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Thinking Skills: Students' Critical and Creative in Digital Electronics Subjects in Term of Gender Equality

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Abstract

Critical and imaginative thinking is essential for learning because it teaches students how to draw careful, exhaustive conclusions based on various points of view. Each subject, particularly the Digital Electronics course, should incorporate the development of critical and creative thinking skills. The purpose of this study is to investigate the role of gender in critical and creative thinking processes in the study of Digital Electronics.

The findings revealed that (1) male critical thinking capacity, with an average value of 82.82 and a practical value of 73.25, and a final score of 78.04. Female students have an assignment score of 84.5, a practical score of 80.41, and an average final score of 82.46 for critical thinking ability. (2) Men's average creative thinking ability is 71 percent, which is sufficient, while women's creative thinking capacity is 70 percent, which is also sufficient. The findings of this study reveal that male and female pupils have diverse thinking abilities, with some parts scoring better than others. A student-centered, problem-solving-focused learning strategy is required to promote critical thinking skills. More activities can be designed by lecturers. The implication of this research is that there has never been a research difference in critical and creative thinking skills between boy and girl students in Digital Electronic Learning. While male students' capacity for critical thought is higher than that of female students, the value of female students' creative thinking in the realm of elaboration is noticeably higher.

Keywords: Thinking Skills, Critical Thinking, Creative Thinking, Gender Equality

I. PRELIMINARY

The 21st century requires integrated abilities in reading, knowledge, skills, attitudes, and technological expertise. This is the goal of current education[1]. Critical thinking, creativity, collaboration, and communication skills are important because they can prepare students to make decisions from many points of view critically, intellectually, completely, and rationally during the learning process [2]. If the ability to think critically and creatively is instilled and developed in students, it will form human resources who are intelligent in thinking and critically in solving problems. The success of a student depends on skills in the 21st century, so students must play an active role to be able to master knowledge and skills through the learning process. Graduates from high school and colleges continue to lack proficiency in [3]: Critical thinking and problem-solving are listed first, followed by oral and written communication, work ethics and professionalism, participation in various groups, teamwork, collaboration, technology use, project management, and leadership. Critical thinking skills are important for students in any educational program. Critical thinking is not only owned by students, but teachers must be

able to apply critical learning in the classroom. Critical thinking means the importance or centrality of thinking that leads to a problem[4]. Thinking critically, someone will be able to analyze a problem, to find a solution or answer to the problem[5].

Creative thinking is a process that develops unusual ideas and produces new thoughts that have a broad scope[6]. Creative thinking, namely: Fluency, Flexibility, originality, elaboration, and problem sensitivity[7]. The five main characteristics of creative people, namely (1) *self-discipline in doing creative work*, (2) *openness to experiences*, (3) *risk-taking*, (4) *tolerance for ambiguity*, and (5) *group trust*. Creative thinking is the ability to develop unusual ideas, of high quality, and appropriate to the task[8]. This demonstrates how the ability to think creatively can lead to the development of broad-based insight. Students' critical and creative thinking abilities differ from one another. Likewise gender differences in critical and creative thinking[9].

People's perceptions of the differences between men and women based on primary (physical) biological characteristics have been entrenched, thus influencing people's perspectives. Equality[10] is seen in a person's ability to make decisions for himself without pressure and coercion and not sacrificing others. Gender equality[11] means that women want to have equal access and opportunities according to their competencies[12], including in education. Based on data from the National Socio-Economic Survey, the number of male and female university graduates is almost equal to 6.43 percent for men and 6.11 percent for women[13][14]. However, the percentage of women who do not have an education certificate is still higher, at 27.66 percent, while for men it is 22.38 percent. the percentage of women who work part-time is higher at 36%, compared to men who work part-time at 19.39%. These statistics show that the number of women who enter *full employment status is* still far below that of men. Physically, men are bigger than women, so men are better able to analyze problems better. Men, in this case, can solve problems and make decisions more than women. Men and women also have different structures, so they have different logical thinking patterns, perceptions, analyses, emotions, and senses of sound and space.

The influence of the Covid-19 pandemic has also accelerated variations to be able to accept digital technology for all aspects of life including education by utilizing the internet network for online learning[15]. However, the current learning process has not shown satisfactory results, it is difficult for students to be involved in solving problems through the scientific method. Many aspects affect the process and learning outcomes.

So far, there has never been a difference in critical and creative thinking skills between boy and girl students in Digital Electronic Learning. The critical thinking ability of female students is higher than that of male students, while in elaborative aspect of female creative thinking has a significantly higher value than male students.

In learning Digital Electronics, an appropriate learning strategy[16] is needed so that the cognitive, affective, and psychomotor domains can be developed in students. The problem in this study is stated as follows: (1) How are the critical thinking abilities of regular students and those taking the Digital Electronics course different? (2) How do the different levels of creativity among students and learners in the Digital Electronics course compare?

II. METHODOLOGY

This research is survey research, where the researcher wants to know the change in critical and creative thinking services between college students and university students. The subjects of this study were undergraduate students who programmed the Digital Electronics course at the Department of Electrical Engineering, Electrical Engineering Education Study Program, Universitas Negeri Surabaya with a total of 22 students.

Critical thinking ability [17] is measured through learning outcomes tests in the form of assignments or projects (three questions). The task is done by handwriting then scan the PDF

and make a simulation with the Proteus application. Learning outcomes tests were distributed to male and female students, to find out the differences in critical thinking skills between male and female students.

Table 1. *Critical Thinking Ability Grid[18]*

Category of Analytical Ability	Analysis Ability Indicator
Differentiating	Describe the function of components
	Distinguishing characteristics of digital components in a circuit
Organizing	Analyze the function between components in a digital circuit
	Describing the network view
Connecting (*attributing*)	Assembling a device or component

The creative thinking questionnaire consists of 20 statement items, which describe the description of each aspect, namely aspects of Fluency, flexibility, originality, elaboration, and evaluation are all types of thinking. The questionnaire was distributed to male and female students, to find out the differences in creative thinking abilities between male and female students[19].

Table 2. *Creative Thinking Grid*

Aspect	Number of Statement Items
Smooth Thinking	4
Think Flexible	4
Think Original	4
Thinking Elaboration	4
Evaluative Thinking	4

Data analysis technique

The critical thinking skill of male and female students is measured by a Digital Electronics learning outcome test[8] in the form of a task or project, which consists of three questions and has different weights. Question number 1 has a maximum score of 50, while numbers 2 and 3 have a maximum score of 25. In addition to the value of assignments or projects, there are practical values. Learning is done online, as well as during practice, each student presents the results of their work in a simulation using the Proteus software media.

Creative thinking ability in the Digital Electronics course, a creative thinking ability questionnaire is used[20]. The creative thinking questionnaire consists of: Fluency, flexibility, originality, elaboration, and evaluation are all types of thinking.. Respondents were asked to answer by choosing four tiered options, namely very suitable (SS), suitable (S), moderate (CS), not suitable (TS), and very inappropriate (STS). The scoring of the questions is carried out in accordance with the scoring guidelines for positive statements, the more appropriate, the greater the score. STS=1; TS=2; C=3; S=4; and SS=5. On the other hand, for negative statements, the more appropriate, the smaller the score.

Table 3. *Criteria for Assessment of Creative Thinking Ability Questionnaire[21]*

Percentage	Criteria
54%	Less once
55%-59%	Not enough
60%-75%	Enough
76%-85%	Well
86%-100%	Very good

Analysis of critical thinking skills is obtained from the value of the evaluation results (*post-test*) which aims to measure students' critical thinking skills. The value of students' critical thinking skills is obtained by the following calculations[10].

$$\text{Student value} = \frac{\text{all true answer}}{\text{Amount of score}} \text{ x } 100 \qquad (1)$$

III. RESEARCH RESULT

a. Critical Thinking Ability

Digital Electronics learning uses a project-based learning model. Students work in teams (both) to solve problems in the form of assignments or projects with the following steps: (1) group determination based on attendance serial number; (2) understand the problem or task of the lecturer; (3) solving problems with the group, (4) solving problems with simulation software to present the results to lecturers; (5) examine the work of student projects; and (6) make an assessment assignments and practices[6].

Table 4. *Value of Learning Outcomes*

Participant No	Assignment Value	Practice Value	Final score
1	80	75.08	77.54
2	86	80.08	83.04
3	83	87.08	85.04
4	86	37.8	61.9
5	86	87.08	86.54
6	86	80.08	83.04
7	86	85,08	85,54
8	86	80,08	83,04
9	83	75,08	79,04
10	86	80,08	83,04
11	86	80,08	83,04
12	86	80,08	83,04
13	80	75,08	77,54
14	86	80,08	83,04
15	86	80,08	83,04
16	83	80,08	81,54
17	86	80,08	83,04
18	75	50,44	62,72
19	86	85,08	85,54
20	75	61,6	68,3
21	80	77	78,5
22	75	50,44	62,72
23	83	80,08	81,54
Average	**83.26**	**75.12**	**79.26**

Final score is a combination of the value of the assignment and the value of practice then divided by two. The student's assignment score describes a good score with an average of 83.26 where the score is the student's skill to work on assignments in the way of reports and simulations with Proteus. The value of the assignment is obtained from the skill of students to answer issues in writing and orally to account for the results in the Digital Electronics course.

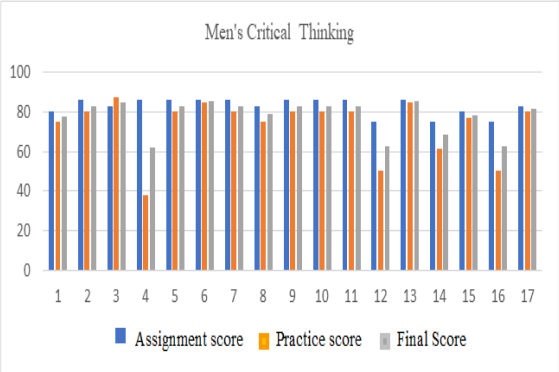

Figure 1. *Male Critical Thinking Ability*

Male critical thinking ability, the average value of the assignment was 82.82 higher than the practical value (73.25), while the final score was 78.04

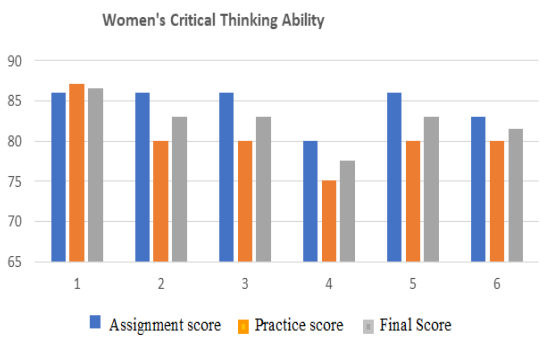

Figure 2. *Women's Critical Thinking Ability*

On the other hand, the critical thinking ability for female students has an assignment score (84.5) and a practical score of 80.41, and an average final score of 82.46.

b. Ability Creative Thinking

The following creative thinking questionnaire is a recap of all male and female students.

Table 5. *Value of creative thinking questionnaire*

Question Items	Amount	Average
1	69	6.0
2	82	7.13
3	75	6.52
4	76	6,61
5	81	7,01
6	82	7,01
7	84	7,3
8	83	7,22
9	77	6.7
10	80	6.96
11	66	5,74
12	71	6,17
13	84	7,3
14	85	7,39
15	72	6.26
16	83	7,22
17	70	6,09
18	82	7,13
19	71	6,17
20	88	7,65

Creative Thinking Ability for female students is described based on every aspect of creative thinking ability, namely Fluency, flexibility, originality, elaboration, and evaluation are all types of thinking, as follows.

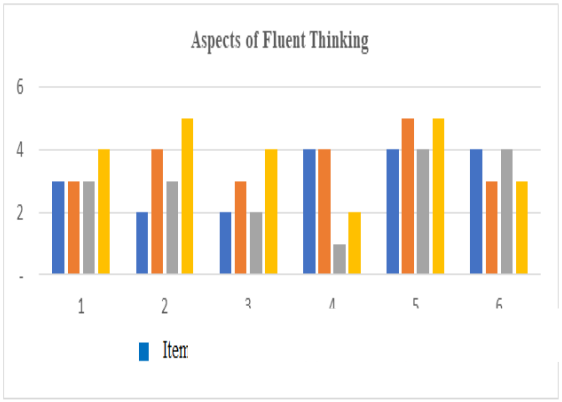

Figure 3. *Aspect of Fluent Thinking*

The number of female students is six (6) people, the picture above is an assessment score of female students for the aspect of fluent thinking ability. The average value obtained by female students is 68% or enough.

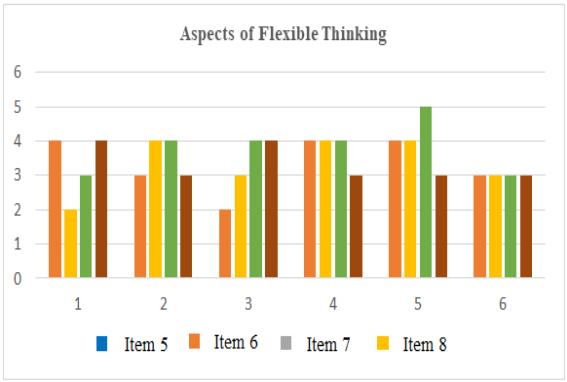

Figure 4a. *Aspect of Flexible Thinking*

The picture above illustrates the average value of female students for creative thinking skills in the flexible aspect of 69% or enough.

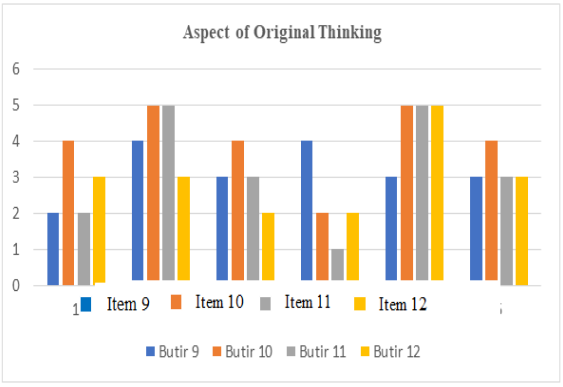

Figure 4b. *Aspects of Original Thinking*

The value of the creative thinking ability of female students for the original thinking aspect is an average of 67% in the Enough category

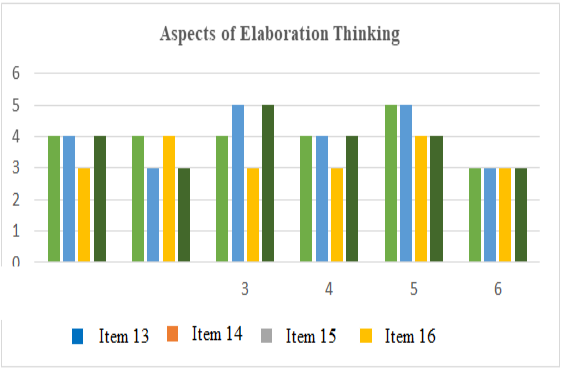

Figure 5. Aspects of Elaboration Thinking

Based on Figure 5, the average value of the Elaboration thinking ability of female students is 76% or Good

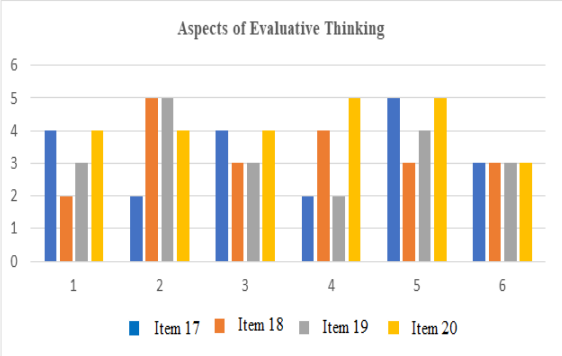

Figure 6. *Aspects of Evaluative Thinking*

Figure 6 illustrates the average score for the aspect of the Evaluative thinking ability of female students of 71% or enough.

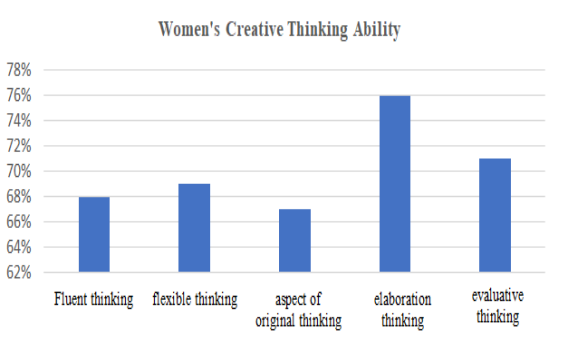

Figure 7. *Graph of Women's Creative Thinking Abilities in All Aspects*

The graph of Women's Creative Thinking Ability for all aspects, shows that the aspect of elaboration thinking is the highest compared to other aspects of creative thinking.

Men's Creative Thinking Ability can also be described based on every aspect of creative thinking ability, as follows.

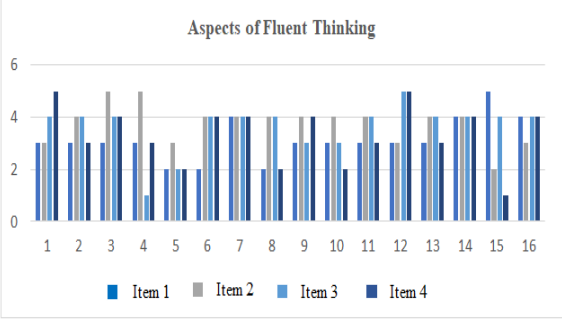

Figure 8. *Aspect of Fluent Thinking*

Figure 8 illustrates the average score for the aspect of the Evaluative thinking ability of male students of 69% or enough.

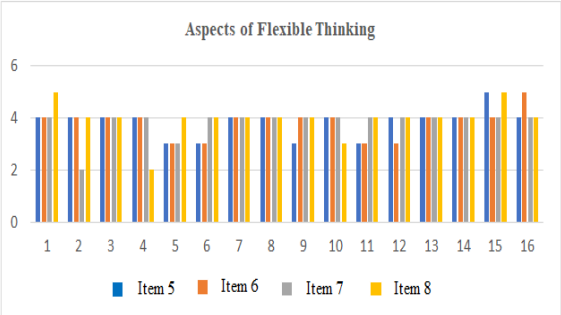

Figure 9. *Aspect of Flexible Thinking*

Figure 9 illustrates the average score for the aspect of Flexible thinking ability of male students of 77% or Good.

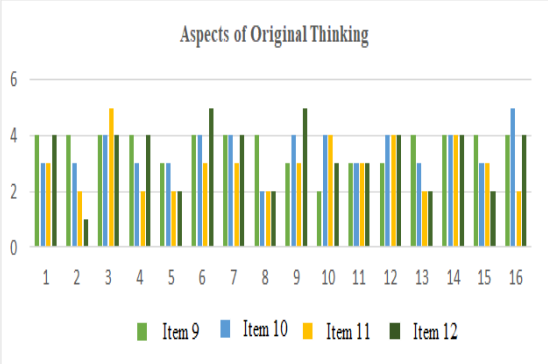

Figure 10. *Aspects of Original Thinking*

The average value for the aspect of original thinking ability of male students is 67% including the Enough classification.

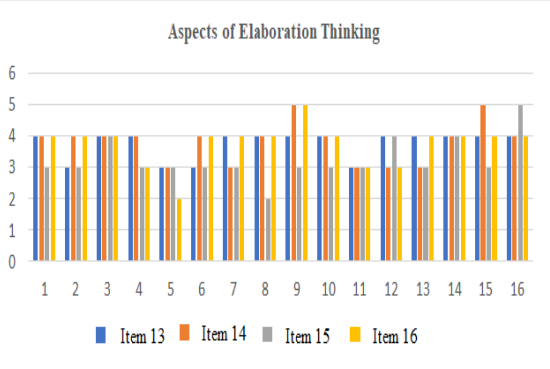

Figure 11. *Aspects of Elaboration Thinking*

Figure 11 illustrates the average score for the aspect of the Elaboration thinking ability of male students of 73% in the enough category

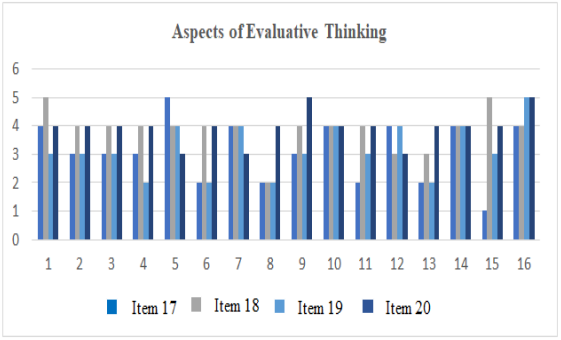

Figure 12. *Aspects of Evaluative Thinking*

Figure 12 illustrates the average score obtained by male students for the aspect of Evaluative thinking ability of 71%, so it is included in the Enough category.

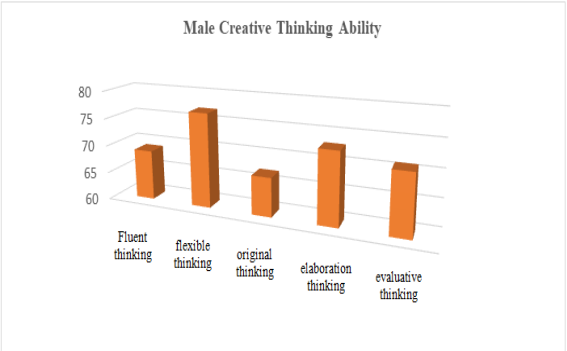

Figure 13. *Male Creative Thinking Ability in terms of all Aspects*

The creative thinking ability of male students in terms of all aspects shows that the flexible thinking aspect is the highest compared to other creative thinking aspects. Based on Figure 13, the aspect of flexible thinking ability of male students is the highest at 77% and is included in the good category.

IV. DISCUSSION

a. Critical thinking

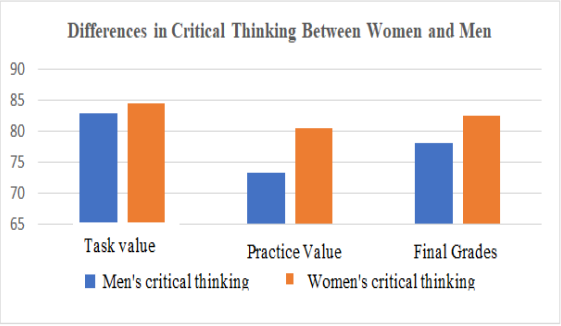

Figure 14. *Differences in Critical Thinking Ability of Women and Men*

The picture above shows that the critical thinking ability of female students is higher than the critical thinking ability of male students. The final score for men is 78.04 while the final score for women is 82.46. Critical thinking skills on the mastered Digital Electronics material are discussed in small groups with group members with the same ability and receive intensive guidance from the lecturer. Constructivist theory explains that knowledge will be meaningful if it is sought and found by oneself. Everyone is able to develop knowledge through existing schemas and these schemas are continuously updated and changed through the process of interpreting new experiences related to schemas and modifying schemas with new situations.

Digital Electronics Learning with project- based or task-based learning models individually or in small groups, is one of the recommended learning models as an innovative learning approach solution in the 21st century which aims to increase student activity and develop skills needed in 21st century learning, namely: (1) critical thinking; (2) creative thinking; (3) collaboration; and (4) communication. The *project-based learning* (P j BL) is a proven strategy to improve the competence of creative thinking skills, critical thinking, collaboration and communication[22].

b. Creative Thinking

When students are engaged in a learning process that requires them to solve problems in their context, as they are when studying digital electronics, learning that is oriented on student actions can help students become more creative thinkers. Additionally, students work in small groups to develop their fluent, adaptable, innovative, elaborative, and critical thinking abilities, which can improve their performance in Digital Electronics courses.

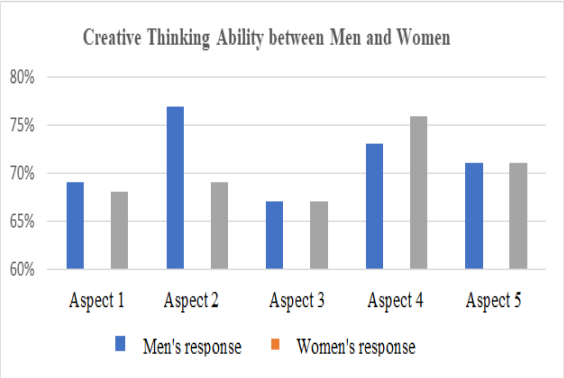

Figure 15. *Creative Thinking Ability between Men and Women*

The difference in the creative thinking ability of men is several aspects higher than the creative thinking ability of women in learning Digital Electronics with Logic Gate material. The ability to think creatively in the fluent thinking aspect (69%) and flexible thinking (77%) for male students is higher than the creative thinking ability in the fluent thinking aspect (68%) and flexible thinking (69%) for female students. On the other hand, the ability to think creatively in the elaborative aspect of female students is 76% higher than the elaborative aspect of male students by 73%. Climate Education now requires activities that involve students in problem solving, through meaningful communication, representing ideas that are original in their group, giving questions to those that relate to relevant theories. To improve students' elaboration skills, it can be trained continuously through a problem-based practicum, where students try to identify circuit images to solve problems, find references and analyze their outputs with various variations of inputs, and are able to express themselves clearly about how they work with the problems found in practice.

V. CONCLUSIONS AND RECOMMENDATIONS

Conclusion

1. Critical Thinking Ability

The male critical thinking ability, the average value of the assignment was 82.82 and the value of practice was (73.25), while the final score was 78.04. The critical thinking ability for female students has an assignment score (84.5) and a practical score of 80.41, and an average final score of 82.46. Based on these data, the critical thinking ability of female students is higher than the critical thinking ability of male students, both in terms of final grades, average assignment scores and practice scores.

2. Creative Thinking Ability

The results showed that the typical innovative thinking ability of men was 71% and was in the sufficient category, while the creative thinking ability of women was 70% in the sufficient category. Male and female students' levels of cognitive ability vary, with certain areas scoring better than others. The creative thinking ability of men for the aspect of fluent and flexible thinking is higher than the ability of women's creative thinking for the aspect of smooth and flexible thinking. On the other hand, the thinking ability of female students for elaborative creative thinking is higher than that of male students for elaborative creative thinking.

When compared to other creative thinking aspects, the creative thinking ability of male students for the flexible thinking aspect (77%) is the highest and is in the Good category, while the creative thinking ability of female students for the elaborative creative thinking aspect (76%) is also the highest and is in the Good category.

Recommendation

1. Critical thinking is a student's thinking skill as the embodiment of problem-solving-oriented learning behavior through activities to formulate problems, provide arguments, conduct analysis, evaluate and make decisions with various alternatives or solutions. To improve critical thinking skills, a student-centered, problem-solving oriented learning model is needed.
2. a teacher - centered learning model, but student-centered, and students are given more opportunities to build their knowledge and experience independently.

Thus, students are able to conceptualize an initial understanding of the knowledge being studied and together with the lecturers, students will gain a deeper understanding through practical activities, discussing and collaborating in groups. Lecturers can design more activities that make students more active, creative and think critically during learning , so that students can develop problem-solving skills into practical situations that will be faced in the future.

3. Research on gender differences can be done to find out more about the ability to think creatively and think critically in offline learning mode.

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