Development of HOTS Literacy-Based e-Student Worksheet for Acid-Base Materials

Vrili Coirala Rama Uli Br Siregar[1], Iis Siti Jahro[2]

[1,2] Program Studi Pendidikan Kimia FMIPA Universitas Negeri Medan, Medan

ABSTRAK

Abstract: *Higher-order thinking skills (HOTS) and science literacy are skills that must be mastered by students in 21st-century learning. However, the learning resources are still not available so their HOTS Literacy skills are still low. This research is development research with the 4D model (define, design, develop, and disseminate). The research objectives are analyzing the Student Worksheet that has been used; designing an e-Student Worksheet based on HOTS Literacy; assessing the feasibility of the e-Student Worksheet; and determining the response of students. The research subjects were validators and students of class XI MIPA SMA Negeri 14 Medan. Data collection used questionnaires, teacher interviews and test instruments. The results are the feasibility of the e-Student Worksheet is 88.8% and interpreted as a very high criterion. The student's response is 99.7% with very interesting criteria. The n-gain value is 0.71 with high criteria. This shows that the HOTS Literacy-based e-Student Worksheet for Acid-Base materials developed is feasible and effective in improving students' HOTS Literacy skills.*

Abstrak: Keterampilan berpikir tingkat tinggi (HOTS) dan literasi sains merupakan keterampilan yang harus dikuasai siswa dalam pembelajaran abad 21. Namun, sumber belajarnya masih belum tersedia sehingga kemampuan HOTS literasi masih rendah. Penelitian ini merupakan penelitian pengembangan dengan model 4D (*define*, *design*, *develop*, dan *disseminate*). Tujuan penelitian adalah menganalisis LKPD yang digunakan; merancang e-LKPD berbasis HOTS Literasi; menilai kelayakan e-LKPD; dan menentukan respon siswa. Subyek penelitian adalah validator dan siswa kelas XI MIPA SMA Negeri 14 Medan. Pengumpulan data menggunakan angket, wawancara guru, dan instrumen tes. Hasilnya tingkat kelayakan e-LKPD adalah 88,8% dengan kriteria sangat tinggi. Respon siswa sebesar 99,7% dengan kriteria sangat menarik. Nilai n-gain sebesar 0,71 dengan kriteria tinggi. Hal ini menunjukkan bahwa e-LKPD berbasis HOTS Literasi pada materi asam-basa yang dikembangkan layak dan efektif dalam meningkatkan kemampuan HOTS Literasi siswa.

INTRODUCTION

In the age of globalization, technological and informational advances are progressing so rapidly that we must be prepared to embrace a range of learning developments that are integrated with the help of technology. The 21st Century Learning Paradigm not only provides teaching materials, but also emphasizes the ability of students to think critically, relate acquired knowledge to real life, collaborate, and master information and communication technologies, so schools must provide their students with 21st century skills (Sulistyorini et al., 2018).

Based on the results of the International Student Assessment Program (PISA) test, which measures the level of science literacy in the country, Indonesian students' science literacy performance remains low. Indonesia itself ranks 74th out of 79 countries (OECD et al., 2019). The definition of PISA includes being able to scientifically explain phenomena, evaluate and design scientific investigations, and interpret data and evidence scientifically. It emphasizes the importance of being able to apply scientific knowledge in the context of real-life situations (OECD, 2017). However, in reality, the proficiency level of Indonesian students does not meet the standards of the OECD (Organization for Economic Co-operation and Development) which requires students to be scientifically literate (PISA, 2019).

Chemistry is an integral part of scientific literacy, it is an important part of developing in class as it relates to the ability to understand and apply chemical knowledge to solve problems in everyday life (Priyasmika et al., 2020). Indirectly, chemistry literacy affects a student's ability to understand chemical concepts. A student's chemistry literacy ability is closely related to higher order thinking skills.

Higher-order thinking skills (HOTS) are abstract abilities that exist in the cognitive domain which include the ability to analyze, evaluate and be creative. The application of HOTS for students is very urgent, considering the times with extraordinary challenges. The development of the digital world which has the potential to create dependency, the apparent maturity of students, and the challenges of globalization need to be answered by implementing HOTS in education (Simamora, 2022). HOTS-based learning involves transforming existing ideas and information by giving them new meaning and implications so that students can think critically and creatively, solve problems, sense, and make decisions. It involves thought processes that require manipulation of ideas and information (Primayana,

2020). This statement means that the level of thinking is the C4, C5, and C6 reasoning.

There are two factors that come to mind when trying to figure out why the education system is causing students to fail: internal and external. Internal factors arise from the students themselves and are simply expressed as their interest and motivation for learning. External factors came out outside the students, such as learning methods and parental attention. Therefore, this is one of the fundamental problems in the Indonesian education system that needs improvement. The development of learning tools must be adapted to the different skills that educational needs are aimed at.

Learning in Indonesian schools is still generally focused on teachers, at the same time students' thinking skills have not been explored and the differences in students' abilities make it difficult to apply (Zahroh & Yuliani, 2021). Therefore, one way to improve students' chemistry literacy and reasoning skills is to develop HOTS literacy-based learning tools in the form of student worksheets. A student worksheet is a kind of learning tool which contain tasks that students complete as a form of instruction designed to help students understand what is being taught (Fitria et al., 2020).

Initial observations at SMA Negeri 14 Medan indicated that student worksheets were not widely used for learning. Most textbook questions are in the form of Lower Order Thinking Skills level (C1 to C3 cognitive level) and no test has yet been developed in schools to measure chemical literacy. A contributing factor to students continued low critical thinking and scientific literacy skills in chemistry learning to be still low is the inefficiency of the online learning process implemented during the COVID-19 pandemic. Therefore, the learning process needs e-student worksheets based on HOTS literacy to overcome this problem.

The advantages of electronic student worksheets over non-electronic student worksheets are: worksheets that are digitally created and run systematically and continuously over a period of time. Learning can be more effective by narrowing down space and time, as it is available anytime, anywhere with a laptop or smartphone. It can be an interesting resource when a student's interest in learning is waning. Engage students actively in the learning process (Suryaningsih & Nurlita, 2021; Yuzan & Jahro, 2022).

Acid-base materials are one of the substances that students need to learn and understand as they are prerequisites for being able to understand the following substances which are buffers, salt hydrolysis and acid-base titration. In fact, not all materials in chemistry can be used as his HOTS

Literacy type questions, but acid and basic materials meet the PISA content selection basic principles. Because these materials are relevant and commonly encountered in everyday life (Musayaroh et al., 2021).

In connection with the problems of students who find it difficult to understand acid-base material equipped with learning tools that are less practical and interesting, the researcher developed a learning tool in the form of HOTS Literacy-based e-Student Worksheet using inquiry-based training and the Liveworksheets platform, due to its fairly easy operation without having to download the application and can be used on all Android smartphones and laptops. Through the development model used in this research, a suitable product will be produced to support the learning process. Thus, the results of this research can be used as a reference for developing learning tools in other subjects as well.

METHODS

This is Research and Development (R&D) research using the 4D development model (Define, Design, Develop, and Disseminate). The purpose of this research is to produce HOTS Literacy-based e-Student Worksheet for acid-base material that is valid based on BNSP standards as well as knowing the student responses and N-gain score.

This research was conducted at SMA Negeri 14 Medan which is located at Jalan Pelajar Gg. Darmo, Kecamatan Medan Denai, Kota Medan, Sumatera Utara. The research subjects are validators and students of class XI MIPA while the object is the feasibility of HOTS Literacy-based e-Student Worksheet for Acid-Base material used in chemistry learning.

The instruments of this research are teacher interview sheet, needs analysis sheet, validation sheet, pretest-posttest sheet and student response questionnaire. The instruments prepared using the BSNP assessment criteria and the scoring of answers in the validation instrument is based on a Likert scale.

Table 1. Scoring of Answers

No	Answer Choices	Score
1	Strongly Agree (SS)	5
2	Agree (S)	4
3	Less Agree (KS)	3
4	Disagree (TS)	2
5	Strongly Disagree (STS)	1

The data obtained were analyzed using the following formula:

$$\%X_{in} = \frac{\sum S}{S\ max} \times 100\%$$

with:

$\%X_{in}$ = Percentage of answers to the i-th statement in the questionnaire

$\sum S$ = The number of total answer scores in the i-th statement

$S\ max$ = The maximum score expected in the i-th statement

The categories for the analysis results:

Table 2. Interpretation of the validation result

Percentages (%)	Criteria
80.1 – 100	Very high
60.1 – 80	High
40.1 – 60	Medium
20.1 – 40	Low
0 - 20	Very Low

The research procedure with 4D development research model can be explained by this picture below:

Define	• Curriculum Analysis • Media Analysis • Student Analysis • Material Analysis
Design	• Selection of Media (Liveworksheets) • Selection of Format (HOTS Literacy-based)
Develop	• Material Expert and Teacher Validation • Media Expert Validation • Product Revision
Disseminate	• Pre-test and Post-test • Student Response
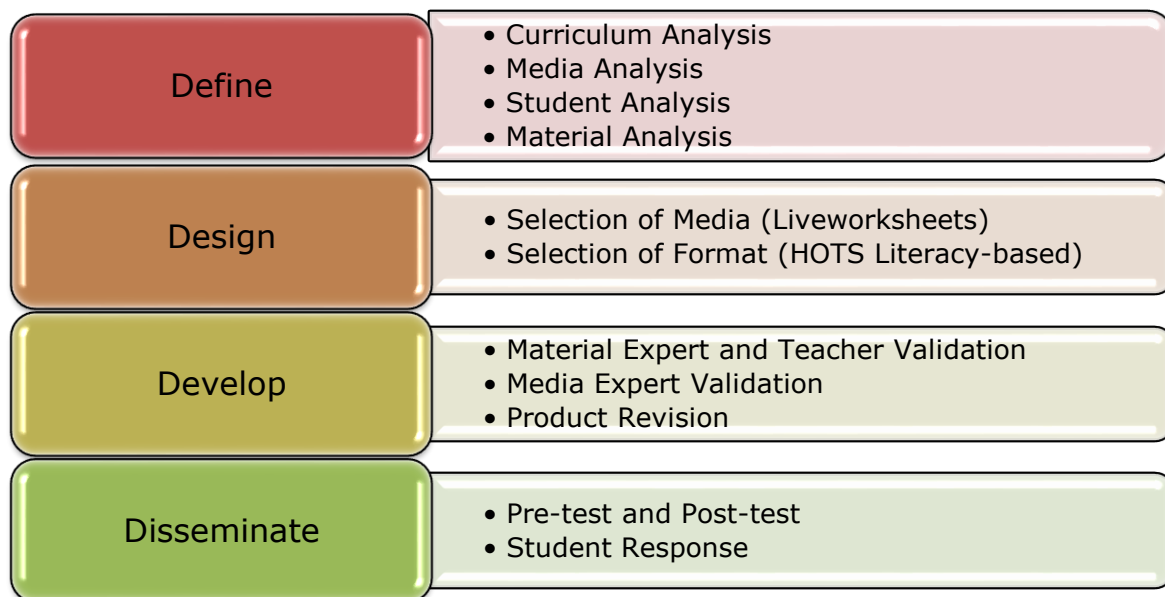
Figure 1. Research Procedure

Students were given a response questionnaire to determine the practicality of the e-student worksheet that had been developed. The results of the analysis, evaluation and student responses are used to determine the attractiveness of the media. The questionnaire was assessed using a Likert scale questionnaire with the same five assessment categories as Table 1.

After calculating the average percentage of each aspect, data obtained from questionnaires and observations of student activities were converted based on categories:

Table 3. Interpretation of the questionnaire result

Percentages (%)	Criteria
81 – 100	Very good
61 – 80	Good
41 – 60	Enough
21 – 40	Poor
0 - 20	Very Poor

The developed e-worksheet can be said to be practical if the average students response questionnaire are ≥ 61% with a good category (Felitasari & Rusmini, 2022).

The question of how learning success can be measured is not easy and is subject to many methodological difficulties. Higher pretest scores tend to have smaller absolute gains, all other things being equal. Alternatively, normalize the winning scores to account for the variance of scores before testing. One such measure is g, the normalized gain. This is the absolute gain divided by the maximum possible gain. Data from the pretest-posttest results of HOTS Literacy from the limited trial test will be analyzed using the following formula (Meltzer, 2002):

$$g = \frac{posttest\ score - pretest\ score}{maximum\ possible\ score - pretest\ score}$$

The interpretation of the N-gain value into different categories, as shown in table below (Tawil, 2014):

Table 4. N-gain value category

No	N-gain value (g)	Category
1	g > 0.7	High
2	0.3 ≤ g ≤ 0.7	Medium
3	g ≤ 0.3	Low

RESULTS AND DISCUSSION

The preliminary analysis or needs analysis stage is carried out by observing the school as well as interviewing the teacher and a questionnaire was distributed to class XI MIPA students. The curriculum analysis finds out that curriculum used at SMA Negeri 14 Medan is the 2013 Curriculum.

Media analysis find out that the learning process carried out in class still uses printed media which is considered unattractive to students, this causes students to be less enthusiastic when the learning process takes place. The student analysis aims to find out the characteristics of students and also their initial knowledge related to HOTS Literacy and 88.9% of students stated that they would be more interested if the assignments were made in digital or paperless form. Therefore based on a needs analysis questionnaire filled out by 20 students as respondents, 100% of students stated that they need learning tools that utilize technology such as HOTS Literacy-Based e-Student Worksheet for Acid-Base Materials. The material analysis result is the e-Student Worksheet will contain acid-base material studied in class XI semester 2 based on the chemistry syllabus used by the school.

In the design stage, the developed e-Student Worksheet is presented using questions that are considered capable of forming students' critical thinking skills as well as science literacy. The product design uses the Canva and then converted to the Liveworksheets website application to allow students to directly work on the questions in the worksheet as long as they are connected to an internet connection. Some of the content in e-Student Worksheet are: instructions for creating a Liveworksheets account, how to use e-Student Worksheet, a list of competency achievements, indicators and learning objectives, acid-base concept maps, descriptions of learning activities with guided inquiry stages as well as questions and issues related to the subject matter of acid-base that are adjusted to the indicators of HOTS Literacy questions (C4, C5 and C6 reasoning).

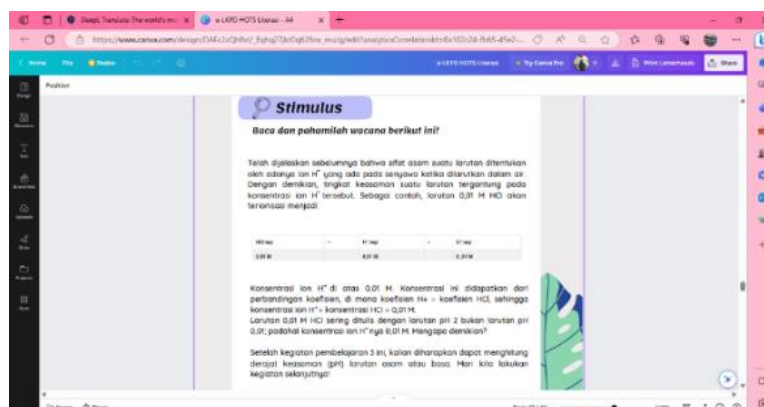**Figure 2**. The Product of a HOTS Literacy-based e-Student Worksheet

Figure 3. There is a Stimulus as a Characteristic of HOTS Literacy

Figure 4. HOTS Literacy-based Questions

The results of this product development were validated by validators before tested on students. This material expert assessment sheet was given to two chemistry lecturer validators and a chemistry teacher at SMA Negeri 14 Medan.

Table 5. Results of Material Validation

Aspects	Validator I, II, III			Average	
	L 1	L 2	Teacher	Score	Value (%)
Content Feasibility	4.38	4.38	4.5	4.42	88
Presentation Feasibility	4	4.33	4	4.11	82
Language Feasibility	4.75	4.75	4.5	4.67	93
	Overall Average			*4.4*	*88*
	Percentage Interpretation				*Very High*
	Feasibility Level Criteria				*Feasible/Valid*

The media expert assessment sheet was given to two chemistry lecturer validators.

Table 6. Results of Media Validation

| Aspects | Validator IV, V | | Average | |
	L 3	L 4	Score	Value (%)
Activities in e-Student Worksheet	5	4.25	4.63	93
Graphics	4.25	4.5	4.38	87.5
Language Feasibility	5	4.5	4.75	94
	Overall Average		*4.58*	92
	Percentage Interpretation			Very High
	Feasibility Level Criteria			Feasible/Valid

The overall feasibility assessment result can be seen in the Figure 5.
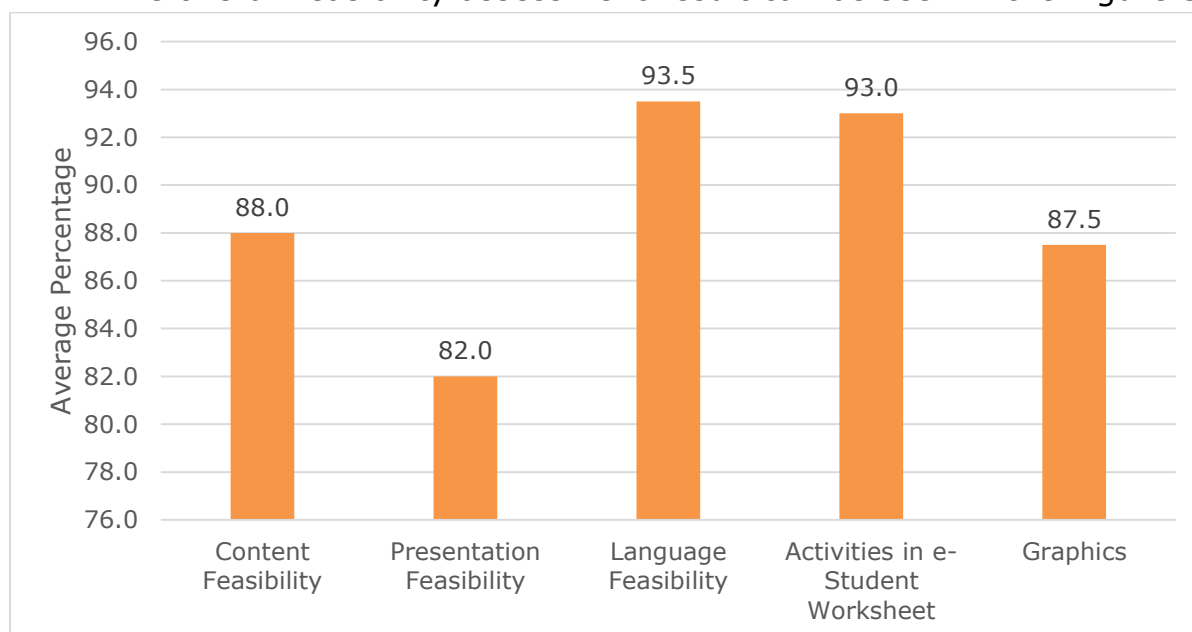

Figure 5. Validator Assessment Results

Based on the results of validation conducted by material expert lecturers, chemistry teachers and media expert lecturers, an average of 88.8% was obtained so that it can be concluded that the HOTS Literacy-based e-Student Worksheet for acid-base material is feasible or valid according to BSNP criteria. Based on the eligibility criteria, the validation results in this development are in the "very high" and "feasible with some improvements" criteria.

After the product is validated, revised and declared feasible by the validator, it is tested in a class XI MIPA of SMA Negeri 14 Medan. The trial was conducted with a pretest-posttest to measure the effectiveness of the

use of HOTS Literacy-based e-Student Worksheet on acid-base material through the calculation of the N-gain score. Then students were asked to fill out a response questionnaire containing statements related to HOTS Literacy-based e-Student Worksheet on acid-base material through google form to measure the level of product practicality. The results obtained from the trial are described as follows:

Table 7. N-Gain Test Result

Average		
Pretest	**Posttest**	**N-Gain Score**
19.5	75.85	0.71

Product effectiveness is obtained from pretest and posttest scores. The HOTS Literacy-based e-Student Worksheet on acid-base material is declared effective because the N-gain Score value obtained is 0.71 with high criteria.

The students' responses to HOTS Literacy-based e-Student Worksheets for acid-base materials contain positive responses, described as follows:

Table 8. Student Response Result

On the Aspect of	Average Percentage (%)
Interest in e-Student Worksheet	99.69
Presentation of e-Student Worksheet	99.82
Learning Component Based on HOTS Literacy and Guided Inquiry	99.58
Average	*99.7*
Criteria for Interpreting Questionnaire Result	*Very Interesting*

For the student response, the researcher asked students to fill out a questionnaire that had been distributed. Based on the result, a percentage of 99.69% was obtained on the aspect of interest, a percentage of 99.82% on the presentation aspect and a percentage of 99.58% on the aspect of learning components based on HOTS Literacy and guided inquiry. The average percentage result of the student questionnaire sheet score is 99.70%. So that this student response shows that the e-Student Worksheet developed is very interesting, useful and adds insight to students' knowledge.

The average percentage result of the student response is 99.7% so it shows that the e-Student Worksheet developed is very interesting, useful and adds insight to students' knowledge.

Previous research has also been conducted by Sumanik (2022), this research is about the development of science literacy-based e-Student Worksheet to train critical thinking skills, which also produces interactive e-Student Worksheet products using the Liveworksheets application. Based on the results of the response questionnaire, the percentage obtained was 90.8% in the small group while the large group was 91.20%, both groups were classified as effective. This shows that the use of interactive e-Student Worksheet in the form of Liveworksheets will motivate students in learning because this innovative and fun method encourages students to be more active and achieve more. The results of interviews with chemistry teachers also stated that students are now more interested in learning using interactive media rather than just using printed books. Technology-based learning tools are considered more interesting and can prevent students from getting bored while working on them.

Research by (Huda et al., 2019) used HOTS questions on Science Literacy-based Student Worksheets to measure the higher-order thinking skills of grade VIII junior high school students. The validation results are included in the "very feasible" category with a percentage of 94%. The increase in High Order Thinking Skills (HOTS) was measured using the t-test and obtained t_{count} of 1.884 and t_{table} 1.697. Student learning outcomes increased by 14% with 100% completeness. The conclusion of the research results obtained shows that the science literacy-based Student Worksheet using questions of types C4, C5, and C6 can improve students' High Order Thinking skills (HOTS).

CONCLUSIONS

The results of needs analysis at SMA Negeri 14 Medan show as many as 100% of students needed teaching materials in the form of HOTS Literacy-based e-Student Worksheet for acid-base material. The student worksheet designed using Canva application and developed into interactive e-Student Worksheet using Liveworksheets application. The feasibility level of HOTS Literacy-based e-Student Worksheet for acid-base material based on National Education Standards Agency (BSNP) is very high and has valid criteria for use with an average percentage of 88.8%. The responses of high school students in class XI MIPA SMA Negeri 14 Medan are 99.7% and stated as very interesting. This shows that the e-Student Worksheet developed is feasible, interesting and effective to improve students' HOTS Literacy skills so it can be used as one of the supporting teaching materials

in chemistry learning. Further research is needed to do to provide more benefits of e-Student Worksheet use.

REFERENCES

Felitasari, A., & Rusmini, R. (2022). Development of E-Worksheet Assisted by Liveworksheets to Improve Science Process Skills and Collaboration on Chemical Equilibrium Materials. *Scientiae Educatia*, *11*(1), 10. https://doi.org/10.24235/sc.educatia.v11i1.10235

Fitria, A., Wijaya, M., & Danial, M. (2020). Pengembangan Lembar Kerja Peserta Didik (LKPD) Berbasis High Order Thinking Skill (HOTS). *Chemistry Education Review (CER)*, *3*(2), 163–171. https://doi.org/10.26858/cer.v3i2.13315

Huda, K., Primiani, C. N., & Lukitasari, M. (2019). PENGEMBANGAN LEMBAR KERJA SISWA (LKS) BERBASIS LITERASI SAINS UNTUK MENINGKATKAN HIGH ORDER THINKING SKILLS (HOTS) SISWA SMP KELAS VIII MATERI SISTEM EKSKRESI MANUSIA. *Prosiding Seminar Nasional SIMBIOSIS IV*, 197–207.

Meltzer, D. E. (2002). The relationship between mathematics preparation and conceptual learning gains in physics: A possible "hidden variable" in diagnostic pretest scores. *American Journal of Physics*, *70*(12), 1259–1268. https://doi.org/10.1119/1.1514215

Musayaroh, T., Yuliana, I. F., & Fatayah. (2021). PENGEMBANGAN INSTRUMEN TES LITERASI KIMIA BERBASIS HOTS YANG LAYAK DITINJAU DARI VALIDITAS ISI OLEH AHLI. *UNESA Journal of Chemical Education*, *10*(3), 243–251. https://ejournal.unesa.ac.id/index.php/journal-of-chemical-education/article/view/42687/36754

OECD. (2017). How does PISA for Development measure scientific literacy? In *PISA for Development Brief: Vol. I*. OECD.

OECD, F. Avvisati, A. Echazarra, P. Givord, & M. Schwabe. (2019). PISA 2018 Results (What 15-year-old students in Indonesia know and can do). *Indonesia - Country Note*, *I–III*. http://www.oecd.org/pisa/

PISA 2018 Assessment and Analytical Framework. (2019). OECD. https://doi.org/10.1787/b25efab8-en

Primayana, K. H. (2020). *Menciptakan Pembelajaran Berbasis Pemecahan Masalah Dengan Berorientasi Pembentukan Karakter Untuk Mencapai Tujuan Higher Order Thingking Skilss (HOTS) Pada Anak Sekolah Dasar*.

Priyasmika, R., Farida Yuliana Jurusan Pendidikan Kimia, I., Billfath, U., Komplek Al Fattah Siman Sekaran, J. P., & Lamongan, K. (2020).

Prosiding Seminar Nasional Kimia (SNK) 2020 Jurusan Kimia FMIPA Universitas Negeri Surabaya.

Simamora, K. F. (2022). Kemampuan HOTS Siswa Melalui Model PjBL Ditinjau dari Kemampuan Literasi Kimia Siswa. *JURNAL INOVASI PEMBELAJARAN KIMIA* , *4*(1), 55–65. https://jurnal.unimed.ac.id/2012/index.php/jipk

Sulistyorini, S., Harmanto, Z., & Abidin, J. (2018). PENGEMBANGAN LEMBAR KERJA PESERTA DIDIK (LKPD) TEMATIK TERPADU MENGINTEGRASIKAN PENGUATAN PENDIDIKAN KARAKTER (PPK) DAN LITERASI SISWA SD DI KOTA SEMARANG. In *Jurnal Kreatif* (Vol. 9, Issue 1).

Sumanik, N. B. (2022). Pengembangan Lembar Kerja Peserta Didik Elektronik Berbasis Literasi Sains untuk Melatih Kemampuan Berpikir Kritis. *PAEDAGOGIA*, *25*(2), 147–161. https://doi.org/10.20961/paedagogia.v25i2.64080

Suryaningsih, S., & Nurlita, R. (2021). Pentingnya Lembar Kerja Peserta Didik Elektronik (E-LKPD) Inovatif dalam Proses Pembelajaran Abad 21. *Jurnal Pendidikan Indonesia*, *2*(7), 1256–1268. https://doi.org/10.36418/japendi.v2i7.233

Tawil, Muh. (2014). PEMBELAJARAN BERBASIS SIMULASI KOMPUTER UNTUK MENINGKATKAN KETERAMPILAN BERPIKIR KREATIF MAHASISWA. *Jurnal Ilmu Pendidikan*, *20*(1), 100–106.

Yuzan, I. F., & Jahro, I. S. (2022). Pengembangan e-LKPD Berbasis Inkuiri Terbimbing pada Pokok Bahasan Ikatan Kimia untuk Mengukur Kemampuan Berpikir Kritis Siswa. *Ensiklopedia: Jurnal Pendidikan Dan Inovasi Pembelajaran Saburai*, *2*(01), 54–65. https://doi.org/10.24967/esp.v2i01.1598

Zahroh, D. A., & Yuliani. (2021). PENGEMBANGAN e-LKPD BERBASIS LITERASI SAINS UNTUK MELATIHKAN KETERAMPILAN BERPIKIR KRITIS PESERTA DIDIK PADA MATERI PERTUMBUHAN DAN PERKEMBANGAN. *BioEdu*, *10*(3), 605–616. https://ejournal.unesa.ac.id/index.php/bioedu