The measurement of the practicality of the e-worksheet was seen based on student response questionnaires. The measurement scale used for practicality is the Gautman scale in Table 3. After obtaining the percentage score, then the percentage was converted to see the level of practicality of the developed e-worksheet as given in Table 4.

Table 3. Gautman Scale

Description	Score
Yes	1
No	0

Table 4. Score Conversion

Score (%)	Category
0.00 – 20.0	Not practical
20.1 – 40.0	Less practical
40.1 – 60.0	Practical enough
60.1 – 80.0	Practical
80.1 – 100.0	Very practical

Metacognitive measurement of students - before and after treatment using the MAI questionnaire in the aspects of planning, monitoring, and evaluating were measured based on the Likert scale. The MAI questionnaire used a questionnaire developed by Scraw & Dennison (1994).

Furthermore, the data from the ordinal Likert scale was converted into interval data using

successive interval method (SIM) that was installed in Microsoft Excel. The action was performed because if the ordinal scale data was still used in the quantitative test analysis, it will be an erroneous interpretation. Therefore, this needs to be converted into interval data. Converting data from ordinal Likert scale data to interval data using the SIM method does not cause any difference in the analysis conclusions so this data conversion can be used (Suliyanto, 2011). Furthermore, the data was tested using the paired sample t-test. The results of the t-test of metacognitive abilities were strengthened by the results of the t-test of cognitive abilities based on the results of the pretest and posttest of the cognitive test, which consists of 6 essay questions.

Table 5. MAI Likert Scale

Score	Description
1	Never
2	Very rarely
3	Seldom
4	Often
5	Very often

RESULTS AND DISCUSSION

In this study, the development of e-worksheet was tested for its validity, practicality, and effectiveness in training students' metacognitive abilities. This e-worksheet is developed using the R&D method by Sugiyono (2016). Figure 1 illustrates the steps of the R&D.

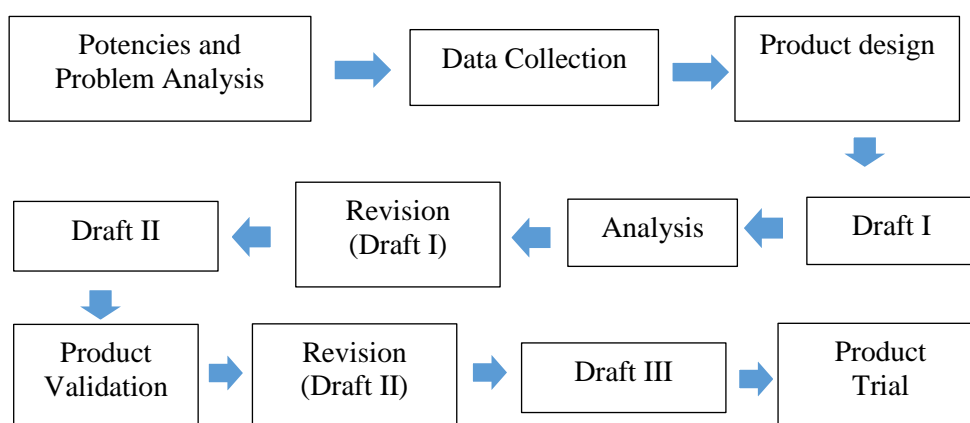


Figure 1. Seps of R&D

1. Potencies and Problems

Potencies and problems aim to identify initial problems that occur in the field. This is carried out through a preliminary study by distributing questionnaires to students of SMAN 19 Surabaya. The results of the preliminary study show that the stoichiometry material is difficult.

Based on the results of the preliminary research, it is found that the metacognitive ability of

the students of SMAN 19 Surabaya was measured using an MAI questionnaire. The percentage of the planning aspect is 67.24% in the good category. The percentage of the monitoring aspect is 64.38% in the sufficient category. Finally, the percentage of the evaluating aspect is 61.44% in the sufficient category. Based on these results, the metacognitive ability of students at SMAN 19 Surabaya is 64.35% in the sufficient category.

The results of the questionnaire state that 87.1% of students considered chemistry as a difficult subject because it consists of many calculations and theories that need to be memorized and the worksheet is less supportive. Then, 77.4% students considered stoichiometry material a difficult material in learning chemistry. Not only many calculations, but also many concepts need to be memorized. 61.3% students do not understand the stoichiometry material taught by the teacher during the learning process because the teacher often uses the discourse or lecture method.

Based on the results of teacher interviews, chemistry lessons are considered difficult because students have not received chemistry lessons in junior high school. So, chemistry is a new lesson. Learning stoichiometry chemistry is one of the difficult materials for students. Even in the stoichiometric material, many students' scores are below the minimum completeness criteria.

The challenge in chemistry learning is choosing or getting media that is appropriate for students

according to the student's thinking ability. According to the chemistry teacher, an e-worksheet is needed that can improve students' metacognitive skills in chemistry subjects. So, the teacher also strongly agrees that the e-worksheet based PBL should be developed for stoichiometric material because the PBL learning strategy expects students to solve problems according to the material. This makes learning more meaningful with the help of an e-worksheet, which is very useful for students.

2. Data Collection

Data collection aims to collect various information and data that can be used for product development planning to solve the problems.

3. Product Design

The product design aims to develop the e-worksheet media design as a stoichiometry learning media. Figure 2 shows the design display of the developed e-worksheet.

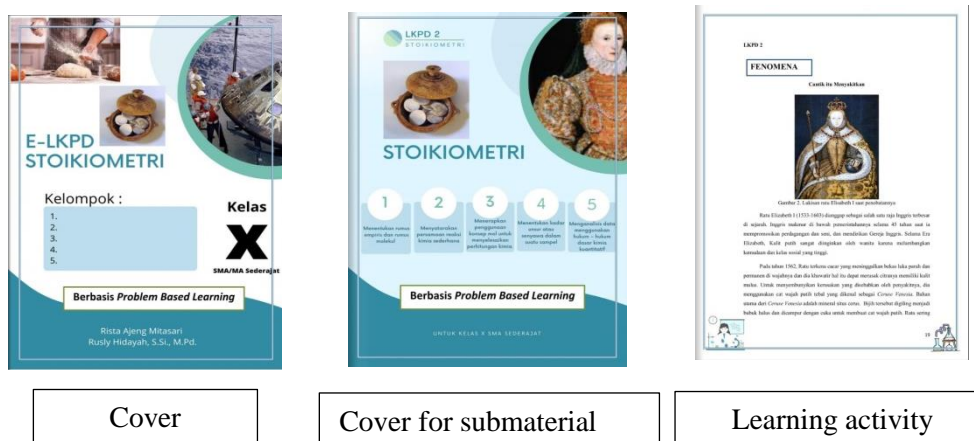


Figure 2. The e-worksheet design display

4. Analysis

After making the e-worksheet design, then, the e-worksheet is given to the reviewers who are media expert lecturers. The review stage aims to improve the media before validation so that the validation results are satisfied.

5. Product Validation

The product validation stage aims to assess the reviewed and revised product to determine the feasibility in terms of the validity. Based on the results of the product validation, the results of the validity of the developed e-worksheet is presented in Table 7.

Contents	89.76	Very high validity
Graphic	86.67	Very high validity
Presentation	83.33	Very high validity
Language	86.67	Very high validity

Based on the validation results, it is found that the developed e-worksheet has very high validity. The assessments of this validity have 4 components. The first component is the content of the e-worksheet. The content component includes the compatibility of the e-worksheet with the 2013 Curriculum; its conformity with core competencies, basic competencies, indicators, and objectives; conformity with stoichiometric material which includes facts and concepts; suitability of the influence given to students such as to train students' metacognitive abilities and following the PBL

Table 7. E-worksheet Validation Result

Component	Score (%)	Category
-----------	-----------	----------

strategies; conformity with the syllabus and lesson plans; conformity with the students' cognitive pretest and posttest sheets; and conformity with the e-worksheet practicality questionnaire.

The second component is the graphics component, which consists of the cover representing the content of the manuscript; phenomena that arouse students' curiosity; pictures that can help students understand concepts; presentation of the material allows students to work together and interact with friends, teachers, and/or other learning resources that support and are by the learning material.

The third component is presentation that consists of an assessment of the attractiveness of the cover. So, this presents the contents of the e-worksheet; the use of fonts (type and size), which

makes it easier for students to use the e-worksheet; the suitability of the e-worksheet background with colors and text; text, matching image, and table layout; mold quality; and well written terms, symbols, and formulas.

The fourth component is language that includes an assessment of the use of language following the enhanced spelling of Bahasa Indonesia; writing of the e-worksheet using appropriate words and language that is easy to understand, convey messages, and effective sentences.

6. Product Trial

The product trial aims to determine the practicality and effectiveness of the products. The product trial stage is carried out in a limited manner and offline.



Figure 3. Product Trial Activity

Table 8. E-worksheet Practically Result

Component	Percentage (%)	Category
PBL Strategy	94.64	Very Practical
Metacognitive	99.29	
Graphic	95.24	
Presentation	97.62	
Language	94.05	
Total	96.19	

The measurement of the practicality of the e-worksheet is conducted through a student's response questionnaire. The results of the developed e-worksheet are presented in Table 8. Based on the practicality results, the developed e-worksheet is in the very practical category. The practicality score is seen from 5 components, i.e.: the PBL strategy as the basis of the e-worksheet, the practicality of the e-worksheet in training students' metacognitive abilities, the graphics of the e-worksheet, the presentation in the e-worksheet, and the language used in the e-worksheet.

The components of the PBL strategy that were assessed, namely the interest of students when using the e-worksheet; students' learning enthusiasm when using the e-worksheet; the level of students' critical thinking when working on problems related to real life; level of awareness to

learn more when using PBL strategies; students' interest in understanding the material better because the phenomena exist in real life. Problem-solving strategies involve analyzing problems, planning problem solving, executing actions, and drawing conclusions (Agustin *et al.*, 2022).

The assessed metacognitive components are students' awareness to 1) plan the learning process; 2) monitor the learning process, 3) evaluate their learning process, 4) think harder, and 5) learn more.

The assessed graphic components are the attractiveness of color combinations in the e-worksheet, the convenience of e-worksheet media to be viewed as a whole, and students' interest in learning to use the e-worksheet.

The assessed presentation components are the ease of 1) use of the e-worksheet, 2) operation of the buttons on the e-worksheet, and 3) e-worksheet instructions to understand.

The assessed language components are the ease of language to be understood, ease of problem to understand, and the absence of words that cause double meaning (ambiguous).

In addition, based on observations of student activities, 100% of the activities have been conducted. So it can be concluded that all activities are carried out. The student activity observation sheet consists of assessing the

enthusiasm of students in learning, using the developed e-worksheet, group discussions, working on the e-worksheet, and conducting metacognitive activities.

In line with study conducted by Febriani and Sudomo (2017), PBL-based e-worksheets developed were in the good category in terms of practicality. The effectiveness of the e-worksheet

is observed through the results of the MAI questionnaire on planning, monitoring, and evaluating aspects. The effectiveness assessment is seen from the results of the questionnaire before and after the product trial. The following are the results of the effectiveness of the developed e-worksheet in training students' metacognitive abilities.

Table 9. Normality Test Result

	Tests of Normality					
	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
pre_planning	0.096	30	0.200*	.982	30	0.865
post_planning	0.113	30	0.200*	.974	30	0.652
pre_monitoring	0.104	30	0.200*	.973	30	0.618
post_monitoring	0.065	30	0.200*	.975	30	0.670
pre_evaluating	0.105	30	0.200*	.967	30	0.472
post_evaluating	0.087	30	0.200*	.957	30	0.253

*. This is a lower bound of the true significance.
a. Lilliefors Significance Correction

A normality test is used to determine whether the data is normally distributed or not. If the data is normally distributed, then the paired sample t-test can be continued (Ubaidillah & Wilujeng, 2019). Based on the data, all data from the MAI Likert scale questionnaire has been converted into

interval data using SIM. The data is normally distributed. So, the parametric analysis of the paired sample t-test can be used. Several statistical techniques cannot be processed using ordinal data. Then the ordinal data should be converted into an interval scale using the SIM (Sartika, 2010).

Table 10. Paired Sample t-test Result

		Mean	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)
Pair 1	Pre-planning – Post-planning	-5.37783	4.86920	.88899	-6.049	29	0.000
Pair 2	Pre-monitoring – Post-monitoring	-2.51727	5.07605	.92676	-2.716	29	0.011
Pair 3	Pre-evaluating – Post-evaluating	-5.62763	4.67701	.85390	-6.590	29	0.000

Based on Table 10, the value of sig.(2-tailed) in the planning, monitoring, and evaluating aspects are $0.000 \leq 0.05$, $0.011 \leq 0.05$, and $0.000 \leq 0.05$, respectively. So, in all these aspects H_0 is rejected and H_1 is accepted. This shows that there is a significant increase in the metacognitive abilities in the aspects of planning, monitoring, and evaluating of students after using the PBL-based e-worksheet on stoichiometry material.

Problems given to students in the PBL are used as a stimulus and focus of student learning activities. So, it trains students' ability to think (Hestiana & Rosana, 2020).

The MAI questionnaire developed by Scraw & Dennison (1994) was used to determine students' metacognitive abilities. Figure 2 presents the answers to the questionnaire from the students.

In the monitoring aspect, before using the e-worksheet, students are often anxious to get optimum achievement, rarely consider various possible answers on a chemistry test, rarely have options when solving questions about the material of chemistry, rarely repeat things that can make studying chemistry easier, often analyzes the learning strategies, never checks the understanding regularly, and often asks on how good to learn something new. Meanwhile, after using the e-worksheet, students very often tries to achieve maximum achievement, often consider possible test answers, often have options on tests, often repeat things that make it easier in learning, very often analyzes the learning strategies, rarely checks their understanding, and often ask to learn new things.

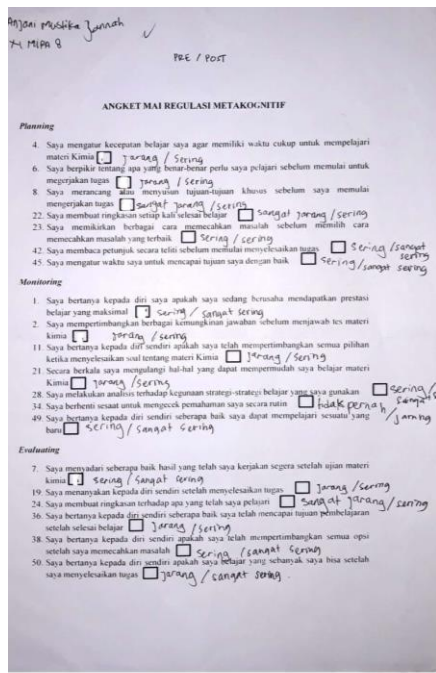


Figure 2. The Answers of MAI Questionnaire

In the evaluating aspect, before using the e-worksheets, students often realize how good their learning outcomes, rarely ask after completing

assignments, very rarely make learning summaries, rarely ask themselves how well they have achieved the learning goals, often ask themselves to consider all options after solving a problem, rarely asks if they have learned as much as they could. Meanwhile, after using the e-worksheets, students are often aware of how well their score after the exam, often ask after completing assignments, make summaries, often ask for options after solving problems, and often ask questions whether they learn as much as they can.

Based on the results of the MAI student questionnaire, students experienced an increase in every metacognitive aspect because the e-worksheets is developed based on PBL and aims to train metacognitive skills. So, students are required to actively find out various existing reference to increase their understanding. As the result, they can also improve their metacognitive abilities.

The results of the t-test of metacognitive abilities are corroborated by the results of the t-test of cognitive abilities. The results of the t-test of students' cognitive abilities are presented in Table 12.

Tabel 11. Normality Test Result

	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	Df	Sig.
Pre-cognitive	.109	30	.200*	0.947	30	.136
Post-cognitive	.106	30	.200*	0.942	30	.102

*. This is a lower bound of the true significance.
a. Lilliefors Significance Correction

Tabel 12. Paired Sample t-test Result for Cognitive

Pair	Mean	Std. Deviation	Std. Error		t	df	Sig. (2-tailed)
			Mean	t			
1 Pre-cognitive – Post-cognitive	-19.16667	6.57625	1.20065	-15.964	29	0.000	

Based on Table 12, the results of the paired sample t-test from the cognitive score data of students' produces the value of sig. 2 tailed ≤ 0.05 so that H_0 is rejected and H_1 is accepted. This shows that there is an increase in students' cognitive abilities after using the e-worksheets-based PBL on stoichiometry material. This finding can strengthen the results of students' metacognitive abilities where students' metacognitive abilities increase.

In line with a previous study by Ni'mah *et al.* (2017) the PBL-based e-worksheets to train scientific literacy receives a response of 94.99% in the very good category. In addition, Lestari & Hidayah (2014) states that students received a positive response to metacognitive-based worksheets on stoichiometry material with a percentage of 61%. Based on a study by Astuti *et*

al. (2018), the e-worksheets-based PBL improves students' critical thinking skills because the results of the N-Gain test analysis are 0.824 in the high category. A study by Komarudin *et al.* (2021) states that PBL-based Makerspace Approach STEM Learning has an effect on students' ability and understanding of mathematical concept.

The increase in students' metacognitive and cognitive abilities due to the PBL strategy provides more opportunities for students to explore information in various learning resources and the freedom to use various learning media to build their knowledge. In addition, the PBL strategy provides real or theoretical problems to be investigated in various learning resources. This activity makes students more active in finding solutions to problems so that students understand what they are doing (Aisyah, 2015). The

implementation of STEM-integrated PBL helps students acquire experience from studying situations, solving complex problems, and gaining a deep understanding of chemical material (Octafianellis *et al.*, 2021). Hence, it is urgent to improve students' learning outcomes, by which their metacognitive skills grow as well. Assessment of the learning outcomes is used to assess the achievement of student competencies, materials, and improve the learning process (Maryanto *et al.*, 2020).

CONCLUSION

Based on the results of data analysis, it can be concluded that the developed e-worksheet is valid with a value of 86.61% in the very high category. The content component is 89.76% in the very high category, the graph component is 86.67% in the very high category, the presentation component is 83.33% in the very high category, and the language component is 86.67% in the very high category. The results of the practicality of the e-worksheet are 96.19% in the very practical category whereas in the PBL strategy component is 94.64% in the very practical category. The metacognitive is 99.29% in the very practical category, the graphic component is 95.24% in the very practical category, the presentation component is 97.62% in the very practical category, and the language component is 94.05% in a very practical category. The results of the effectiveness of the e-worksheet show that the H_0 is rejected and H_1 is accepted. Hence, there is an increase in students' metacognitive abilities after using the developed e-worksheet. This is further strengthened by the increase of students' cognitive abilities after using the e-worksheet.

REFERENCES

- Agustin, A., Retnowati, E., & Ng, K. T. (2022). The Transferability Level of Junior High School Students in Solving Geometry Problems. *Journal of innovation in Education and cultural research*, 3 (1), 59–69. <https://doi.org/10.46843/jiecr.v3i1.57>
- Aisyah, S. (2015). Pengaruh Strategi Pembelajaran Jigsaw Dan Problem Based Learning. *Journal of Biology Education*, 4(1), 22–28.
- Alismail, H. A., & McGuire, P. (2015). 21st century standards and curriculum: Current research and practice. *Journal of Education and Practice*, 6 (6), 150–154.
- Alrahlah, A. (2016). How effective the problem-based learning (PBL) in dental education. A critical review. *The Saudi Dental Journal*, 28 (4), 155–161. <https://doi.org/https://doi.org/10.1016/j.sdentj.2016.08.003>
- Astuti, S., Danial, M., & Anwar, M. (2018). Pengembangan LKPD Berbasis PBL (Problem Based Learning) Untuk Meningkatkan Keterampilan Berpikir Kritis Peserta Didik Pada Materi Kesetimbangan Kimia. *Jurnal Pendidikan Kimia*, 15 (2), 3–11.
- Dasna, Wayan, I., & Sutrisno. (2007). *Pembelajaran Berbasis Masalah*. Accessed on <http://lubisgrafura.wordpress.com/2007/00A09/19/pembelajaranberbasismasalah/>.
- Greenstein, L.. (2012) *Assesing 21 st Century Skill: A Guide To Evaluating Mastery and Authentic Learning*. California: Corwin A Sage Company.
- Hestiana, H., & Rosana, D. (2020). The Effect of Problem Based Learning Based Socio-Scientific Issues on Scientific Literacy and Problem-Solving Skills of Junior High School Students. *Journal of Science Education Research*, 4 (1), 15–21. <https://doi.org/10.21831/jser.v4i1.34234>.
- Huber, M. T., & Hutchings, P. (2008). Integrative learning: Mapping the terrain. *The Carnegie Foundation for the Advancement of Teaching and Association of American Colleges and Universities (AAC&U)*.
- Jonassen, D. (2011). *Learning to Solve Problem A Handbook for Designing Problem-Solving Learning Environment*.
- Komarudin, K., Suherman, S., & Anggraini, A. (2021). Analysis of Mathematical Concept Understanding Capabilities: The Impact of Makerspae STEM Learning Approach Models and Student Learning Activities. *Journal of Innovation in Educational and Cultural Research*, 2 (1), 35–43. <https://doi.org/10.46843/jiecr.v2i1.21>.
- Lestari, F. D., & Hidayah, R. (2014). Students, Development Of Students Worksheet Based On Metacognitive Strategy On Stoichiometry Matter For X Grade Senior High School. *Unesa Journal of Chemistry Education*, 3(1), 144–118.
- Livingston, J. A. (1997). *Metacogniton: An Overview*. Retrieved from <http://www.gse.buffalo.edu/fas/shuell/CEP564/Metacog.html>.
- Maryanto, A., Rosana, D., & Setyawarno, D. (2020). Increasing Teacher Professional Competence in Developing Procedural Abilities Using the Application of Assessment of Integrated Science Using Mobile Learning on Android Platform Gadgets. *Journal of Science Education Research*, 4(2), 60–69. <https://doi.org/10.21831/jser.v4i2.35716>.
- Mustofa, R. F., & Hidayah, Y. (2020). The effect of problem-based learning on lateral thinking skills. *International Journal of Instruction*, 13(1), 463–474.

- Ni'mah, M., Aprianto, Hidayati, N., & Hidayah, R. (2017). Kepraktisan dan keefektifan LKPD berbasis problem based learning untuk melatih kemampuan literasi sains pada materi asam basa. *Jurnal Pendidikan Kimia*, 9(3), 352–355.
- Octafianellis, F. D., Sudarmin, S., Wijayanti, N., & Pancawardhani, H. (2021). Analysis of student's critical thinking skills and creativity after problem-based learning with STEM integration. *Journal of Science Education Research Journal*, 5 (1), 31–37.
- Sartika, E. (2010). Pengolahan Data Berskala Ordinal. *Sigma-Mu*, 2(1), 60–69. <http://digilib.polban.ac.id>.
- Schraw, G., & Dennison, R. S. (1994). Assessing metacognitive awareness. In *Contemporary Educational Psychology*, 19 (4), 460–475. <https://doi.org/10.1006/ceps.1994.1033>.
- Siska, F., & Joko S. W. S. (2017). Development of student worksheet based on problem based learning approach to increase 7. *Journal of Science Education Research*, 1 (April), 4–7. <https://journal.uny.ac.id/index.php/jser/article/view/16179>.
- Sugiyono. (2016). *Metode Penelitian Kuantitatif, Kualitatif dan R&D*. Bandung: PT. Alfabeta.
- Suliyanto. (2011). Perbedaan Pandangan Skala Likert Sebagai Skala Ordinal atau Skala Interval. *Prosiding Seminar Nasional Statistika Universitas Diponegoro*, 51-60. <http://eprints.undip.ac.id/33805/>.
- Teal. (2010). *Metacognitive processes*. New York: The Teacher Excellence in Adult Literacy (TEAL) Center was Developed by the American Institutes for Research.
- Trianto. (2010). *Mendesain Model Pembelajaran Inovatif Progesif*. Jakarta: Kencana.
- Ubaidillah, M., & Wilujeng, I. (2019). Developing Physics SSP Based on the Problem Solving to Improve the Process Skills and Problem-Solving Ability. *Journal of Science Education Research*, 3(1), 30–42. <https://doi.org/10.21831/jser.v3i1.27325>.
- Widodo. (2016). Language Policy in Practice : Reframing the English Language Curriculum. *English Language Education Policy in Asia*, 1(11), 127–151. <https://doi.org/10.1007/978-3-319-22464-0>.