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Exploring the Prospective Teachers' Critical Thinking and Critical Analysis Skills

ABSTRACT

This study aims to explore the prospective teachers' critical thinking and critical analysis skills based on gender. This is a descriptive quantitative study with survey methods. The research samples were 50 males and 50 females who take the anatomy and plant development courses selected using purposive random sampling. The data of prospective teachers' critical thinking and critical analysis skills were collected using the instrument developed that was validated by two experts and tested on 20 biology education students. The data of prospective teachers' critical thinking and critical analysis skills were analyzed descriptively and statistically using a software (IBM SPSS Statistic 23). The results of the study show that (1) the prospective teachers' critical thinking and critical analysis skills as underdeveloped; (2) critical thinking skills differ in the components of interpretation, explanation, and self-regulation; (3) critical analysis skills differ on the explanation and interpretations; and (4) there is a positive correlation between prospective teachers' critical thinking and critical analysis skills. Based on the result of the study, serious and planned handling can be done through important learning. The results of this study can be an initial reference and priority determination of lecturers in teaching prospective teachers' critical thinking and critical analysis skills based on gender.

Keywords: critical thinking skills, critical analysis skills, gender

INTRODUCTION

Critical thinking skill is still a priority of learning and research in various disciplines. Aliakbari & Sadeghdaghighi (2011) stated that critical thinking skill is important since they are integrated with everyday life. According to Facione (2007); Ennis (1996), critical thinking greatly influences the success of one's learning and career. In line with those statements, the 21st century learning which really puts it emphasize on student-oriented learning requires innovative thinking skill such as critical thinking skill (Mishra & Kereluik, 2011), analysis based on good reasoning (Muhali, 2018) with regard to disposition thinking (Facione, 2007; Ennis, 1996).

Many definitions of critical thinking were proposed by experts such as critical thinking is an art in analyzing and evaluating (Paul & Elder, 2019) as an effort to improve thinking independence through good judgment and evaluation (Reid, 2006). Critical thinking has long been an approach in learning. (Dewey, 1933) introduces critical thinking as "reflective thinking" which is explained as an active, persistent, thorough consideration of a belief and form of knowledge received in terms of reasons that support it and further conclusions that become its tendency (Fisher, 2011). Critical thinking skill as a process according to Ennis (2011) is reflective and evaluative processes to determine what funds are believed to do. According to Facione (2007) critical thinking is basically a detailed description of several characteristics which include the process of interpretation, analysis, evaluation, inference, explanation and self-regulation. On the other hand, Ennis (1996) provided the same definition as Hassard & Dias (2013) about the concept of critical thinking in which critical thinking as a reasonable and reflective thought that focuses on deciding what to believe or do. Critical thinking is an intellectual process that is actively and skillfully conceptualizing, applying, analyzing, synthesizing, and or evaluating information collected, or produced by observing, reflecting, considering, or communicating, as a guide to trust and do (Moore & Parker, 2009). Specifically, critical thinking is seen as a cognitive process. Common cognitive abilities include the ability to interpret, analyze, evaluate, infer, explain and regulate themselves (Facione, 1990).

If the definition is examined, critical thinking skills consist of 2 (two) important components that is critical thinking cognitive skills and critical thinking dispositions. Cognitive thinking and critical thinking dispositions have a role in analyzing fairness and solving problems faced. A good critical thinker should not only has critical thinking cognitive skill, but also critical thinking dispositions so that the contribution of critical thinking as a provider of fair analysis in solving problems can be fulfilled (Facione, 2007).

Almost everyone who deals with critical thinking has produced a list of thinking skills that they see as the basis for critical thinking. Critical thinking is a skill, thinking responsibly which facilitates good decisions because (1) it depends on criteria, (2) it is self-correction, and (3) it is sensitive to context (Lipman (1987). Rudinow & Barry (2007) stated that critical thinking is like a set of conceptual devices by connecting intellectual abilities and strategies that are useful for making reasonable decisions about what to do or believe. On the other hand, Paul & Elder (2019) explained the role of the function of critical thinking skills into eight functions in which each function represents an important part of the quality of thinking and results as a whole such as: (1) questioning at issue (questioning the problem); (2) purpose; (3) information in the form of data, facts, observation, experience or other sources that can help someone solve the problem at hand; (4) concept is in the form of thinking patterns that become a frame of work in thinking and acting; (5) assumptions that describe the mind's "baseline"; (6) points of view in the form of a person's point of view in reasoning and thinking that involves a process of interpretation and understanding something; (7) interpretation and inference (interpretation and drawing conclusions) which function to understand data and draw conclusions; and (8) implication and consequence in the form of readiness to face the

implications and consequences of thought processes carried out.

Critical analysis is the ability of students to describe information into smaller parts so that deeper meaning is obtained through organizing and connecting the parts in the information so that more comprehensive meaning is obtained based on the results of the analysis students will be able to make decisions correctly (Asy'ari & Fitriani, 2017). Appropriate decision making is a component of critical analysis that is closely related to critical thinking (ability to evaluate) (Ennis, 2011). Through these evaluating activities, students will be able to find weaknesses and strengths so that they can produce something new or different from what has already exists. Furthermore, Krathwohl Anderson (2009) explained that analyzing is the ability to break things down into smaller parts so that deeper meaning can be obtained. Analyzing is the ability to organize and connect between parts to obtain a more comprehensive meaning. The ability to analyze will end in the process of critical thinking so that someone is able to make decisions correctly (evaluative). Critical analysis requires a logical, critical, and creative thinking process; so that it is able to solve the problem (Brookhart, 2010). Critical analysis is shown through identification of inferential relationships between statements, questions, concepts, data descriptions or other forms of representation intended to express beliefs, judgments, experiences, reasons, information or opinions. The ability of critical analysis in this study is the ability of students to decipher information into smaller parts so that deeper meaning can be obtained through several indicators that is: 1) organizing, 2) linking parts or variables in that information, 3) interpreting data, 4) evaluating of informing, 5) reflecting of processes, 6) making decisions relevant to the concepts and problem solving that are formulated (Facione, 1990).

The learning process in higher education which focuses on transferring information becomes an important supporting factor for developing dispositions, critical thinking skills, and critical analysis of students. Knowledge that has characteristics that can be justified, true, and can be trusted (Brookhart, 2010) is indeed relevant to be taught through thinking skills including critical thinking and critical analysis. Critical thinking and critical analysis have become an important part of learning objectives that must be achieved at the tertiary level in Indonesia, as stated in Permendikbud No. 73 of 2013 concerning the Indonesian National Qualifications Framework (IQF/KKNI). The excerpt in KKNI level 6 qualification levels is stated that students must be able to formulate procedural problem solving, make appropriate decisions based on information analysis, and provide guidance in choosing various alternative solutions. The study of several theories shows that the aspects of competency that must be achieved by students in the IQF are important aspects in critical thinking and critical analysis. The objectives the IQF are in accordance with indicators of critical thinking disposition, critical thinking skills, and critical analysis according to experts, that is the process of solving problems (Mitrevski & Zajkov, 2011), making the right decisions (Rudinow & Barry,2007; Paul & Elder , 2019; Fisher, 2011; Ennis, 1996), and analyzing information (Facione, 2007; Kiltz, 2009; Ennis, 1996) and consciously (reflective) choosing various alternative solutions (Ennis, 1996; Lai et al., 2015; Cropley, 2015; Bakir & Oztekin, 2014; Ceran et al., 2011).

Gender is one of the factors that can influence one's thinking skills (Aliakbari Sadeghdaghighi, 2011; Harish, 2013; Mahanal et al, 2017). Gender is a general term that refers to male and female (Fin & Ishak, 2012; Mahanal et al, 2017) that shapes psychology and one's social role (Fuad, et al., 2017) so that it affects how individuals think, behave, and feel a phenomenon within themselves (Santrock, 2011).The exploration of students' critical thinking skills based on gender were conducted by Duff (2005) who measured critical thinking skills and critical thinking disposition using the CCTST (California Critical Thinking Skills Test) and CCTDI (California Critical Thinking Disposition Inventory) developed by Facione (2007) found that female students were better at critical thinking skills than male students, but there were no differences in the critical thinking disposition between female and male students. On the other hand, Dagun (1992) stated that male and female can differ in the context of thinking and disposition skills in which male tend to think more analytically and flexibly than female, while female are less capable of abstract and logical thinking (Krutetskii, 1976). Male and female have no difference in understanding concepts, but male are superior in problem solving than female (Gok, 2014). Teghva et al (2014) stated that there was no significant critical thinking correlation between male and female, while Fitriani et al (2018) stated that the female prospective teacher was better than male in composite inquisitiveness and maturity, while male were better on self-confidence and open-mindedness components. On the other hand, Demirhan & Koklukaya (2014) found that prospective science teachers' critical thinking disposition is significantly different between male and female in inquisitiveness and systems. Mutakinati et al (2018) found that the students` critical thinking skill was categorized as advanced thinker: 41.6%, practicing thinker: 30.6%, beginning thinker: 25%, and challenged thinker: 2.8%. The category for students`critical thinking was practicing thinker in general but there is no specific classification regarding the critical thinking component studied.

This study is important to conduct because differences in thinking skills caused by gender have been extensively studied but none have been specific to the prospective teachers' critical thinking skills (critical thinking components) and critical analysis. This study aims to identify the critical thinking skills of prospective teacher students consisting of 6 (six) components that are: 1) interpretation, 2) analysis; 3) inference, 4) evaluation, 5) explanation, 6) self-regulation; and critical analysis skills of prospective teachers consisting of 6 (six) components that are: 1) organizing, 2) linking parts or variables in the

information (association), 3) interpretation of data, 4) evaluation of information, 5) reflection process, 6) make decisions that are relevant to the concepts and problem solving that are formulated. The results of the study were classified according to gender which in this study were male and female gender and were expected to be able to provide a general picture of critical thinking skills, and critical analysis of prospective biology teachers based on gender to be considered in choosing strategies, approaches, and a more effective learning model for teaching thinking skills and dispositions.

METHODS

This is a descriptive quantitative study with survey methods to explore prospective teachers' critical thinking and critical analysis skills of 100 biology procpective teachers (50 males and 50 females) who take the anatomy and plant development courses selected using purposive random sampling (Fraenkel et al., 2011). Twelve item test descriptions of plant anatomy and development material were used to collect data on critical thinking skills and critical analysis of prospective teacher students. Descriptive test developed to collect data on critical thinking skills are prepared based on six indicators of critical thinking skills by Facione (1990) and six indicators of critical analysis in the study, namely: 1) organizing, 2) associations, 3) interpretation, 4) evaluation, 5) reflection, 6) make a decision.

The instrument of critical thinking skills was developed in accordance with the indicators of critical thinking skills in the anatomy and development of plants. The instrument developed was then assessed for content and construct validity by 2 experts categorized in Table 1.

Table 1. The category of instrument validity based on the average value of the validator

Score Interval	Category
> 3.6	Very valid
2.8 – 3.6	Valid
1.9– 2.7	Invalid
1.0– 1.8	Not veryvValid

Adapted from Ratumanan and Laurens (2011).

Instrument reliability was analyzed using equations: *Percentage of agreement = 100 [1- (AB) / (A+ B)]* (Emmer & Millett in Borich, 1994), where A is the frequency of behavioral aspects observed by the observer giving a high frequency, and B are the frequency of behavior aspects observed by other observers by providing a low frequency. The instruments are declared reliable if the reliability score is ≥ 75%.The results of testing the validity and reliability of the instruments developed based on content and construct validity are presented in Table 2 below.

Table 2. The content and construct validity and reliability of instruments

N	Content validity	Reliability	Construct validity	Reliability
12	3.83	0.97	3.87	0.98

The instrument developed was also tested on 20 biology students who had taken anatomy and plant development courses to determine the validity and reliability of the tests developed. The results of the instrument trials were then analyzed to determine the validity and interpretation of the instrument. The results of testing the validity and reliability of the instruments developed are presented in Table 3 and Table 4 below.

Table 3. Results of instrument validity test

Items	Pearson Correlation	Sig. (2-tailed)	Remarks
Number 1	.598	.005	Valid
Number 2	.354	.126	Invalid
Number 3	.682	.001	Valid
Number 4	.369	.110	Invalid
Number 5	.661	.002	Valid
Number 6	.165	.486	Invalid
Number 7	.550	.012	Valid
Number 8	.357	.123	Invalid
Number 9	.431	.058	Invalid
Number 10	.374	.105	Invalid
Number 11	.737	.000	Valid
Number 12	.338	.145	Invalid

Table 4. Reliability Instruments

Cronbach's Alpha	N of Items
.703	12

Based on the test results, it is found that reliable instruments are used to collect data on critical thinking skills and critical analysis of prospective biology teachers in anatomical and plant development material. The following are presented two examples of the intended essay test items.

1. If you observe plants in the surrounding environment, you might see a variety of colors of flowers and fruit. If this is related to the function of organelles found in the cells making up these organs, why do flower and fruit organs have varying colors? Explain your reasons!
2. One of the functions of vacuole is to play a role in cell growth, how do you explain the function of the vacuole?

Respondents' answers were then analyzed using the critical thinking skills rubric and critical analysis adapted from the rubric that had previously been developed by Facione et al (1994) with scores of 1 to 4 as shown in Table 5.

Table 5. The critical thinking skills rubric

Indicators	Score	Description
Interpretation	4	Students are able to interpret the problems given by describing the relationship between relevant variables precisely (sharply).
	3	Students are able to interpret the problems given by describing the relationship between the relevant variables but still not precise or lacking precision.
	2	Students are able to interpret the problems given but are less relevant to the variables contained in the problem.
	1	Not able to interpret the problem given
Analysis	4	Given a phenomenon or data then students are able to provide the right arguments and are based on the analysis in accordance with the concept.
	3	Students are able to provide the right argument but are based on analysis that is not in accordance with the concept.
	2	The arguments conveyed were quite good but were unable to provide reasons that were in accordance with the correct concept.
	1	Cannot analyze claims, facts or arguments.
Evaluation	4	Significance or assumptions are given then students are able to provide precise predictions and evaluate these predictions based on variables that are in accordance with the correct and precise concepts.
	3	Learners are able to provide the right predictions and evaluate these predictions based on the analysis in accordance with the concept, but the analysis given is less precise.
	2	Students are able to provide precise predictions but cannot provide appropriate evaluations based on the correct analysis and according to the concept.
	1	Students are able to provide predictions and evaluate these predictions.
Inference	4	Given a number of data, graphics or images, students are able to make precise predictions and formulate or make inferences correctly based on predictions, data, and graphics or images that are presented based on the correct concept.
	3	Students can make the right predictions but are less precise in formulating or making inferences based on data, graphics or images provided.
	2	Students are able to make precise predictions but are unable to formulate or make inferences according to the data, graphics or images presented.
	1	Not able to make inference
Explanation	4	Phenomena or assumptions are given then students are able to make statements and provide explanations based on the correct concepts.
	3	Give an explanation based on the correct concept, but cannot make a statement or statement contrary to the explanation given.
	2	Able to make statements, but less relevant to the correct concept.
	1	Unable to give statements and explanations
Self-regulation	4	The phenomenon or assumptions are given then students are able to explain the causes of the event can occur based on the knowledge they know and explain the relevance of their explanations to the concepts/laws/principles that are correct.
	3	Explaining the causes of these events can occur based on the knowledge they know but are less precise in explaining the relevance of their explanations to the correct concepts/laws/principles.
	2	Explaining the causes of these events can occur based on the knowledge they know but cannot explain the relevance of their explanation to the correct concept / law / principle.
	1	Unable to regulate their knowledge.

Respondents' answers were then analyzed using the critical thinking skills rubric and critical analysis adapted from the rubric that had previously been developed by Facion (2007) with scores of 1 to 4. The results of analysis of critical thinking skills and critical analysis were then categorized by categories in Table 6.

Table 6. The Criteria of Levels of Critical Thinking and Critical Analysis

Criteria	Score
Not yet visible or still underdeveloped	1-2
Start developing or developing well	3-4

The variables in this study were analyzed using IBM SPSS 23 software. The results of the analysis include the results of the identification of differences in each component of the variables and the correlation between the variables in this study.

RESULTS AND DISCUSSION

The critical thinking skills and critical analysis of prospective teacher, as a whole, need to be developed further. The complete results are presented in Table 7 below.

Table 7. Critical thinking skills and critical analysis of prospective teacher as a whole

Criteria	Score	Gender	Number of Students	Percentage	Total Percentage
Not yet visible or still underdeveloped	1-2	Male	50	78%	81%
		Female	50	84%	
Start developing or developing well	3-4	Male	50	22%	19%
		Female	50	16%	

Table 7 shows that 81% of prospective biology teachers of FPMIPA IKIP Mataram have critical thinking skills and critical analysis with criteria that have not yet appeared or are still underdeveloped, while only 19% are categorized as developing or developing well. The results of critical thinking skills and critical analysis of male and female biology teacher students are presented in Table 8 below.

Table 8. Independent sample test of critical thinking skills and critical analysis of male and female biology teacher candidates

Variables	Gender	N	Mean	ΣN	p
Critical Thinking	Male	50	46.6670	100	.359
	Female	50	48.1672		
Critical Analysis	Male	50	55.1940	100	.319
	Female	50	53.5580		

Female biology prospective teachers have better critical thinking skills (mean: 46.1672) than male (mean: 46.6670), while male students have better critical analysis skills (mean: 55.1940) than female (mean: 53.5580), yet critical thinking skills (p: .359) and critical analysis (p: .19) of students of male and female prospective teachers are not significantly different. The following are the results of the study in full with different indicators of critical thinking skills and critical analysis of prospective biology teacher students in terms of gender.

Critical Thinking Skill

Critical thinking skills of prospective teachers are collected using 6 (six) item descriptions with characteristics of interpretation, analysis, evaluation, inference, explanation, and regulation (Facione, 1990). The results of the respondent's answers were then analyzed using rubric critical thinking skills based on 6 (six) indicators of critical thinking skills as described earlier. The results were then analyzed statistically using the U (Mann-Whitney Test) test because the results of the test of distribution of data on critical thinking skills of prospective teacher were declared not normally distributed. The test aims to determine the differences in the components of students' critical thinking skills as presented in Table 9.

Table 9. The Results of U test for critical thinking skills of prospective teachers.

Mann-Whitney Test					
Component	Gender	N	Mean	ΣN	p
Interpretation	Male	50	59.81	100	.001
	Female	50	41.19		
Explanation	Male	50	37.40	100	.000
	Female	50	63.60		
Self- Regulation	Male	50	41.09	100	.000
	Female	50	59.91		

Table 9 shows that the components of students' critical thinking skills differ in 1) the interpretation in

which male are better at interpreting the problem given (mean = 59.81) than female (mean = 41.19); 2) explanation, female prospective teacher are better at explanation (mean = 63.60) than male (mean = 37.40); and 3) self-regulation, female students who are female sex teachers are also better at solving problems that require respondents to regulate their knowledge (mean = 59.91) than students who are male teacher candidates (mean = 41.09).

Critical Analysis

The results of critical analysis skills of prospective students were analyzed statistically using the U (Mann-Whitney Test) test because the results of the test of data distribution of critical analysis abilities of prospective teachers were declared not to be normally distributed. The test aims to determine the differences in the components of critical analysis abilities of prospective teachers as presented in Table 10.

Table 10. The results of U-test critical analysis of prospective teacher

Mann-Whitney Test					
Component	Gender	N	Mean	ΣN	p
Interpretation	Male	50	66.14	100	.000
	Female	50	34.86		
Explanation	Male	50	39.46	100	.000
	Female	50	61.54		

Based on Table 10, the critical analysis ability of female prospective teachers is better (mean = 61.51) than male (mean = 39.46) on explanatory components, while male prospective teachers are better (mean = 66.14) than female (mean = 34.86) in the interpretation component. This result is in line with the same component of critical thinking skills where male are better than female in the interpretation component and female are better than male in the explanatory component.

The results show that critical thinking skills and critical analysis of prospective teachers still need to be developed, but the correlation between critical thinking skills and critical analysis of prospective teacher shows a positive correlation between the two components as presented in Table 11, so it is important to teach critical thinking skills and critical analysis comprehensively.

Table 11. Correlation of critical thinking skills and critical analysis of prospective teachers

Variables	N	Pearson Correlation	p	Annotation
Critical thinking skills (CT) Critical analysis (CA)	100	.685	.923	100^{CTCA}

Critical thinking skills and critical analysis of prospective teachers

Critical thinking skills and critical analysis of biology teacher candidates in general are declared not yet visible or still underdeveloped (score 1-2) with a percentage of 81%. The response shown based on student answers shows the lack of student interpretation and explanation skills towards the phenomena presented in the test instruments given. The implication of these results is the teachers' low skills on critical thinking indicators and other critical analyzes. Critical thinking and critical analysis are essentially reflective thinking processes (Dewey, 1933; Ennis, 1996; Facione, 1990) which are human activities in looking back on their experiences, thinking about those experiences, considering and evaluating them (Loughran, 2002) where activity these activities are interconnected (Ennis, 2011; Facione, 2007; Rudinow & Barry, 2007).

The weakness of critical thinking skills and critical analysis of students is indicated by the inability to show good interpretation, explanation, and self regulation. The statement was based on students' response to problem number 1. FM student state that *flower and fruit organs have varying colors because the flower and fruit organs are influenced by certain hormones, this results in different color and fruit organs.* Other students wrote a response similar to the response written by FM students that*the flowers and fruit experience segmentation where this segment affects the color of the flower and fruit.* Some students wrote the response that color differences in fruits and leaves were caused by plants having chloroplasts, while kroroplast functioned when plants carried out photosynthesis, for example AI stated that *plants have chloroplasts in which there are several types of color pigments such as chocolate, blue, etc., these pigments cause various types of colors that exist in fruit, leaves, and stems, because chloroplasts are found in all parts plant.* Similar response with AI student, MJ student stated that *fruits and flowers have varying colors because there are chlorophyll/chloroplasts in the cells making up these organs.*

Student responses indicate that critical thinking skills and critical analysis of students are not well developed. The overall response of students is more

likely to be doubtful and not comprehensive. Students fail to consider the possibility of color variants giving fruit and flowers such as chromoplast and leukoplas found in plastids. Cell organelles that have one of the functions as a place for storing color pigments a vacuoles also fail to be considered by students as a possible solution to the problem given.

Critical thinking skills and critical analysis of students as much as 18% are categorized as developing or developing well. Student responses indicate the construction of arguments supported by general concepts, although not yet detailed. Students must be able to make arguments based on the theory of problem solving (Vargas Alfonso, 2015). Self-regulation is important in this situation to manage thoughts, feelings, and actions based on plans (Zimmerman & Schunk, 2001) to regulate cognition strategies (Asy'ari & Ikhsan., 2019)so that students can analyze the problem critically and make conclusions sharply (Fahim & Eslamdoost, 2014).

On the other hand, QAH and TW student who have critical thinking skills and critical analysis that are beginning to develop gave an answer that had a similar concept but was not elaborated in detail i.e. *the color varies in flowers and fruit depending on the plastids found in the plant, because each plant has a different colour level with different levels of colour requirements. Plant cell organelles found in plastids such as chloroplast, leucoplast, and chromoplast, cause fruits and flowers to have different colours.*

Two examples o tudent responses indicate that some students begin to develop critical thinking skills and critical analysis. The response can be categorized as constructed based o concept that is relevant to the problem given. The development of critical thinking skills and critical analysis of students can be facilitated through the provision of routine problems, linking new knowledge (Thompson, 2011) so as to help students make decisions for what is done and trusted (Ennis, 1996).

High-level thinking skills including critical thinking and critical analysis are mental habits that require students to think about their thinking and around to improve the process, requiring students to use high-level thinking skills, not memorizing data or accepting what they read or being told without thinking about it so that thinking dispositions are important also to be explicitly taught in the learning process (E s, 1996; Facione, 2007). Furthermore, Alper (2010) stated that there is a significant difference between someone who has good critical thinking skills and someone who fails critical thinking related t hoosing, organizing, and using data. The teacher plays an important role in teaching critical thinking to students (Demirhan & Köklükaya, 2014).

Critical thinking skills and critical analysis of male and female students

Gender influences critical thinking skills (Fuad et 2017). Table 8, Table 9, and Table 10 show the critical thinking skills of different prospective students in the components of interpretation, explanation, and self-regulation, where female students are better at explanation and self-regulation components, while male stude are better at the interpretation component. These results are in line with the results of critical analysis, female students are better at the explanation component, while male students ar tter at the interpretation component. In general, female students have critical thinking skills better than male udents, while male students have critical analytical skills better than female. The results of this study are in line with the statements of Moafian & Ganizadeh 11); Mahanal (2012); and Mahanal et al (2017) that female's critical thinking skills are better than male. Female students are more precise, thorough, and logical in asking questions than male students Crawfo t al. (2005).

The results of the study show that critical thinking skills and critical analysis of male and women are not significantly different. These results are supported by the results of Yanice (2012) research; Kucuk & Uzun (2013); Tumkaya (2011); A r (2010);Salahshoor and Rafiee (2016) which states that there is no significant difference between critical thinking skills of male and women. Different resu were conveyed by Bezci & Sungur Vural (2013) that the learning outcomes of female students were better than male. This result might occur considering the results of the Yang (2016) study showed that female students were better at processing textual information. This phenomenon is influence y initial knowledge as a person's basic capital in critical thinking (Fuad et al, 2017).

The description the results indicates that it is important to teach critical thinking skills and critical analysis of prospec teachers given the many positive implications that can be attributed to critical thinking skills and critical analysis towards learning outcomes and the construction of independent thinking processes such as dem nds of 21st century. The opinion was supported by the results of the study that showed a positive correlation between critical thinking skills and critical analysis of prospective teachers. In line with the results of Alpe research (2010); Tumkaya (2011) research found a positive correlation between critical thinking skills and learning outcomes.

Improving critical thinking skills and critical analysis through innovative learning

When developing thinking dispositions, thinking skills, and critical analysi re the focus of the learning process, students must be given the freedom (and responsibility) to explore content, analyze resources, and apply information. Although some students may be naturally curious, training is need that is systematically analytical, fair and open. With these skills, students can become self-confident in their reasoning and apply critical thinking skills and their critical analysis to each area of content or discipline (Peter, 2012).

High-level thinking skills including critical thinking and critical analysis are often associated with scientific methods which are systematic and procedural approaches to thought processes (Scriven & Paul, 2007). Scientific methods or scientific skills are often termed science process skills that are believed to be the basis for gaining knowledge and developing life skills

including thinking skills (Nur, 2011) and critical analysis (Mishra & Kereluik, 2011; Muhali, 2018). In line with this opinion, Ibrahim et al (2010) stated that process skills can bridge a person to independent learning, self-development and lifelong learning.

The application of a systematic approach such process skills does not guarantee the achievement of the development of thinking dispositions, critical thinking skills, and good critical analysis for students. These results are also proven empirically from the results of study that show that critical thinking skills and critical analysis are generally categorized as not yet visible or still underdeveloped (score 1-2) so that teaching books as supporting learning need to be provided properly. Textbooks as a supporter of the effectiveness of learning support competency and effective communication in each model innovation and learning strategy.

Textbooks are compiled but not in accordance with the characteristics of teaching material and the learning model tends to have a impact on biased and undirected learning so that the general goal of education is to optimize the skills of learners (Dancy et al., 2016). Knowledge in textbooks has characteristics that can be justified, true, and can be trusted (Brookhart, 2010) is very relevant to be learned through process skills. The science process skills are believed to be the basis for gaining knowle e and developing life skills (Nur, 2011). One life skill that needs to be developed through the education process and becomes an important issue in 21st century research is thinking skills (Mishra & Kereluik, 2011) such as critical thinking, critical analysis, and thinking dispositions (Thomas, 2012; Zohar, 2012; Wasis, 2016).

In addition, the m terial contained in textbooks in fulfilling functions as a source of learning and improving the quality of learning must be supported by actions or activities carried out by students, because the presentation of knowledge is not enough, presentation of material must be combined with a process skills approach (Kurnia & Fathurrohman, 2014), as a basis for gaining knowledge and developing high-level thinking skills (Adise aja & Romlah, 2007; Asy'ari & Fitriani, 2017) so as to be able to learn independently, develop themselves and lifelong learning (Ibrahim et al., 2010).

Critical thinking and critical analysis are the domains of high-level thinking, where high-level thinking can and should be taught (Woolfolk, 2012) persistently and continuously and thoroughly (Fisher, 2011), and can be trained with simple learning patterns Eggen & Kauchak, 2012) and by choosing the right learning strategy. Critical thinking can be trained through inquiry activities (Arends & Castle 1991; Fuad al, 2017) by questioning what is seen and heard. Critical thinking requires students to actively and skillfully conceptualize, apply, analyze, synthesize, and or evaluate information collected or generated from observation, experience, reflection, communication reasoning, or as a guide to beliefs and actions (Mitrevski & Zajkov; 2011) not only absorb ideas from teachers (Lunenburg, 2011). The results of the Prayogi & Asy'ari (2013) study stated that those students' critical thinki skills can be improved through the application of problem-based learning models, because in learning students are required to solve the problems posed to activ practice their thinking skills. Fink (2003) showed that students learn more and maintain knowledge longer if they get it actively rather than passively.

Integration of science process skills in teaching materials can help students make simple observations/experiments, discoveries, problem analysis, problem solving, and communication of new knowledge so that abstract material can be understood concretely and comprehensively by students. This opinion is in line with the statement of Madsen et al. (2016) that textbooks contain the principles of experimentation, discovery, inquiry, and problem solving, including science process skills, in addition to being a learning resource it is also a student guide to linking procedural, factual, and conceptual and metacognition of student interests and talents.

CONCLUSION

This study h achieved its objectives. The study aims to explore prospecti teachers' critical thinking and critical analysis skills based on gender. The results of the study show that the prospective teachers' critical thinking and critical analysis skills differ in several components although overall there is no significant difference between male and female prospective teach rs' critical thinking and critical analysis skills. The results of the study also showed a positive correlation between critical thinking skills, and critical analysis of prospective teachers. e prospective teachers' critical thinking and critical analysis skills still need to be developed.

The need for specific supporting teaching materials as structured and detaile learning guidelines for furniture teaching critical thinking skills and critical analysis of students so that the goal of developing high-level thinking skills can be achieved. These findings contribute as lecturers' references in teaching critical thinking skills and critical analysis of prospective te chers in learning by paying attention to differences in skills based on prospective teachers' gender.

The results of this study are limited to the investigation of critical thinking skills and critical analysis of prospective biology teacher FPMIPA IKIP Mata n in the anatomy and development of plants. The results of this study can be used as a basis for ther discussion and research in the context of other high-level thinking skills such as creative thinking, problem solving, and metacognition.

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