The analysis of output based learning implementation in improving students creative and innovative thinking skills in solving $H$-Irregularity

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Abstract. This research aims to find out the implementation of output-based learning (OBL) in increasing students’ creative and innovative thinking skills in solving $H$-irregularity. The research method used in this research is mixed methods. Mixed methods is a combination of qualitative and quantitative methods. Qualitative methods are used to obtain data related to the testing result on each indicator and the result of phase portrait while quantitative methods are used to analyze statistics using SPSS program. The research subject consists of two classes, which are 38 students of the control class and 40 students of the experimental class. Both classes are given different treatments. OBL methods are applied at the control and experimental classes, but only the experimental class that uses students' worksheets. The research result is that two homogeneous classes using the pretest result show the sig value 0.681 > 0.05 so that the average difference of both classes is not significant. The result of inferential statistics and independent sample t-test on the post-test result shows that the sig (2-tailed) value is 0.007 ($p \leq 0.05$) so that it is significant. The conclusion is that there is a significant effect from the implementation of OBL in increasing students’ creative and innovative thinking skills in solving the $H$-irregularity problem.

1. Introduction

Along with the rapid current development, the role of education becomes very important in preparing learners to have 21st century skills. One of the efforts to answer this challenge is by changing the teacher’s role that the first only has a role as the provider and information conveyor into the facilitator to share information and knowledge as well as to train problem-solving skills on the learner [1].

The development of science and technology in the 21st century requires several changes in the education world. One of them is skills dominated by technology focusing on higher-order thinking skills. According to P21 (Partnership for 21st century learning) the change in the education world has to be done continuously along with the rapid development of the world so that the whole learners get enough knowledge and skill in facing new challenges in the future. The skills needed in the 21st century are: (1) learning and innovation skills; (2) information, media, and technology skills; (3) life and career skills. Those three skills can be developed only if the educational environment provides a change of educational perspective and supporting facilities to train students to face the future in this 21st century. From the aspect of learning and innovation skills, there are several indicators expected to be in the 21st century among others: creativity and innovation, critical thinking and problem solving,
communication, collaboration. Therefore, creative and innovative thinking skills become one of the important things and need attention in the education world to head to the 21st century [1].

One of the ways to train and increase learners’ creative and innovative thinking skills is by giving the problem of total $H$-irregularity strength in this course that needs learning that has feedbacks between the educator and the learners. At the theory of $H$-irregularity strength, each student will have different ideas about the illustration of graph theory. Total $H$-irregularity strength problem can demand students to think creatively and innovatively to find some alternatives to problem solving in labeling vertices and edges on the graph, determining the weight of each subgraph that has to be different, and determining total $H$-irregularity strength ($tHs$) value from the graph. In the process of finding a solution for each problem, students need creative and innovative thinking skills especially covering creative thinking and applying different innovations from every student. From there, the student later can think creatively and innovatively in solving the total $H$-irregularity strength problem to be made a research in this research.

One of the learning models that can support and train students’ creative and innovative thinking skills is the learning model of OBL. This learning model allows learners to build research steps. OBL which is oriented towards meaning, students must focus only on meaningful activities where students pay attention to the meaning of stimuli and responses and are allowed to produce products which in this case are monographs [16]. One of the important functions of OBL is helping learners to realize the gap between linguistic knowledge and language systems. OBL has a characteristic form that is a presentation of all future forms with a paradigmatic way and the use of activities where learners have to train to produce the right future form [6].

In this research, there are three indicators to measure students’ creative and innovative thinking skills expressed anonymously [18] that are (1) thinking creatively based on certain criteria, a) skills to produce creative idea such as arguments, b) create a new thing, ordinary and extraordinary concepts, c) collaborate their ideas to increase creative results, (2) working creatively with other people on certain criteria, a) develop, implement, and communicate new ideas to other people, b) work intensively within groups and can give suggestions to the work, c) open and response a new and different thing, (3) carrying out an implementation and innovation on certain criteria, a) work in a creative idea to make something real and be useful becoming a study where innovation will happen, b) produce a new thing, c) able to work with own results. Scores can be measured with the level of creative and innovative thinking skills according to explained in the table below [17].

| Creative Thinking Skills Level | Score |
|-------------------------------|-------|
| Level 0 (Not Creative)        | 0-5   |
| Level 1 (Less Creative)       | 5-10  |
| Level 2 (Quite Creative)      | 10-15 |
| Level 3 (Creative)            | 15-20 |
| Level 4 (Very Creative)       | 20-25 |

This research aimed to analyze learning activities based on OBL to increase students’ creative and innovative thinking skills in solving total $H$-irregularity strength problems. Data were obtained from pretest, post test and interview. Student Worksheets (LKM) used was the LKM by using the indicator of creative and innovative thinking skills. The chart of OBL implementation steps according to attached in the table below [6]:

| No | Phase                                      |
|----|--------------------------------------------|
| 1. | *Explanation of rules in a paradigmatic way* |
| 2. | *Practice in output*                       |
| 3. | *Some focus on meaning through meaning-oriented output practice* |
The purpose of this study is to investigate the effectiveness of OBL in improving students' creative and innovative thinking skills in solving H-irregularity problems.

Total H-irregularity strength as a natural extension of the tes(G) and tvs(G) parameters. G is a graph that recognizes H-covering [3]. For subgraph $H \subseteq G$ under total $\alpha$-labeling $\varphi$ associated with H-weight is define as

$$\text{wt}_\varphi(H) = \sum_{v \in V(H)} \varphi(v) + \sum_{e \in E(H)} \varphi(e).$$

The total $\alpha$-labeling is called H-irregular total $\alpha$-labeling of the graph G if $\text{wt}_\varphi(H') \neq \text{wt}_\varphi(H'')$ for every two different subgraphs of $H'$ and $H''$ isomorphic to $H$. The smallest integer $\alpha$ for which an H-irregular total $\alpha$-labeling of exists is known as the total H-irregularity strength of G and denoted by $tHs(G,H)$.

**Teorema 1.** [4] Let G be a graph that recognizes H-covering provided by the $t$ isomorphic subgraph to H. Then

$$tHs(G,H) \geq \left[1 + \frac{t - 1}{|V(H)| + |E(H)|}\right].$$

In this research, students were asked to label vertices and edges on the graph, determine the weight of each subgraph that must be different, and determine total H-irregularity strength ($tHs$) value from the graph based on the definition of OBL steps.

### 2. Research Methods

This research used mixed methods research which is a research method combining qualitative and quantitative methods. Quantitative data was obtained from the test containing the indicator of creative and innovative thinking skills on the H-irregularity subject, while qualitative data was obtained from the interview to know the phase portrait of students’ thinking. The research used two classes consisting of 40 students as the experimental class and 38 students as the control class. The research steps are that both classes were given pre-test and post-test that gave the indicator of creative and innovative thinking in it. The research design on table 2 below explains that both classes were chosen randomly (R). Each of the experimental class and control class was given different treatments. At the experimental class and control class, the learning method based on OBL was implemented, but only the experimental class used Student Worksheets (LKM).

| Class          | Pre-Tes | Treatment     | Post-Tes |
|----------------|---------|---------------|----------|
| Experiment Class | R₁      | LKM and OBL   | R₂       |
| Control Class   | R₃      | OBL           | R₄       |

### 2.1 Population

Students of Mathematics Education at the University of Jember in the third semester who take combinatoric courses in class A and class B are the population in this study. Researchers took the sample of this study consisting of class A with a total of 40 students to serve as an experimental class, while class B with a total of 38 students to serve as a control class.

### 2.2 Instruments

In this study using instruments consisting of pretest, post test, and interview. Whereas, on the observation sheet the 0-4 rating scale is used, which is 4 for very creative and innovative, 3 for creative and innovative, 2 for quite creative and innovative, 1 for less creative and innovative, and 0 for non-creative and innovative. The observation and interview sheets have a scoring scale of 0-4 that has been validated by the experts.
2.3 Task
In this study, researchers gave assignments to students including pretest, post test, and student worksheets that were in accordance with indicators to measure students' creative and innovative thinking skills. Students who are in the control class and the experimental class are given pretest and post test but only students who are in the experimental class are given a student worksheet. Students are asked to label points and edges on the graph, determine the weight of each subgraph that must be different, and determine the total value of the \( H \)-irregularity strength \( (t HS) \) of the graph. The tasks given to the students are as follows:

\[
V = \{x_i, 1 \leq i \leq n\} \cup \{..., 1 \leq i \leq \cdots\}
\]
\[
E = \{x_i, x_{i+1}, 1 \leq i \leq n-1\} \cup \{..., 1 \leq i \leq \cdots\} \cup \{..., \}
\]
\[
|V| = \cdots
\]
\[
|E| = \cdots
\]
Data collection and data analysis

In this study, data analysis consisted of quantitative and qualitative data analysis. Researchers conducted qualitative data analysis using interviews, observation, and ordinal data, while for quantitative data analysis using t-test. Descriptive and inferential statistics are the analysis of qualitative and quantitative data used in this study. Statistical data were obtained from mean values, standard deviations, and frequencies, while the inferential data related to OBL used were normality tests, homogeneity tests, and independent tests between the control class and the experimental class. The purpose of the independent sample using is to compare the control class and experimental class with the difference of significance value at a level of 0.05.

Research Finding

The qualitative method which consists of validity and reliability tests on post-test questions that will be tested on students is the initial research conducted by the researcher. The purpose was to determine...
the accuracy level of measurement instruments in doing the measurement function. The following will be explained the result of validity and reliability tests conducted by the research subject. The sample used in the validity and reliability tests is 40 students.

Table 4. results of question validity

| PROBLEM_1 | PROBLEM_2 | PROBLEM_3 | PROBLEM_4 | TOTAL |
|-----------|-----------|-----------|-----------|-------|
| Pearson Correlation | 1.000 | 0.704** | 0.516** | 0.174 | 0.667** |
| Sig. (2-tailed) | .000 | .001 | .284 | .000 |
| N | 40 | 40 | 40 | 40 |

| PROBLEM_2 | Pearson Correlation | 0.704** | 1.000 | 0.802** | 0.492** | 0.907** |
| Sig. (2-tailed) | .000 | .000 | .001 | .000 |
| N | 40 | 40 | 40 | 40 |

| PROBLEM_3 | Pearson Correlation | 0.516** | 0.802** | 1.000 | 0.632** | 0.924** |
| Sig. (2-tailed) | .001 | .000 | .000 | .000 |
| N | 40 | 40 | 40 | 40 |

| PROBLEM_4 | Pearson Correlation | 0.174 | 0.492** | 0.632** | 1.000 | 0.750** |
| Sig. (2-tailed) | .284 | .001 | .000 | .000 |
| N | 40 | 40 | 40 | 40 |

| SCORE_ TOTAL | Pearson Correlation | 0.667** | 0.907** | 0.924** | 0.750** | 1.000 |
| Sig. (2-tailed) | .000 | .000 | .000 | .000 |
| N | 40 | 40 | 40 | 40 |

From the output on table 4, the value of the \( r_{count} \) on question 1 was 0.667; \( r_{count} \) on question 2 was 0.907; \( r_{count} \) on question 3 was 0.924; \( r_{count} \) on question 4 is 0.750 while \( r_{table} \) for n = 40 was 0.3044. So that it can be concluded that \( r_{count} \) on question 1-4 > \( r_{table} \) thus all question were valid.

Based on table 5, the reliability value was 0.819 and \( r_{table} \) from the significance level was 0.05 with \( dk = N - 2 = 38, r_{table} = 0.3120 \). Therefore \( r_{count} > r_{table} \) thus the instruments were reliable.

Table 5. test of the results of question reliability

| Cronbach’s Alpha | N of Items |
|------------------|------------|
| .819             | 5          |

The control class and the experimental class are used for taking pre-test and post-test scores. Quantitative data were obtained by t-test while qualitative data were obtained by interview, observation, and ordinal data analysis. Analysis of qualitative and quantitative data using descriptive and inferential data. Statistical data obtained from the average value, standard deviation, and frequency. Inferential data were obtained from normality tests, homogeneity tests, and independent tests conducted in the control class and the experimental class. The experimental class and the control class get different treatment; the experimental class uses OBL based on student worksheets then analyzed with regression tests while the control class uses OBL without student worksheets. Independent samples were used to compare the two classes with significant differences at the 0.05 level.

Pre-test and post-test in the control class and the experimental class were obtained from the number of the two classes of 78 students. Pre-tests are used to determine students’ initial and creative thinking skills in the problem of irregularities \( H \). The pretest questions consist of 3 indicators of creative and innovative thinking skills with \( H \)-irregular problems. While the post-test consists of questions to measure students’ creative and innovative thinking skills after learning by using student worksheets.
based on OBL methods. Based on the pre-test results, both classes, namely the experimental class and the control class have the same variant.

The percentage of pre-test result from 38 students in the control class on each indicator among others for the indicator of thinking creatively (level 1) is 65.79%, for the indicator of working creatively with others (level 2) is 57.89%, and for the indicator of implement innovation (level 3) is 42.11%. While the percentage of pre-test result from 40 students in the experimental class on each indicator among others or the indicator of thinking creatively (level 1) is 70.00%, for the indicator of working creatively with others (level 2) is 60.00%, and for the indicator of implement innovation (level 3) is 45.00%.

**Chart 1.** the chart pre-test result percentage of each OBL indicators

| Indicator                  | Control Class | Experiment Class |
|----------------------------|---------------|------------------|
| Thinking Creatively (Level 1) | 65.79%        | 70.00%           |
| Working Creatively with Others (Level 2) | 57.89%        | 60.00%           |
| Implement Innovation (Level 3) | 42.11%        | 45.00%           |

**Chart 2.** the chart of distribution student creative and innovative skill in control class

innovative thinking skills were categorized into five, which were not creative and innovative category, less creative and innovative category, quite creative and innovative category, creative and innovative category, very creative and innovative category. The results of the analysis of the percentage of control classes include: 0% in the not creative and innovative category, 25% in the less creative and innovative category, 32% in the quite creative and innovative category, 26% in the creative and innovative category, and 17% in the very creative and innovative category.

Based on chart 3 of the pre-test result at the experimental class, it was 0% in the not creative and innovative category, 24% in the less creative and innovative category, 34% in the quite creative and
innovative category, 25% in the creative and innovative category, and 17% in the very creative and innovative category. The next step the researcher conducted is data analysis with quantitative methods obtained from pre-test and post-test by using the SPSS application. Statistic test done at the control class and experimental class is the normality test, homogeneity test, and independent test. The first step in the analysis by using SPSS is the homogeneity test of both classes to find out whether the ability of both classes is the same or not.

Chart 3. the chart distribution of student creative and innovative skill in experimental class

Table 6. the results of normality test of pre-test in the experimental class and the control class

| GROUP         | Kolmogorov-Smirnova | Shapiro-Wilk |
|---------------|---------------------|--------------|
|               | Statistic          | df | Sig. | Statistic | df | Sig. |
| PRE-TEST      | CONTROL CLASS      | .117 | 38  | .200      | 38  | .174 |
| EXPERIMENT CLASS | .116             | 40  | .194 | .973      | 40  | .459 |

The second step taken by researchers is the normality test. The average in the control class is 64.55 while in the experimental class is 65.82. In the control class it produces a standard deviation of 8.20250 while in the experimental class it produces a standard deviation of 7.3271. Based on the results of the pre-test data normality test, table 6 kolmogorov-smirnov shows a significant value of the control class 0.174 and the experimental class 0.459. The significance of both data is higher than 0.05, so we can conclude that the two classes are normally distributed.

Table 7. the results of mean pre-test tests in the control class and experiment class

| GROUP         | N    | Mean   | Std. Deviation | Std. Error Mean |
|---------------|------|--------|----------------|-----------------|
| PRE-TEST      | CONTROL CLASS | 38   | 64.5526 | 8.20250 | 1.33062 |
| EXPERIMENT CLASS | 40   | 65.8250 | 7.32711 | 1.15852 |

In Table 7 we can see the results of statistical tests that show the average of each control class is 64.55 and the experimental class is 65.82. This concludes that the average control class is lower than the experimental class.
Based on the independent test result in table 8, we obtain the significance value of 0.311. Because the significance is higher than 0.05, it can be concluded that the pre-test from the control class and experimental class has an equal variance. The sig (2-tailed) value from equal variances assumed is 0.372, while from equal variances assumed is 0.473. The t value > t table and the p-value is higher than 0.05, meaning that there is no difference between the control class and experimental class.

**Chart 4.** the chart of post-test result percentage of each OBL indicators

| OBL Indicator | Level 1 | Level 2 | Level 3 |
|---------------|--------|--------|--------|
| Control Class | 85.00% | 75.00% | 55.00% |
| Experiment Class | 73.68% | 65.79% | 47.37% |

After conducting a pre-test on the experimental class and the control class but only the experimental class gets the student worksheets, then a post-test is conducted which aims to find out the student learning outcomes after the learning process. The post-test consisted of 4 H irregular questions that were attached with 3 indicators of creative and innovative thinking skills. From 38 students taking the post-test in the control class, the percentage of each indicator respectively is 73.68% for the indicator of thinking creatively (level 1), 65.79% for the indicator of working creatively with others (level 2), 47.37% for the indicator of implement innovation (level 3). While from 40 students taking the post-test in the experimental class, the percentage of each indicator respectively is 85.00% for the indicator of thinking creatively (level 1), 75.00% for the indicator of working creatively with others (level 2), 55.00% for the indicator of implement innovation (level 3).

In chart 5 we can see the results of the post-test analysis of students, the percentage of the control class, it was 0% in the not creative and innovative category, 22% in the less creative and innovative
category, 23% in the quite creative and innovative category, 27% in the creative and innovative category, and 28% in the very creative and innovative category.

**Chart 5.** The chart of distribution student creative and innovative skill in control class

![Chart 5](image)

Based on chart 6, in the experimental class, it was 0% in the not creative and innovative category, 13% in the less creative and innovative category, 24% in the quite creative and innovative category, 34% in the creative and innovative category, and 29% in the very creative and innovative category.

**Chart 6.** The chart of distribution student creative and innovative skill in experiment class

![Chart 6](image)

The average value of the control class was 71.44, while the average value of the experimental class was 84.47. The normality test results of the experimental class and the control class in table 9 obtained the results that are normally distributed. This is because the significance value of the experimental class and the control class is 0.200> 0.05, so it can be concluded that both data have a normal distribution.

**Table 9.** The result of normality test of post-test in the control and experimental classes

| GROUP               | Kolmogorov-Smirnov<sup>a</sup> | Shapiro-Wilk |
|---------------------|-------------------------------|--------------|
| POST-TEST CONTROL CLASS | Statistic | df | Sig. | Statistic | df | Sig. |
|                     | .098 | 38 | .200<sup>*</sup> | .975 | 38 | .557 |
| EXPERIMENT CLASS    | .118 | 40 | .173 | .945 | 40 | .051 |

<sup>a</sup> Statistic

<sup>*</sup> Significant at the 0.05 level.
Statistical test results in table 10 show that the average control class is 71.44 while the average experimental class is 84.47. So it can be concluded that the experimental class has an average higher than the average of the control class.

**Table 10.** The result of mean of post-test in the control and experimental classes

| GROUP             | N   | Mean  | Std. Deviation | Std. Error Mean |
|-------------------|-----|-------|----------------|-----------------|
| POST-TEST CONTROL CLASS | 38  | 71.4474 | 7.49305       | 1.21553         |
| EXPERIMENT CLASS  | 40  | 84.4750 | 6.11844       | .96741          |

Post-test data analysis through homogeneity tests in the experimental class and control class in table 11 has a homogeneous distribution with sig values 0.503 > 0.05. Significance value is higher than 0.05 so it can be concluded that the experimental class and the control class post-test have the same variant.

**Table 11.** The result of independent test of post-test in the control and experimental classes

| Levene's Test for Equality of Variances | t-test for Equality of Means | 95% Confidence Interval of the Difference |
|----------------------------------------|-----------------------------|------------------------------------------|
| F           | Sig. | t     | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | Lower | Upper |
| POST-TEST  | Equal variances assumed    | .453 | .503 | -8.430 | .000 | -13.02763 | 1.54546 | -16.10569 | -9.94957 |
| Equal variances not assumed            | -8.386 | 71.501 | .000 | -13.02763 | 1.55351 | -16.12487 | -9.93039 |

Independent test results obtained by variance with sig. (2-tailed) 0.000 < 0.05. So it can be concluded that after the implementation of learning is based on OBL, between the experimental class and the control class have significantly different post-test results.

After we see the results of normality, homogeneity, and independent t-test using SPSS, this explains that there is no significant difference between the control class and the experimental class which means H1 is accepted. Therefore, it can be concluded that the post-test results between the control class and the experimental class have significant differences after the application of learning based on OBL in the form of student worksheets.

The following is the result analysis of $H$-irregularity problem-solving by students in labeling vertices and edges on the graph, determining the weight of each subgraph that must be different, and determining the total $H$-irregularity strength ($tHs$) value from the graph. The result analysis of student works aimed to get information in the interview that within the students’ interview answer is suitable for their work.

The work presented in Figure 9 is the work of student 1 in the category of students with highly creative and innovative thinking skills. Student 1 can solve all $H$-irregularity problems consisting of determining the graph and its cardinality, labeling points and sides of the graph that must be in accordance with the rules of the $H$-irregularity concept, determining the total weight value of each subgraph and determining the total value of $H$-irregularity strength of the graph.
After students solved the problem related to $H$-irregularity, the researcher interviewed mind mapping in solving the problem of $H$-irregularity. This interview aimed to find out the students’ mindset when solving $H$-irregularity problems.

Interview excerpts are explained as follows:

Researcher : Can you solve this problem?
Student 1 : Alhamdulillah, Yes I can, Miss.
Researcher : Did you understand this material?
Student 1 : Yes I did understand Miss. Oh yes Miss Diana, I asked to be sure, if my graph like this is allowed?
Researcher : Yes, what is the name of the graph that you found?
Student 1 : In my opinion, this graph is a wheel graph.
Researcher : Okey good.
Student 1 : The notation for one point inside means I notated a while the edge I gave notation x1, x2, ..., etc.
Researcher : For the next step, what do you do after you find the cardinality?
Student 1 : I set the placement of the labeling of points and sides to achieve a minimum label and a different weight for each subgraph. After that, I searched and checked again by means of my graph expand again mom. Actually I made a number of possibilities for labeling ma’am so that if the pattern was expanded the same. Alhamdulillah we finally met, then I calculated the total value of $H$-irregularity strength ($tHs$) using the formula in theorem 1.

Researcher : Are you having trouble solving this problem?
Student 1 : Yes a little but not too difficult, Miss.
Researcher : What difficulties are you experiencing?
Student 1 : Finding the pattern must be careful and patient in my opinion.

Figure 10. the result of student 1 (very creative and innovative category)

Figure 11. the phase portrait of student 1
Figure 10 shows that the portrait of student 1’s thinking flow phase in solving the $H$-irregularity problem starts with thinking straight (forward) from stage 1A to stage 3C. But at stage 1C, student 1 returns to 1B, likewise at stage 2C student 1 returns to 2B, so student 1 can be said to do backward. Sometimes student 1 also jumps from stage 1C to stage 2C. Based on the characteristics of the phase portrait that shows the indicators and sub-indicators that have been mastered, student 1 is in the category very creative and innovative thinking skills.

The work presented in Figure 11 is the work of student 2 in the category of students with creative and innovative thinking skills. Student 1 can solve all $H$-irregularity problems consisting of determining the graph and its cardinality, labeling points and sides of the graph that must be in accordance with the rules of the $H$-irregularity concept, determining the total weight value of each subgraph and determining the total value of $H$-irregularity strength of the graph.

![Diagram](image)

**Figure 12.** the result of student 2 (creative and innovative category)

After students solved the problem related to $H$-irregularity, the researcher interviewed mind mapping in solving the problem of $H$-irregularity. This interview aimed to find out the students’ mindset when solving $H$-irregularity problems.

The following is the interview result with student 2:

**Researcher:** Can you solve this problem?

**Student 2:** Alhamdulillah, Yes I can, Miss.

**Researcher:** Did you understand this material?

**Student 2:** I did understand Miss, but I'm a little confused.

**Researcher:** Okay. What do you think the name of the graph you found?

**Student 2:** In my opinion, this graph is a ladder graph but there is a center line, Miss.

**Researcher:** Okay. How about the cardinality?

**Student 2:** In my opinion, this graph is a ladder graph but there is a center line, Miss.

**Researcher:** Okay. How about the cardinality?

**Student 2:** Cardinality not yet ma'am. I focus on looking for subgraphs and labeling patterns and the time is up yesterday.

**Researcher:** Can you find it?

**Student 2:** I can find Miss. For $H$-irregularity labeling, but I doubt that I have the same subgraph in the graph but I don't see the point, side, and weight of the subgraph.

**Researcher:** What was the first step you took to resolve this problem?

**Student 2:** Yes, I determined the subgraph of the graph. I continued to label the points and sides until we found the weights of each different subgraph. I also found the $H$-irregularity label when extended a long time ago, but yes, it's doubt that I have the same subgraph triangle shape. What is my wrong graph or how ma'am I do not know.

After I finished working, I thought there was another subgraph I could look for using the concept of $H$-irregularity in this graph, Miss.

**Researcher:** Broadly speaking difficult or not?

**Student 2:** No Miss. Only I was not careful enough to take the subgraph.
Figure 12 shows that the portrait of student 2’s thinking flow in solving the H-irregularity problem starts with thinking straight (forward) from stage 1A to stage 3C. But in stage 2B, student 2 does not pass stage 2C so student 2 goes directly to stage 3A. Student 2 made a jump from stage 1C to stage 3B. Based on the characteristics of the phase portrait that shows the indicators and sub-indicators that have been mastered, student 2 is in the category creative and innovative thinking skills.

The work presented in Figure 13 is the work of student 3 in the category of students with quite creative and innovative thinking skills. Student 3 completes the H-irregularity challenge consisting of the decision of the graph and its cardinality, labeling the points and sides of the graph that is not in accordance with the rules of the H-irregularity concept, determining the total weight value of each subgraph and also the total H-strength irregularity of the graph.

After students solved the problem related to H-irregularity, the researcher interviewed mind mapping in solving the problem of H-irregularity. This interview aimed to find out the students’ mindset when solving H-irregularity problems.

The following is the interview result with student 3:

**Researcher**: How can you solve this problem?
**Student 3**: Alhamdulillah, Yes I can, Miss.

**Researcher**: Did you understand this material?
**Student 3**: I did understand Miss, but I’m a little confused.

**Researcher**: What is the name of the graph that you found?
**Student 3**: I think this graph is a wheel graph. That circle is like that ma’am. But this is only an outline of my subgraph, so the picture is just like this.

**Researcher**: Okay. What about the cardinality?
**Student 3**: Cardinality already, Miss.
Researcher : Did you find the labeling pattern?
Student 3 : I found with the small subgraph image, Miss. But I am not sure if the subgraph image is continued until the wheel graph is a circle.

Researcher : Try to explain your first step in solving this H-irregularity problem!
Student 3 : Graphic drawings, label points, edges, and weights, name the chart and find cardinality but only slightly. I gave the label but only the shape is small.

Researcher : How do you do next?
Student 3 : I determined cardinality to continue to label the H-irregularity to the minimum node weight. So that I can expand the graph and find the minimum label, I will repeatedly draw the graph. I also found the H-irregularity label when extended long ago, but yes, it's doubt that I have the same subgraphic form. What is my wrong graph or how ma'am I do not know.

Researcher : What difficulties are you experiencing?
Student 3 : Actually I felt confused in completing it so that I ran out of time and my work was not finished yet, so the graph I used was small.

Researcher : Okey, Thank you
Student 3 : Okey Miss.

Figure 15 shows that the portrait of student 3's thinking flow in solving the H-irregularity problem starts with thinking straight (forward) from stage 1A to stage 3C. But in stage 2B, student 3 does not pass stage 2C so student 2 goes directly to stage 3A. Student 2 made a jump from stage 1A to stage 2B, as well as doing backward from stage 1B to stage 2B. Based on the characteristics of the phase portrait that shows the indicators and sub-indicators that have been mastered, students 3 are in the category quite creative and innovative thinking skills.

Based on the results of interviews with the first student to the third student, a combination of the global creative skills and innovative portrait phases is obtained from each student. Figure 15 is a combination of phase portraits of students 1, 2, and 3. The combination of phase portraits on speculating skills is how students think globally, they have their own way of solving a problem.
The activity of OBL and the indicator of creative and innovative thinking skills shown on student worksheets aimed to train students’ creative and innovative thinking skills and at the same time became the research steps in the study of $H$-irregularity labeling. While the final task given in student worksheets aimed to discover a new finding in the study of $H$-irregularity. All student findings would be summarized in a monograph.

Based on the observation on the students’ activity in solving $H$-irregularity though learning implementation based on OBL that there is a significant effect on learning implementation based on OBL in improving students’ creative and innovative thinking in solving $H$-irregularity problems. This is in line with the research that there is a significant effect on learning implementation based on $H$-irregularity on students’ learning achievements.

**Chart 7.** the chart of distribution student activities during OBL implementation

| Student Activities | Very Inactive | Inactive | Distratate | Active | Very Active |
|-------------------|---------------|----------|------------|--------|-------------|
| explained rules   | 2             | 4        | 8          | 14     | 12          |
| Practice in output| 4             | 4        | 8          | 14     | 10          |
| Some focus on meaning-oriented output practice | 2 | 2 | 6 | 16 | 14 |

Student activities show positive results. The distribution of student activities during the implementation of learning based on research in the experimental class showed that students were very inactive by 7%, students were inactive by 8%, students doubted by 18%, students were active by 37%, students were very actively active by 30%.
4. Discussion
The researcher/lecturer can implement this research into the learning through OBL methods so that students want to know the advance of the latest research, and students get experiences in conducting the research. Students will be directed to higher-order thinking from creative and innovative thinking. Being creative in this research relates to how students can find unexplored new graphs previously and this students’ findings are analyzed to determine students’ creative and innovative thinking levels. The result of this research shows that the research conducted has significant value on students’ creative and innovative thinking skills in the experimental class.

The research result shows that the improvement in learning results and students’ thinking skills are seen from the post-test. The experimental class value is significantly better because supported by student worksheets based on OBL to increase students’ creative and innovative thinking skills. The research result obtained from the control class is 73.68% for the indicator of thinking creatively (level 1), 65.79% for the indicator of working creatively with others (level 2), 47.37% for the indicator of implement innovation (level 3). While the experimental class is 85.00% for the indicator of thinking creatively (level 1), 75.00% for the indicator of working creatively with others (level 2), 55.00% for the indicator of implement innovation (level 3).

The result of the independent test obtains the value of sig. (2-tailed) 0.000<0.05. It can be concluded that the post-test result between the control class and experimental class has a significant difference after implementing OBL.

5. Conclusion
Based on the research that was done, the application of OBL has a significant effect on students’ creative and thinking skills in the experimental class. The research results show the improvement in students’ learning results and thinking skills seen from the post-test they have done. The experimental class produces a better value because it has implemented the learning based on OBL in increasing students’ creative and innovative thinking skills. Therefore, OBL learning is very good to improve students’ creative and innovative thinking skills.

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