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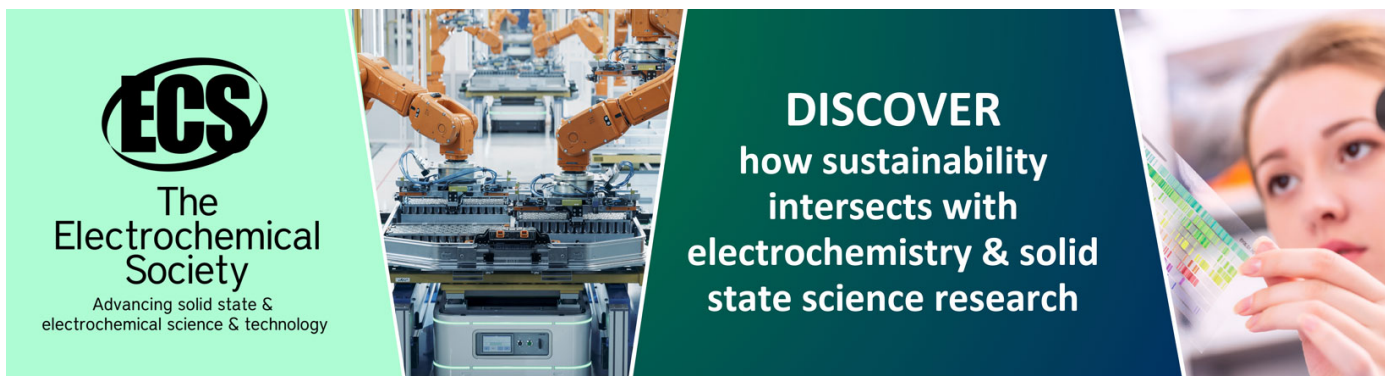
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Critical thinking skills and student learning independence of chemistry department undergraduate programs in lectures of chemistry education seminar through critical analysis techniques

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Abstract. The purpose of this study was to develop behavior critical thinking skills (CTS) and Learning Independence (LI) of students through critical analysis of learning techniques in the subject of Chemistry Education Seminars. The methods used are 1) explanation and assignment of critical analysis assignments, 2) conduct critical analysis of national and international journal articles, 3) compile presentation materials and discuss the results of critical analysis in class, 4) conduct class presentations and discussions, 5) compile report books the results of critical analysis of articles that are validated, 6) direct observation of the process of learning, and 7) filling in the CTS, LI, and student questionnaire responses. The subjects were students of the Chemistry Department of FMIPA UNM in the academic year 2017/2018 with thirty students. Results showed that the average value of students' critical thinking skills was 4.14 with the high category, the average value of student learning independence was 3.95 with the medium category, and the average value of student response to the critical analysis of learning techniques was 3.09 with the category responds positively. Furthermore, it was obtained information that the articles analysed critically were related to the needs of the elements of the student thesis research plan, namely the elements of background problems, literature reviews, and research methods.

1. Introduction

The learning independence of student becomes an important and needs attention in an effort to improve the condition of education. Independent learning is more directed towards creating opportunities and experiences needed by students to be skilled and motivated to continuously learn. The learning independence gives responsibility on students to achieve learning goals and students are expected to appreciate the value of learning as an activity of interest in order to create an adult person who is responsible for themselves and the environment in which they live [1][2].

Likewise the awareness of thinking, students are expected to be responsible for the learning process. Students consciously know their learning goals, know how or the process of thinking to achieve their learning goals, and also know how to know that these goals have been achieved. Attempts to develop the awareness of thinking, lectures can encourage students to verbally express his thought processes to understand a material, including parts that have not been well understood. Lectures become model for their students in developing the students thinking awareness [3].



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Lectures responsible in the learning process and need to devise and pursue a learning process that is capable to improve students thinking skills in higher level and behavior of their learning independent. Learning based on critical analysis of a source libraries, such as national journal articles, international journal articles, books, or other scientific reports is suspected can overcome the problems of learning in the classroom.

Critical analysis of articles is an activity of reviewing and observing articles to retrieve the contents of articles that are relevant to the article writing [4]. For example of the topic of critical analysis of an article is "The Effectiveness of Problem-Based Learning Methods in Biochemistry Learning" [5]. From this article, students were asked to analyze critically in the following order: 1) write the bibliography of the author, 2) write down the purpose of the article, 3) write down the unique facts contained in the article, 4) write down the questions after reading the article, 5) identify the main concept of the article, and 6) self-reflection about the benefits to read the articles [3].

Benefits expected from the application of learning through the critical analysis techniques include 1) can improve critical thinking skills of students, 2) can utilize technological progress, 3) can improve the learning independence, and 4) can improve writing skills. Therefore, this learning technique can be a basic for building a culture of self-reliance in learning and can develop thinking awareness of students.

2. Research Methods

The research is a qualitative descriptive analysis to improve the critical thinking skills and learning independent of students through the application of learning techniques based analysis of critical articles. This research is oriented to the learning process and product of critical analysis results. Subject of this study are students of chemical education courses, undergraduate of Chemistry Department for the academic year 2017/2018 of thirty students. The object of this research is subject of the Chemistry Education Seminar.

The procedures of this study include: 1) providing critical analysis assignments, 2) conducting critical analysis of the national and international journal articles, 3) preparing presentation material and discussing the results of critical analysis in class, 4) conducting class presentations and discussions, 5) compiling report books of the critical analysis result of the validated articles.

The instrument used in this study is critical thinking skills test that is refers to Ennis [6], learning independent questionnaire (modification of [7]) includes aspects of responsibility, freedom, liveliness, confidence, and initiative action. The student response questionnaire [8] includes aspects of reading interest, utilization of technological advances, critical thinking skills, learning outcomes, literary abilities, and critical content. The assessment sheets of product is used to assess or to categorize the quality of report books of the student analysis result that cover aspects of the type of analysis material and problems found, the extent of the presentation of critical analysis as a study they found and then presented based on critical analysis format, the benefits of the analysis results, they have make a connection with research plan of students, the update, and the type of reference source.

This study data were processed and analyzed descriptively [9][10] includes data of critical thinking skills, learning independence, student response, observation data during presentations and discussions, and critical analysis report book.

3. Results and Discussions

3.1. Research result

3.1.1. Critical Thinking Skills. Data of critical thinking skills of students that were taught by critical analysis techniques of articles for Chemistry Education Seminar subjects are presented in Table 1.

Table 1. Student Critical Thinking Skills

No.	Aspect	Indicators	Score	Category
1	Provide a basic explanation	1. Focus questions 2. Ask questions and answer questions that need explanation	4.28	High
2	Building basic skills	Observe and consider the results of observations	4.04	High
3	Making conclusions	1. Make deductions and assess the results of deductions 2. Induction	4.00	High
4	Make explanations more smooth	1. Defining terms and considering definitions using the right criteria 2. Identifying assumptions	4.17	High
5	Implement strategies and tactics	1. Decide an action 2. Interact with others	4.23	High
Score average			4.14	High

3.1.2. Learning independence

Data of student learning independence that was taught by critical analysis techniques of articles for Chemistry Education Seminar subject is presented in Table 2.

Table 2. Student Learning Independence

No.	Aspect	Indicators	Score	Category
1	Responsible	1. Have awareness of the benefits of learning 2. Discipline in following the learning process	4.32	High
2	Independence	1. Having the independent to carry out to carry out learning without pressure from other parties 2. Able to complete tasks in the learning process	3.97	Medium
3	Active	1. Do various ways to achieve success 2. Actively participate in finding information	3.88	Medium
4	Confidence	1. Able to make decisions from yourself 2. Believe in your own abilities	3.65	Medium
5	Initiative	1. Achieve yourself optimally in learning 2. Able to determine how to learn	3.93	Medium
Score average			3.95	Medium

3.1.3. *Student response to critical analysis learning.* Student response data that was taught by the article critical analysis techniques for Chemistry Education Seminar subject is presented in Table 3

Table 3. Student response

No.	Aspect	Score	Category
1	Increasing interest in reading of students	2.55	Medium
2	Utilization of technological progress	3.50	High
3	Increasing critical thinking skills of students	3.25	Medium
4	Improved student achievement/learning outcomes	2.63	Medium
5	Improved writing skills	3.40	High
6	Increased critical load	3.30	High

Score average	3.09 Medium
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3.1.4. Report product of critical analysis results. Presentation of product of article critical analysis stated in the form of reports of critical analysis results with the following systematics:

3.1.4.1 Bibliography. Students write journal articles were analyzed, including the name of authors, year of publication, the article title, journal name, issue number, publisher, and the article pages. The bibliography of articles presented by students generally follow this systematic pattern, both articles from national journals and international journals.

3.1.4.2 Objectives of article. This section has involved student to think analytically, because student must read this article to understand the importance purpose of this article being written or published. The results show that students have conducted a critical analysis that is good in finding objectives of article writing.

3.1.4.3 Unique facts. This section requires student to write down as many unique facts or essential information to be revealed from the article. The results show that students have not been optimal in revealing facts. Generally the facts revealed have not yet been described as unique facts, but still mostly reveal general facts. Students have not revealed and criticized the meaning of the data presented by the article authors. In addition, students also have not elaborated on the important information contained in the data presentation and discussion.

3.1.4.4 Asking question. This section requires the student as an analyzer for asking critical questions related contents of the journal article. The results showed that the students are very good in asking critical questions related to information presented as well as things that relevant are not very relevant but it related to the article content.

3.1.4.5 Main concept. This section requires student to find the main concept of an article content. The results show that in general, student thinking skills are adequate in finding and presenting the main concepts of an article.

3.1.4.6 Self-reflection. This stage requires student to identify the benefits of the article. The results show that all articles that analyzed critically is one of the literature sources in preparing the research plan. The benefits on research proposal plan, especially intended for the needs of the elements of literature review, research methods, and background of the problem. The benefit on research method components especially on independent variables, dependent variables, and specific aspects in the research instrument.

3.1.4.7 Article sources. Articles that analyzed critically sourced from national and international journals, each an article for each student. The topics of the articles chosen for analysis are learning approaches, learning models, learning methods, learning techniques, learning media, learning outcomes, instruments of observation and assessment, thinking skills, and the development of resources, tools and learning media, and curriculum development.

3.2. Discussion

3.2.1. Depth of critical thinking. Based on Table 1 shows that the critical thinking skills of students after learned with critical analytical techniques was 4.14 in the high category. Table 1 also shows that all aspects of critical thinking skills in high category. This means that the process of learning

Chemistry Education Seminars through critical analysis techniques, articles contributed positively to the fifth aspect of critical thinking skills. These five aspects are described as follows:

3.2.1.1 *Provide a basic explanation.* Learning of Chemistry Education Seminars with critical analysis techniques an article can develop the competence of students in the cognitive level for explaining a fact or information. Through reading activities and efforts to understand the meaning of the information contained in the article is an activity in article analysis that can develop an explanatory competences. Basic explanatory competences be trained early through the bibliographic writing stage and the purpose of article writing. These two stages require students to recognize and understand well the author's biography and the purpose of writing the article. Competency explain also trained when students focus questions or simplify questions so that it is easier and more direct to be answered properly. Explanations for various questions in presentation and question-answer becomes a learning experience through this learning process so that it can impact on the improvement of basic explanatory competencies.

3.2.1.2 *Develop basic skills.* Learning with critical analysis techniques can develop basic skills of student, namely skills in making and utilizing observations. The observation results are unique facts that presented in the report of the critical analysis result is then presented, discussion, and frequently asked questions in class. The presentation of these unique facts is displayed as best as possible by considering that facts or information are essential, true, logic/rational, and can be accounted for scientifically. Thus the basic skills of students can be developed through learning with critical analysis techniques, especially at the stage of collecting and writing unique facts from a reading source, namely articles.

3.2.1.3 *Making conclusions.* In this stage, students through reading activities and understanding well the reading as a whole can draw conclusions about the purpose of writing and the main concepts. The formulation of the purpose of writing articles and main concepts can only be concluded correctly if all contents of the article are read and understood well. Thus the skills to build conclusions or deductive and inductive thinking skills can be trained through the stages of critical analysis activities.

3.2.1.4 *Making Further Explanations.* Student skills in explaining a fact or information and data can be developed through the formulation of a critical question, because a critical question be indicator that there are cognitive conflict within oneself. Skills to make further explanations can be trained through a fact writing or a unique information.

3.2.1.5 *Implement strategies and tactics.* Skills in implementing strategies and tactics to interact and act can be developed through learning activities with critical analysis techniques. These skills are trained especially in the stage of self-reflection. In this stage, students can evaluate themselves whether the results of critical analysis can be followed up in the form of learning strategies and tactics or research activities on learning. Thus the learning experiences are revealed in the process of learning to develop students' skills in applying various strategies and techniques to interact, good interaction between students, and subject coordinator or around classroom.

3.2.2. *Learning Independence.* Based on the data in Table 2 shows that learning independence behavior of student after being taught through critical analysis techniques, of articles were 3.95 in medium category. Table 2 also shows that all aspects of learning independence are responsibility, independence, active, confident, and the initiative is at high level. This shows that learning through critical analysis techniques contributes well on learning independence behavior of student. The explanation of the five aspects of learning independence is described as follows:

3.2.2.1 Responsible. Activity learning of Chemistry Education Seminars through critical analysis techniques of articles improve a sense of responsibility towards the student. Selection of article topics that they are interested to be analyzed. Student feel the need and realize that what they choose as the topic of critical analysis must be accounted for the form of carrying out analytical activities until they get the knowledge or information related to the topic of their analysis. Their form of accountability for this analysis must be reported in class in a complete and thorough manner both objectively and scientifically both the implementation process and the products produced. They must be able to explanations of how the information was obtained, where the source of the information was obtained, the instrument used to obtain information or data, and the correctness of the information analyzed.

3.2.2.2 Independence. Independent in learning activities is one aspect that is created in learning through critical analysis techniques. Students have freedom in using techniques and learning resources to find reliable information. Students complete their analytical tasks without pressure from other parties.

3.2.2.3 Active. Active participation in learning is a very important aspect in the success of a learning process with critical analysis techniques. Students carry out in-depth analysis to get as much information as possible. Full involvement becomes a requirement in the analysis process. The success in finding a variety of information is very much determined by the involvement of students in tracing information in various learning sources and performing various techniques and forms of study. Without active involvement, students will not be able to find much information or solutions to a topic of analysis. This certainly can have a less scientific impact when presenting the results of the analysis. Activity of student becomes an aspect learning experiences during the learning process.

3.2.2.4 Confidence. Learning with critical analysis techniques can make students able to make decisions from themselves. What topic will be the task of analysis and how to do it is entirely determined by students. The decision of student in determining the topic of critical analysis is one of the markers that students have the confidence that they are able to carry out the analytical task. Self-confidence in his abilities makes students decide and determine the topic of analysis. They certainly think about the way the task of analysis is done earlier and how to solve it

3.2.2.5 Initiative. Initiative is one aspect or potential in students which can be empowered through learning with critical analysis techniques of a learning resource. Critical analysis process carried out by students can realize itself as a learner who is able to optimally find various information- unique information and solve a problem. The ability of the students themselves is applied to the maximum in order to complete this analytical task. The skills possessed or the knowledge possessed by students is empowered in carrying out critical analysis, ways of learning, and ways to solve problems found. Skills in taking the initiative to determine how to analyze information and define it as a way of learning to think critically in obtaining information and completing the tasks realized by themselves.

3.2.3. Student Response. Table 3 shows that the response of students to learning through critical analysis techniques for Chemical Education Seminar subject for all aspects of the response were 3.09 in responding positively category. Explanation of the six aspects is described as follows:

3.2.3.1 Improving of students reading interest. Critical analysis of the articles, students should not you look for articles that relate to the subject material assigned by the lecturer. They must read and understand well before being written in the form of a critical analysis report. If articles are from international journals, they first transfer to Indonesian. Thus, they must read and listen carefully. It is possible that the article must be read repeatedly to be understood well. Therefore, through learning with this technique can increase student interest in reading.

3.2.3.2 Ability to take advantage of technological advances. Student can take advantage of communication technologies such as the internet to access the articles required. Today, there are very many available downloadable online articles, national journals or reputable international journals. Thus, the activities of critical analysis of articles can improve students' ability to utilize information technology progress.

3.2.3.3 Improving critical thinking skills of students. Critical thinking skills will developed through critical analysis of articles. Articles obtained from reading sources are analyzed according to the analysis guide. Critical analysis train students develop critical thinking skills. The ability to think critically is based on the thought process to analyze arguments and emerge insight into each meaning of a problem.

3.2.3.4 Improving learning achievement of students. One of the stage is the analysis activities students must relate the results of analyzes with chemical concept that became the object of research or studies that were analyzed in the article. Thus, all students will better understand of the chemistry concepts. If student mastered the material or chemical concept of this part in the activities of the analysis, it is expected that its chemistry learning achievement will increase.

3.2.3.5 Training student to improve their writing skills. The activity of critical article analysis is a good means to be able to apply the theory of learning to write. It looks at the stage of great activities the students write a bibliography author of the article, the author's purpose, and the unique facts found in the article. The stage of self-reflection writing faces the article they read can demonstrate the ability to create a narrative masterpiece students to express their feelings. Thus, a person's ability to write a paper can be started from analyzing national articles or international articles.

3.2.3.6 Critical content. Critical analysis activities will give critical information as a result of the critical thinking process to a fact found in the article. Analytical results from the bibliographic writing stage to the self-reflection stage contain critical information which is the result of detailed identification of the unique facts contained in the article, especially in the presentation of research results and discussion.

3.2.4. Utilization for thesis research plans and quality analysis. Results of critical analysis of articles that have been done by the students on the topic of learning, learning, media, assessment instruments, and the curriculum is good. They have done a critical analysis and revealed many important information related to their thesis research plan. The topics of analysis can be a basis for thinking and a conceptual framework in compiling literature reviews, frameworks, formulating research hypotheses, and testing hypotheses. Information about the benefits of the results of critical analysis of the article was also revealed when there was a process of discussion, question and answer, and reflection on the results of questions and suggestions when they conducted discussion activities. Generally they stated that the results of the analysis of this article are useful in the framework of the preparation of their thesis research plan and product quality of critical analysis

Several research results and theoretical studies that are relevant to this finding include Danial [11] which reports that the application of critical analysis techniques to the learning of Chemical Colloquium subject for students of Chemistry Education Master's programs influences critical thinking skills and learning independence of student [4]

4. Conclusions

Critical thinking skills of students who are taught by critical analysis learning of articles on Chemistry Education Seminar courses are on the score 4.14 in the high category . Student learning independence that is taught by learning critical analysis articles in Chemistry Education Seminar courses is on the score 3.95 in the medium category. The response of students to teaching critical analysis of articles on

the Chemistry Education Seminar courses was 3.09 in moderate category and respond positively. Relationship articles that analyzed critically with the benefits and needs of the elements of the thesis research plan related to the elements of literature review, research methods, and background of the problem.

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