EXPLORING THE PROSPECTIVE TEACHERS’ CRITICAL THINKING AND CRITICAL ANALYSIS SKILLS

H. Fitriani¹, M. Asy’ari*², S. Zubaidah¹, S. Mahanal¹

¹,²Institut Keguruan dan Ilmu Pendidikan (IKIP) Mataram, Indonesia
³,⁴Biology Department, Universitas Negeri Malang, Indonesia

DOI: 10.15294/jpii.v8i3.19434

Accepted: May 9th, 2019. Approved: September 28th, 2019. Published: September 30th, 2019

ABSTRACT

This study aimed 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.

© 2019 Science Education Study Program FMIPA UNNES Semarang

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 be-

come its tendency (Fisher, 2011). Critical think-
ing is a process according to Ennis (2011) that
is reflective and evaluative processes to deter-
mine 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, anal-
ysis, evaluation, inference, explanation and self-
regulation. On the other hand, Ennis (1996)
predicted that the definition as Hassard & Dias
(2013) about the concept of critical thinking in
which critical thinking as a reasonable and ref-
lective thought that focuses on deciding what to
believe or do.

Critical thinking is an intellectual process
that is actually and skillfully conceptualizing,
applying, analyzing, synthesizing, and or evalu-
ating information collected, or produced by
observing, reflecting, considering, or commu-
nicating, 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,
evolve, infer, explain and regulate themselves
(Facione, 2007).

If the deﬁnition is examined, critical think-
ing components consist of 2 (two) important
components that is critical thinking cognitive
skills and disposition. Critical thinking dispo-
sions, and critical thinking requires a logical, critical, and
creative thinking process; so that it is able to
produce something new or different from what
has already exists. Furthermore, Krathwohl
and 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 it is possible to make decisions correctly (evaluative).

Critical thinking analysis requires that the
student should have a role in analyzing fairness and solving problems faced. A good critical
thinker should not only have critical thinking cognitive skill, but also critical thinking dispositions so that the
critical thinking of a provider of fair analysis in solving problems can be ful-

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 responsibil-
ity 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 that
what to do or believe. On the other hand, Paul
& Elder (2019) explained the role of the
function of critical thinking skills into eight
important components 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, observa-
tion, experience or other sources that can help
someone or female can solve the problem at hand; (4) evaluation is in the form of thinking patterns that become
a frame of work in thinking and acting; (5) as-
sumptions 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 (in-
ferring or drawing conclusions) which is the
function to understand data and draw conclu-
sions; 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 orga-

nizing and connecting the parts in the infor-
mation so that more comprehensive meaning is
obtained based on the results of the analysis
student can be able to make decisions correctly
(Asy’ari & Fitriani, 2017). Appropriate deci-
sion making is a component of critical analysis
that is closely related to critical thinking (abi-
dity to evaluate) (Ennis, 2011). Through these
evaluating activities, students will be able to
find weaknesses and strengths so that they can
make something different from the right decision
(Rudinow & Barry,2007; Paul & Elder, 2019;
Fisher, 2011; Ennis, 1996), and analyzing in-
formation (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., 2014).

Gender is one of the factors that can in-
fluence one’s thinking skills (Aliakbari & Sa-
dehgahbigihi, 2011; Harish, 2013; Mahanal et
al., 2017). Gender is a general term that refers to male and female (Fin & Ishak, 2012; Maha-
hal et al., 2017) that shape psychology and one’s social role (Fuaa, et al., 2017) so that it
affects how individuals think, behave, and feel
a phenomenon within themselves (Santrock,
2011). The exploration of students’ critical thin-
kings based on gender were conducted by
Ruff (2005) who measured critical thinking skills and critical thinking disposition using the
CCSTST (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 gender were expected to be able
to have different thinking and disposition skills in which male tend to think more analytically and flexibly than female, while female are less capable of abstract and reflective thinking. On the other hand, male and female have no difference in understand-
ing concepts, but male are superior in prob-
lem solving than female (Gok, 2014). Teghva
et al. (2018) stated that the 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 think-
ing disposition is significantly different be-

There were no differences in the critical thinking correlation of the critical thinking component studied.

The research was important to conduct be-
cause 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 compo-
ments) and critical analysis. This study aims to
identify the critical thinking skills of prospective
students consisting of 6 (six) components that are:
(1) interpretation; (2) analysis; (3) inference; (4) evaluation; (5) explanation.; and (6) self-regulation; and critical analysis of prospective teachers consisting of 6 (six) components that are:
(1) organizing; (2) linking parts or variables in the information (as-
sociation); (3) interpretation of data; (4) evalu-
ation of information; (5) reflection process; and
(6) make decisions that are relevant to the con-
cepts and problem solving that are formulat-
ed (Facione, 1990).

The learning process in higher education which
is an educational process that some students can
become an important supporting factor for de-
volution dispositions, critical thinking skills, and critical analysis of students. Knowledge that
has characteristics and logical thinking that can
be trusted (Brookhart, 2010) is indeed rele-
vant to be taught through thinking skills inclu-
ding critical thinking and critical analysis. Cri-
tical thinking and critical analysis have become an important part of learning objectives that
must be achieved at the tertiary level in Indones-
ian, as stated in Permenkubd No. 73 of 2013
concerning the Indonesian National Qualifica-
tions 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 gui-
dance in choosing various alternative solutions.

The study of several theories shows that the as-
pects of competency must be achieved by students in the IQF are important aspects in cri-
tical thinking and critical analysis. The objec-
tive of critical analysis and critical thinking are formulated (Facione, 1990).

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 responsibil-
ity 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 that
what to do or believe. On the other hand, Paul
& Elder (2019) explained the role of the
function of critical thinking skills into eight
important components 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, observa-
tion, experience or other sources that can help
someone or female can solve the problem at hand; (4) evaluation is in the form of thinking patterns that become
a frame of work in thinking and acting; (5) as-
sumptions 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 (in-
ferring or drawing conclusions) which is the
function to understand data and draw conclu-
sions; and (8) implication and consequence in
the form of readiness to face the implications and consequences of thought processes carried
out.
METHODS
This is a descriptive quantitative study with survey methods to explore prospective teachers’ critical thinking and critical analysis skills of 100 biology prospective 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 on plant anatomy and development material were used to collect data on critical thinking skills and critical analysis of prospective teacher students. Descriptive tests 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; and (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 in accordance with the criteria categorized in Table 1.

Table 1. The Category of Instrument Validity Based on the Average Value of the Validator

| Score Interval | Category     | Percentage of Agreement |
|----------------|--------------|-------------------------|
| > 3.6          | Very Valid   | 100%                    |
| 2.8 – 3.6      | Valid        | 100%                    |
| 1.9 – 2.7      | Invalid      | 100%                    |
| 1.0 – 1.8      | Not Very Valid| 100%                    |

Adapted from Ratumanan and Laurens (2011).

Instrument reliability was analyzed using the following equation: Percentage of agreement = 100 × [(A + AB)] / (A + B), where A is the frequency of behavioral aspects observed by the observer giving a high frequency, and B is 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 vary in 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 the 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 |
|------------|-------|-------------|
| Analysis   | 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 |
| Interpretation | 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     | 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 presented. |
|            | 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. |
The critical thinking skills and critical analysis of prospective teacher, as a whole, need to be developed further. The results are presented in Table 7 below. The table shows that 81% of prospective biology teacher candidates 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 prospective biology teacher students are presented in Table 8 below.

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

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

Table 7 shows that 81% of prospective biology teacher candidates 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 prospective biology teacher students 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% |
| Start developing or developing well | 3-4 | Male | 50 | 22% | 19% |

### Critical Thinking Skill

Critical thinking skills of prospective teacher students are collected using 6 (six) item descriptors 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 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 8.

### 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 | 46.67 | 250 | 100 .319 |
| Thinking | Female | 50 | 48.17 | 250 | 100 .359 |
| Critical Male | 50 | 55.14 | 250 | 100 .319 |
| Analysis | Female | 50 | 53.58 | 250 | 100 .319 |

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: 55.1400) than female (mean: 53.5800), yet critical thinking skills (p: 0.359) and critical analysis (p: 0.19) 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 teacher candidates are collected using 6 (six) item descriptors with characteristics of interpretation, analysis, evaluation, inference, explanation, and regulation (Facione, 1990). The results of the respondent’s answers were then analyzed 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 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 7.

### Table 9. The Results of U-Test for Critical Thinking Skills of Prospective Teachers

| Component | Gender | N | Mean | p |
|-----------|--------|---|------|---|
| Interpretation | Male | 50 | 59.81 | 0.01 |
| Female | 50 | 41.19 | |
| Explanation | Male | 50 | 37.40 | 0.00 |
| Female | 50 | 63.60 | |
| Self-Regulation | Male | 50 | 41.09 | 0.00 |
| Female | 50 | 59.91 | |

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 in critical thinking indicators and other critical analyses. 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 stated that flowers and fruit organs have varying colors because the flowers 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 krooplast function when plants carried out photosynthesis, for example AI stated that plants have chloroplasts in which there are several types of color pigments such as chlorophyll, etc., these pigments cause various types of color 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 color because there are chlorophyll/chloro-plasts 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 chromatoplast and leukoplas found in plastids. Cell organelles that have one of the functions as storage place for color pigments are 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 delayed or weak. 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 problem-solving (Vargas Aftonso, 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 depend on the plant has a different colour level with different levels of requirement. Plant cell organelles found in plastids such as chloroplast, leucoplast, and chromoplast, cause fruits and flowers to have different colours.

Two examples of student responses indicate that some students begin to develop critical thinking skills and critical analysis. The responses can be categorized as constructed based on a concept that is relevant to the problem given. The development of critical thinking skills and critical analysis can be facilitated through the provision of routine problems, linking new knowledge (Thompson, 2011) so as to help students make connections for what is done and trusted (Ernis, 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 in the least to what they read or being told without thinking about it so that thinking dispositions are important also to be explicitly taught (Ernis, 1996; Facio, 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 to choosing, 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 al, 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 compared with male students, while male students 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 were better at the interpretation component. In general, female students have critical thinking skills better than male students, while male students have critical analytical skills better than female. The results of this study are in line with the statements of Bezci & Sungur Vural (2013); 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 Crawford et 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), Tumakva (2011); Alper (2010); Sultanab and Rafiee (2016) which states that there is no significant difference between critical thinking skills of male and women; different results were conveyed by Bezi & Sugur Vural (2013) that the learning outcomes of female students were better than male. This result might occur considering the result of the Prayogi & Asy’ari (2013) study stated that those students’ critical thinking skills can be improved through the application of problem-based learning models, because this learning model is required to solve the problems posed to actively 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, discovers, 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 has achieved its objectives. The study aims to explore prospective teachers’ critical thinking and critical analysis skills based on gender. The results of the study show that the prospective teachers’ critical thinking and cri-
critical analysis skills differ in several components although overall there is no significant difference between males and females for the prospective teachers' 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. The prospective teachers' critical thinking and critical analysis skills still need to be developed.

The need for specific supporting teaching materials and more detailed and precise guidelines for furniture teaching critical thinking skills and critical analysis of prospective teachers 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 PMIPA IKIP Mataram in the anatomy and development of plants. The results of this study can be used as a basis for further research and discussion in the context of other high-level thinking skills such as creative thinking, problem solving, and metacognitive

ACKNOWLEDGMENTS

We would like to thank to Ministry of Research, Technology and Higher Education of the Republic of Indonesia who has provided funding support in the completion of this study (Decree number: 3/E/KPT/2018).

REFERENCES

Adiendja, Y. H., & Romen, O. (2007). Analisis Buku Ajar Sains Badesakan Literasi Ilmiah Sebagai Dasar untuk Membuat Buku Ajar Sains (Biologi). In Disampaikan dalam Seminar Pen, didik dan Pendidikan, Vol. 8 (pp. 29-36). Pemuda Perguruan Pendidikan PMIPA (pp. 25-26).

Alper, A. (2010). Critical Thinking Disposition of Pre-Service Teachers. Eğitim ve Bilim, 31(188), 14.

Vargas Alfonso, D. (2015). Evidence of Critical Thinking in High School Humanities Classrooms. Glimpsing and Learning Research Journal, 11(6), 24-26.

Aliakbari, M., & Saghebdaghjii, A. (2011, August). Investigation of the relationship between gender, field of study, and critical thinking: The Case of Iranian Students. In The 16th Conference of the Polish Association of Applied Linguistics, The Chinese University of Hong Kong. Knuthwohl, D. R., & Anderson, L. W. (2009). A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives: Cognitive Domain. Longman.

Facione, P. A. (2007). Critical Thinking: What It Is and Why It Counts. Millstreet, CA: California Academic Press. Retrieved, #28, 2007.

Facione, P. (1990). Critical Thinking: A Statement of Expert Consensus for Purposes of Educational Administration and Instruction (The Delphi Report).

Facione, N. C., Facione, P. A., & Sanchez, C. A. (1999). How to Assess Higher-Order Thinking Skills. Journal of Nursing Education, 38(3), 134-143.

Bakir, S., & Öztekin, E. (2014). Creative Thinking Level of Preservice Science Teachers in Terms of Different Variables. Journal of Baltic Science Education, 13(2), 231-242.

Berci, F., & Sungur Vural, S. (2013). Academic Procrastination and Gender as Predictors of Science Achievement. Journal of Educational & Instructional Studies in the World, 2(2).

Borich, G. D. (1994). Observation Skills for Effective Teaching. New York: Longman.

Brookhart, S. M. (2010). How to Assess Higher-Order Thinking Skills in Your Classroom. ASCD.

Ceran, S. A., Güngören, S. Ç., & Boyacıoğlu, N. (2014). Determination of Scientific Creativity Levels of Middle School Students and Perceptions Through Their Teachers. European Journal of Education, 49(3), 283-293.

Crawford, A., Saul, W., & Mathews, S. R. (2005). Teaching and Learning Strategies for the Thinking Classroom. IDEA.

Cropley, D. H. (2015). Promoting Creativity and Innovation in Engineering Education. Psychology of Mathematics Education, Creativity in the Arts, 9(2), 161.

Dagun, S. M. (1992). Maskulin dan Feminin: Perbedaan Pria-Wanita dalam Fisikologi, Psikologi, Sekual, dan Peran dalam Masyarakat. Jakarta.

Dancy, M., Henderson, C., & Turpin, C. (2016). How Faculty Learn about and Implement Research-Based Implementations: The Case of Peer Instruction. Physical Review Physics Education Research, 12(1), 011010.

Demirhan, E., & Kolk blastay, A. N. (2014). The Critical Thinking Dispositions of Prospective Science Teachers. Procedia-Social and Behavioral Sciences, 116, 1551-1555.

Dewey, J. (1933). How We Think: A Restatement of the Relation of Reflective Thinking to the Educational Process. DC Heath.

Eggen, P., & Kauchak, D. (2012). Stratig for Model Pembelajaran. Jakarta: Indos.

Emira, R. H. (1996). Critical Thinking Dispositions: Their Nature and Assessability. Informal Logic, 18(2).

Emira, R. H. (2001). The Nature of Critical Thinking: An Outline of Critical Thinking Dispositions and Abilities. University of Illinois, 2,4.
Indonesia, 7(1), 54-65.
Nur, M. (2011). Modul Keterampilan-Keterampilan Proses Sains. Surabaya: Pusat Sains dan Matematika Sekolah Universitas Negeri Surabaya.

Paul, R., & Elder, L. (2019). The Miniature Guide To Critical Thinking Concepts & Tools. Rowman & Littlefield.

Peter, E. E. (2012). Critical Thinking: Essence for Teaching Mathematics and Mathematics Problem Solving Skills. African Journal of Mathematics and Computer Science Research, 3(3), 39-43.

Prayogi, S., & Asy’ari, M. (2013). Implementasi Model PBL (Problem Based Learning) untuk Meningkatkan Hasil Belajar dan Kemampuan Berpikir Kritis Siswa. Prisma Sains: Jurnal Pengkajian Ilmu dan Pembelajaran Matematika dan IPA IKIP Mataram, 1(1), 80-88.

Ratumanan & Lauren. (2011). Evaluasi Hasil Belajar pada Tingkat satuan Pendidikan Edisi 2.

Reid, J. C. (2006). Mengajari Anak Berpikir Kreatif, Mandiri, Mental, dan Analitis. Terjemahan oleh Ahada Eriawan.

Rudinow, J., & Barry, V. E. (2007). Invitation to Critical Thinking. Cengage Learning.

Ruff, L. G. (2005). The Development of Critical Thinking Skills and Dispositions in First-Year College Students: Infusing Critical Thinking Instruction into a First-Year Transitions Course (Doctoral dissertation).

Santrock, J. W. (2011). Life-Span Development 13th Edition. New York: Mcgraw-Hill. Schunk, D. (2005). Self-Regulated Learning: The educational legacy of Paul R. Pintrich. Educational Psychologist, 40(2), 85-94.

Scriven, M., & Paul, R. (2007). Defining Critical Thinking. The Critical Thinking Community: Foundation for Critical Thinking. Retrieved July 2, 2017.

Thomas, G. P. (2012). Metacognition in Science Education: Past, Present and Future Considerations. In Second International Handbook of Science Education (pp. 131-144). Springer, Dordrecht.

Thompson, C. (2011). Critical Thinking across the Curriculum: Process over Output. International Journal of Humanities and Social Science, 1(9), 1-7.

Tümkaya, S. (2011). Comparison of College Science Major Students’ Learning Styles and Critical Thinking Disposition. Ahi Evran University Journal of Faculty of Education, 12(3), 215-234.

Woolfolk Hoy, A. (2012). Academic Optimism and Teacher Education. The Teacher Educator, 47(2), 91-100.

Yang, S. H. (2016). Conceptualizing Effective Feedback Practice through an Online Community of Inquiry. Computers & Education, 94, 162-177.

Yenice, N. (2012, December). A Review on Learning Styles and Critically Thinking Disposition of Pre-Service Science Teachers in Terms of Miscellaneous Variables. In Asia-Pacific Forum on Science Learning and Teaching (Vol. 13, No. 2, pp. 1-31). The Education University of Hong Kong, Department of Science and Environmental Studies.

Zimmerman, B. J., & Schunk, D. H. (Eds.). (2001). Self-Regulated Learning and Academic Achievement: Theoretical Perspectives. Routledge.

Zohar, A. (2012). Explicit Teaching of Metastrategic Knowledge: Definitions, Students’ Learning, and Teachers’ Professional Development. In Metacognition In Science Education (pp. 197-223). Springer, Dordrecht.