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EXPERIMENTAL LEARNING OF ENAMEL ON GLASS MEDIA ON COPPER METAL AT POLITEKNIK SENI YOGYAKARTA

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Abstract

The learning process is not just a knowledge transfer process but fosters motivation and creativity through more interactive, inspiring, fun, challenging, and explorative learning activities. A learning process that provides unrestricted space for developing creativity and independence by the talents and interests, according to students' physical development and psychological aspects. One way to achieve this can be by conducting joint research in the learning process of enamel glass media on copper metal at Politeknik Seni Yogyakarta. Researchers conduct research with students to expand teaching materials, such as enamel experiments. Enamel is a metal coating technique that uses high temperatures. Enamel material is still complex to obtain, so it is necessary to find a substitute material. One way to be able to find a substitute for enamel media is to conduct experiments. Thus, conducting media experiments in art is very necessary. It is helpful to find a new medium of expression that is more effective and efficient to channel the expression of the soul through art. This research aims to find enamel materials that utilize waste in our environment, namely broken Glass. The experiment will observe: (1). How strong is glass adhesion to copper metal? (2). What is the boiling point of glass waste? (3). How is the color achieved? The results of the experiments show that (1) Waste glass can be utilized as enamel material for copper metal. (2). The average boiling point temperature of waste glass is 900 C. (.3). The desired enamel color game can be done by applying Metal oxide, Cobalt oxide, Copper oxide, Iron, Mangaan, Uranium, and Tin to the Glass.
Keywords: Learning, Enamel Experimentation, Metalwork and Glassware

INTRODUCTION

The national education system has enacted the National Education Standards through the Minister of National Education Regulation No. 19 of 2005. The content of the regulation includes eight minimum standards of education that every educational unit in Indonesia must meet. Educational standards related to learning media are process standards and infrastructure standards. In the process standard in Chapter IV, article 19, paragraph (1), it is stated as follows: "The learning process in educational units is organized in an interactive, inspiring, fun, challenging, motivates students to participate actively, and provides sufficient space for initiative, creativity, and independence by the talents, interests, and physical and psychological development of students."

This article implies that in carrying out the learning process, teachers must be able to carry out learning that is interesting and fun for students according to the level of the education unit so that it can foster student creativity. For this reason, teachers need to prepare various learning strategies supported by appropriate, exciting media and facilitate the growth of understanding, creativity, and a positive attitude after the material is delivered/learned. Furthermore, the standard of infrastructure facilities in Chapter VII paragraph (1) describes educational facilities as follows. “Each educational unit is required to have facilities which include furniture, educational equipment, educational media,

books and other learning resources, consumables, and other equipment needed to support an organized and sustainable learning process."

In connection with these process standards, in semester VII, the Fine Arts Education Study Program, Faculty of Teacher Training and Education, Sarjanawiyata Tamansiswa University, contains expertise courses, including Experimental Crafts. This course requires all students to be able to experiment in every creation so that they can make innovations in every work created. Thus, all works created can keep up with the times and meet the community's needs. Creating works can be experimented with media expression, technique, form, and function. In this regard, the researcher, as a supervisor, is also obligated to conduct experiments to expand the teaching materials that will be delivered to students. On this occasion, the researcher experimented with students related to media expression as the realization of artworks so that they would find new media expression in the realization of the work. The research was deliberately conducted with students to achieve the process standards in experimental craft learning. The experiment was "Experimentation of Enamel with Glass Material on Copper Metal." The metal is copper.

Enamel is a technique for replacing works by coating a mixture of silica and alkali compounds on metal by heating it at a high temperature. Up to now, ready-to-use enamel materials are still mostly imported from abroad and are challenging to obtain because not all shops sell them. It will hinder the expression of people who use Enamel as a form of expression. The research aims to find ready-to-use substitutes for enamel materials by using easy-to-obtain and cheap materials, as well as providing joint learning with students. The title above emphasizes that what the author means by Glass is broken Glass. This material was chosen for the enamel experiment because the structure of the glass-making material is almost the same as the structure of the enamel material. Besides, broken Glass is easy to obtain and is a waste item. If this business is booming, enamel material will be received, which is cheaper and can overcome environmental waste. In connection with the abovementioned challenges, researchers are interested in conducting experiments regarding media, techniques, and forms. To be able to answer this, this research is entitled "ENAMEL EXPERIMENT WITH GLASS MATERIAL APPLIED TO COPPER METAL." Meanwhile, the thickness of the copper metal to be coated is 0.8 mm, 0.7 mm, 0.5 mm, and 0.3 mm.

METHOD AND PROCEDURES

Research Subjects and Objects

The subjects and objects in the research are as follows:

1. Research subjects: Crown glass and flint glass materials, dyes, and flint glass.
2. Research object: Experimental results with glass material coated on copper sheet, namely:
   a. Adhesion of crown glass and flint glass materials to copper metal.
   b. Achieving the color of crown and flint glass bonded to copper metal at high temperatures.
   c. The durability of metal coated with crown and flint glass at high temperatures.

One way to achieve this can be by conducting joint research in the learning process of enamel glass media on copper metal at Politeknik Seni Yogyakarta. Researchers research with students to expand teaching materials, such as enamel experiments. Enamel is a metal coating technique that uses high temperatures. Enamel material is still complex to obtain, so it is necessary to find a substitute material. One way to be able to find a substitute for enamel media is to conduct experiments. Thus, conducting media experiments in art is very necessary.

RESULTS AND DISCUSSION

The two theoretical studies, Enamel and Glass, show that they use almost the same materials, both primary and coloring ingredients. In this regard, crown and flint Glass can be used as enamel materials for copper metal.

1. Enamel

   H. Moh Nuh Miraza et al. (1972: 112) wrote that Enamel means email, an item coated with email. Meanwhile, Jinks McGrath (1994: 94) wrote about enabling the fusing of Glass to metal at high temperatures. (Enamel is combining Glass or metal glass at high temperatures). It is further written that Enamel is a mixture of silica and alkali compounds, which lower the melting temperature of the silica, lead oxides, salts of soda, potassium, and borac oxides. Colorless Enamel is known as fluxes, and the color is obtained by adding various metallic oxides and or stains. Cobalt oxide for blues. Copper oxide for turquoise and some greens. Iron and gold for reds. Platinum for greys. Manganese for purples. Uranium and antimony for yellows. Tin for white. Iridium for black. (Jinks McGrath, 1994: 16). Generally, this enamel material has a melting point ranging from 750 C to 900 C.

2. Copper Glass

   Etymologically, the English word for Glass is Glass, which means glass or glass items. Daruza Taman further explained that two types of Glass are usually used to imitate gems. The kinds of Glass are:

   a. Crown glass (kroonglas), window or bottle: Silicia, potash, soda, lime, iron oxide, and titanium oxide as a coloring agent.
   b. Flint glass or good Glass: This material consists of silica, potash, soda, and lead oxide. It can be used as imitation stones. (Daruza Taman, 1958: 47).

Figure 1. Experimental Learning of Creative Process Enamel Material in Glass Medium

c. In the Encyclopedic Dictionary, what is meant by copper metal is Metal element, symbol Cu; atomic number 29; atomic weight 63.54 density 8.92 hardness 2.5-3.0; melting point 10830 C, boiling point 23100C, specific heat 0.788 isotope composition 63 (70.13%), 65 (29.87%), general metal is malleable, clay is relatively soft, in air it changes to oxide and is resistant to dilute acids. Salt water causes corrosion. (Hassan Shadily, 1977: 1089).
d. When compared between the average melting point of enamel material and the melting point of copper, it can be seen that the melting point of copper is higher than that of enamel material. It shows that copper can be enameled because the enamel material melts when heated, while the copper does not. It is the principle in enameling, namely that the melting point of the enameled object is higher than that of the enameled material. The explanation of the theoretical study above shows that the materials used for Enamel and glass-making have almost the same structure. The average melting temperature of enamel material is below the melting temperature of copper. Enamel color play can be done by adding metallic oxide, cobalt oxide, copper oxide, iron, manganese, uranium, and tin to the enamel alloy. It can be assumed that Glass can be used as an enamel material for copper metal. Meanwhile, to achieve the desired color, you can add metal oxide, cobalt oxide, copper oxide, iron, manganese, uranium, and tin to the glass material.

Experimental Process. In the experimental process, the tools used, the materials used, and the process of experimenting will be explained. Each sub-chapter is as follows:

a. Tools. The tools used in the enamel process are as follows: (a) Furnace: In this case, the author uses an ELECTRIC KILN 240-volt furnace.
b. Angsang. Used to place objects in the furnace during combustion.
c. Susruk. Used to pick up and remove burned items from the furnace.
d. Pliers. The function of the pliers here is the same as the function of the stake.

e. Plastic bowl. It is helpful to mix glass powder with glue.
f. Paintbrush. Used to brush glass powder that has been mixed with glue onto the object to be coated.
g. Sandpaper. Used to clean objects to be coated.
h. Fireproof gloves. Used to protect from the heat of fire.

Figure 2. Furnace & Figure and Various experimental tools

3. Material

The materials used in the experimental process are as follows;

a. Coated material, Copper plates with thicknesses of 0.8 mm, 07 mm, 0.5 mm, and 0.3 mm and an average length of 5 cm and an average width of 5 cm.
b. Enamel material: (1) Glass that has been ground into powder. (2) GlueIn this case, it is in liquid form with the brand name A THOMPSON ENAMEL HOLDING AGENT. (3) Dyes consisting of Cobalt Oxid, Comium Oxid, and Copper Oxid.

Figure 3. Enamel Creative Process Activity

4. Implementation of Enamel Experimentation

The work steps in the experimental process are as follows:

a. The items to be coated are cleaned by washing and sanding until clean and then drying.

b. The glass powder is washed and then mixed with glue, considering its viscosity so that it can be brushed onto the object.
c. The glass powder is brushed onto the object according to the design.
d. After the placement of the glass powder is complete, the object is placed on the swan.
e. Using a grill, the object and the vulture are put into a burning furnace with a high temperature of 7500 C—9250 C.
f. If the furnace temperature is 9000 C, the item is held in the furnace for approximately ten to fifteen minutes, and then the glass is checked to see whether it has melted. If the glass powder has melted, the object can be removed immediately, or the furnace can be turned off.

Figure 4. Experimental Form and Effect on Enamel Material Product

The results of the experiment will be presented in table form as follows,

a. Results of Enamel Experiments with Crown Glass, Blue Color Temperature 9000 C
b. Results of Enamel Experiments with Crown Glass, blue With Cobalt Oxid dye, temperature 900oC
c. Results of Enameling Experiments with Crown Glass, Blue Color with Cobalt Oxid Dye, Temperature 9250 C
d. Results of Enameling Experiments with Crown Glass, Green Color Temperature 9000 C
e. Results of Enameling Experiments with Crown Glass, Green Color with Chromium Oxid Dyes, Temperature 9000 C
f. Results of Enameling Experiments with Crown Glass, Green Color with Chromium Oxid Dye Temperature 9250 C.
g. Results of Enameling Experiments with Crown Glass, Brown Color Temperature 9000 C
h. Results of Enameling Experiments with Crown Glass, Brown Color, and Copper Oxid Dye, Temperature 9000 C

i. Results of Enameling Experiments with Flinta Glass, Temperature 9000 C

Figure 5. Enamel on Copper Metal Glass

Figure 6. Examples of Creative Products developed by Creative Industries marketed through Digital Marketing

In the discussion sub-chapter, each experimental result will be discussed, especially regarding Burning temperature, glass material, color attainment, adhesion, and condition of copper.

Discussion of Experiment Results

1. From the presentation of the data above obtained from experiment 1, it can be analyzed as follows:
   a. Blue Crown glass powder can be used as an enamel material on copper with a metal thickness of 0.8mm, 0.7mm, or 0.5mm.
   b. The resulting color is not blue. (c) Enamel adhesion is excellent when applied to copper thicknesses of 0.8 mm and 0.7 mm with an enamel thickness of 0.1 mm. (d) The experimental results can be seen in image no. 1

2. Experiment 2. In the two experiments described above, it shows that:
   a. Adding 1% color element to Crown glass powder does not change the liquid temperature of the glass powder.
   b. Crown glass powder added with 1% cobalt oxide can be used on 0.8 m and 0.7 mm copper metal with an enamel thickness of 1 mm. (c) The resulting color becomes the hubcap color and is according to your wishes. (d) Enameling materials are unsuitable for 0.5 mm and 0.3 mm copper metal because the metal becomes wavy. (e) The experimental results can be seen in no. 2.
3. Experiment 3. The data presented in experiment three shows the following: (a) Adding 1% color element to the blue crown glass powder does not change the liquid temperature of the material. (b) Increasing the firing temperature of the object does not change the resulting color but reduces the plasticity of the Enamel. (c) Enamel adhesion could be better. (d) The experimental results can be seen in image no. 3.
4. Experiment 4. Experiment four can be analyzed as follows: (a) Green crown glass powder can be applied to 0.8 mm copper metal with a coating thickness of 0.1 mm. (b) Enameling cracked, possibly due to sudden cooling. (c) The resulting color is according to your wishes. (d) The results can be seen in image no. 4.
5. Experiment 5. From the presentation of the data in experiment five it can be analyzed as follows:
   a. Adding 1% color element (chromium oxide) to Crown glass powder does not change the liquid temperature.
   b. Green crown glass powder plus 1% coloring element (chromium oxide) can be applied to 0.8 mm and 0.7 mm copper metal with an enamel thickness of 1 mm, but it would be better if the enamel thickness were 0.1 mm.
   c. The resulting color is according to your wishes.
   d. Enameling adhesion is good.
   e. Results can be seen in attached image no. 5.
6. Experiment 6. Likewise, the results of experiment six can be analyzed as follows,
   a. Increasing the combustion temperature from 9000 C changes the color from dark green to blackish green.
   b. Increasing the firing temperature, as mentioned above, does not reduce the adhesion of copper enamel.
   c. Enameling can be applied to a 0.8 mm copper sheet with an enamel thickness of 0.1 mm.
   d. The experimental results can be seen in Figure 6.
7. Experiment 7. The results of experiment seven can be analyzed as follows:
   a. The brown crown glass powder is not suitable for Enamel.
   b. Many experimental results cracked, possibly due to sudden cooling and a too-thin coating. The resulting color is according to your wishes.

c. Enamel adhesion could be better.
d. The experimental results can be seen in image no. 7.

8. Experiment 8. The analysis results from experiment eight when viewed in terms of the addition of coloring elements, the resulting color and enamel adhesion are as follows:
   a. Adding 1% coloring element (coper oxide) to brown crown glass powder does not change the melting point.
   b. The enamel color occurs according to your wishes.
   c. The adhesive strength of the Enamel could be better.
   d. The experimental results can be seen in attached image no. 8.
9. Experiment 9. Likewise, the results of the nine experiments, when analyzed in terms of enamel material, the resulting color and enamel adhesion show the following:
   a. Green, blue, and reddish-yellow flint glass materials are suitable for coating 0.8 mm and 0.7 mm copper.
   b. The colors that appear are as desired.
   c. Good enamel adhesion
   d. The experimental results can be seen in figure no. 9

CONCLUSION

From the results of several experiments and based on the results of the discussion, the following conclusions can be drawn,

1. Crown glass and flint glass powder can be used to enamel 0.8 mm and 0.7 mm copper metal with an enamel thickness of 0.1 mm.
2. The average melting point of crown glass and flint glass powder is 9000 C. Adding color elements such as chromium, cobalt, and copper can achieve a play of color. Adding color elements to glass powder does not change the melting point. Flint glass produces better Enamel than crown glass. The experiments above were only carried out on metal in a horizontal position.

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