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Development of E-Worksheet Assisted by Liveworksheets to Improve Science Process Skills and Collaboration on Chemical Equilibrium Materials

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abstract

This study aimed to determine the feasibility of e-worksheet assisted by liveworksheets to improve science process skills and collaboration on chemical equilibrium materials based on aspects of validity, practicality, and effectivity. This type of research is research and development using the ADDIE development model (Analyze, Design, Development, Implementation, and Evaluation). The participants of the limited trial were 30 students of class XI Science at ITP Senior High School in Surabaya. The method used is interviews, questionnaires, observations, and tests. This study uses an analysis technique that combines qualitative elements and quantitative elements. Qualitative elements were analyzed descriptively. Quantitative elements were analyzed using Aiken's V analysis, percentage analysis, normality test (Shapiro-Wilk Test), Paired Sample T-Test, and N-Gain analysis. The results of the validity with a value of 0.81 which is categorized as very valid. The practical results with the percentage value of the questionnaire responses and observations of students are 88% and 80.66% in the very good category. The effectivity results in the value of N-Gain cognitive and science process skills of 0.67 and 0.68 with the medium category. And the results of the questionnaire and observation of collaboration skills are 94% and 89% in the very good category. So, it can be concluded that e-worksheet assisted by liveworksheets can improve students' science process skills and collaboration on chemical equilibrium.

1. Introduction

One of the science subjects is chemistry which has often taught in a mixture of theory and scientific activities (Nainggolan & Mutiah, 2020). Chemistry learning, which is a part of the Natural, should be able to improve scientific literacy ability to think critically, creatively, communicatively, and collaboratively (Sugiyarti et al., 2018). Chemistry learning should emphasize hands-on learning experiences through the development and implementation of scientific process skills and scientific attitudes (Wulandari et al., 2019). One of the high school chemistry subjects for class XI is chemical equilibrium. This chapter requires students to be able to understand the concept well. Students are required to work together to improve their motivation and a proactive role in the involvement of the learning process.

Currently, most schools in Indonesia adhere to the 2013 curriculum for their learning process. The 2013 curriculum requires schools to change the learning approach that was initially teacher-centered to student-centered (Astuti et al., 2018). The 2013 curriculum also requires students to be active, able to learn independently, and not be fixated on information from the teacher (Ameliawati et al., 2021). The 21st century requires students to have the four skills (4C), communication, collaboration, critical thinking and problem-solving, and creativity and innovation (Pratiwi et al., 2020; Rusilowati, 2017; Malik & Ubaidillah, 2020). The 2013 curriculum employs a range of scientific approaches, including observing, questioning, experimentation, association, and communication, balancing the development of attitudes, knowledge, and skills (Mahjatia et al., 2021) so that this proves that both science process skills and collaboration skills are essential to be trained for students.

Science Process Skills (SPS) can be defined as the ability to understand or master student concepts with direct involvement in the learning process. SPS comprises basic skills and integrated skills (Nur, 2011). Through the SPS approach, a series of activities could be created to improve the mastery of concepts for students (Yanti et al., 2020). Research from Agustina & Agustini (2020) supports this statement, pointing out that most students have difficulty learning chemistry because the concepts are difficult to understand and that various activities created through SPS can help to improve students' understanding of concepts. There an effort that could be made to enhance students' performance is to implement interactive learning media. That will, allow for the creation of fun learning activities and enhance students' mastery of concepts in chemistry lessons. In addition, collaboration skills are needed to increase motivation, take a proactive role, and increase mastery of concepts.

Collaboration Skills (CS) can be defined as the ability to participate in every activity to build relationships with others, respect each other's relationships and work as a team to achieve the same goal (Le et al., 2017; Malik et al., 2021). Collaboration is related to relationships with others, a way to respect differences, share power, and gather knowledge from others. Therefore, cooperation means more than just cooperation (Woofolk, 2007). Nurjanah et al. (2020) found that students have not yet shown an active attitude to contribute, work productively, be flexible, take responsibility, and respect others. Therefore, to overcome these problems, an effort is made to use learning media in the form of worksheets that stimulate students to actively collaborate and improve their mastery of concepts.

Student Worksheet has an important function so the learning process can be carried out properly. Using student worksheets can support mastery of concepts and practice a sense of working together in teams to solve problems through discussion to obtain conclusions (Rahmatillah et al., 2017; Husna et al., 2020). The development of science and technology is growing rapidly (Asry, 2020; Fahmi et al., 2020). This resulted in a change in learning methods from conventional in the form of printed worksheets to electronic versions, namely e-worksheet. The electronic worksheet could be created using the liveworksheets application. The liveworksheets is a platform provided free by Google. This application converts the printed worksheet into an interactive online worksheet, can grade students' work automatically, and can send answers to the author. Students could work on and submit worksheets online. The advantages of this application are that it saves paper and time, is interactive, and motivates students.

Based on the results of interviews with chemistry teachers in class XI Science at one of the senior high schools in Surabaya in February 2022, it is known that the learning media used in the school are still conventional, such as books and printed worksheets. The school never uses e-worksheet with components of SPS and collaboration to support student learning activities in chemical equilibrium material. This is supported by the results of the pre-research questionnaire

given to 30 students of class XI Science 1 showed that 93.3% of the student never used an e-worksheet with an SPS component and 90% of the student never used an e-worksheet with a collaborative component. This can be associated with the student's situation who have difficulties in mastering the concept and lack an attitude of cooperation with one another. Research conducted by Saidaturrahmi et al. (2019) states that the developed student worksheet can improve SPS with a series of activities contained in the student worksheet. Octaviana et al. (2022) observed that the development of e-worksheet can improve CS in students.

Based on the earlier description, a learning media could be developed as an e-worksheet assisted by liveworksheets to improve science process skills and collaboration on chemical equilibrium material. Typically, the components of SPS comprise observing, classifying, making hypotheses, identifying variables, analyzing data, and drawing conclusions. Meanwhile, typical CS indicators are contributed actively, showing flexibility, showing an attitude of responsibility, and showing an attitude of respect. This study aimed to determine the feasibility of e-worksheet in terms of validity, practicality, and effectivity.

2. Method

The type of research used is research and development (R&D). The research model used in this study was adapted from Lee & Ownes (2004), namely ADDIE (Analysis, Design, Development, Implementation, and Evaluation) (Eliana et al., 2021). Analysis was conducted to collect information in the form of material analysis, curriculum analysis, and needs analysis. The design was carried out to make the design of the e-worksheet that will be developed and also includes the instrument's preparation. Development was performed to test the validity of two lecturers in the department of chemistry and one chemistry teacher at a high school in Surabaya. Implementation was piloted to test the e-worksheet practicality and effectiveness for class XI Science students as our participants in the limited trial. Meanwhile, evaluation provides an assessment and analysis of the data obtained from the trial phase.

The target of this research is the feasibility of e-worksheet with three aspects: validity, practicality, and effectivity. The data sources in this study were three chemists and 30 students of class XI Science 1 at ITP Senior High School in Surabaya. The research design used in the limited trial was the One Group Pretest-Posttest Design (Creswell & Creswell, 2017).

The methods used to collect data were interviews, questionnaires, observations, and tests. The interview method followed an interview guide instrument given to the chemistry teacher in class XI Science 1. The questionnaire used a validation sheet instrument, a pre-research questionnaire sheet, a student response questionnaire sheet, and a CS questionnaire sheet. The validation sheet assessment guidelines use a Likert scale adapted from Riduwan (2015), as shown in Table 1.

Table 1. Likert scale.

Score	Criteria
1	Very poor
2	Poor
3	Enough
4	Good
5	Very good

Guidelines for scoring the questionnaire using the Guttman scale as shown in table 2.

Table 2. Guttman scale

Answer	Positive Statement	Negative Statement
Yes	1	0
No	0	1

The observation method used the instrument of student activity observation sheets and CS. Guidelines for scoring the questionnaire using the Guttman scale adapted from Munawaroh and Yonata (2021) as shown in table 2. The test method uses a pretest-posttest test sheet for cognitive and SPS.

This study uses an analysis technique combined with both elements, qualitative and quantitative. Qualitative elements were obtained from interview guidelines and pre-research questionnaire sheets; the acquired qualitative data were then analyzed descriptively. Meanwhile, Quantitatively elements were obtained from validation sheets, student response questionnaire sheets, student activity observation sheets, cognitive pretest-posttest question sheets, SPS pretest-posttest question sheets, CS questionnaire sheets, and CS observation sheets.

Validity Analysis

Validation data were calculated using Aiken's V validity with the following formula (Dewi et al., 2020; Aiken, 1985):

$$V = \frac{\Sigma S}{n(c-1)}$$

Subsequently, the results of the validation data are converted based on the categories adapted from Aiken (1985) in table 3.

Table 3. Result of validation category

Value	Category
$0.00 < V \leq 0.20$	Very Invalid
$0.20 < V \leq 0.40$	Invalid
$0.40 < V \leq 0.60$	Sufficiently
$0.60 < V \leq 0.80$	Valid
$0.80 < V \leq 1.00$	Very valid

Researchers determined a standard value > 0.60 as a valid category so that the developed e-worksheet can be said to be valid.

Practicality Analysis

Data obtained from questionnaires and observations of student activities were converted based on categories adapted from Riduwan (2015) in table 4.

Table 4. Result of questionnaire and observation category

Percentage (%)	Category
0-20	Very poor
21-40	Poor
41-60	Enough
61-80	Good
81-100	Very good

The developed e-worksheet can be said to be practical if the average response questionnaire and student activity observation are ≥ 61% with a good category.

Effectivity Analysis

Data from the pretest-posttest results of cognitive and SPS were analyzed quantitatively using the normality test (Shapiro-Wilk Test) to test if the obtained data were normal or abnormal. Paired Sample T-Test was carried out to examine the difference in the mean scores of pretest and post-test students. The N-gain analysis was performed to determine the improvement in cognitive knowledge and SPS based on the pretest-posttest. The N-gain was calculated using the following formula below (Munawaroh & Yonata, 2021; Hake, 2022):

$$N\text{-}gain = \frac{posttest\ score - pretest\ score}{maximal\ score - pretest\ score}$$

The interpretation of the N-gain value into different categories was based on Hake (2002), as shown in Table 5.

Table 5. N-gain value category

N-gain	Category
N-gain > 0,7	High
0,3 < N-gain ≤ 0,7	Medium
N-gain ≤ 0,3	Low

The effectivity was analyzed from the data from the questionnaire, and the observation of the CS of students was converted into different categories adapted from Riduwan (2015) in table 4. The developed e-worksheet can be said to be effective if N-gain is >0.3, which is categorized as medium. Meanwhile, the developed e-worksheet can be said to be effective if the obtained data from the questionnaire and observation of CS is ≥ 61%, which is categorized as good.

3. Result and Discussion

This research on the development of e-worksheet assisted by liveworksheets to improve SPS and CS using the ADDIE model comprises the Analysis stage, Design stage, Development stage, Implementation stage, and Evaluation stage (Eliana et al., 2021). The results of the study can be described as follows:

The analysis stage consists of material analysis, curriculum analysis, and analysis of needs. This stage was conducted by interviews with chemistry teachers and the distribution of pre-research questionnaires to 30 students of class XI Science 1 at the ITP Senior High School. Regarding the material analysis, the material used was chemical equilibrium, especially on chemical equilibrium factors. The material was chosen because the questionnaire result stated that the students have difficulty in understanding the concepts of factors shifting the direction of chemical equilibrium correctly. This difficulty may be due to the characteristics of the material that require an understanding of the concept so that it must be sought through observations, conjectures or hypotheses, data analysis, discussions, and conclusions (Rohmah et al., 2019). Regarding the curriculum analysis, the 2013 curriculum (K-13) was used as most schools in Indonesia currently use that curriculum. Curriculum analysis typically encompasses Basic Competency analysis that is in according with the material to determine indicators and learning objectives that must be achieved by students. The results of the curriculum analysis are using Basic Competency 3.9 to analyze the factors that influence the shift in the direction of the equilibrium and its application in industry and 4.9 to design, carry out, conclude and present the experimental results of the factors that influence the shift in the direction of the equilibrium. Regarding the analysis of needs, during the interview and distribution of questionnaires obtained information that: 1) teachers still often use conventional methods or are teacher-centered; 2) students are less active in the involvement of the learning process; 3) the learning media used are limited to books and printed worksheets from schools; 4) never use electronic learning media; 5) have never used learning media to increase comprehension of concepts; 6) students still have a low collaboration attitude. The results of the analysis it is used as the basis for the development of the e-worksheet to be made.

The design stage consists of making the e-worksheet design and compiling an assessment instrument. The making of the e-worksheet design is adjusted to the results of the analysis stage. This can be associated with the product obtained in the form of 3 pieces of chemical equilibrium factors e-worksheet (concentration, temperature, and volume and pressure) and the e-worksheet

filling procedure assisted by the liveworksheets application. Each e-worksheet contains components of SPS and CS. The components of SPS include observing, classifying, making a hypothesis, identifying variables, analyzing data, and drawing a conclusion. Components of CS include actively contributing; showing flexibility; showing an attitude of responsibility; showing respect. After compiling the e-worksheet, the expert will review it first before validating it. Next, develop an assessment instrument to get a valid assessment.

The development stage tested the validity of two lecturers in the department of chemistry and one chemistry teacher at ITP Senior High School in Surabaya. Perform a validity test by filling out a product validation sheet. The validation sheet consists of statements covering the criteria for content, language, presentation, and graphics (BSNP, 2006). The validator will provide an assessment score for the e-worksheet covering the aspects of the validation sheet. The product can be valid if the value obtained has reached the minimum value of 61% with a valid category.

Implementation stage, the e-worksheet, which the validator has validated, is then tested on students in class learning. The revised e-worksheet states that it is valid and can be an object of study. In this stage, practicality and effectiveness tests are carried out for students of class XI Science 1 as participants in a limited trial. The practicality test was carried out by giving response questionnaire sheets to students and student activity observation sheets filled out by the observer. Fill in the students' cognitive pretest-posttest questions and SPS to test the effectivity. In the first step, students are given pretest questions to determine students' cognitive knowledge and SPS before using the e-worksheet assisted by liveworksheets. In the second step, students are given an e-worksheet assisted by liveworksheets to improve cognitive knowledge and SPS that are done collaboratively. Last, students are given post-test questions to determine the improvement in cognitive knowledge and SPS after using the e-worksheet assisted by liveworksheets. In addition, CS questionnaire sheets were also given to students and CS observation sheets to observers.

Evaluation stage, the last stage which aims to provide an assessment of the e-worksheet assisted by liveworksheets and analyze the data that has been obtained. Evaluation in this study was carried out based on the results of data analysis of validity, practicality, and effectivity.

Results of validity analysis

The validity of the e-worksheet is obtained from the results of the validation data. The display image of the validated e-worksheet is shown in Figure 1.

Figure 1. Cover (left) and content of e-worksheet (right)

Improvements for the e-worksheet after the validation process, improving the cover by providing attractive images and improving the content by adding guidelines for using the e-worksheet. And then, analyze the data from the validation results using quantitative analysis

techniques (Aiken, 1985). The total score obtained from the validator is then on average. The recapitulation of the e-worksheet validation results assisted by liveworksheets is shown in Figure 2.

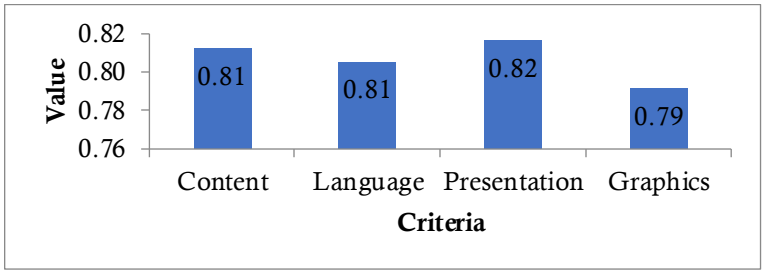

Figure 2. Value of e-worksheet validation results

Figure 2 shows the value results for each criterion. The content criteria in the e-worksheet are very valid categories, including the suitability of the title with the material; conformity of the material with core competencies and basic competencies; conformity with SPS; suitability of CS; conformity with learning objectives; as well as the accuracy of the facts, the truth of the concept, and the suitability of the theory in the presentation. The language criteria in the e-worksheet are very valid categories, including language that is easy to understand; accuracy of sentence structure; the rigidity of the term; conformity of grammar and spelling with Indonesian language rules; as well as the consistency of writing scientific names or foreign languages. The presentation criteria in the e-worksheet are very valid categories, including the suitability of presenting material with a learning approach, concept stage, the inclusion of references, completeness of identity, and accuracy of numbering in the presentation of text, and tables, images, and attachments. The graphic criteria in the e-worksheet are valid categories, including the type and size of letters that make it easier to understand, read and attract; compatibility of appearance design; illustrations that clarify and facilitate understanding; ease of opening websites and operating e-worksheet. The final average score of the validation results was 0.81, which means that the e-worksheet assisted by liveworksheets got a very valid category. This can be associated with the e-worksheet can be used as a learning medium because the value results in more than > 0.60. This is according to Nieveen (1999), the product developed can be said to be valid if the material components are based on existing needs, up-to-date knowledge, have an element of novelty (content validity), and use grammar, good layout formats, and all components must be consistently linked (construct validation). The validation criteria used in this study were also used by Enistoneisya et al. (2019), who got the percentage of a final score for the student worksheet validation of 81.79%, which was categorized as very valid.

Results of practicality analysis

The practicality of e-worksheet can be obtained from the results of student response questionnaire data and observations of student activities. Then, analyze the data from the questionnaire responses and observations of student activities using quantitative analysis techniques (Sudjana, 2005). The results of data analysis on student responses to e-worksheet assisted by liveworksheets obtained an average score which was then converted into percentages. The recapitulation of the results of the student response questionnaire analysis is shown in Figure 3.

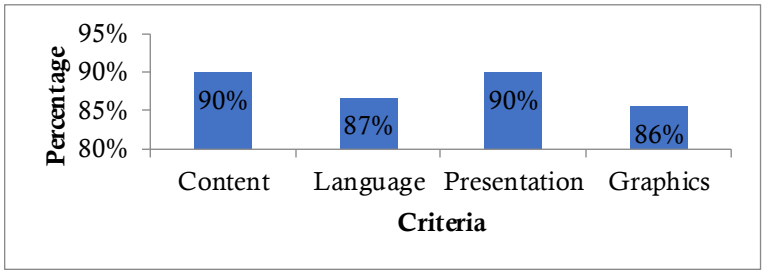

Figure 3. Percentage of student response questionnaire results

Figure 3 shows that the final average score of the student response questionnaire results obtained is 88%, which means that the e-worksheet assisted by liveworksheets is in the very good category. So, the e-worksheet with the help of a liveworksheets can be said to be practical because it gets results ≥ 61%. The use of student response questionnaires in this study was also used by Rahmawati & Yonata (2019) get the percentage results from each criteri ≥ 61% and get a positive response from students.

Analysis of student activity observation data supports the results of the response questionnaire to determine learning activities while using the e-worksheet assisted by liveworksheets. The activities of students assessed include all activities contained in the e-worksheet: observing, asking, collecting data, associating, and concluding. The five activities contain components of SPS and collaboration. Student activities are adjusted to the number of e-worksheet developed. The results of the analysis of student activity observations obtained an average score which was then converted into a percentage. The recapitulation of the results of the analysis of student activity observations is shown in Figure 4.

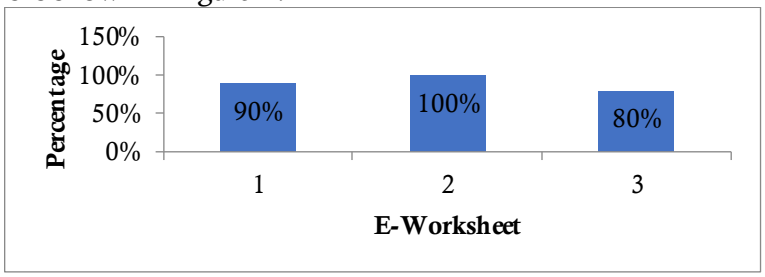

Figure 4. Percentage of student activity observations results

Figure 4 shows that the final average score of the student activity observation results was obtained 90%, which indicates that the e-worksheet assisted by liveworksheets is a very good category. So, the e-worksheet assisted by liveworksheets can be said to be practical because it gets a value ≥ 61%. This is relevant to Nieveen (1999), who states if the use of the developed product can be used easily and can be used in accordance with the designed learning plan, then the product developed is considered practical. Yanni et al. (2018) also analyzed student activity observations in this study which got a percentage of 80.66%, with a very good interpretation.

Results of effectivity analysis

The effectiveness of the e-worksheet was obtained from the results of the pretest-posttest scores of cognitive and SPS, the results of the CS questionnaire, and the results of the observation of CS. The results of the pretest-posttest scores of cognitive and SPS were analyzed quantitatively using the normality test using, Shapiro-Wilk Test, Paired Sample T-Test, and N-gain analysis. This test was carried out with the help of the SPSS version 20. The results of the questionnaire and observation of CS were analyzed using quantitative analysis techniques (Sudjana, 2005). According to Nieveen (1999), a product developed can be said to be effective if it can describe the

experience and learning outcomes to students. The results of students' pretest-posttest questions on SPS are shown in Figure 5.

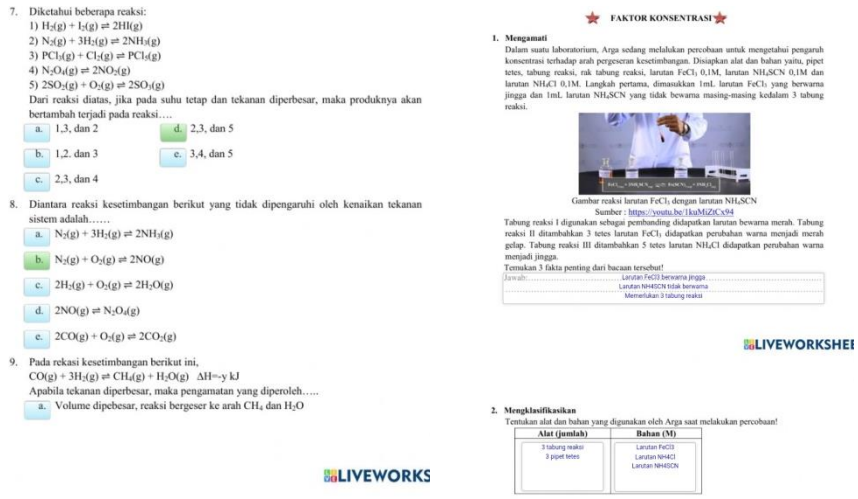

Figure 5. Results of cognitive (left) and SPS (right)

After getting the results of the pretest-posttest scores of cognitive and SPS, then analyzed using the normality test, are shown in Tables 6 and 7.

Table 6. Cognitive normality test

	Shapiro-Wilk		
	Statistic	**df**	**Sig.**
Pretest	.943	30	.109
Posttest	.943	30	.109

Table 7. SPS normality test

	Shapiro-Wilk		
	Statistic	**df**	**Sig.**
Pretest SPS	.941	30	.097
Posttest SPS	.950	30	.169

Table 6 shows a cognitive significance value of 0.109 which means that the data is normally distributed because of the sig value. > 0.05. Table 7. shows an SPS significance value of 0.097 and 0.169, which means the data is normally distributed because of the sig value > 0.05. Next, test the data using the Paired Sample T-Test as shown in Tables 8 and 9.

Table 8. Paired Sample T-Test of cognitive

	t	**df**	**Sig. (2-tailed)**
Pretest-Posttest	-52.143	29	.000

Table 9. Paired Sample T-Test test of SPS

	t	**df**	**Sig. (2-tailed)**
Pretest-Posttest	-41.356	29	.000

Table 8 and 9 shows the value of sig. (2-tailed) cognitive and SPS are 0.00, meaning there are differences in the average pretest-posttest scores of cognitive and SPS because of the value of sig. (2-tailed) $\leq$ 0.05. Finally, the N-Gain analysis was carried out, and the N-Gain values were

interpreted according to the category (Hake, 2002). The N-Gain score for cognitive knowledge is 0.67 in the medium category and 0.68 for SPS in the medium category. So, e-worksheet assisted by liveworksheets can be said to be effective. The N-gain values for each aspect of SPS are presented in table 10.

Table 10. N-Gain value for each aspect of SPS

Rated Aspect	N-Gain
Observing	0.93
Classifying	0.86
Making a hypothesis	0.79
Identifying variables	0.78
Analyzing data	0.69
Drawing a conclusion	0.65

Table 10 shows the N-gain value for each aspect of SPS ranges in the medium-high category. Analyzing data and concluding is classified as a medium category because of the lack of variation in the question-answer model in the form of essay answers. The high category involves observing, classifying, making hypotheses and identifying variables. This is because, in the e-worksheet, there are varied activities in the form of watching practicum videos and variations of the question-answer model. These activities provide learning by Piaget's cognitive learning theory. Piaget's cognitive learning theory emphasizes a person's learning process that goes well if the new subject matter can be compatible with the student's cognitive structure (Arvyaty et al., 2015). Research from Aydin (2013) shows that the aspect of observing in science process skills is a high category. Abungu et al. (2014) also follow this study by showing that training SPS to students effectively improves chemistry learning. The research conducted by Wati & Suliyanah (2018) got an average N-Gain value of 0.7 with a medium category, which means that the student worksheet developed can be said to be effective be used in teaching and learning process.

The results of the CS questionnaire analysis obtained an average score which is converted into a percentage. This is also supported by the results of the CS observation of the students. The recapitulation of the results of the questionnaire and observation of CS is shown in Figure 6.

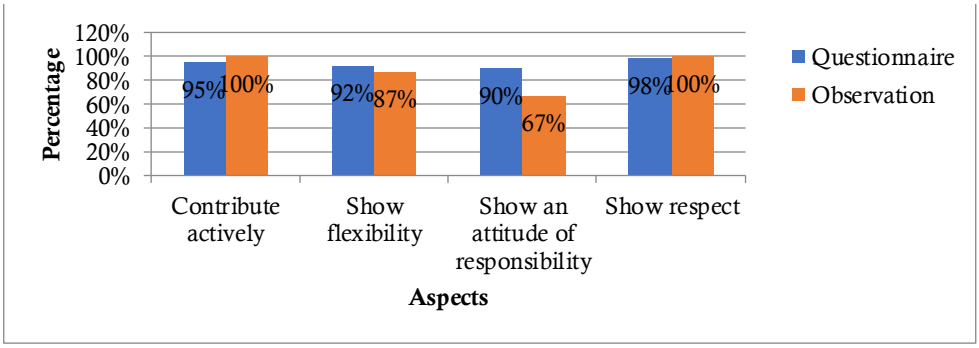

Figure 6. Percentage questionnaire and observation of CS

Figure 6 shows the average of each aspect of CS obtained from questionnaires and observations. The aspects of contributing actively get very good categories, including the attitude of expressing and expressing ideas, suggestions, or solutions in discussions. The aspects of showing flexibility get very good categories, including the attitude of accepting joint decisions, awards, criticisms, suggestions, and always compromising with the team to solve problems. The aspect of showing an attitude of responsibility gets a very good category and good category

including the attitude of following orders which are their duties and not depending on others. The difference in scores was obtained because the observer still sees some students who do not carry out orders according to their duties and still depend on others to complete their tasks in groups. The aspects of showing respect get very good categories, including showing politeness, listening, and respecting friends' opinions. The final average score of the questionnaire results was 94%, and the observation results were 89% in the very good category. So, the e-worksheet assisted by liveworksheets can be said to be effective because it gets a percentage value $\geq 61\%$. The existence of activities in e-worksheets that involve students playing an active role in learning by discussing to answering all questions results in an improvement in every aspect of CS. This activity, according to Vygotsky's social constructivism learning theory. Vygotsky's theory of social constructivism explains that cognitive development was carried out through social interaction and learning as a result of collaborative interactions between individuals (Erbil, 2020). Research from Antonio (2014) stated that the use of collaborative skills in students showed good or positive results. It also shows that students already have a very high consciousness of the importance of CS in the learning process. In line with 21st-century skills, which require students to have four skills, one of which is a collaboration (Pratiwi et al., 2020; Malik & Ubaidillah, 2021; Maryuningsih et al., 2020). The aspect of CS used in this study was also used by Rahmawati et al. (2019), who got the percentage value for CS in the aspect of actively contributing is 68.88% in the good category. The aspect shows the flexibility of 80.73% with a very good category. Aspects show an attitude of responsibility of 86.65% with a very good category. And the aspect of showing respect is 89.17% in the very good category. The results of this study are expected to be used as a source of inspiration for further research activities to improve SPS as the basis for skills and CS as 21st-century skills that must be mastered by every student.

4. Conclusion

Based on the results and discussion, it can be concluded that the e-worksheet assisted by liveworksheets to improve science process skills and collaboration on chemical equilibrium material is feasible to use in terms of three aspects: validity with a very valid category; practicality with a very good category; and effectiveness with the value of N-Gain cognitive and SPS of in the medium category. The results of the questionnaire and observation of collaboration skills are categorized as very good categories. The results of the N-gain value show that the use of e-worksheet assisted by liveworksheets can improve the cognitive knowledge and science process skills of the student. Based on the result of this research, it is essential to develop an e-worksheet assisted by liveworksheets for different chemistry materials and skills.

References

Abungu, H. E., Okere, M. I., & Wachanga, S. W. (2014). The effect of science process skills teaching approach on secondary school students' achievement in chemistry in Nyando District, Kenya. *Journal of Educational and Social Research*, *4*(6), 359–372.

Agustina, S. N. A., & Agustini, R. (2020). Pengembangan LKPD berbasis guided inquiry untuk meningkatkan keterampilan proses sains dan penguasaan konsep pada materi kesetimbangan kimia. *UNESA Journal of Chemical Education*, *9*(I), 59–63.

Aiken, L. R. (1985). Three coefficients for analyzing the reliability and validity of ratings. *Educational and Psychological Measurement*, *45*(1), 131–142.

Ameliawati, M., Permadi, A., & Maspupah, M. (2021). Development of student worksheets based on socio-scientific issues (SSI) on climate change materials for junior high school Students. *Scientiae Educatia*, *10*(1), 64.

Antonio, T. L. (2014). Collaborative activities for solving multi-step problems in general chemistry. *Journal of Technology and Science Education*, *4*(4), 250–259.

Arvyaty, Jazuli, L. O. A., Rosdiana, & Kansil, Y. E. Y. (2015). Development of learning devices of cybernetic cooperative in discussing the simplex method in mathematics education students of FKIP UHO. *International Journal of Education and Research*, *3*(2), 589–598.

Asry, L. (2020). Hubungan ilmu pengetahuan dan teknologi. *Jurnal Biram Samtani Sains*, *4*(1), 40–50.

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. *Chemistry Education Review (CER), Pend. Kimia PPs UNM*, *1*(2), 30–42.

Aydin, A. (2013). Representation of science process skills in the chemistry curricula for grades 10, 11, and 12/Turkey. *International Journal of Education and Practice*, *1*(5), 51–63.

BSNP. (2006). *Instrumen Penilaian Tahap II Buku Teks Pelajaran Kimia*. Badan Standar Nasional Pendidikan.

Dewi, C., Yanto, D. T. P., & Hastuti. (2020). The development of power electronics training kits for electrical engineering students: a validity test analysis. *Jurnal Pendidikan Teknologi Kejuruan*, *3*(2), 114–120.

Eliana, E., Nindiasari, H., & Santosa, C. A. H. F. (2021). Development of e-learning teaching materials on matrices based on cognitive load theory. *Prima: Jurnal Pendidikan Matematika*, *5*(1), 47.

Enistoneisya, A., Lukman, H. S., & Mulyanti, Y. (2019). Pengembangan lembar kerja siswa (Lks) berbasis komok strip dengan metode guided dicovery learning untuk materi perbandingan trigonometri. *Symmetry Pasundan Journal of Research in Mathematics*, *4*(1), 61–71.

Erbil, D. G. (2020). A Review of flipped classroom and cooperative learning method within the context of Vygotsky theory. *Frontiers in Psychology*, *11*, 1157.

Fahmi, R., Tusa'diah, H., Aswirna, P., & Sabri, A. (2020). Pengembangan keterampilan kolaborasi melalui penerapan modul interaktif berbasis TTI. *Ejournal.Uinib.Ac.Id*, *6*(2), 2477–6181.

Hake, R. R. (2002). Relationship of individual student normalized learning gains in mechanics with gender, high school physics, and pretest score in mathematics and spatial visualization. *Physic Education Research Conference*, *66*, 1–14.

Husna, E., Adlim, M., Gani, A., Syukri, M., & Iqbal, M. (2020). Developing STEM-Based Student Worksheet to Improve Students' Creativity and Motivation of Learning Science. *Scientiae Educatia: Jurnal Pendidikan Sains, 9*(1), 57-75.

Le, H., Jereon, J., & Theo, W. (2017). Collaborative learning practices: teacher and student perceived obstacles to effective student collaboration. *Cambridge Journal Of Education*, *48*, 110.

Lee, W., & Owens, D. (2004). *Multimedia-Based Instructional Design*. Pfeiffer.

Mahjatia, N., Susilowati, E., & Miriam, S. (2021). Pengembangan LKPD berbasis STEM untuk melatihkan keterampilan proses sains siswa melalui inkuiri terbimbing. *Jurnal Ilmiah Pendidikan Fisika*, *4*(3), 139.

Malik, A., & Ubaidillah, M. (2020). Students critical-creative thinking skill: a multivariate analysis of experiments and gender. *International Journal of Cognitive Research in Science, Engineering and Education*, *8*(S), 49-58.

Malik, A., & Ubaidillah, M. (2021). Multiple skill laboratory activities: How to improve students' scientific communication and collaboration skills. *Jurnal Pendidikan IPA Indonesia*, *10*(4), 585-595.

Malik, A., Ubaidillah, M., Fatmawati, S., Aswirna, P., Qaddafi, M., & Sutarno, S. (2021). Collaborative skills of prospective teachers in laboratory activities related to the concept of elasticity. In *Journal of Physics: Conference Series* (Vol. 1731, No. 1, p. 012073). IOP Publishing.

Maryuningsih, Y., Hidayat, T., Riandi, R., & Rustaman, N. (2020). Developing Performance Assessment Instruments to Measure 4C Skills in Online Discussion Activities of Science Learning. *Scientiae Educatia: Jurnal Pendidikan Sains, 9*(1), 109-120.

Munawaroh, E. A. F., & Yonata, B. (2021). Development of students worksheet based stem (science, technology, engineering, and mathematics) to improve student critical thinking skill in reaction rate. *Jurnal Pendidikan Dan Pembelajaran Kimia*, *10*(3), 128–138.

Nainggolan, B., & Mutiah, R. (2020). Pengajaran Materi kesetimbangan kimia menggunakan pembelajaran problem based learning disertai macromedia flash hasil pengembangan. *Journal Of Innovation in Chemistry Education*, *2*, 71–80.

Nieveen, N. (1999). Prototyping to reach product quality. In *Design Approaches and Tools in Education and Training* (pp. 125–135). Kluwer Academic Publisher.

Nur, M. (2011). *Modul Keterampilan Proses Sains*. Universitas Negeri Surabaya Pusat Sains dan Matematika Sekolah (PSMS).

Nurjanah, S., Rudibyani, R. B., & Sofya, E. (2020). Efektivitas LKPD berbasis discovery learning untuk meningkatkan keterampilan kolaborasi dan penguasaan konsep peserta didik. *Jurnal Pendidikan Dan Pembelajaran Kimia*, *9*(1), 27–41.

Octaviana, F., Wahyuni, D., & Supeno. (2022). Pengembangan E-LKPD untuk meningkatkan keterampilan kolaborasi siswa SMP pada pembelajaran IPA. *Edukatif : Jurnal Ilmu Pendidikan*, *4*(2), 2345–2353.

Permendikbud. (2013). *Peraturan Menteri Pendidikan Pendidikan Dan Kebudayaan Republik Indonesia Nomor 70 Tahun 2013 Tentang Kerangka Dasar Dan Struktur Kurikulum Sekolah Menengah Kejuruan/Madrasah Aliyah Kejuruan*. Kementrian Pendidikan dan Kebudayaan.

Pratiwi, H. R., Juhanda, A., & Setiono. (2020). Analysis of student collaboration skills through peer assessment of the respiratory system concept. *Journal of Biology Education*, *3*(2), 110.

Rahmatillah, Halim, A., & Hasan, M. (2017). Pengembangan lembar kerja peserta didik berbasis keterampilan proses sains terhadap aktivitas pada materi koloid (Development of student Worksheets based on science process skills on activities on colloidal materials). *Jurnal IPA & Pembelajaran IPA*, *1*(2), 121–130.

Rahmawati, A., Fadiawati, N., & Diawati, C. (2019). Analisis keterampilan berkolaborasi siswa sma pada pembelajaran berbasis proyek daur ulang minyak jelantah. *Jurnal Pendidikan Dan Pembelajaran Kimia*, *8*(2), 1–15.

Rahmawati, A., & Yonata, B. (2019). Development of LKPD based on contextual teaching and learning (CTL) to train science process skills in equilibrium chemistry. *Unesa Journal of Chemical Education*, *8*(2), 15–22.

Riduwan. (2015). *Skala Pengukuran variabel-variabel penelitian.* Alfabeta.

Rohmah, M., Ibnu, S., & Budiasih, E. (2019). Pengaruh real laboratory dan virtual laboratory terhadap kualitas proses pada materi kesetimbangan kimia. *Orbital: Jurnal Pendidikan Kimia*, *3*(1), 1–14.

Rusilowati, A. (2017). *Peningkatan dan penguatan fundamental research melalui pendidikan MIPA*. UIN Walisongo.

Saidaturrahmi, Gani, A., & Hasan, M. (2019). Penerapan lembar kerja peserta didik inkuiri terbimbing terhadap keterampilan proses sains peserta didik. *Jurnal Pendidikan Sains Indonesia*, *7*(1), 1–8.

Sudjana, N. (2005). *Metode Statistika*. Tarsito.

Sugiyarti, L., Arif, A., & Mursalin. (2018). Pembelajaran abad 21 di sekolah dasar. *Prosiding Seminar Dan DiskusiNasional Pendidikan Dasar*, 1–20.

Wati, L. L., & Suliyanah. (2018). Pengembangan lembar kerja peserta didik (LKPD) Berbasis model learning cycle 7E untuk melatihkan keterampilan proses sains. *Jurnal Inovasi Pendidikan Fisika*, *07*(02), 123–127.

Woofolk, A. (2007). *Educational Psychology Tenth Edition*. Education.

Wulandari, P., Widiyawati, Y., & Sari, D. S. (2019). Pengembangan LKPD berbasis nature of science untuk meningkatkan keterampilan proses sains. *Saintifika*, *21*(2), 23–34.

Yanni, M. L., & Utiya, A. (2018). Pengembangan lembar kegiatan siswa (LKS) berbasis Literasi Sains pada materi kesetimbangan kimia kelas XI. *Unesa Journal of Chemical Education*, *7*(3), 308–314.

Yanti, L., Miriam, S., & Suyidno. (2020). Mengembangkan keterampilan proses sains peserta didik melalui creative responsibility based learning. *JPPS (Jurnal Penelitian Pendidikan Sains)*, *09*(02), 1790–1796.