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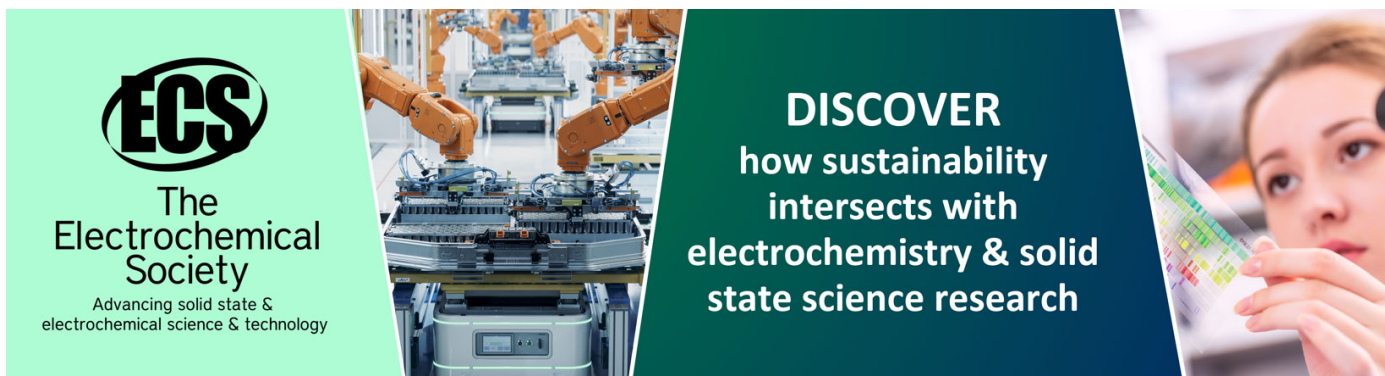
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Science Batik Ciwaringin: The Implementation of Ethno-STEM PjBL Model in learning Biotechnology at PGSD Students

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Abstract. Indonesian batik has been awarded by UNESCO as one of the world's non-object cultural heritages. And this is a challenge for young generation on how to preserve this culture. The purpose of this research is to implement Biotechnology learning through the Ethno-STEM PjBL model for PGSD students and produce sains batik, so it can trigger the young generation to preserve it. This learning model is a project based learning in analyzing several natural materials as natural dyes for batik, dye-making techniques that are integrated into the concept of biotechnology, and producing a product designed by the students. This research method is R&D research. It has 3 steps: (1) Define; (2) Design Development; and (3) Disseminate. The instruments used in this research are product validation sheets, assessment rubric products on the designs, colors, and symbolic value. Data were analyzed descriptive qualitative and descriptive statistics. The finding of the research showed that the products of sains batik validated, one of which is "piperidine seribu daun" has a secondary metabolite content of the mango combined with the design of thousand of leaves, the special Ciwaringin batik. It has a meaning of togetherness to preserve the environment for manga as local plant of Cirebon. The conclusion from this research is that students not only learn the concept of biotechnology but also they can develop Ciwaringin batik. The implication of this research is that it can stimulate the young generation to take a part in preserving and developing the Indonesian batik industry.

1. Introduction

Indonesian batik is one of the world cultural heritages out of 76 non-object cultural heritages that have been declassified by UNESCO on October 2, 2009 [1]. This is a challenge for young generation to raise batik as a culture that must be preserved and to be one of the pillars of Indonesian economy. However, this challenge has several obstacles, one of which is human resources (HR), such as the old craftsmen, so it needs special efforts to stimulate the young generation to take a place in the industry of batik. According to [2], she stated that almost part of the young generation who reside in Ciwaringin village do not know the characteristics of Ciwaringin batik of their area. the Ciwaringin batik, which is located



in the Cirebon, applies original scientific knowledge about the extraction of natural materials that are used as batik dyes, and has a special design “nuanced-flora” with the symbolic meanings of each design [3]. Another obstacle is related to the inadequate intellectual property rights (IPR), where traditional design of batik are copied by craftsmen from other countries. [4].

Based on the above problems, it is necessary to make efforts to pass on the knowledge of batik skills to be attractive and easy as well as efforts to maintain cultural heritage so that these original Indonesian products remain the property of the nation [5]. One of the efforts that directs the community to develop their cultural heritage pride is through multicultural-based schools [6]. Multicultural-based learning is appropriate school learning in preparing for the challenges of the 21st century [7]. The Ethno-STEM approach is one of multicultural-based science learning, namely learning that integrates culture with Science, Technology, Engineering, and Mathematics to foster students to be innovators, independent, think logically, solve problems, be able to connect culture with education, develop citizens STEM literate countries, so as to increase the competitiveness of science and technology, entrepreneurship, and equip the competence of graduates to be ready to face the real world of work according to the challenges of the 21st century [8,9,10,11,12,13]. The previous research conducted by [14] stated that PjBL Ethno-STEM can improve critical and creative thinking skills, which is the most important part of fulfilling 21st century skills. in research [15], Ethnoscience is integrated with STEM. a learning that is ready to face the challenges of the 21st century, where the results of this research students are able to develop entrepreneurial character, mastery of chemical concepts, be creative and innovative, and preserve the nation's culture.

The purpose of this research is to implement Biotechnology learning through Ethno-STEM PJBL for elementary school teacher candidates and produce Ciwaringin science batik products, so that it is hoped that it can stimulate the young generation to take an active role in preserving and developing the batik industry. In this learning stage, students are equipped with the cultural ability to make batik both from understanding the basic ingredients of dyes, engineering in producing batik products and batik technology of high quality and high competitiveness, so that it is economically profitable. Studies related to cultural-based scientific knowledge in both batik designs and the basic ingredients of natural dyes used are well maintained, conserved and used as a source of science learning [16,17]. The use of natural materials as batik dyes in Ciwaringin-Cirebon is a local wisdom [2], where the people have traditionally used several local plants to be used as dyes through a very simple technique. The creation of STEM model learning is by involving authentic problem solving activities in social, cultural, and functional contexts in science learning [18]. Learning science in this research is Biological Science, where the concept of biotechnology science helps students to solve the problems of local cultural conservation that are faced by society in the current global era.

Learning through Ethno-STEM PJBL prepares learning in the era of industrial revolution 4.0, which is also known as the phenomenon of disruptive innovation which emphasizes students to have technological literacy skills, to be multicultural and innovative, skillful in social and cultural life, collaborative, think critically, and effective communication [14]. This learning is in line with attachment III Permendikbud No.34 of 2018 [19]; the learning process is held based on activities in an interactive, inspirational, fun, challenging, and motivating way for students. There have been several previous studies related to the importance of cultural aspects of science learning, namely examining cultural aspects of science learning on critical thinking skills, ethnoscience towards biodiversity literacy, cultural-based scientific science reconstruction, and as a vehicle for instilling conservation soft skills in students. [11, 15, 17 , 18]

2. Research Method

The writers used Research and Development (R&D) in this study. According to [7], R&D method consists of three stages; define, design & development, and dissemination (Fig. 1). The sampling technique was carried out by purposive sampling to the PGSD students of FKIP in Universitas Swadaya Gunung Jati, Cirebon. The instruments used in this study were the Ciwaringin scientific batik product

design validation sheet through the FGD, product assessment rubric of batik on the design, color, and symbolic value in each product.



Figure 1. The Stages of Research & Development (R&D) [7]

The second stage of this research is Design & Development (Fig. 1). This stage designs the Biotechnology learning design using the PjBL Ethno-STEM model which is validated by experts, then it can produce several scientific batik design products and designs. Ciwaringin science batik motif, which was validated through FGD involving several academics, practitioners, and humanists. Furthermore, the product of scientific batik motif design is re-validated and revised several times until it reaches the conclusion that "batik is feasible to be produced with or without improvement", after that the product of this design is produced into "Ciwaringin science batik" which is ready to be marketed. This Ciwaringin scientific batik product was validated by 5 validators, including lecturers, cultural observers, and craftsman figures. Product validation uses the Delphi technique [20], in the scale of 4: Very Good (AB), Good (B), Fairly Good (CB), and Bad (KB). The results of Delphi were analyzed using descriptive qualitative and descriptive statistics, the results of the assessment on a scale of 4 were converted into a score with the following conditions: Very Good = 4, Good (B) = 3, Fairly Good (CB) = 2, Bad (KB) = 1. The results of the mean score were compared with the assessment standards to determine the qualifications of Ciwaringin scientific batik products, both in terms of color modification, design, and symbolic meanings of each batik product. The assessment standard used is a modification of the standard developed by [21,22]

Table 1. The Assesment Standard in Scale of 4

Mean Score	Qualification	Conclusion
>3,24 – 4,00	Very Good	Batik is ready to produce without revision
>2,50 – 3,25	Good	Batik is ready to produce with minor revision
>1,75 – 2,5	Fairly Good	Batik is ready to produce with lots of revision
≤ 1,75	Bad	Batik is not ready to produce

The modification from [21,22]

3. Findings and Discussion

3.1. The Model of Ethno-STEM PjBL in Biotechnology Learning

The application of the PjBL Ethno-STEM model in Biotechnology learning integrates the batik-making of the Ciwaringin people with the PjBL STEM. The syntax used in this PjBL STEM model, according to [23], consists of 6 syntaxes. In this step, the students were taught on how to make batik with natural dyes. The students were also required to produce innovative products in term of designing and modifying the design of Ciwaringin batik into a "Ciwaringin science batik design". This aims to stimulate students to take a part in the batik industry, develop an understanding of the concept of biotechnology, and preserve the Ciwaringin batik culture that uses natural materials as natural batik dyes.

Based on the previous research conducted by [3], they stated that the original knowledge of the Ciwaringin people in utilizing local plants as a basic material for batik dyes is a unique local wisdom to maintain environmental balance that can be reconstructed and conceptualized into a form of formal scientific knowledge, so that it can be used as a source of culture-based science learning in schools (ethnoscience). The Ethno-STEM design can be seen in table 2, the Ethno-STEM model design in this study has been published [24].

Table 2. Design of Ethnoscience Integrated STEM Approach in Analyzing Natural Dyes [24].

Science	• Types of plants that produce fabric dyes: Rambutan (<i>Nephelium lappaceum</i>), Indigofera, mangosteen (<i>Garcinia mangostana</i>), Mango (<i>Mangifera indica</i>), Mahogany (<i>Swietenia macrophylla</i>), tegeran (<i>Cudrania javanensis</i>), tingi (<i>Ceriops tagal</i>). • Natural ingredients that produce secondary metabolites as natural dyes: Tannins (Brown), flavonoids (Yellow), Anthocyanins (light brown). • Various fixation materials: alum, chalk, and arbor, as well as the reaction result of fixation and natural color mixture. • Extraction techniques through biotechnological processes.
Technology	• The technology in coloring good batik • The use of computers to design batik • The internet technology in product marketing "Batik Sains"
Engineering	• Designing scientific batik • Determining the tools and materials that will be used to extract natural materials • Determining the duration of the brewing process in the extraction stage • Designing natural color mixtures and different fixations so that they become a unique color blend • Designing how many times and how long the fabric is dyed to the desired color strength.
Mathematics	• Evaluating product results for design improvement • Calculating distances and sizes in the pattern of science batik • Measuring the composition of the ingredients required for each color extraction • Calculating the amount of extraction produced against the required number of fabrics • Calculating the number of material and technology requirements if the scale of manufacture is enlarged and multiplied • Calculating the required capital, so that it can determine the selling value and the losses incurred

**Figure 2.** The Activity of Batik-Making through PjBL Ethno-STEM Model

3.2. The Product of Ciwaringin Batik Sains through Ethno-STEM PjBL

The implementation of Biotechnology learning through PjBL Ethno-STEM to PGSD students resulted in several scientific batik designs, one of which can be seen in fig.2. After being validated, the design was revised and then re-designed and collaborated with the typical Ciwaringin batik design, so that the modified scientific batik design was validated through FGD, becoming Ciwaringin scientific batik (fig.3,4,5). Batik Sains Ciwaringin is a collaboration of Ciwaringin batik design with scientific design, both chemical structure design and plant morphology from the natural dyes used. The Ciwaringin Batik product as a result of the implementation of the PjBL Ethno-STEM model in Biotechnology learning was validated by several expert validators, and was revised several times until it resulted in

"good" and "very good" categories, and got the conclusion "ready to produce, with little improvement and no improvement".

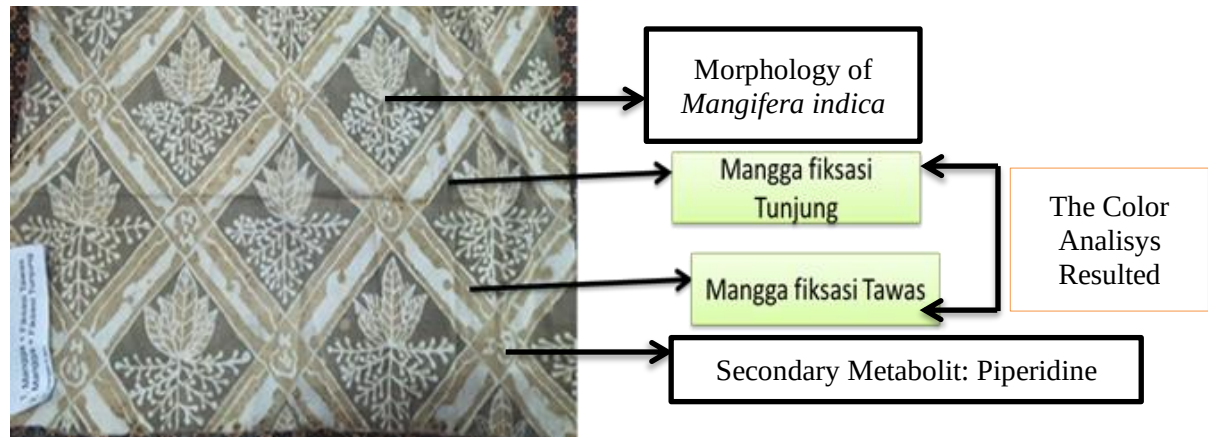


Figure 3. The result analysis: the Example of Natural Dyes in a Batik design (initial product)

The results of the revision of the batik design which were designed from Ciwaringin original design with scientific design through the Corel Draw design application program, which resulted in several designs, one of which is:

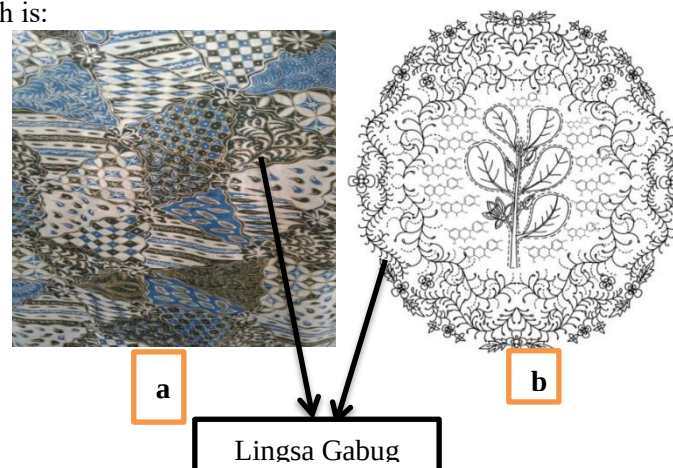


Figure 4. The model of lingsa gabug, (a) the original design of Ciwaringin people, (b) scientific design.

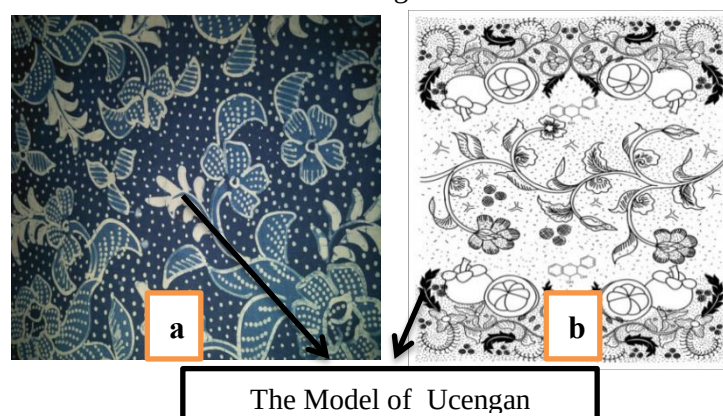


Figure 5. The Model of Ucengan Design, (a) the original design of Ciwaringin people, (b) scientific design.

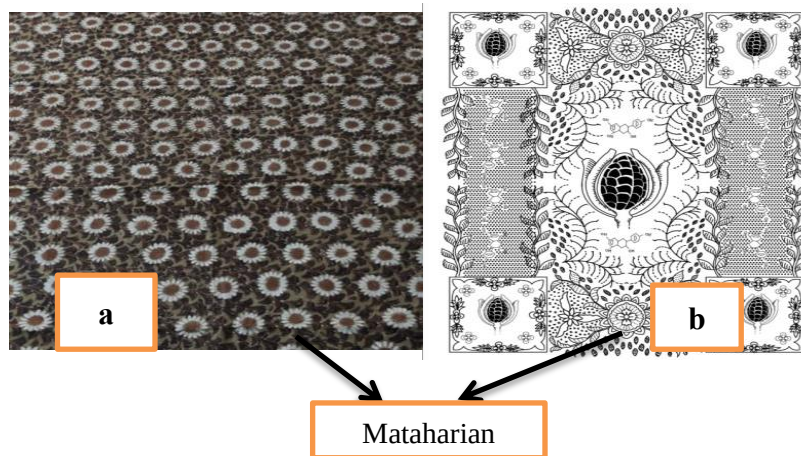


Figure 6. The Model of Mataharian, (a) the original design of Ciwaringin people, (b) scientific design.

The following are some of the final products of Ciwaringin science batik which have been validated several times by several validators to the conclusion "ready to sell" that can be seen in tables 3,4, 5.

Table 3. Ciwaringin Science Batik “Piperidine Seribu Daun”

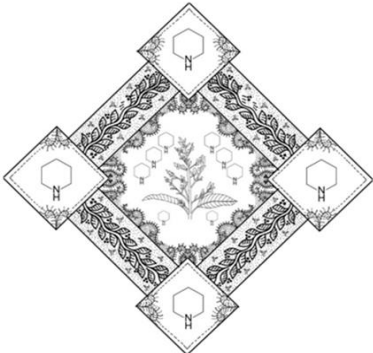
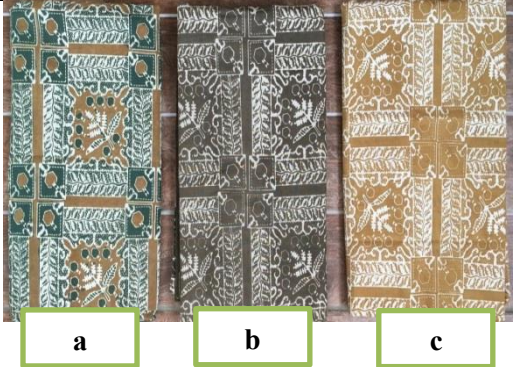
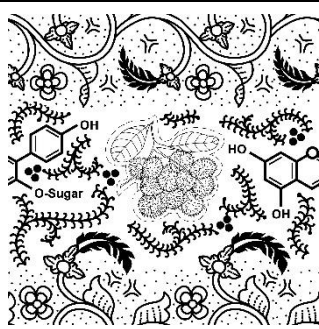
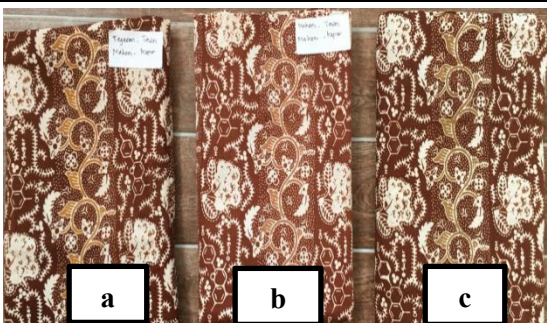
The Design of Batik Sains	The Product of Batik Sains “Piperidine Seribu Daun”
	
• Symbolic Meaning: Ciwaringin Batik Science “Piperidine Seribu Daun” is a collaboration of the unique Ciwaringin thousand leaf design with the piperidine compound structure contained in mango (<i>Mangifera Indica</i> L), which produces brown color, but it depends on the fixation result. This thousand leaf design is in the form of vine leaves, which have the meaning of togetherness in protecting the environment to preserve mango which is a local plant of Cirebon. The color of batik: - Using two natural dyes, namely Tegeran and Indigo wood, with two different types of fixation materials. The first staining with Tegeran then fixed with alum to produce a yellow color, the second staining with Indigo and then fixed with vinegar to produce a bottle green color. - Using one natural dye, namely mango bark, but with two different fixation ingredients. After staining with mango, the first fixation using alum produces a light yellowish brown color, after that, the second fixation with arbor material produces a darker dark gray color. - Using one natural dye, namely mango bark, but with two different fixation ingredients. After staining with mango, the first fixation using alum produces a light yellowish brown color, after that, the second fixation with lime produces a slightly dark yellow color. • Price per cloth (2.5 x 1 m) IDR 300,000	

Table 4. Ciwaringin Science Batik “Uceungan *Cudrania javanesis*”

The Design of Batik Sains	The Product of Batik Sains “<i>Uceungan Cudrania javanesis</i>”
	
The Description: Ciwaringin batik "<i>Cudrania javanesis</i>" is a collaboration of the typical Ciwaringin "ucengan" batik design with the flavonoid compound structure motif which is a secondary metabolite of the tegeran tree (<i>Cudrania Javanesis</i>). The meaning of this design is the great use in this plant, namely as a natural dye that produces a distinctive yellow color, which is very rarely found in other plants. The Color of Batik: - Using two natural dyes, namely Tegeran and Mahogany, with two different fixations. The first staining with Tegeran, then fixation with alum to produce yellow, then the second staining with Mahogany then fixation with alum which produces a maroon color. - Using one natural dye, namely tegeran, with two different fixation ingredients, namely, alum and tunjung. First staining with tegeran, then fixed by alum to produce a yellow color. Then the second stain with tegeran and fixed with a gazebo produces a dark gray color. - Using one natural dye, namely tegeran, with one fixing ingredient, namely, alum. First staining with tegeran, then fixed by alum to produce a yellow color. - Price per cloth (2.5 x 1 m) IDR 300,000	

Table 5. Ciwaringin Science Batik “Antosianin Dampyang luber”

The Design of Batik Sains	The Product of Batik Sains “Antosianin Dampyang luber”
	

Description:

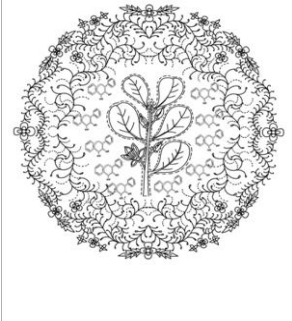
The anthocyanin content in the rambutan fruit skin which has enormous benefits is combined with the typical Ciwaringin “Dampyang Leber” design that adorns the lines of each of these rambutan morphologies which can provide an overview of the rhythm of the overflowing air so that it means that the natural coloring of the rambutan rind must be preserved in environmental conservation.

The Color of Batik:

- Using two natural dyes, namely Tegeran and Mahogany, with two different fixation ingredients (alum and lime). The first staining with Tegeran was then fixed with alum to produce a yellow color. Then the second stain with Mahogany fixed with alum produces a brown color.
- Using one natural dye, namely Mahogany, with two different fixing ingredients (lime and tunjung). First staining with mahogany and then fixation with lime to produce a light brown color. Then the second coloring with Mahogany which is fixed with a gazebo produces a slightly dark brown color.
- Using two natural dyes, namely Rambutan and Mahogany, with two different fixing ingredients (alum and tunjung). The first staining with rambutan then fixed with alum to produce a light brown color. Then the second stain with Mahogany which is fixed with arbor produces brown color.

Price per cloth (2 x 1.25 m) IDR 300,000

Table 6. Ciwaringin Science Batik “Tanin *Curiops tagal*”

• The Design of Batik Sains	• The Product of Batik Sains Ciwaringin “Tanin <i>Curiops tagal</i> ”
	
Description: Batik Sains Ciwaringin "Curiops tagal tannins" is a collaborative design of tannins as secondary metabolites found in the bark of Tingi, surrounded by the typical design of Ciwaringin isen tabu drum, and lingsa gabug. The drum taboo is a form of drumming, which originates from the repertoire of Islamic culture. The drum and musician are very familiar with the Ciwaringin people, so that they appreciate one of the isen characters of Ciwaringin, while the Isen lingsa Gabug, which surrounds the high design, can be interpreted as a guard in environmental conservation of this plant. The Color of Batik: - Using two natural dyes, namely Mango and Mahogany, with two different fixation ingredients (alum and lime). The first staining with Mahogany and then fixation with alum produces a yellowish brown color. Then the second stain with Mahogany fixed with alum produces a brown color. - Using two natural dyes, namely Rambutan and Mahogany, with two different fixing agents (alum and lime). The first staining with Rambutan was then fixed with alum to produce a	

creamy brown color. Then the second stain with Mahogany which is fixed with chalk produces a slightly dark brown color.

- c. Using two natural dyes, namely Tegeran and Indigo, with two different fixing ingredients (alum and vinegar). The first staining with Tegeran was then fixed with alum to produce a yellow color. Then the second stain with Indigo fixed with vinegar produces a bottle green color.

Price per cloth (2 x 1.25 m) IDR 300,000

3.3. The Result of Validation Product of Batik Sains Ciwaringin

The product of Batik Ciwaringin shown in the table 3, 4, 5 were validated by 5 validators. The result of validation can be seen in the following figure 7 and 8.

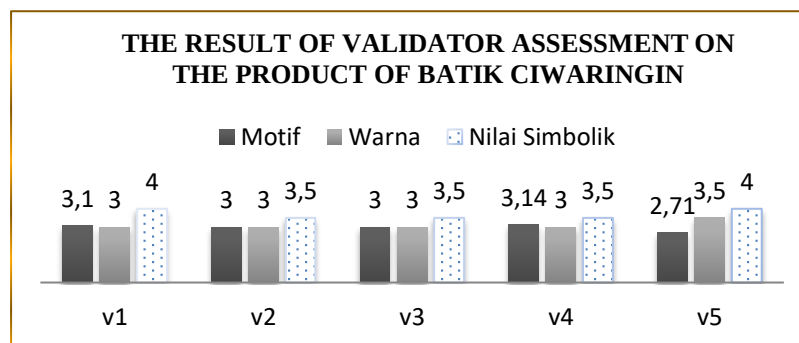


Figure 7. The Graph of Validator Assessment

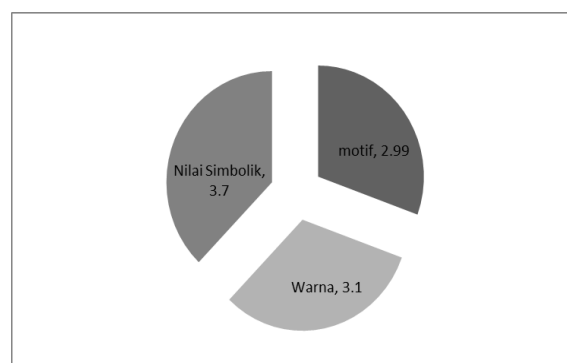


Figure 8. The Result of Validation

The result of mean score of the validation product for batik Ciwaringin is based on 3 aspects (fig. 7); design (7 assessment indicators), color (4 assessment indicators), and Symbolic meaning (2 assessment indicators). The conclusion of the validation score (fig. 8) for the design assessment has a mean score of 2.99. If it is converted to the standard qualification the assessment, it has the qualification of "Good", so the creation of the ciwaringin science batik motif by these students is ready to be produce.

The color aspect in scientific batik products resulted in a mean score of 3.1 (fig.8), while the aspect of symbolic meaning values resulted in a mean score of 3.7 (fig.8). So that the color aspect produces the "good" category while the symbolic meaning value aspect results in the "very good" category, this means that the use of natural dyes in this product is ready to produce. In this study, students succeeded in creating scientific batik products using natural dyes, this is in line with research conducted by [15] showing that through ethno-STEM PjBL on the concept of terpenes, steroids, flavonoids, and alkaloids, it can develop student entrepreneurship and produce chemical batik design so that it is ready to produce for economical demand. In this research, PjBL Ethno-STEM, in addition to learning science concepts, students are also creative in developing regional batik, so it is able to preserve the cultural heritage of Ciwaringin batik. According to [25], the schools must be able to instill the cultural values of the

community so that students can foster a love for culture and preserve it. According to [26], learning based on local wisdom by positively appreciating jumputan batik as a local cultural heritage produces a very high value of science process skills, namely 60%. Learning in schools by integrating batik culture is an effort to form networks in the field of education as a strategy for preserving intangible cultural heritage [27].

4. Conclusion

The implementation of the PjBL Ethno-STEM model in Biotechnology Learning for PGSD Students, can apply the concept of biotechnology and is also creative in developing Ciwaringin batik design in collaboration with scientific design that produce several Ciwaringin scientific batik products. It can also preserve the heritage of the batik culture in the area. This research can be developed for further research in developing and preserving batik in other regions in Indonesia. The implications of this research are expected to stimulate the young generation to take an active role in preserving and developing the Indonesian batik industry, as well as preparing students in the era of the industrial revolution 4.0.

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