Development of Electronic Portfolio Assessment Within a Chibernetic Approach Framework to Build Z's Generation Critical Thinking Skills in Chemistry Learning

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Abstract. The aim of this study is to develop an electronic portfolio assessment within a cybernetic approach to enhance students' critical thinking skills related to salt hydrolyzed materials. The method used consists of three 4-D phases. The participants of this study were 30 MIPA 11th grade. The developed portfolio assessment tool consists of tasks and assessment criteria created based on a combination of indicators of competency achievement and indicators of critical thinking skills. The developed tasks consist of three tasks: writing a summary, completing an analytical essay question and writing a practical report. The study results show that the developed portfolio assessment tool is valid and reliable. The pre-test and post-test results show that the developed e-portfolio assessment was effectively implemented in the limited experiment. Tasks 1, 2, and 3 showed improvement in higher categories due to the feedback provided. The results of the limited trial of the developed e-portfolio assessment tool based on N-gain values show that it can improve up to six indicators of students' critical thinking skills on salt hydrolyzed materials in the intermediate and high categories.

Keywords: Assessment, Electronic Portfolio, Instruments, Critical Thinking, Salt Hydrolysis.

1 Introductions

Entering the 21st century, the Indonesian nation faces many global challenges, one of which is for the world of education, the learning system is required to be able to improve graduate competencies in accordance with 21st century skills [1]. 21st century skills focus on critical thinking and problem-solving skills, creativity and innovation, and communication and collaboration [2]. There are four types of high-level thinking: critical thinking, creative thinking, problem solving, and decision-making. Of the four high-level thinking types, critical thinking is the foundation for the other three types of thinking [3]. Critical thinking is part of the 21st century skills that need to be developed in learning activities to shape students as a knowledge-based society [4]. The learning process of chemistry requires critical thinking skills to analyze symptoms and phenomena [5].

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For a generation to remain competitive, even in the 21st century, knowledge alone is not enough, it must be supported by skills [6]. However, evidence from the field shows that the assessment processes carried out by educators tend to focus on the knowledge aspect, while not enough attention is paid to the skill aspect [7]. Other facts in the field show that there are still frequent complaints about the critical thinking skills of primary school graduates and university graduates [8]. To determine the level of success in the development of students' critical thinking skills, assessment tools are needed that can measure these skills [9].

The use of portfolios as an assessment tool in education is relatively new and has received attention from educational experts because of its great potential to reveal students' competencies comprehensively [10]. The use of portfolio assessments in learning activities is expected to improve students' critical thinking skills because students will learn to be more active in thinking and understanding subject [11]. The results of comparative research between traditional portfolios and electronic portfolios conducted by [12] suggest using electronic portfolios which will lead to better learning outcomes.

Salt hydrolysis is a chemistry subject [13] that contains concepts related every aspect, the solving of whose problems requires critical thinking skills [14]. The salt hydrolysis material contains concepts that cannot be memorized, but also concepts that need to be covered in labs and group discussions. The hydrolysis material also has calculations, understand the concepts and be able to apply the formulas [15].

Research conducted on medical students also said the majority of students have bad quality of sleep (31, 32, 33, 34, 35, 36), as well as in nursing students (37, 38, 39). In pharmacy, poor sleep quality is often found in low GPA (grade point average) students (40).

Cybernetic theory is the result of the development of cognitive learning theory. Both have something in common, namely prioritizing information processing in the thinking process. Cybernetic theory is a form of combining theory and practice like in computing and laboratories. This theory believes that computing is not only useful for presentations, data processing, communication tools, or databases. Computing can also be a tool to improve problem solving to create new knowledge. In cybernetic theory, it is explained that there is no learning process that is ideal for all situations or suitable for the diverse characteristics of students. This can happen because of the influence of information systems on learning.

Information processing is based on how people deal with environmental stimuli, identify problems, organize data, develop concepts, and solve problems by interpreting or using both verbal and nonverbal symbols. This information processing is related to a person's way of analyzing information about their environment and understand those experiences. There are at least three assumptions that are used as references in information processing theory. Here are the details. 1) Between stimulus and response, it is based on assumptions, i.e. the processing of information, each phase takes a certain amount of time. 2) The stimuli processed in these phases change in form or content. 3) One of the phases has limited capacity. Structural components and control devices of the information processing flow are developed based on these three premises.

The basis for the choice is the difference in function, capacity for the form of information and the process of forgetting. These three components consist of sensory

memory, working memory and short term memory, long term memory. Sensory memory or sensory register (SM/SR) is the cell where information is first received from the outside. Sensory memory receives information or stimuli from the environment in the form of light, smell, heat, color, sound, and so on continuously through receiving devices (receptors). Receptors are usually referred to as sensory organs which are part of the body's mechanisms for seeing, tasting, hearing, touching, smelling and feeling. The information received will be stored in sensory memory for a short time so that it will be easily disturbed and changed. Working memory is a part of human memory that is able to capture information through individual attention. Then store them as thoughts. Information that is received by someone and gets attention will be sent to the short term memory (STM) system. Information entering STM comes from sensory memory and may also be obtained through the third basic component of the memory system. One way to maintain memory of information in short-term memory is by repeating it through a practice process. Without repetition and practice, it is very likely that information will be lost. Especially if the individual has received newer and stronger information. Long term memory (LTM) possessed by individuals is knowledge with unlimited capacity. Once information is stored in long-term memory, it will never be deleted or lost.

The advantages of cybernetic learning theory are that process-oriented thinking is more prominent, the presentation of knowledge properly takes into account the economic aspects, learning skills can be presented more completely, all learning activities are aligned towards the goal to be achieved, learning is transferred. In line with the real environment, learning control allows rhythmic learning and informative feedback clearly indicates the level of performance achieved compared to the expected performance. Based on the problems above, this research was conducted to produce an appropriate assessment instrument that is able to motivate students to improve learning outcomes in salt hydrolysis material through improving aspects of their critical thinking skills.

2 Method

The methodology of this study is the research and development (R&D) model [16]. This model consists of four development phases: definition, design, development, and dissemination. In the research and development of this electronic portfolio assessment tool, not all research and development phases were carried out, but only up to the development phase. Four chemistry lecturers and three chemistry teachers participated in this study as experts (validators) and four as evaluators (reliability tests), and 30 11th grade students from MIPA studied materials on salt hydrolysis in a limited experiment.

To analyze the students' assignment evaluation data, normalized gains (N-gains) are used, which are determined from each student's assignment evaluation before and after feedback. Task gains were calculated and classified and interpreted according to Hake's N-Gain criteria.The effectiveness of electronic portfolio assessment using Edmodo on students' learning outcomes is determined by conducting an N-Gain test. The scores

obtained on the pretest and posttest are then calculated as the average score, N-Gain achievement, and learning completeness.

3 Results and Discussion

3.1 Development of an Electronic Portfolio Assessment Instrument

The Define stage consists of literature review, field survey at the high school used as the research site, material analysis, and task analysis. Based on a literature review obtained from various related research journals, it was found that ideal learning is learning that can support students to achieve the expected competencies [17], one of which is critical thinking skills [1]. To achieve this competency, appropriate evaluation tools or assessment instruments are needed to be used in the learning process. [18] who believe that the learning process with electronic portfolios can make assessments more effective and efficient. The results of the literature review become a reference for researchers to conduct field surveys.

The field study was carried out through interviews with chemistry teachers. Based on the results of the field study carried out in one of the secondary schools in the city of Bandung, it became clear that there is a need to develop an electronic portfolio-based assessment tool that can improve students' critical thinking skills, including salt hydrolysis materials. At the Define stage, material analysis is also carried out, namely to determine basic competencies (KD) and main material that can be accommodated in the electronic portfolio assessment.

At this stage, a task analysis is also carried out which aims to determine alternative student work (tasks) that can be used as a portfolio in one semester. Apart from that, task analysis also aims to identify student skills that will be studied on the instrument being developed. Apart from referring to the 2013 curriculum, the development of this critical thinking skills instrument adapts to Ennis' critical thinking skills indicators.

The design of the instrument developed refers to development steps including determining the skill aspects to be assessed, identifying the indicators (critical thinking skill indicators) that will be achieved, selecting the type of activity (task), and determining the instrument for assessing the task. Next, researchers identify which indicators of critical thinking skills will be achieved. The results of this identification are adjusted to indicators that make it possible to measure students' critical thinking skills.

In this research, it consists of three tasks which were developed with reference to indicators of critical thinking skills. Three tasks designed in relation to indicators of critical thinking skills. The tasks given are to create an outline, address an analytical essay question, and write a report on the results of the internship. Next, the researcher identified which indicators of critical thinking skills would be achieved by adjusting the indicators that made it possible to measure students' critical thinking skills on salt hydrolysis material. These critical thinking indicators will later be combined with competency achievement indicators (GPA) to produce critical thinking skills task indicators. After the tasks and indicators of critical thinking skills have been determined, the next step is to prepare an initial draft of the portfolio assessment instrument and scoring

rubric. Then proceed with the selection of media used as an electronic portfolio assessment tool.

In the final stage, validity tests and inter-rater reliability tests by experts, as well as quality tests of the instrument, including limited experiments are performed. Limited trials are carried out in accordance with one of the assessment for learning strategies, namely providing constructive feedback.

3.2 Instrument Quality

In developing this electronic portfolio instrument, it was determined based on the considerations and decisions of experts (expert judgment) consisted of seven people, The results of this expert evaluation are processed by calculating the Content Validity Ratio (CVR), a content validity approach to determine the suitability of the domain measured using the items based on the experts' judgments for each suitability dimension. Calculations to determine the CVR value follow the steps according to Lawshe. Table 1 shows the results of the CVR validity test.

Table 1. CVR Value of Instrument

Critical Thinking Skills Task Indicator	Rated aspect	Number of Validators Who Say "Yes" Suitability of Critical Thinking Skills Task Indicators and Tasks	Conformity of Tasks and Rubrics	CVR Value Critical Thinking Skills and Task Indicators	Decision Indicators Task Critical Thinking Skills and Tasks	CVR Value Task and Rubric	Decisions
Task 1: Making a summary							
3.11.1.A 3.11.2.A	1.1	7	7	1	Valid	1	Valid
3.11.1.B 3.11.2.B	1.2	7	7	1	Valid	1	Valid
3.11.1.C 3.11.2.C	1.3	7	7	1	Valid	1	Valid
3.11.1.B 3.11.2.B	1.3	7	7	1	Valid	1	Valid
Task 2: Working on analytical essay questions							
3.11.1.D	1	7	7	1	Valid	1	Valid
3.11.1.B	2	7	7	1	Valid	1	Valid
3.11.2.A	3	7	7	1	Valid	1	Valid
3.11.3.E	4	7	7	1	Valid	1	Valid
3.11.2.A	5	7	7	1	Valid	1	Valid
Task 3: Making a Practical Report							
4.11.1.A	3.1	7	7	1	Valid	1	Valid
4.11.3.B	3.2	7	7	1	Valid	1	Valid

Critical Thinking Skills Task Indicator	Rated aspect	Number of Validators Who Say "Yes" Suitability of Critical Thinking Skills Task Indicators and Tasks	Conformity of Tasks and Rubrics	CVR Value Critical Thinking Skills and Task Indicators	Decision Indicators Task Critical Thinking Skills and Tasks	CVR Value Task and Rubric	Decisions
4.11.1.E	3.3	7	7	1	Valid	1	Valid
4.11.1.E	3.4	7	7	1	Valid	1	Valid
4.11.1.E	3.5	7	7	1	Valid	1	Valid
4.11.2.C	3.6	7	7	1	Valid	1	Valid

Based on table 1 the results of the CVR calculation above by comparing the minimum CVR values, it is found that all aspects are declared valid because they have a CVR value = 1 or more than the minimum CVR value of 0.99. However, there are several aspects that are declared valid but with several suggestions.

Interrater reliability was determined by calculating the Cronbach Alpha value. The calculation results of the Cronbach Alpha value and its categories are shown in table 2.

Table 2. Cronbach's Alpha Value Reliability Category

Critical Thinking Skills Task Indicator	Rated aspect	Cronbach's Alpha Value	Reliability Category
*Tasks*1 (Summary Creation)			
3.11.1.A 3.11.2.A	1.1	0.996	Very good
3.11.1.B 3.11.2.B	1.2	0.887	Good
3.11.1.A 3.11.1.A	1.3	0.935	Very good
*Tasks*2 (Working on Analytical Essay Questions)			
3.11.1.C	Question 1	1,000	Very good
3.11.1.A	Question 2	1,000	Very good
3.11.2.D	Question 3	1,000	Very good
3.11.3.E	Question 4	1,000	Very good

Critical Thinking Skills Task Indicator	Rated aspect	Cronbach's Alpha Value	Reliability Category
3.11.1.F	Question 5	0.997	Very good
*Tasks*3 (Preparation of Practical Report)			
4.11.1.D	3.1	1,000	Very good
4.11.3.A	3.2	0.900	Very good
4.11.1.E	3.3	1,000	Very good
4.11.1.E	3.4	1,000	Very good
4.11.1.E	3.5	0.939	Very good
4.11.2.F	3.6	0.960	Very good
4.11.1.A	3.7	1,000	Very good

Based on table 2 shows that there are fourteen aspects of skills in the very good category, one aspect of skills in the good.

3.3 Student's Critical Thinking Skill

The average value obtained from each task is categorized based on students' knowledge success category. Table 3 shows the results of the average scores for the entire task.

Table 3. Average value of critical thinking skill

	Task 1	Revision Task 1	Task 2	Revision Task 2	Task 3	Revision Task 3
Average	62.50	98.71	71.92	94.89	64.28	94.63
Category	Good	Very good	Good	Very good	Good	Very good

Based on Table 3 it can be seen that the use of the electronic portfolio assessment tool as an assessment for learning salt hydrolysis materials can improve students' critical thinking skills. Moreover, this can be seen from the increase in the mean scores of each task before and after the treatment from the "good" category (before feedback) to the "very good" category (after feedback).

The data was then graphed to see a comparison of the mean values before and after the treatment and to identify in terms of the increase caused by N-Gain. A graph of the mean scores before and after the treatment for all tasks is shown in Figure 1.

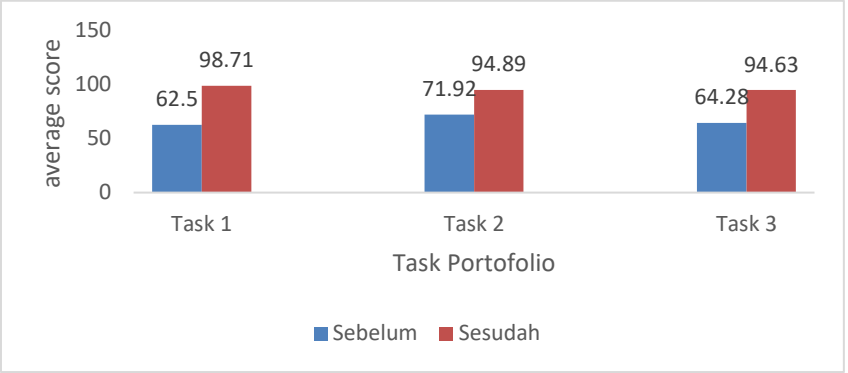

Fig. 1. Comparison of Average Scores Before and After Giving Feedback on All Tasks.

Based on Figure 1 the mean ratings for each task increased before and after the feedback. In summary, students achieved a mean score classified as good (62.5) in Task 1, which rose to very good (98.71) after the treatment. This category re-fers to Arikunto's category of successful students' knowledge.

In general, the mean scores achieved by students after feedback showed an improvement. To examine the extent to which students' critical thinking skills improved, an analysis of the N-Gain scores was performed, which is described in Table 4.

Table 4. N-gain value

Task Type	Average value		N-Gain Achievement	
	Before	After	Mark	Interpretation
Task 1	62.5	98.71	0.87	High
Task 2	71.92	94.89	0.81	High
Task 3	64.28	94.63	0.89	High
Average			*0.85*	*High*

Based on Table 4, it shows that the students' task scores increased after being given feedback with the overall average N-Gain achievement being relatively high (0.85). Each task has a different N-Gain achievement value in the high category.

4 Conclusion

The aim of this study is to develop an electronic portfolio assessment within a cybernetic approach to enhance students' critical thinking skills related to salt hydrolyzed materials. The developed portfolio assessment tool consists of tasks and assessment criteria created based on a combination of indicators of competency achievement and indicators of critical thinking skills. The developed tasks consist of three tasks: writing a summary, completing an analytical essay question and writing a practical report. The study results show that the developed portfolio assessment tool is valid and reliable. The pre-test and post-test results show that the developed e-portfolio assessment was

effectively implemented in the limited experiment. Tasks 1, 2, and 3 showed improvement in higher categories due to the feedback provided. The results of the limited trial of the developed e-portfolio assessment tool based on N-gain values show that it can improve up to six indicators of students' critical thinking skills on salt hydrolyzed materials in the intermediate and high categories.

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