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Development of a Tulungagung Batik Booklet as an Ethnoscience-Based Chemistry Learning Resource

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ABSTRACT

Tulungagung Batik is a culture that needs to be introduced to chemistry students. One of the efforts is to provide a chemistry booklet with the theme Batik Tulungagung. Students have never used booklets based on ethnoscience. This research aims to develop a chemistry booklet based on Tulungagung Batik ethnoscience, describing the feasibility and student responses to the booklet developed. The research method used is research and development using a 4D model. This research involved 67 students who filled out questionnaires, three lecturers as validators, and five students who were interviewed. The instruments used are a needs questionnaire, interview sheet, validation sheet, and response sheet. Data in the form of suggestions and interview results were processed qualitatively, while data from validation and questionnaires were processed descriptively qualitatively. The research results showed that the suitability of the Tulungagung Batik ethnoscience booklet in terms of content was 95.24%, a presentation was 94.44%, language was 90.37%, and graphics was 90.67%. The student response to the Tulungagung Batik ethnoscience booklet was 85.86%. Thus, the booklet developed is very good for use as an independent learning resource in studying chemistry.

INTRODUCTION

Tulungagung is a region renowned for its local wisdom, batik. Some batik producers in Tulungagung include Batik Gadjah Mada, Batik Barong Gung, and Batik Satrio Manah. Tulungagung batik, unlike other regions, is characterized by its motifs incorporating Tulungagung's local wisdom, such as Tulungagung flora and fauna, parang and kendang motifs, and Krisna puppet motifs (Annisa & Silfianah, 2023; M. Putri & Josef, 2021; Shanti & Ratyaningrum, 2016).

Batik is a form of cultural heritage and an integral part of Indonesia's national identity. It has been known to the Indonesian people since ancient times and continues to develop today. Batik has been recognized by UNESCO as an Intangible Cultural Heritage of Humanity, which further underscores its cultural importance. Therefore, it is essential that batik be preserved and passed down from generation to generation.

As a world cultural heritage, Indonesians should take pride in wearing their own batik creations and introducing batik to students, including those at the university level. In this era of globalization, however, Indonesians face challenges due to the rise of diverse fashion trends that may shift public interest away from batik. In line with Indonesia's National Education System Law No. 20 of 2003, which states that the foundation of national education lies in the

nation's religious and cultural values, the integration of culture into school and university learning is crucial.

In science education, there is an approach that considers culture as an object of study, known as ethnoscience. Ethnoscience refers to the process of transforming indigenous or traditional knowledge into scientific understanding. True scientific knowledge encompasses all knowledge related to the facts and practices of society, which are often derived from beliefs and traditions passed down through generations (Eka Rahayu & Sudarmin, 2015) .Ethnoscience-based learning should be implemented to help prevent Indonesia's noble cultural values from being eroded by globalization.

Several studies have demonstrated the benefits of ethnoscience-based learning, including improving students' scientific literacy (Melyasari et al., 2018), providing real-life experiences and fostering environmental awareness (Fahrozy et al., 2022), enhancing learning outcomes and creative thinking skills (Damayanti et al., 2017), and improving overall academic achievement (Lia et al., 2016), enhance cognitive and critical thinking ability (Arfianawati et al., 2016). (Dewi et al., 2019) also emphasized that chemistry lecturers need to design learning programs that utilize local cultural potential to strengthen students' scientific literacy.

One example of local culture in Tulungagung previously explored by researchers is the Reog Kendang dance, which serves as an ethnoscience-based learning source for developing students' character (Fitriyah & Wahyuni, 2022). Research on regional batik in the context of education has also been carried out by (Astriandini & Kristanto, 2021) and (Safitri et al., 2022). However, these studies focused primarily on an ethnomathematics approach rather than ethnoscience. Meanwhile, a study on Tulungagung batik was conducted by (Afifah et al., 2020), but it has not yet been associated with chemistry learning.

Research linking batik to chemistry has been carried out by (Warli & Musa, 2022) as well as by (Azizah & Premono, 2021). These studies examined chemical concepts related to the batik-making process; however, they have not been developed into learning resources or teaching materials. Further research on the development of ethnoscience-based teaching materials was conducted by (Utari et al., 2021), whose resulting learning media were found to be suitable for use in chemistry education.

Research has been conducted to develop ethnoscience-based teaching materials for Pekalongan batik. (Lia et al., 2016) research developed an ethnoscience-based module for Pekalongan batik and produced a highly valid mo[1]dule that could improve student learning outcomes. Development an E-module integrated with Etno-STEAM has been researched by (Fikriana et al., 2023), resulting in highly feasible teaching materials and a very high response. Both studies examined Pekalongan batik on electrolyte and non-electrolyte solution materials. Therefore, it is necessary to develop ethnoscience batik teaching materials that examine other chemical concepts.

To date, no research has specifically examined Tulungagung batik from a chemistry perspective. Based on interviews with several chemistry lecturers, Tulungagung batik has the potential to serve as an ethnoscience-based topic that can be integrated into chemistry learning. Likewise, interviews with chemistry education students revealed that many students still lack an understanding of ethnoscience-based learning or of the chemical concepts that can be related to the batik-making process in Tulungagung, such as the types of dyes used, the kinds of fabrics involved, and aspects of batik waste management.

Given the above, it is essential to explore Tulungagung batik in relation to chemical concepts and to develop it further as an ethnoscience-based learning resource. This study analyzes the chemical concepts associated with batik, particularly those found in the production process, through observation and interviews with local batik artisans. The findings are then used

to develop a chemistry learning resource in the form of a booklet. The use of booklets in chemistry learning has been shown to positively influence student learning outcomes (Lingga & Silitonga, 2022) and to receive very favorable responses from students (Wijayanti et al., 2022). The teaching materials were developed in booklet form because booklets are concise, practical, and visually engaging, containing essential material that aligns closely with the research results.

METHODS

Research Design

This study employed a research and development (R&D) approach using the 4D development model proposed by Thiagarajan (1974), which consists of four stages: Define, Design, Develop, and Disseminate. The process produced a learning product in the form of an ethnoscience-based chemistry booklet designed as a learning resource for chemistry education students. This research was conducted up to stage develop. The define stage involves curriculum analysis, needs analysis, task analysis, and concept analysis. The curriculum analysis includes graduate profile analysis, learning outcomes, and analysis of courses taught in the chemistry education study program. The needs analysis was conducted through a questionnaire distributed to chemistry education students at UIN Sayyid Ali Rahmatullah Tulungagung. Interviews were also conducted with lecturers, owners of the Satrio Manah and Gajah Mada batik industries in Tulungagung, and chemistry students at Surabaya State University. The task and concept analysis involved identifying important concepts that will be presented in a booklet related to Tulungagung batik.

In the design stage, the following steps were taken: (1) designing the booklet format, namely determining the size, number of pages, color, and visual style; (2) creating a storyboard (page structure and flow of images and text); (3) determining the delivery strategy, including writing style, fonts, illustrations, and layout; and (4) preparing assessment instruments in the form of validation sheets and response questionnaires. In the development stage, a prototype booklet was prepared containing content supplemented with images, videos, and practice questions. Once the booklet was completed, it was validated by three material and media experts. Revisions were made based on suggestions and input from the validators. After the initial revision, the booklet was trialed with students. The final stage involved product revision, resulting in a booklet based on Tulungagung batik ethnoscience. The following is an image of the booklet development research design.

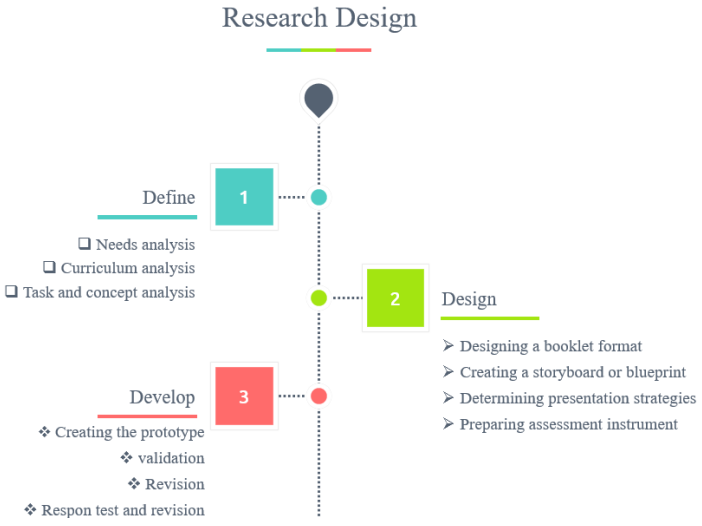

Figure 1. Booklet Developmet Stage Chart

Research Target

The subjects of this study included chemistry education students, owners of the Satrio Manah and Gajah Mada batik enterprises, and lecturers who served as validators. Preliminary data on the need for the booklet were collected from 67 chemistry education students at UIN Sayyid Ali Rahmatullah Tulungagung through questionnaires and five chemistry education students from Surabaya State University through interviews. The validation process involved three expert lecturers—one from the Chemistry Education Department at Malang State University and two from the Chemistry Education Department at UIN Sayyid Ali Rahmatullah Tulungagung.

Research Data

The data obtained in this study are data on the need for teaching materials, chemical concepts related to batik feasibility and student responses to the ethnoscience-based Tulungagung Batik booklet.

Research Instruments

The instruments used in this study included a preliminary study instrument, a booklet validation instrument, and a booklet response instrument. The preliminary study instruments consisted of interviews and questionnaires. The booklet validation instruments consisted of material expert validation and media expert validation. The student response questionnaire contained statements on aspects of display, content, and benefits.

Table 1. Data, Source of Data and Instruments

No.	Data	Source of Data	Instrument
1	Needs analysis	Lecturers and students	Interview and questionnaire sheets
2	The concept of chemistry in batik	Tulungagung batik business owner	Interview and observation instruments
3	Feasibility	Lecturers	Feasibility validation instrument
4	Respons	Students	Response questionnaire

Data Analysis

Data obtained from interviews and validator feedback were analyzed using descriptive qualitative methods. Meanwhile, feasibility data and student responses were analyzed using descriptive quantitative methods by calculating the percentage scores.

RESULTS AND DISCUSSION

1. Development Process of the Ethnoscience-Based Tulungagung Batik Booklet

a. Define

Based on the needs questionnaire data, it was found that most students find it difficult to relate chemistry to everyday life. One reason is the lack of learning resources or teaching materials. Chemistry is the science that studies matter. As is known, matter is anything that occupies space and has mass, and this is certainly abundant in everyday life. Based on the questionnaire data, it can be seen that students need teaching materials that are interesting, easy to understand, accompanied by images and videos, and provide examples or applications in everyday life. One way is to introduce local culture or wisdom in chemistry learning. According to research (Hidayati & Julianto, 2025), learning that links science concepts with local culture and wisdom can increase students' motivation and critical thinking skills.

In addition to administering the questionnaire, a needs analysis was also conducted through interviews. Interviews with chemistry lecturers at UIN Sayyid Ali Rahmatullah Tulungagung revealed that chemistry lessons that incorporate Tulungagung batik as a theme are necessary. This aims to introduce Tulungagung batik culture to students,

making the learning meaningful because it relates to everyday life. The owners of Satrio Manah and Gajah Mada batik also expressed a similar sentiment, stating that chemistry students need to be familiar with Tulungagung batik to develop a love for the culture.

Interviews with five final-year chemistry students at Surabaya State University revealed that they had never studied chemistry in a way that connected it to local culture or wisdom. The results of the interviews with the chemistry students were similar to the results of a questionnaire distributed to chemistry education students at UIN Sayyid Ali Rahmatullah Tulungagung. The majority (95.5%) of students stated that they had never received chemistry lessons related to Tulungagung batik.

Tulungagung batik can be introduced to students by creating ethnoscience-based chemistry teaching materials. Based on student interviews and a needs questionnaire, no one has used chemistry teaching materials related to batik. One teaching material that can be used in chemistry learning is a booklet. All students interviewed had never used a booklet in chemistry learning. Meanwhile, the questionnaire results showed that 92.5% of students had never used a booklet as a chemistry learning resource. Both interview and questionnaire respondents strongly agreed that a chemistry booklet with a Tulungagung batik theme should be developed.

The booklet developed in this study contains chemical concepts related to Tulungagung batik. Data on chemical concepts related to Tulungagung batik were obtained from the results of triangulation methods, namely field observations, interviews, and literature studies. Observations were carried out to observe the tools and materials used in batik making. In addition, observations were also made during the Tulungagung Batik making process. This research was conducted at the Satrio Manah and Gajah Mada Batik industries in Tulungagung. The data obtained are processed in the following table 2:

Table 2.Chemical Concepts Related to Tulungagung Batik

No	Stages/Process of Making Batik	Chemistry Concept
1	*Molani*	Organic chemistry (carbon used in pencils)
2	*Nyanting/ngecap*	Elemental chemistry (The *canting* used is made of copper)
3	Pewarnaan	Organic chemistry (naphthol is a group of phenols)
4	*Nemboki*	Organic Chemistry (*malam*)
5	Color lock	Chemical bond (Use salt to lock in color) Napthol with diazonium salt Indigosol with HCl Remazol with $Na_2(SiO_2)$
6	*Pelorodan* (boiling)	Organic Chemistry (intermolecular forces) Environmental chemistry (laundry waste)
6	Coloring	Physical chemistry (soap colloid) Environmental chemistry (laundry waste)
7	Drying	General chemistry (change of matter)

b. Design

The booklet was compiled using CorelDRAW 2020. A video of the production process was recorded using a camera and edited using Filmora. The resulting video was then uploaded to YouTube. Within the booklet, the video link was converted into a barcode scan using the ME-QR website.

c. Develop

The booklet was then validated by three chemistry lecturers. After validation, the next step was to revise the booklet based on the validator's suggestions and input. The material expert's suggestion was to add the application of Tulungagung Batik chemistry

to chemistry lessons. Furthermore, the validator's suggestion was to add a reflection at the end. Based on these suggestions, the booklet was revised by adding the implementation of the ethnoscience booklet in chemistry lessons and its reflection. The reflections were presented in the form of crossword puzzles and essay questions. Suggestions from the three media experts, including typos and the need to add image identification, particularly regarding chemical formulas, were also revised. After revision, the booklet was distributed to students to gather feedback. Twenty-four third-semester students and 21 fifth-semester students responded to the booklet. The responses were analyzed and used as considerations for booklet revisions. The following is an image of the booklet display after being revised based on suggestions from the validator.

Figure 2. Booklet Display after Being Revised

2. Feasibility of the Ethnoscience-Based Tulungagung Batik Booklet

Feasibility data were obtained from the assessments of three validators—two subject matter experts and one media expert. The results of the expert validation are presented below.

Table 3. Booklet Validation Results

Validator	Material Assessment	Media Assessment
1	98.18%	99%
2	82.73%	78%
3	98.18%	95%
	93.03%	**90.67%**

The validation results indicate that the developed booklet is highly suitable for use in chemistry learning. This conclusion is based on the calculated averages of the material assessment (93.03%) and media assessment (90.67%). These findings are consistent with those of (Hakim et al., 2023; N. M. Putri et al., 2023; Zuyina & Widodo, 2020) who also reported that ethnoscience-based booklets are suitable learning materials.

Table 4. Results of Material Assessment

No.	Feasibility	Score	Persentage (%)	Criteria
1	Content	100	95.24	Very good
2	Presentation	85	94.44	Very good
3	Language	122	90.37	Very good

Based on the results presented in Table 2, the content feasibility of the booklet reached 95.24%, which falls under the highly suitable category. The assessment of content feasibility included aspects such as material coverage, accuracy, currency and contextual relevance, as well as the application of scientific and entrepreneurial skills. The presentation feasibility, obtained from the validation results, was 94.44%, also categorized as highly suitable. The presentation criteria evaluated included presentation techniques, supporting materials, learning structure, and overall presentation completeness. The language feasibility was 90.37%, which was classified as highly feasible. The linguistic criteria assessed by the validators covered appropriateness for university students' cognitive development, readability, clarity, coherence and logical sequence of ideas, adherence to language conventions, and appropriate use of terminology. Finally, the graphic feasibility, as evaluated by media experts, reached 90.67%, indicating a high level of suitability. The graphic aspects assessed included booklet size, cover design and layout, content arrangement, and typography.

3. Student Response to the Tulungagung Batik Ethnoscience Booklet

The booklet, which had been revised based on suggestions from the validators, was subsequently tested on students to obtain data regarding their responses to the developed material. A total of 45 students participated in the trial, consisting of 24 third-semester and 21 fifth-semester chemistry education students. The results of the student response assessment are presented in Figure 1.

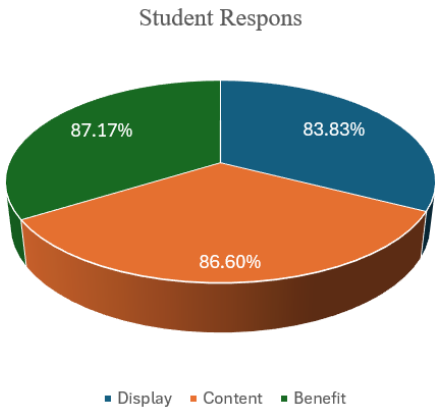

Figure 3. Student Responses to the Tulungagung Batik Ethnoscience Booklet

The results indicate that students responded very positively to the Tulungagung Batik Ethnoscience Booklet. This is evident from the overall average score of 85.86%, with details of 83.83% for the display aspect, 86.60% for the content aspect, and 87.17% for the benefit aspect. Responses to the display aspect included several indicators: the attractiveness of the booklet cover (77%), the use of color variations (79%), the readability of the text (89%), the use of sentences following standard Indonesian grammar (PUEBI) (85%), and the effectiveness of images in supporting students' understanding of the chemistry material (87%).

Students' responses to the content aspect indicated that the material presented in the booklet was easy to understand and did not lead to multiple interpretations (87%). The alignment of the material with the table of contents received a response of 88%. The terminology used in the booklet was considered clear and easy to comprehend (82%), while the language was viewed as communicative and easy to understand (85%). The highest response, 91%, was obtained for the statement that the material in the booklet enhanced students' understanding of chemistry and its relationship with Tulungagung batik.

In addition to the display and content aspects, students also provided feedback on the usefulness of the booklet. The booklet as a learning resource was perceived to enhance knowledge about Tulungagung batik, receiving the highest response of 95%. As a learning medium, the booklet was also reported to increase students' motivation to learn (83%). Students agreed that the booklet could be used anytime and anywhere (86%), could serve as an independent learning resource (87%), and could be reviewed repeatedly (87%). Furthermore, the booklet was considered practical, easy to carry, and convenient to store (85%).

The results of this study are consistent with previous research, which reported that students showed positive responses and interest in ethnoscience-based booklets (Putri et al., 2023). In addition to receiving favorable responses, ethnoscience-based booklets have also been shown to enhance students' scientific literacy skills(Hakim et al., 2023; Magfiroh et al., 2025), improve learning outcomes and student engagement (Andayani et al., 2025; Mahendrani & Sudarmin, 2015), and increase students' interest in learning (Mubin et al., 2024).

Based on the trial results, the lowest response percentages were observed for the cover attractiveness (77%) and color variation (79%) indicators. Although still categorized as *good*, these were the lowest among all evaluated aspects. Consequently, revisions were made to the cover design, and several color variations were improved to enhance visual appeal.

Figure 4. Revised Cover and Content Layout of the Tulungagung Batik Ethnoscience Booklet

CONCLUSION AND RECOMMENDATIONS

The development of the Tulungagung Batik ethnoscience booklet was carried out through the stages of Define, Design, and Develop. The research began with a curriculum analysis and a needs analysis for the booklet. The needs analysis was conducted through interviews with lecturers, batik business owners, and other relevant stakeholders. In addition, observations were made of the batik production process at Gajah Mada and Satrio Manah. This was followed by a concept analysis stage related to the chemistry involved in batik production. During the design stage, storyboards and videos were created, and the booklet was compiled. In the development stage, the booklet underwent validation by both subject matter experts and media experts. It was then revised based on suggestions and feedback from the validators. Subsequently, the booklet was tested with students to obtain response data, after which further revisions were made.

The feasibility of the Tulungagung Batik ethnoscience booklet achieved the following scores: content 95.24%, presentation 94.44%, language 90.37%, and graphics 90.67%. These results indicate that the developed booklet is highly feasible and can be effectively used as a chemistry learning resource. The student response to the booklet averaged 85.86%, suggesting that the developed material is very well-suited for use as an independent learning resource in chemistry education.

This study was conducted only up to the limited trial stage. Therefore, further research should be carried out through wider-scale trials of the developed booklet. In addition, future studies on teaching material development may focus on incorporating other forms of local culture or wisdom from different regions. For lecturers, the results of this study can serve as teaching material for explaining chemistry concepts related to the batik-making process in Tulungagung. For students, the developed booklet can be used as an independent learning resource, allowing them to learn about Tulungagung Batik while studying chemistry. It is therefore expected that students will gain a better and more contextual understanding of chemistry concepts related to the tulungagung batik making process.

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