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ELECTRONIC PORTFOLIO ASSESSMENT INSTRUMENTS IN IMPROVING STUDENTS' CREATIVE THINKING SKILLS

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ABSTRACT

The objective of the study is to determine the stage of the process of developing electronic portfolio assessment instruments and obtain a valid and reliable electronic portfolio assessment instrument that can be used as an alternative effective assessment in improving students' creative thinking on redox reaction materials. The research method employed was Research and Development (R&D) with a 4-D development model: define, design, develop, and disseminate. The data sources for this study were obtained from chemistry education lecturers, chemistry teachers, and eleventh-grade students in one of the high schools in Bandung. The instruments used in this study were interview guidelines, instrument content validation sheet, task assessment observation sheet, creative thinking skills assessment task and rubric, portfolio assessment rubric, pre-test and post-test questions and rubrics on chemical reaction equations that have tested for validity. The developed electronic portfolio assessment instrument was realized in a task and assessment rubric based on 21st-century creative thinking indicators. The results reveal that the developed electronic portfolio assessment instrument has good quality because it fulfils the valid requirements with a CVR value of 1.00 and fulfils the reliable requirements with a Cronbach Alpha value of 0.702-0.982. Electronic portfolios can be used as one of the assessment tools for science learning. The developed electronic portfolio assessment instrument may promote students' creative thinking on redox reaction material based on the N-Gain 0.72 with the high category and has good effectiveness based on the N-Gain 0.61 with the medium category. Based on the category of mastery learning, the effectiveness is 9.66%.

Keywords: assessment; creative thinking; electronic portfolio

INTRODUCTION

One of the most important aspects in determining the success of the learning process and student learning outcomes is assessment (Idrus, 2019). Assessment in education is the act of gathering and analyzing data to determine the accomplishment of student learning outcomes or student competencies (a set of abilities) (Ratnawulan, 2015). However, the facts show that the current assessment still focuses on student learning outcomes rather than assessing the learning process (Nahadi & Siswaningsih, 2021). One type of assessment used to assess student learning is a portfolio assessment. A portfolio assessment is used to assess the development of student competencies within a specific time by providing feedback so that information related to students' strengths and weaknesses is obtained and can be used as material for improvement in the following learning process (Arifin, 2012).

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The portfolio assessment system still has weaknesses. It takes much time for the teacher to carry out the assessment while the material to be delivered is very much. In addition, it also requires a large area to collect each student's work, coupled with not always being accessible to document data in the form of books or hard copies. Not to mention, when a teacher needs a document that has been stored for a long time, it is difficult to retrieve the document using the current document storage system; with conventional methods like that, student tasks will not be well documented, resulting in a student portfolio that is not systematically organized (Firmansyah et al., 2019). Hence, electronic portfolio assessments are now replacing conventional portfolio assessments which used assignment/task as parameter. This is consistent with the findings of Joice et al. (2018), who investigated the nature and factors associated with assignment/task quality in terms of intellectual demand.

Electronic portfolio assessment has several advantages over conventional portfolio assessment, including more accessible (Nurhayati & Sumbawati, 2014), more practical (Mohamad et al., 2016; Koraneekij & Khlaisang, 2019), and more effective and efficient because the electronic portfolio has more comprehensive network access and connections so that the assessments carried out can be more innovative and varied, as well as allow collaboration between students (Juanengsih & Danial, 2018; Zidan, 2019; Aziizah, 2021; Masluhah & Afifah, 2022). The distinctive advantage of portfolio assessment is the availability of document collection, which is evidence of student learning outcomes so that when examining the results, the teacher can immediately identify students' abilities, attitudes, and shortcomings, allowing the teacher to provide immediate feedback to students (Juhanda et al., 2015). This explanation is supported by Gamlem and Munthe's (2014) statement that feedback is essential in learning because it can help develop students' skills.

One of the applications used for electronic portfolio assessment is Edmodo. Edmodo is a free educational website built on social networking that can be used by students and educators. It provides limitless storage space and allows teachers to engage with students via private and public messaging features (Alshawi & Alhomoud, 2016). Edmodo is used as a Learning Management System (LMS) in electronic portfolio assessment with several advantages, including (1) students have positive perceptions and satisfaction with using LMS (Furqon et al., 2023); (2) more effective (Gultom et al., 2022); (3) easy to use and familiar (Wulan et al., 2018). Thus, electronic portfolio assessment using Edmodo is one of the alternative assessments relevant to learning in the 21st Century because it can increase the understanding of the instructional technology community (Aljamaeen et al., 2020). Edmodo helps teachers connect with students and organize student activities by easily sharing course materials, quizzes, polls, and exercises, and allowing discussion activities in the comments feature (Balasubramanian et al., 2014).

A generation that can compete in the 21st Century is not only equipped with aspects of knowledge but must be supported by aspects of skills (Mardhiyah et al., 2021). Graduate competencies must adhere to the 21st century skills specified by the Partnership for 21st Century Skills, which include critical thinking, creative thinking, communication, and collaboration skills (Zubaidah, 2018). Creative thinking is influenced not only by students' originality and subjectivity, but also by students' relationships with their surroundings (Yanti et al., 2018).

The skills aspect, especially creative thinking skills, is one of the essential things to develop, which is expected to help students master learning concepts (Meika & Sujana, 2017). Creative thinking activities in class can direct students to develop other competencies simultaneously (Tirri et al., 2017). Based on this, the skill aspect, especially creative thinking, is essential to be developed again and hopefully can help students master learning concepts even though the facts in the field show that the assessment process carried out by teachers focuses more on the knowledge aspect while the skill aspect does not get enough attention (Nahadi et al., 2016).

Creative thinking skills in the 21st Century are not only about creative ways of thinking, such as originality, flexibility, and fluency. It addresses three main types of skills: thinking creatively (1.A), working creatively with others (1.B), and applying creative thinking to innovation (1.C) (Borrowski, 2019). According to the results of The Global Creativity Index in 2015, Indonesia placed 115 out of 139 nations for its level of creative thinking skills (Florida, 2015).

Students' creative thinking activities and skills, particularly fluent and flexible thinking, remain poor. This has an impact on students' undeveloped creative thinking skills. One endeavor to increase students' creative thinking skills is to produce more relevant and engaging learning, as well as learning that involves students as much as possible so that students' creative thinking skills can be developed. As a result, it is vital to improve students' creative thinking skills by developing learning in schools. Portfolio assessment is one strategy for developing creative thinking skills, and it is seen to be capable of improving and influencing creative thinking skills in students (Jatiningtyas, 2019). Electronic portfolio assessment is being utilized to boost students' creative thinking skills as a result of technological advancements.

In this research, the assignments given are posters, LKS, and popular articles. Posters are chosen for their ability to convey messages through visuals that engage the sense of sight, and the messages sent are embedded in visual communication symbols. These symbols must be appropriately comprehended in order for the message-delivery process to be successful and efficient (Rikmasari & Wati, 2018). Then, one technique to assess effectiveness in increasing creative thinking skills is to create media in the form of LKS, also known as LKPD (student worksheet); hence, the assignment in the form of LKS is chosen (Juwita et al., 2019). Popular articles are chosen because writing popular articles requires creativity. The writer must write about actual issues, and the language/diction must be more "pop" or popular, choosing an interesting angle from the title and content (Ibda, 2019).

One of the subjects at school related to the surrounding environment is chemistry. Chemistry contains almost every aspect of life, culture, and the environment (Whitten et al., 2014).

The chemical material that will be studied to improve creative thinking is oxidation-reduction (redox) reactions. Redox reactions are challenging to understand because they are abstract and often cause misconceptions (Apriadi & Redhana, 2019; Jannah & Utami, 2019; Yuniarti et al., 2020). Redox reaction material is very closely related to everyday life because many events in the surrounding environment are included in redox reactions, presenting many interesting real problems (Effendy, 2012).

However, based on the research by Jannah and Utami (2020), students' creative thinking skills on redox reaction materials are still relatively low. Discussion and feedback are particularly significant in boosting students' creative thinking skills, especially while learning chemistry, which requires a test for each learning topic. Chemistry learning is more than just memorizing information, concepts, and principles; it is also a process of discovery (Djonomiarjo, 2020). Several previous studies are relevant to the research to be carried out, namely the research of Juanengsih and Danial (2018) and Yanti et al. (2018) using a Facebook-based portfolio assessment. Research by Zidan (2019), Nurbani and Permana (2020), and Aziizah (2021) uses an Edmodo-based portfolio assessment to increase students' creativity. There are differences between previous research and what will be examined, especially in the material used. Based on the background described, the researchers consider it necessary to conduct research on "Electronic Portfolio Assessment Instruments in Improving Students' Creative Thinking Skills" since Electronic Portfolios have become a popular pedagogical approach in the tertiary educational landscape worldwide (Lu, 2021).

In this study, the electronic portfolio assessment instrument is developed in the form of creative thinking assessment tasks and rubrics; the quality of the electronic portfolio assessment instrument is determined based on the instrument's content validity and reliability; pretest and post-test questions are used to determine the effectiveness of the electronic portfolio assessment instrument developed.

METHODS

The objective of the study is to determine the stage of the process of developing electronic portfolio assessment instruments and obtain a valid and reliable electronic portfolio assessment instrument that can be used as an alternative effective assessment in improving students' creative thinking on redox reaction materials. This study used the Research and Development (R&D) method with the Thiagarajan (1974) model, which consists of four stages, including (1) define, (2) design, (3) develop, and (4) disseminate. The first stage, often called the Define stage, was needs analysis. The second stage was Design, where the conceptual framework of the model and learning tools were developed. The third stage was Develop, which involved validation testing or assessing the feasibility of the media. The last stage was Disseminate, where implementation was carried out on the actual research subject. However, the research reached the limited trial stage in the third stage of the 4D research and development steps, or only up to the development stage. The research flow and development conducted is summarized in Figure 1.

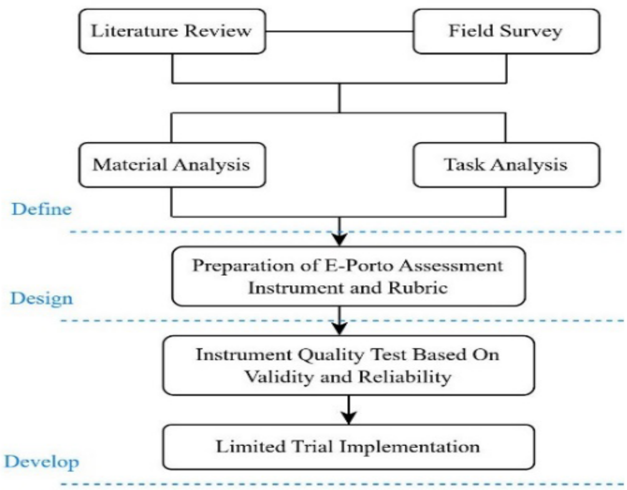

Figure 1. Research Flow

Table 1 below presents some of the data analyzed through this study.

Table 1. Data Analysis Techniques

No	Research Question	Instrument	Data Type	Data Source	Data Analysis
1	What is the process of developing electronic portfolio assessment instruments to improve students' creative thinking skills on redox reaction materials?	Interview guidelines	Interview Sheet	Field Survey	Interview results with chemistry teacher
2	Does the quality of the electronic portfolio assessment instrument developed on redox reaction materials have sufficient validity?	Instrument content validation sheet	Content validity of electronic portfolio assessment task and rubric instruments	Validator (expert judgment)	Content Validity Ratio (CVR) calculation according to Lawsche (1975)
3	Does the quality of the electronic portfolio assessment instrument developed on redox reaction materials have sufficient reliability?	Task assessment observation sheet	Reliability of task instruments and rubrics	Student and rater	Inter-rater method and calculation of Cronbach Alpha value according to Bhatnagar (2014)
4	How can the developed Electronic Portfolio Assessment instrument improve students' creative thinking on redox reaction materials?	Creative thinking skills assessment task and rubric and portfolio assessment rubric (Firman, 2013)	Creative thinking skill scores for each task (task scores before and after revision) and e-portfolio scores (best task).	Student	Mean score calculation and N-gain index analysis (Hake, 1998)
5	What is the effectiveness of the Electronic Portfolio Assessment instrument in improving students' creative thinking on redox reaction materials?	Pre-test and post-test questions and rubrics on chemical reaction equations that have been tested for validity	Pre-test and post-test scores	Student	N-gain index analysis (Hake, 1998)

This study used several instruments to collect data: interview guidelines, instrument validation sheets, assessment observation sheets, creative thinking assessment tasks and rubrics, and pre-test and post-test questions. The interview guideline contained questions about school assessments, especially electronic portfolio assessments. Interviews were conducted with chemistry teachers at the school where the research was conducted. The instrument validation sheet consisted of combined task indicators (Combined results of redox reaction materials indicators with creative thinking indicators developed by Chambers and Jennifer (2012). The assessment observation sheet was used in the limited trial stage of the instrument to assess students' portfolio tasks. The assessment on the observation sheet was carried out by filling in the score by the aspects assessed based on the assessment rubric developed. The task measured students' creative thinking skills before and after giving feedback through Edmodo. The tasks developed had been adjusted to the task indicators of a combination of creative thinking and redox reaction materials indicators. This study used three rubrics: the task assessment rubric, the electronic portfolio assessment rubric (best task), and the pre-test and post-test assessment rubrics. The task assessment rubric assessed students' creative thinking skills after working on the tasks. The pre-test and post-test questionnaires were used to determine the effectiveness of the developed instrument. The pre-test was given before giving portfolio tasks in Edmodo, while the post-test was given after the portfolio assessment of the students' best tasks. The lattice of pre-test and post-test questions consisted of question numbers, item indicators, combination question indicators (the results of adjusting the item indicators of redox reaction materials with creative thinking indicators developed by Chambers and Jennifer (2012)), question items, rubrics in the form of answer keys and scoring guidelines.

The research involved four chemistry education lecturers, three chemistry teachers as validators, and eleventh-grade science students in one of the senior high schools in Bandung to conduct a trial of instrument development. The data analysis in this study was conducted by testing the quality of the instrument (content validity and reliability), task score analysis, and pre-test and post-test. The content validity test was analyzed based on the Content Validity Ratio (CVR) calculation. The following is the formula for calculating CVR according to Lawshe (1975).

$$CVR = \frac{ne - N/2}{N/2}$$

ne : The number of validators who say valid
N : Scores obtained by students

The results of the CVR calculations were then compared with the minimum One-tail CVR value of 0.05 (Lawshe, 1975). The reliability test of the assessment instrument was determined using the inter-rater method, and the Cronbach Alpha value was calculated using SPSS Statistics 25 software. Reliability was determined by interpreting the results of the Cronbach Alpha calculation on reliability according to Bhatnagar and Many (2014), which can be seen in Table 2.

Table 2. Interpretation of Cronbach Alpha Values (Bhatnagar, 2014)

Satisfaction Level	Criteria
$\alpha > .9$	Very Good
$.7 < \alpha < .9$	Good
$.6 < \alpha < .7$	Acceptable
$.5 < \alpha < .6$	Less Acceptable
$\alpha < .5$	Not Acceptable

Task scores and pre-test and post-test were analyzed quantitatively using the gain index. Before the N-Gain test, the average value of the scores obtained by students was calculated. The average value obtained refers to the category of student success, according to Arikunto et al. (2007). The use of N-Gain refers to Hake (1998). The calculation of N-Gain uses the following formula:

$$< g > = \frac{S_{pre} - S_{post}}{S_{max} - S_{pre}}$$

$<g>$: Normalized gain
S_{pre} : Score before giving feedback
S_{post} : Score after giving feedback
S_{max} : Maximum score

The calculation results were interpreted and grouped based on the gain index category according to Hake (1998), as shown in Table 3.

Table 3. N-Gain Category (Hake, 1998)

Limitation	Category
$g > .7$	High
$.3 \leq g \leq .7$	Medium
$g < .3$	Low

The effectiveness of the instrument in this study was analyzed based on the increase in N-Gain and referred to the Mastery Learning category. According to Gentile and Lalley (2003), students are considered to have completed learning if they can complete, master competencies, or achieve learning objectives of at least 70% - 90% of all learning objectives.

RESULTS AND DISCUSSION

Research on the development of electronic portfolio assessment instruments is carried out based on the stages developed by Thiagarajan (1974), including (1) Define, (2) Design, (3) Develop, and (4) Disseminate. However, this research is limited to the develop stage only.

The define stage consists of several stages: initial analysis (literature review and field survey), concept analysis, and task analysis. The initial analysis is carried out by analyzing several literature studies, and a field survey is also conducted through interviews with chemistry teachers in one of the high schools in Bandung. Then, concept analysis is carried out at the define stage to determine the KD (basic competencies) and subject matter that can be achieved through electronic portfolio assessment. Task analysis is carried out to identify alternative tasks used as portfolio tasks in the instrument developed. This task analysis is adjusted to the aspects of students' creative thinking that will be achieved through electronic portfolio assessment.

Then, at the design stage, the results of the analysis at the define stage are used as a basis for developing electronic portfolio assessment instruments in the form of tasks and rubrics. The design of the instrument in this study begins with adjusting the indicators of chemical reaction equation material and several indicators of creative thinking selected from the 21st-century creativity indicators developed by Chambers and Jennifer (2012) so that the task indicators (combination) are obtained.

Moreover, at the develop stage, the quality test of the electronic portfolio assessment instrument that has been developed is carried out. This quality test includes content validity testing by experts and inter-rater reliability testing. Instruments that have gone through the quality test and revised based on expert input are used in a limited trial of the instrument.

The content validity test is carried out by asking for considerations and opinions from experts or expert judgment as validators of as many as seven people, including four chemistry education lecturers and three chemistry teachers. This validity test uses a validation sheet that contains task indicators (combinations), tasks, assessed aspects, scoring rubrics, suitability of task indicators (combinations) with tasks, suitability of tasks with rubrics, and suggestions for revision. The results of the content validation of the developed instrument obtained a CVR value of 1.00 with several revisions. According to Hayati and Lailatussaadah (2016), data is said to be more accurate when the validity value of the instrument is also higher.

In this study, an inter-rater reliability test is used to see the extent to which the consistency of different raters gives an estimate of the consistency of the same phenomenon. The inter-rater reliability test in this study is carried out by raters to assess portfolio tasks that have been done by the same students and are assessed with the same assessment rubric. The inter-rater reliability test in this study is conducted once on thirty eleventh-graders who have studied redox reaction material. The raters who assessed the students' tasks in this study were four students from the chemistry education study program. The reliability of the developed instrument obtained a Cronbach Alpha value of 0.702-0.982.

According to Azwar (in Arissaryadin & Arimbawaa, 2020), the reliability coefficient is closer to 1, meaning that the reliability is also higher. Conversely, a coefficient closer to 0 means the reliability is lower. Based on this, it can be said that the instrument developed has high reliability.

The use of electronic portfolio assessment with the Edmodo application in learning includes giving tasks by teachers, working on tasks by students, uploading tasks by students, giving feedback by teachers on tasks that have been done by students, improving tasks by students based on feedback given by the teacher, and collecting revisions task by students (Zidan, 2019). Each task that has been done and collected by students through Edmodo is assessed by the researcher. Files of student work are downloaded through Edmodo, then checked and given a score according to the rubric of the creative thinking assessment developed. The shortcomings found in students' tasks can be used as the basis for providing feedback. In this case, the researcher gives an initial value in the scoring column and provides feedback on the task done through the comments feature in Edmodo. In line with research conducted by Misdi (2020), portfolio assessment with Edmodo is an innovative learning process assessment and a promising assessment for teachers and students.

Based on the work on the task, the initial score is obtained before giving feedback, and the final score is after the student has corrected the task that has been done based on the feedback given. The average value obtained by students from each task is categorized based on the category of knowledge success from Arikunto (2007). A comparison of the average value before and after being given treatment identifies the increase through N-Gain. The graph of the average value before and after being treated for all tasks is presented in Figure 2.

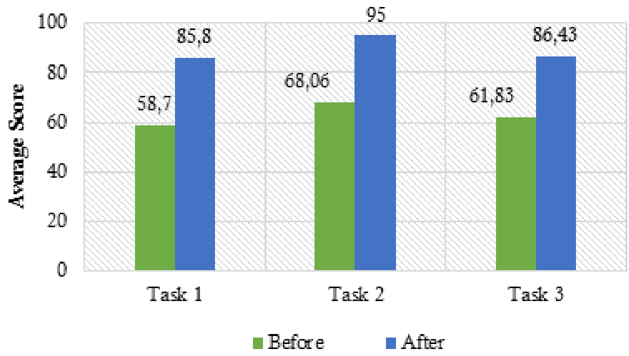

Figure 2. Comparison of the Average Values before and after Treatment for All Tasks

Figure 2 shows that there is an increase in the average value of each task from before and after being given treatment. In task 1, making posters, the average score before being treated is included as the quite good category (58.70), and after being given the treatment, it increases to very good (85.80). In task 2, making worksheets done in groups, the average score obtained by students before being treated is included in the good category (68.06) and after being given the treatment, it increases to the very good category (95). In task 3, making popular articles is done individually, the average score obtained by students before being treated is included as the good category (61.83) and after being given treatment it increases to the very good category (86.43). In general, the average score obtained by students after treatment shows an increase. As relevant to what Firmansyah (2019) explain, the feedback received by students during the learning process can motivate students to continue to develop their abilities and affect student learning outcomes.

To find out the increase in students' creative thinking, an N-Gain analysis is carried out based on the criteria for the Gain Hake index (1998). The data for the analysis of N-Gain achievements for all assessed tasks can be seen in Table 4.

Table 4. Achievement of N-Gain

Achievement			Type of Task			Average
			1	2	3	
Creative Thinking on The Whole Task	Average Score	Before	58.70	68.06	61.83	
		After	85.80	95.00	86.43	
	N-Gain	Before	.66	.86	.64	.72
		Interpretation	Medium	High	Medium	High
Creative Thinking Using Various Techniques to Create Ideas	Average Score	Before	70.83	68.33	62.08	
		After	93.33	95.83	94.17	
	N-Gain	Before	.77	.87	.36	.67
		Interpretation	High	High	Medium	Medium

Achievement			Type of Task 1	2	3	Average
Creative Thinking by Creating New Ideas	Average Score	Before	70.00	66.67	50.00	
		After	83.33	93.06	71.67	
	N-Gain	Score	.44	.79	.44	.56
		Interpretation	Medium	High	Medium	Medium
Skills in Applying Creative Ideas	Average Score	Before	35	70.83	72.50	
		After	80.83	100	85	
	N-Gain	Score	.70	1.00	.44	.71
		Interpretation	High	High	Medium	High

Creative thinking using various techniques to generate ideas can measure students' free of thinking because the theory "cognitive free will learning theory" states that an individual can actively choose the decision to learn or not learn (Glenn, 2013).

The most significant increase in the average score of students occurs in task 2, task 3, and task 1. This is because the techniques used by students in creating ideas in task 1 have obtained higher scores than other tasks, and if seen from the poster made before, the average treatment has met the criteria of the assessed indicators, so it does not require much improvement. Several types of tasks are provided because offering choice in the classroom is one way to increase student motivation and competence (Beymer & Thomson, 2015). The improvement of creative thinking skills using various techniques to create ideas before and after being treated by researchers can be seen in the N-Gain achievements presented in Table 4.

Table 4 shows that most of the students make improvements, as suggested by the researcher, to support the improvement of creative thinking using various techniques to create ideas.

The increase in the value of the skill of creating new ideas is highest in task 2, then task 3, and the lowest is in task 1. This is because, in task 2, students can freely describe ideas, especially in the phenomena section in the worksheet, which is made original according to each group's creativity. In addition, in the tools and materials section, each group also chooses various tools and materials, making each group's worksheet different. On the other hand, each group makes improvements on the advice of the researcher well, so that the worksheets produced are better than before being treated.

In task 3, the average value obtained has increased, which is not too high compared to task 2. This is because the problems described in the introduction have similarities among students, so they do not produce articles with new ideas. In addition, students tend not to make improvements on the advice of researchers, so the scores obtained are not significantly increased. If students desire to make changes to produce something new, their creativity will be more developed (Kenedi, 2017). Likewise, with task 1, the increase in the average score of students is the lowest compared to tasks 3 and 2. This is because the material content described as posters tends to have similarities among students. On the other hand, students have already obtained grades before being treated in a good category, so the increase is not too significant.

In creating new ideas, students are required to be able to present diverse ideas. These ideas come from creative thinking skills that exist in students and are combined with redox material that students have mastered. The existence of treatment in the form of giving feedback on the task can help students maximize an idea. This is in line with Lou (2017), who states that the treatment (feedback) from the teacher can guide students to think more openly and develop their abilities so that they are more courageous in acting and are challenged to be better. The increase in creative thinking by creating new ideas can be seen based on the N-Gain achievements presented in Table 4.

Based on the data, Table 4 shows that most of the students make improvements, as suggested by the researcher, to support the improvement of creative thinking by creating new ideas. Furthermore, creative thinking is original and emphasizes originality, divergence, and appropriateness, belonging to image thinking (Dou et al., 2021). In this case, most of the flexibility and fluency found from the improved task are in the moderate value.

The increase in the average score of students shows that the electronic portfolio assessment instrument can help students apply creative ideas. The application of assessment using effective feedback to increase students' creativity (Wu et al., 2015). The improvement of skills in applying creative ideas can be seen based on the N-Gain achievements in Table 4.

The achievement of N-Gain on this skill shows that the treatment given by the researcher can improve the skills of applying creative ideas to creative products, which means that students can produce a new product. In this case, the new product referred to is not something that has never existed. However, students with these skills will try to find new combinations, relationships, and structures with different qualities from existing products (Kenedi, 2017). The highest N-Gain achievement occurred in the product that was done in groups (task 2). This aligns with research by Rahmawati and Suryadi (2019), which explains that group collaboration makes it easier to hone students' mindsets to innovate creative products by integrating existing ideas.

Mastery of the material in this development trial is revealed based on a qualitative analysis of the tasks carried out by students. Basic Competencies (KD) and Competency Achievement Indicators (GPA) are integrated into the creativity assessment task and rubric as a reference for assessing students' mastery of redox reaction materials. In task 1, overall, students can make posters that can explain the development of the concept of redox reactions in terms of the binding and release of oxygen, the release and acceptance of electrons, and the increase and decrease in oxidation numbers.

In task 2, students in groups make worksheets about redox reactions based on changes in oxidation states. The worksheets made by students consist of several parts, including titles and phenomena, formulating problems and hypotheses, collecting data (choosing materials, tools, variables, designing procedures), analyzing data, testing hypotheses, and formulating conclusions. Some groups have been able to make worksheets well. In the phenomena section, each group is required to describe problems related to redox reaction materials in everyday life; several groups have described phenomena well, such as rusting of iron, bleaching clothes, and rotting apples. This shows that in addition to mastering the material, creative thinking skills can also increase because of the student's relationship with the surrounding environment (Yanti et al., 2018). In addition, students' conceptual understanding is also seen based on student's ability to make questions for analyzing data according to material indicators, including determining oxidation states, oxidizing agents, and reducing agents.

In task 3, each student writes a popular article about the results of the analysis of redox reactions in the rusting of iron in terms of the concept of oxidation state. In general, popular articles consist of an introductory section containing problems related to iron rusting, contents regarding an explanation of the factors that cause corrosion, an explanation of the redox concept in terms of oxidation state changes, and a concluding section containing conclusions or solutions to problems regarding iron rusting.

Based on the results of the tasks carried out by students, which show an increase in creative thinking, the student's mastery of the material can also increase. In line with the results of research conducted by Zidan (2019), there is a directly proportional relationship between creativity and conceptual mastery. The content of the redox reaction material described by students in each task shows a good understanding of the concept. The feedback provided by the researcher can also help students to correct the misconceptions presented previously.

In this study, portfolio assessment is carried out by assessing one of the students' best tasks after working on three tasks. Creative thinking skills that are still low are influenced because the learning process sometimes has not facilitated students in developing creative thinking skills (Purwati & Alberida, 2022) because the low involvement of students in online learning results in a decrease in their academic performance (Sholikah & Harsono, 2021). Student portfolio products are assessed using the electronic portfolio assessment rubric set by Firman (2013).

Components of portfolio product assessment include portfolio content, portfolio writing or presentation, and portfolio display. The portfolio content section has several criteria, including selection of work samples, accuracy of chemistry knowledge, and creativity/novelty. The components of student portfolio content can be categorized as good, as seen from the acquisition of student portfolio content scores in the range of scores of 3 to 4. A good portfolio content indicates that the selected sample can reveal students' chemistry knowledge and creativity well. The assessment for the writing or presentation component of a portfolio includes document organization, explanatory narrative, and collection time is sufficient. This is because students do not include an explanatory narration of the collected works, so the score obtained in the explanation narrative aspect is only 1.

Meanwhile, document organization and collection time are categorized as good. In the portfolio display component, the multimedia assessment criteria and design/layout obtained an average score in the very good category. The designs made by students show quite good creativity because they can combine text, images, and various colours so that the portfolio display is interesting to see. Portfolio assessment can be used to increase students' creativity. This is following Arifin's (2014) research states that portfolio assessment is an alternative assessment that can be used to determine the level of achievement and development of students based on the results of assignments from time to time as a whole in terms of knowledge, attitudes, and skills.

Table 4 shows that the electronic portfolio assessment instrument on redox material is effective in improving students' creative thinking skills because there is an increase in the average score from before and after implementing the electronic portfolio assessment. A comparison of the average value before and after being given treatment identifies the increase through N-Gain.

The average value before treatment is categorized as quite good (46.94), and after treatment, it increases to very good (83.06). Overall, the instrument developed effectively improves students' creative thinking on redox material. The N-Gain from the pre-test and post-test score is .68, which falls into the medium category.

Based on the results, it can be concluded that portfolio assessment by giving treatment can increase the average score of students. The results of increasing creative thinking skills occur in most students (56.67%) in the medium category and the rest (43.33%) in the high category. The achievement of N-Gain on the pre-test and post-test results shows that the instrument developed effectively improves students' creative thinking. In addition, based on the calculation of mastery learning (Gentile & Lalley, 2003), the effectiveness of the electronic portfolio assessment instrument to improve students' creative thinking reaches 96.66%; 29 of 30 students obtained a post-test score of more than 70 or met the criteria for learning mastery. This is in line with research conducted by Effendy and Abi Hamid (2016), who find that when viewed from the perspective of student learning outcomes, giving pre-tests and post-tests in learning significantly affects learning outcomes.

Thus, the electronic portfolio assessment instrument effectively improves students' creative thinking. On the other hand, there is a directly proportional relationship between the increase in task indicators and creative thinking questions. A comparison of N-Gain in Creative Thinking Using Various Techniques to Create Ideas on Tasks and Problems is presented in Table 5.

Table 5. Comparison of N-Gain Achievements for Tasks and Questions

Indicator	Creative thinking using various techniques to create ideas				Creative thinking by creating new ideas			
	Average Score		N-Gain		Average Score		N-Gain	
	Before	After	Score	Interpretation	Before	After	Score	Interpretation
Task	67.08	94.44	.83	High	62.22	82.69	.54	Medium
Question	37.78	82.78	.72	High	56.11	83.33	.62	Medium

Table 5 shows that the N-Gain value on creative thinking skills using various techniques to create ideas in tasks and questions has the same category, which is high even though the N-Gain values obtained are different. Table 5 also shows that the N-Gain value on creative thinking skills by creating new ideas in tasks and questions has the same category, which is moderate even though the N-Gain values obtained are different. Thus, there is a directly proportional relationship between the increase in the creative thinking indicators of the task and the indicators of the pre-test or post-test questions used. The creative thinking indicator uses various techniques to create ideas closely related to fluency; the pre-test and post-test results on these indicators show the most significant improvement. In addition, through electronic portfolios, the responsibility of learning communicates with students and makes learning focused on students. This follows Bangalan and Hipona's (2020) statement that electronic portfolios give students ownership and responsibility for their learning process.

CONCLUSION

The research on the development of electronic portfolio assessment instruments shows that this instrument can improve students' creative thinking on redox reaction materials, with the process of developing electronic portfolio assessment instruments consisting of (1) conducting literature reviews and field surveys, (2) concept analysis; (3) task analysis; (4) compiling assessment instruments and electronic portfolio rubrics, and (5) conducting quality tests. The quality of the electronic portfolio assessment instrument developed is valid with a CVR value of 1.00, reliable with a Cronbach Alpha value of .702- .982 in all aspects of the skills assessed, effective based on the N-Gain value of 0.61, and its effectiveness in mastering understanding of 96.66. Furthermore, students' creative thinking skills increase based on the N-Gain value of .72 with a high category.

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