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by Endang Susantini

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Effectiveness of genetics student worksheet to improve creative thinking skills of teacher candidate students

Eficacia de la hoja de trabajo para mejorar las habilidades de pensamiento creativo de los estudiantes de genética

ENDANG SUSANTINI, ISNAWATI, LISA LISDIANA

Department of Biology, The State University of Surabaya, Indonesia
endangsusantini@unesa.ac.id

Abstract

This research aimed to describe the effectiveness of a genetics student worksheet to train the creative thinking skills of teacher candidate students. The effectiveness of the worksheet was evaluated using the indicators achievement, self-assessment, and student responses. The worksheet was planned to give opportunity to develop creative thinking skills. Achievement indicators consisted of: presenting many ideas to solve the problem (fluency), formulating original idea (originality), modifying laboratory instruments, materials and experimental procedures (flexibility) and relating experiment result with theory (elaboration). Students worksheet was implemented with 15 students on the biology education program at the State University of Surabaya, Indonesia. This research was conducted using one group pre and post test. The result showed that there was creative thinking skills improvement (g score = 0.61). 93.3% of students assessed themselves as being able to practice creative thinking skills by using genetics student worksheet and 98.5% of students gave responses that the student worksheet enabled them to practice creative thinking skills. The research showed that the genetics student worksheet was effective in improving creative thinking skills.

Key words: *worksheet, genetics, creative thinking*

Resumen

Esta investigación tuvo como objetivo describir la efectividad de una hoja de cálculo para entrenar las habilidades de pensamiento creativo de los estudiantes candidatos a maestro. La eficacia de la hoja de trabajo se evaluó utilizando las respuestas de autoevaluación de estudiantes. La hoja de trabajo se planeó para desarrollar habilidades de pensamiento creativo. Los indicadores de logros consistieron en la presentacion de ideas para resolver el problema (fluidez), la formulación de la idea original (originalidad), la modificación de los instrumentos de laboratorio, materiales y procedimientos experimentales (flexibilidad), y en relación de los resultados experimentales con la teoria. Quince estudiantes elaboraron las hojas de trabajo en el programa de educación de biologia. Esto se llevó a cabo mediante el uso de diseño de la investigación de prueba pre-post. El resultado mostró que hubo una mejora en habilidades de pensamiento creativo (g = 0,61). La investigación demostró que la hoja de trabajo fue eficaz para mejorar las habilidades de pensamiento creativo de los estudiantes.

Palabras clave: *hoja de cálculo, genética, pensamiento creativo*

INTRODUCTION

Curriculum that is implemented in Indonesia is curriculum of 2013. The objective of the curriculum of 2013 stated in the Policies of the Ministry of Education and Culture No. 69 is to prepare Indonesians to have life skills as individual and citizen who is religious, productive, creative, innovative, effective, and contributive to the nation (Ministry of Education and Culture, 2013). One of the essential abilities written in the Government Regulation and this seems that the challenge for the 21st century is creative thinking. Creativity is one of the main issues in all education and scientific organization that is continuously emphasized (Gholamian, 2013).

Creativity and innovation are the keys to success. Creativity is an important capacity for students to possess in order to face this fast-changing world. All individuals retain the ability to be creative (Raven, 2002). However, traditional sub-parcelling of the creativity has identified the person, the process, the products, and the environment as distinct elements that contribute to what is commonly called "creativity" (Rhodes, 1987). Several

strategies can be implemented to develop creativity. Tsai (2012) illustrated four stages of the creative process: preparation, incubation, illumination, and verification. Developing personal creativity involves the following four elements: understanding the process of creative thinking, identifying barriers to creative thinking and the skills individuals can use to increase creative response, using methods to get fresh ideas and solutions more often, and identifying a personal creative drive and life-long creative vision that will help individuals achieve their personal and professional goals (Mauzy, 2015). Each step in the process of developing personal creativity can be focused independently; and every exercise has been found to have some positive effect on a person's level of creative response. Furthermore, several researchers in the social sciences have identified contextual characteristics that improve the likelihood of being creative or arriving at a creative result (Amabile, 1983; Berry, 1999; Csikszentmihalyi, 1988; Niu & Sternberg, 2001; Raven, 2002; Rhodes, 1987).

There are many commercial products and planned programmes that improve creativity, such as books, kits, and software. Some are single activity, worksheet, or book focusing on a targeted idea or skills. It has been shown that worksheets can be planned to encourage divergent creative thinking and help record and organize ideas (Crammond et al., 1990). Therefore, it is possible to say that worksheet can be used as a strategy to encourage creativity in scientific discoveries and contribute to a country's development. It is known that those who can think creatively and critically are an important factor in the development of a country (Karsli & Sahin, 2009).

Creative thinking is a process allows/encourages gaps or disturbances to appear in conventional knowledge or ways of doing things which enable modification and reevaluation of hypotheses which have been made (Torrance, 2013). Similar to that statement, Anwar et al., (2012) explained that creative thinking is a way to raise ideas that can be applied to the world in a various new ways. Creative thinking is inseparable sense of dialogues concerning research questions and new ideas (Byron, 2012). According to Angawi (2014), creative thinking explains concepts, interprets existing data, and eventually, evaluates and criticizes various solutions. In addition, creative thinking ability is required to solve problems in everyday life (Maharani et al., 2015). Creative thinking is a multicomponent process which is mediated through social interactions that is explained by references to increasingly well-understood mental abilities such as cognitive flexibility and cognitive control that are widely distributed in the population (Dehaan, 2009).

Teachers should be attentive and creative in implementing appropriate learning process that can improve creative thinking ability. Teaching creative thinking supports the scholars by emphasising the links between environmental education and broader theoretical approaches that currently dominate research on creativity. Research in creative thinking is an actively growing field of study with a wide array of theories and perspectives. Creative thinking means posing a problem and trying to find a solution to it. Creative thinking helps the student to assess the causes and effects of a problem and apply a new way of thinking about the problem (Daskolia et al., 2011).

One of the creative thinking foundations is divergent thinking (Guilford, 1959). Divergent thinking requires ideational searching without directional boundaries. It is operationalized primarily by concept of *fluency*, *flexibility*, and *originality*, and secondarily by *elaboration* (Folley, 2006). Therefore, creative thinking has four indicators: (1) *fluence*, as ability to raise many ideas, (2) *flexibility*, as ability to raise various kinds of ideas, (3) *originality*, as ability to raise new ideas, and (4) *elaboration*, as ability to develop or add ideas in order to produce more detailed ideas (Baer in Aryana, 2007). Indicators of creative thinking can be implemented in the learning process by using a student worksheet. Karkockiene (2005) described that the realization of creative ability is not only dependent on knowledge and skills, but also on the usage of different information found in the tasks that need this kind of ability. This worksheet contains a manipulative task load because combining and juxtaposing ideas through trial and error processes has been thought to be a hallmark of creativity (Boden, 2004; Simonton, 2003). Jeffrey & Craft (2004) also explained that creative learning and creative teaching need to be defined, marked, and assessed. However, current student worksheet have not developed creative thinking ability

In biology, creative thinking is very important aspect to answer various questions, solve problems related to life, and to communicate the results of student work. One of the topics in biology that seems fit to develop creative thinking is genetics. Nowdays, students live in an era of ever-greater explosion of information, thus, the coverage of genetics becomes larger and the course curriculum expands (Griffiths & Mayer-Smith, 2000). The students are able to practice creative thinking by raising many ideas to solve the problem (*fluency*), developing the original idea (*originality*), modifying equipments, materials, and experimental procedures (*flexibility*), and relating the experimental result with theory (*elaboration*) through the student worksheet. In order to have effective results from laboratory practices, students should benefit from using worksheets.

The worksheets are developed to meet needs in the learning environment and also used for different purposes according to researchers needs or aims. The worksheet is also used for teaching science concepts (Karsli & Sahin, 2009). Using student worksheets in the learning process help the students to understand the material by themselves. Student worksheets also give a large opportunity for the students to demonstrate their ability and develop thinking process through discovery, observation and logic. The main goal of learning is to change behavior because of an experience. Therefore, this student worksheet was aimed to enrich creative thinking skills. The worksheet provided a suitable variety of opportunities for students to be creative in multiple ways by creating a poster, essay about science problem solving that correlated with environmental education, or other art-works.

The objective of this research was to describe the effectiveness of a genetics' student worksheet to develop creative thinking skills based on the indicator achievement, self-assessment, and student responses. Genetics education is essential for preparing society to engage in an informed debate about the future of genetics research and how its applications affect human health and the environment (Susane, 2006). Genetics is an essential part of biology that requires creative thinking skills to solve existing problems in society.

METHODS

Subject and research design

The sample of this research was 15 students from an advanced placement class, Department of Biology, Biology Education Program, Faculty of Mathematics and Natural Science, The State University of Surabaya. The research was applied using one group pre-post test design (Creswell, 2005). It was carried out at even semester 2013/2014 academic year, from January to May 2014, at Genetics Laboratory, The State University of Surabaya.

Learning objectives

The genetic worksheet expected the students to construct the flow of genetic information using DNA isolation. Students would also be able to correctly order the stages of gene expression and explain a genetic mutation and bacteria mutation.

Teaching strategies

The genetics student worksheet which covered two subtopics, i.e. deoxyribose nucleic acid (DNA) isolation and bacterial mutation, were supplemented with lab practices (experiment) in groups. Students were lectured about the general overview of the material. They were asked to answer a pre-test afterwards. After the lab practice had ended, the students were required to turn in lab report and answered a post-test. They were also asked to communicate their experiment result using creative presentation aids.

The first worksheet which related to the DNA isolation subtopic and asked the student to creatively modify the sample and reagent used (summarized in **Appendix A**). The worksheet explained the basic principle of DNA isolation and asked the student to conduct the experiment using various samples and reagents that could be chosen by their own decision. The samples included plant organs and animal organs, i.e. young leaf, mature leaf, chicken liver, and chicken epidermis. The reagents were replaced by various household chemicals to promote the usage of accessible lab materials in teaching. Most chemicals were provided to replace physiological buffer and sodium dodecyl sulphate (SDS) which would be needed in DNA extraction stage. There were also several questions stated in the worksheet to challenge the students to critically think the reason they chose particular sample and reagents in their experiment.

The second worksheet dealt with bacterial mutation which was induced by UV light (summarized in **Appendix B**). The worksheet explained the concept of mutation and detailed laboratory instruments and materials. However, the students were asked to creatively apply various exposure times and exposure distances of UV light to the bacteria culture. The worksheet also taught the students to calculate mutation rate based on their experimental

result. Critical thinking was promoted by several questions which asked student to present empirical evidence to explain the effect of UV intensity, exposure time, and exposure distance to the bacteria mutation rate.

Evaluation

The students answered the written pre-test before the lecturer introduced the genetics student worksheet. The pre-test consisted of two essay questions about DNA isolation and three essay questions about bacterial mutation. At the end of the session, they were asked to answer other two essay questions about DNA isolation and three questions about bacterial mutation in the post-test. The tests were assessed by rubric criteria and scored in a scale from 1 to 100 points (Table 1). All of the test questions were constructed based on achievement indicators (Table 2).

All students had the opportunity to assess their own learning capabilities using a self-assessment sheet that covered creative thinking indicators (Table 3). Comments were also invited on the content so that the material could be refined to improve student's learning capability. An attempt was also made to assess student response to the learning activities by closed questionnaire. Assessed aspects of this questionnaire was determined by the researchers based on the creative thinking indicators (Table 4).

Data analysis

Data collection was conducted using an essay test and questionnaire method with a self-assessment sheet and learning activities response sheet. The test score analyzed using average normalized gain (g) which is defined as the ratio of the actual average gain to the maximum possible average gain, i.e. $(g)=\frac{S_f-S_i}{100-S_i}$, where S_f and S_i are the final (post) and initial (pre) class average (Hake, 1999). Hake (1999) defined g score>0.7 as highly engaged activity to promote particular understanding; 0.7>g>0.3 as medium-engaged activity; and g<0.3 as poor-engaged activity. The self-assessment sheet and rhe learning activities response sheet were analyzed descriptively.

RESULT AND DISCUSSION

The result of this research consisted of indicator achievement, self-assessment of creative thinking training through genetics student worksheet, and student responses about lecturer's ability to develop creative thinking skills. The result showed that there was an improved indicator achievement with average g score = 0.6 (medium-g) (Table 1). This score indicated that genetics student worksheet could fairly engage students to conduct creative thinking skills.

Table 1. Pre-test and post-test result of DNA isolation and bacteria mutation

Student	Score		g	Category
	Pre-test	Post-test		
1	37.5	83.0	0.73	medium
2	46.3	77.5	0.58	medium
3	38.8	90.0	0.84	high
4	46.3	75.0	0.54	medium
5	48.8	82.5	0.66	medium
6	43.8	84.5	0.72	medium
7	27.5	76.5	0.68	medium
8	48.8	87.5	0.76	high
9	52.5	65.0	0.26	low
10	35.0	62.5	0.42	medium
11	48.8	58.0	0.18	low
12	38.8	72.5	0.55	medium
13	42.5	90.0	0.83	high
14	35.0	89.5	0.84	high
15	60.0	82.5	0.56	medium
Average	43.3	78.4	0.61	medium

Table 2. Achievement indicators in pre- and post-test

Topic	Indicators	Pre-test	Post-test
DNA Isolation	Analyzing the most suitable sample of experiment	34.2	100
	Modifying the experiment procedure of DNA isolation	19.4	65.9
Average Achievement (%)		25.3	79.5
Bacteria Mutation	Analyzing the most suitable sample used in bacteria mutation experiment	77.8	100
	Analyzing manipulation treatment toward bacteria mutation experiment	26.7	45.7
	Modifying the experiment procedure of bacteria mutation	74.7	100
Average Achievement (%)		61.3	80.7

Average achievement percentage of DNA isolation gained 25.3% to 79.5%. Meanwhile, average achievement percentage of bacteria mutation increased from 61.3% in pre-test to 80.7% in post-test (Table 2). This indicated that both of DNA isolation and bacterial mutation showed an improvement in test score after the genetics student worksheet was implemented. The worksheet provides a suitable variety of opportunities for students to be creative in multiple ways. Using the student worksheet in learning helps students to understand the material by themselves. Worksheets are also used for different purposes according to researchers' needs or aims, especially for teaching science concepts (Karsli & Sahin, 2009). There has been shown that well-planned worksheetss encourage divergent creative thinking and help to record and organize ideas (Crammond, et al., 1990).

Table 3. Student self-assessment of self-capability

No.	Aspects	Answer Percentage (%)	
		Negative	Positive
1.	I acquire opportunity to create many ideas to solve the problem (fluency)	0	100
2.	I acquire opportunity to create original idea to solve the problem (originality)	13.3	86.7
3.	I acquire opportunity to modify equipments, materials, procedures of experiment (flexibility)	0	100
4.	I acquire opportunity to relate experiment result with the theory of DNA isolation/bacteria mutation (elaboration)	13.3	86.7
Total		26.6	373.4
Total Percentage (%)		93.3	
The capability/behavior that students want to be improved: Most of students wanted to improve their ability to conduct experiment by raising original and creative ideas. Students also wanted to improve honesty, discipline, carefulness, and thoroughness in learning and to operate laboratory instruments and materials including from the simple to complex technology.			

Table 4. Student response in the learning activities of DNA isolation and bacteria mutation

No.	Aspects	Answer Percentage (%)	
		No	Yes
1.	The capability of lecturer to improve student's ability conducting problem analysis.	0	100
2.	The capability of lecturer to improve student's ability raising many ideas to solve the problem (fluency)	0	100

3.	The capability of lecturer to improve student's ability raising original ideas to solve the problem (originality)	0	100
4.	The capability of lecturer to improve student's ability modifying instruments, materials, and experiment procedures (flexibility)	0	100
5.	The capability of lecturer to improve student's ability relating experiment result and theory of DNA/bacteria mutation (elaboration)	6.7	93.3
Total		6.7	493.3
Total Percentage (%)		98.5%	

Average gain in pre-test and post-test affected learning outcomes. Increased learning outcomes were indicated from the increased achievement percentage. First pre-test achievement indicator that represented student's ability to analyze correct sample in DNA isolation increased from 34.2% to 100% (Table 2). Since the students had never been involved in isolating DNA before, the low score in the pre-test is caused by inadequate prior knowledge to determine which sample that was most suitable in experiment. The correct sample of DNA isolation experiment was chicken liver because the texture was easy to be disrupted and did not have cell wall; therefore this sample was easier to be treated. Most of the students answered young leaf and chicken liver. Even though all of the samples could be categorized as correct sample in DNA isolation, the accuracy of the answer that asked the most suitable sample was also important aspect in creative thinking assessment.

Second achievement indicator in DNA isolation topic that was covered student's ability to modify DNA isolation experiment showed improvement from 19.4% to 65.9% (Table 2). Many students overcame difficulties to modify DNA isolation experiment. Although some student groups failed to conduct the experiment, there was a group that could modify the procedure well so they could obtain the correct result. Modifying DNA isolation procedure could be conducted in these steps: 1) the application of vortexer was replaced by continuous filtration; 2) the usage of SDS solution was replaced by using detergent because this chemical household was colorless and contained high concentration of active SDS that led to easier DNA extraction step. This second indicator allowed the students to gain opportunity to modify laboratory instruments, materials, and procedures (*flexibility*) to promote creative thinking learning. According to Crammond et al., (1990), in order to improve creativity, there are many commercial products and programmes planned, including worksheet that encourages divergent creative thinking and help record and organize ideas.

In the bacterial mutation experiment, the achievement percentage increased from 61.3% to 80.7% (Table 1). This high achievement was represented by the increased achievement indicator. First indicator gained 77.8% to 100%, second indicator gained 26.7% to 45.7%, and third indicator improved from 74.7% to 100% (Table 2). The first indicator in the bacterial mutation was about analyzing the most suitable sample for the bacterial mutation experiment. The students did not overcome any difficulties to analyze the sample regarding to the their earlier experiment in microbiology lectures. The suitable sample for the experiment was *E. coli* or *Sigella*. Both of these bacteria were easier to take from environment and safe to be kept in laboratory. Even though these bacteria were not malignant, the students were aware to conduct safety procedures to maintain their own health. The second indicator was about analyzing behavior or manipulating bacteria mutation experiment. Student's creative thinking could be seen based on the their fair modification in the experiment. This modification consisted of applying various exposure distances to the UV light, various colchicine concentrations and various exposure times to the UV light. This creatively modified step produced highly variable experiment results that could enrich student's learning experiences. The second indicator provided opportunity to raise many ideas to solve the problem (*fluency*) and raise the original idea to solve the problem (*originality*); therefore this learning activities triggered creative thinking skills. Similar to this current result, Maharani et al. (2015) stated that creative thinking ability is required to solve problems in everyday life. The third indicator was about the procedure of bacteriai mutation increased from 74.7% to 100%. This indicator taught the students to conduct experiment by using the correct procedure. Experiment that was conducted by the students was very good because the technique had been applied in the microbiology lab session. This prior laboratory experiences made the students familiar with the procedure used in the bacterial mutation experiment. The third experiment developed the students' ability to think creatively by providing opportunity to modify laboratory instruments, materials, and procedures (*flexibility*). Furthermore, after the students discovered the experimental result, they had the opportunity to present and relate the result of experiment with theory that had been learned (*elaboration*) which was also one of the critical thinking learning aspects. Angawi (2014) explained that creative thinking expands the student to explain concepts, interpret spectral data, and eventually, evaluate and criticize various solutions. All of the test result improvement was consistent with student self-assessment that showed the students were capable of creative thinking skills (Table 3).

Student self-assessment that assessed student's capabilities indicated that most students were able to do creative thinking during their learning activities. However, the percentage of students that could not create original ideas to solve the problem (*originality*) and relate experimental result with the theory of DNA isolation/bacteria mutation (*elaboration*) was 13.3% (Table 3). Student response also showed that 6.7% of students negatively assessed that their lecturer was able to improve their ability to relate experiment result with the theory (Table 4). This result showed that the learning activities involving the genetic worksheet should be refined to help student to improve their capability in *originality* and *elaboration* aspects. Open comments in the self-assessment revealed that most students wanted to improve their honesty, discipline, carefulness, and thoroughness in the learning activities, and be able to use simple and complex laboratory technology.

Student worksheet as a part of teaching resources can foster students to generate their own thinking, ask questions, make connections, evaluate outcomes, so that the autonomy of the students increases as well (Chappell & Craft, 2009). Although an improvement in test was observed in the students, average gain of student worksheet engagement was only detected at medium level with positive self-assessed creative thinking indicators. As noted by McCormack (1971), creative-training may affect very little the actual ability of a person to be creative, but have much more impact on the attitudes and values regarding creativity. Therefore, creative training should include evaluation instruments that involve higher level of thinking, including creative thinking skills. Teacher candidate students should also possess broad understanding of creativity because they will teach mainstream classroom that needs positive impact of creative teaching (Seo et al., 2005).

However, any student worksheets cannot be generalized to improve creative thinking skills in the same way because the sample size was too small. The result of this research tentatively showed that student worksheet which emphasizes creative thinking indicators could be effective to develop creative thinking skills until the future researches with larger sample size confirm and strengthen the findings. These further researches will be needed to study the correlation effect of creative teaching, creative learning resources, and developed creative thinking skills that will provide more information about creative thinking skills improvement of teacher candidate students. Evaluation instrument that facilitate creative thinking assessment would be also helpful.

CONCLUSIONS

Genetics student worksheet was fairly effective to develop creative thinking skills regarding to the increased test score and creative thinking achievement indicator, positive self-assessed creative thinking capability from the students, and positive student response to lecturer's ability to develop creative learning activities. It is recommended that creative thinking-student worksheet should be also supported by creative teaching to increase *originality* and *elaboration* aspects.

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Appendix A

Title: DNA Isolation (Susantini, et al, 2014)

Introduction: Genetics research has been directed to molecular research. Deoxyribose Nucleic Acid (DNA), the genetic material of living organisms that acts as blueprint of genetic information, is important research object in molecular genetics. DNA analysis can be conducted when the DNA has been isolated or extracted from the sample. DNA isolation consists of three stages: 1) extraction, to separate the DNA from the cell using SDS/CTAB/Triton-X as active detergent and concentrated NaCl, 2) purification, to separate extracted DNA from any contaminants, cell debris, protein, and RNA using phenol: chloroform: isoamylalcohol, and 3) precipitation, to precipitate the DNA as transparent or white fiber using cold 96% alcohol. DNA isolation technique is determined by the character of the sample used. Simple DNA isolation steps are as follows:

1. Prior to homogenization, 0.5 gram of sample was placed in the sterile mortar and added with physiological buffer
2. Homogenate was filtered using filter paper and placed in the sterile centrifuge.
3. Filtrate was mixed with 5 ml of SDS 20% and 5 ml of 5M NaCl using vortexer
4. Suspension was centrifuged to separate cellular components with cell debris
5. Supernatant was removed into new tube
6. Cold 96% ethanol was carefully added to the new tube through its wall
7. Please observe whether a white or transparent fiber occurred on the suspension surface

DNA isolation can be taught to high school students using materials around us. Try to conduct DNA isolation experiment by modifying provided instruments and materials

Objective: To modify the procedure of DNA isolation using available materials in the environment

Materials and instruments: mortar and pestle, tube and rack, filter paper, beaker glass, pipette, spatula, mineral water, raw water, young leaf, mature leaf, chicken epidermis, chicken liver, salt, sugar, detergent, dishes soap, liquid soap, alcohol

Discussion:

1. Create flow sheet procedure of your experiment
2. What is your sample? why do you choose that?
3. What is the material can be used to replace physiological buffer? Why do you choose that?
4. What is the material can be used to replace 20% SDS and 5M of NaCl? Why do you choose those?
5. What are the steps you modify to the existing standard procedure?

Please create presentation about your experiment result and attach the picture of your DNA

Appendix B

Title: Bacteria Mutation (Susantin, et al., 2014)

Introduction: Research in mutation is more effective to be conducted in prokaryotes. All of the prokaryotes genomes are exons that encodes functional protein. Therefore, little change in prokaryote's gene causes change in the produced protein. This change that is inherited to the offspring called mutation. Mutation can be caused by mutagen like ultraviolet (UV) radiation or colchicines. Mutation is defined as a permanent change in DNA and can be seen in the phenotype. Mutation can be classified into two groups: 1) spontaneous mutation, which is

caused by one or more unknown factors, and 2) artificial mutation, which is artificially made by known factor. This experiment asks you to learn about spontaneous mutation in *Escherichia coli* and calculate the mutation rate.

What are the possible research questions of this experiment?

Materials and instruments: culture of *E. coli*, nutrient broth, nutrient agar, sterile 0.1 M $MgSO_4$, 40 watt of UV light, sterile Erlenmeyer, 9 tubes which are filled with 9.9 ml of sterile nutrient broth and labeled as K 10^{-2}, K 10^{-4}, K 10^{-6}, L 10^{-2}, L 10^{-4}, L 10^{-6}, D 10^{-2}, D 10^{-4}, and D 10^{-6}, 3 tubes which are filled with sterile nutrient broth and labeled as K 10-7 , L 10^{-7} and D 10^{-7}, 6 Petri dishes which are filled with nutrient agar and labeled as NA-1, NA-2, NA-3, and NA-4, 6 Petri dishes which are filled with nutrient agar and 30 mg/l of penicillin (or another antibiotics) and labeled as NAA-1, NAA-2, NAA-3, NAA-4, NAA-5, andNAA-6,
sterile tubes, cotton buds, 1 ml and 0.1 ml sterile syringes, 70% alcohol, antibiotics, and tin foil.

Please construct the experiment procedures related to the bacteria spontaneous mutation by using the materials and instruments above

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