

# Integrating Semarang's Local Wisdom into R-STEAM (Religion-Science, Technology, Engineering, Art, Mathematics): A Case Study of Lawang Sewu, Batik, and Lumpia

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**Abstract:** An exploration of the local wisdom of Semarang City through the R-STEAM (Religion, Science, Technology, Engineering, Arts, and Mathematics) approach shows the integration of local cultural, historical, artistic, and culinary values with the application of R-STEAM to Lawang Sewu, Semarangan batik, and Semarang spring rolls. This study enriches the understanding of science and technology while strengthening cultural awareness and local identity. Lawang Sewu, as a historical building, becomes an ideal model to study mathematics in geometry, as well as the integration of religious values and art in construction. Batik Semarangan represents the application of R-STEAM in the exploration of the art and technology of batik making, including the use of natural dyes and modern engineering techniques for innovative motifs. Finally, Semarang spring rolls within the R-STEAM framework encompass traditional food processing techniques, health and nutrition aspects, and innovative approaches in combining tradition with modern technology in the culinary industry, particularly in relation to healthy food learning. Overall, the application of R-STEAM tools in this exploration of Semarang's local wisdom provides significant opportunities to integrate cultural heritage with science, technology and arts learning. Practical implications include recommendations for educational curriculum development that integrates R-STEAM with local wisdom, as well as the formulation of education policy that supports the preservation and utilization of local culture in the context of modern education.

**Keywords:** Local wisdom; Pedagogic; Religion; STEAM

## Introduction

State Semarang grows as a multicultural city that produces diverse local wisdom (Anam et al., 2018). Local Wisdom in Semarang City emerged through the internalization process between humans and the environment, resulting in the development of local knowledge, beliefs, and beliefs in the surrounding community to manage and utilize existing natural resources wisely (Njatrijani, 2018; Thoifah Amalia & Purwaningsih, 2017). Based on several studies conducted by researchers, it shows that strengthening

local wisdom through learning makes learning more interesting because the learning content is contextual (Fathurrahman et al., 2021), students become more creative in the process of creating a local wisdom and gain experience from cultural values in the learning process (Kiptiyah et al., 2021; Syakir et al., 2022).

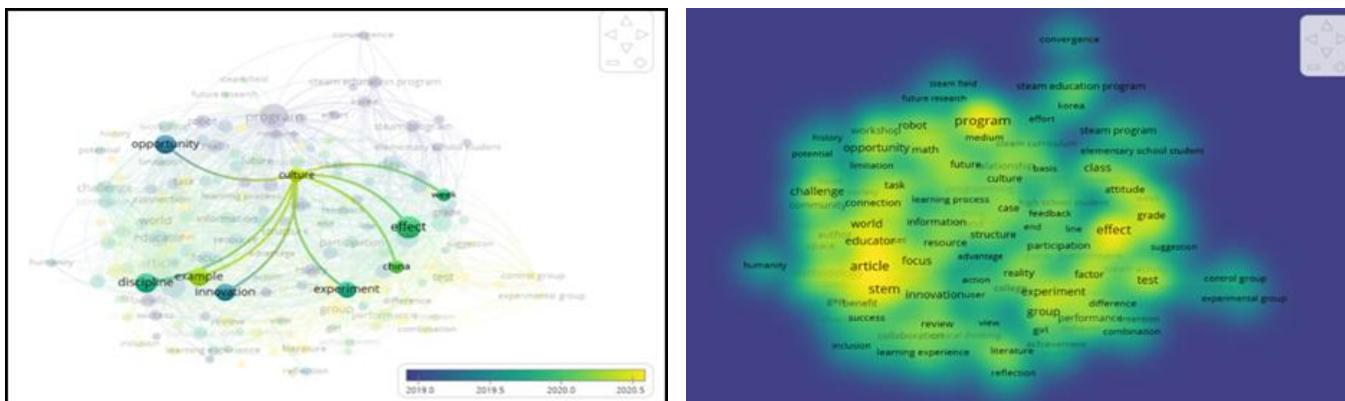
Several studies explain the importance of integrating local wisdom in education to build learning experiences and strong relationships between students and their environment, thus enriching students' learning experiences, and inspiring a sense of pride in local culture and heritage (Cajot, 2020; Kamalia Devi et al.,

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2018). One approach that is widely used by several researchers is the STEAM (Science, Technology, Engineering, Arts, and Mathematics) approach. STEAM focuses on learning real-world situations to develop innovative thinking and skills in solving problems (Neneng Nur & Mulyawan Safwandy Nugraha, 2023; Nurwulan, 2020). STEAM as an effort to equip appropriate skills for students in facing global changes (Anisak et al., 2022; Indah Arsy & Syamsulrizal, 2021). Learning through the STEAM approach is based on the presentation of contextual problems, thus encouraging

students' enthusiasm to connect their knowledge with its application in life which is presented in the context of local wisdom (Isharyadi, 2018; Qomaria & Wulandari, 2022; Sumarni & Kadarwati, 2020). STEAM is able to strengthen critical thinking, problem solving, creativity, and collaboration skills (Ragil Widiyanto Atmojo et al., 2020). As a reinforcement of the integration of STEAM and local wisdom, researchers conducted a Vos Viewer bibliometric analysis which can be seen in Figure 1.



**Figure 1.** STEAM Domain Visualization Figure and Research Opportunity Visualization

Figure 1 shows a visualization of the STEAM program, the involvement of STEAM with humanity, and local wisdom has not been done much so this is a novelty in this research to integrate local wisdom within the STEAM framework. When viewed in Figure 1, to overshadow the humanitarian aspect, it requires the aspect of religion in its integration. (Aulia Azizah et al., 2021)explains that Indonesia has 5 pillars of education including strengthening faith, devotion, and noble character, so adding religion can facilitate the fifth pillar adopted by Indonesia. Some studies explain that religion and knowledge do not have contradictions, but these two aspects reinforce each other as a balance (Howard Ecklund & Scheitle, 2017; Howard Ecklund Elaine, 2020). Therefore, through the exploration of local wisdom in the R-STEAM framework, it is an effort to strengthen students' cultural identity with spiritual, moral and local wisdom values that are part of their identity. Based on the above background, the following problem formulation is presented. (1) How can the exploration of local wisdom in Semarang City be done in the R-STEAM framework? (2) What are the potential R-STEAM tools that can be identified through the exploration of local wisdom in Semarang City?

Based on the formulation of the research problem, this project aims to produce an exploration of local wisdom in Semarang City in the R-STEAM framework, and potential R-STEAM tools that can be identified. These findings can serve as a basis for

policy/recommendations for curriculum development in PGSD and Primary School Study Programs. Potential R-STEAM tools obtained through local wisdom exploration focus on the impact found from local wisdom on learning content using the R-STEAM framework. Previous research found that integrating local wisdom has a positive impact on science learning at the elementary and junior high school levels (Hidaayatullaah et al., 2021). Another study also confirmed that it is necessary to strengthen national and cultural components in pedagogical education content (Toleubekova et al., 2022). Therefore, to do this, the researcher will first explore local wisdom in Semarang city within the R-STEAM framework. The exploration was conducted by researchers with selected informants such as cultural experts and practitioners in the field of cultural heritage in Semarang City related to the historical building Lawang Sewu, traditional food lumpia and presto milkfish, and Semarang batik. This was followed by analyzing what potential R-STEAM tools were found in local wisdom in Semarang City that had been previously explored in learning education pedagogics.

This research will explore local wisdom within the R-STEAM framework in the context of education in Semarang City. So far, research in Indonesia has focused on the context of integration of local wisdom and STEAM approach in learning integration. In fact, local wisdom and STEAM are a large framework that includes

a system. The results of this study aim to be a recommendation for a potential R-STEAM learning design tool with local wisdom found in Semarang City, so that it has an impact on the educational curriculum policy of the PGSD Study Program and education in elementary schools.

Research on local wisdom and STEAM has been widely conducted, especially related to learning. Research conducted (Imron & Shobirin, 2021) shows that through the preparation of teaching materials containing local wisdom can make learning contextualized educational value for students. However, the research he conducted relied on training for the preparation of teaching materials without any aspect of how local wisdom can be integrated into a lesson. Meanwhile, another study explained that the exploration of batik as a culture owned by Indonesia in learning can not only be integrated in art learning, but can also be implemented in science learning (Setianingrum & Jumadi, 2023). Other research results obtained that by adding aspects of religion to STEAM during learning can improve students' social attitudes, because when learning science also teaches scientific attitudes (Azizah et al., 2020).

Other studies are still developing, but focus on the preparation of teaching materials, and meta-analysis studies related to local wisdom and STEAM, while real recommendations based on exploratory research related to potential R-STEAM learning design tools with local wisdom found in Semarang City have not been done. In fact, by combining the three elements of religion, local wisdom, and STEAM will be able to make learning meaningful to students, because it fulfills all aspects of learning, namely related to scientific attitudes, contextual and derived from real problems faced by students through the introduction of surrounding culture that students have. It is important to examine in advance through extracting information related to local wisdom that is incorporated into STEM learning (Sumarni et al., 2020).

This study aims to potential R-STEAM tools with local wisdom in Semarang City before examining their implementation. The local wisdom in Semarang City focuses on Lawang Sewu, spring rolls, presto milkfish, and semarangan batik. Thus, it is expected that through this approach, education will not only be about knowledge and skills, but also about building a deep understanding of culture, religion, and how they interact with knowledge and skills in science, technology, engineering, art, and mathematics.

This project is expected to provide policy recommendations related to the context of R-STEAM learning design with local wisdom. In Figure 2, it can be seen that the research road map for exploring the R-

STEAM learning design with local wisdom for the next 5 years includes a literature study of local wisdom in Semarang City within the R-STEAM framework, followed by research on the development of a validation instrument for the R-STEAM learning design with local wisdom, then the following year research is carried out which focuses on small-scale and large-scale tests of the instruments that have been developed, then in 2027 it is hoped that the results of the research can be used as a reference in developing a policy model in the UNNES PGSD study program curriculum.

## Method

This study is an exploratory qualitative research aimed at gaining a deep understanding of local wisdom within the R-STEAM framework in the context of education in the city of Semarang. Through exploration, it is hoped that potential local wisdom tools within the R-STEAM framework can be identified that can be adapted for learning, so that its implementation focuses on understanding the basic concepts and ideas of local wisdom in the city of Semarang, namely in the categories of cultural heritage in the form of objects (the historic Lawang Sewu building), nationally recognized intangible cultural heritage (bandeng presto and lumpia), and internationally recognized intangible cultural heritage (Semarangan batik).

The exploratory research process begins with the determination of the research topic. At this initial stage, the researcher conducted literature reviews and bibliometric studies related to research opportunities in STEAM and local wisdom. After the research topic was determined, the researcher analyzed journal literature and Scopus metadata related to the topic of local wisdom and STEAM to identify future research opportunities. The research questions are:

- (1) How can the exploration of local wisdom in the city of Semarang be conducted within the R-STEAM framework?
- (2) What are the potential R-STEAM tools that can be identified through the exploration of local wisdom in the city of Semarang?

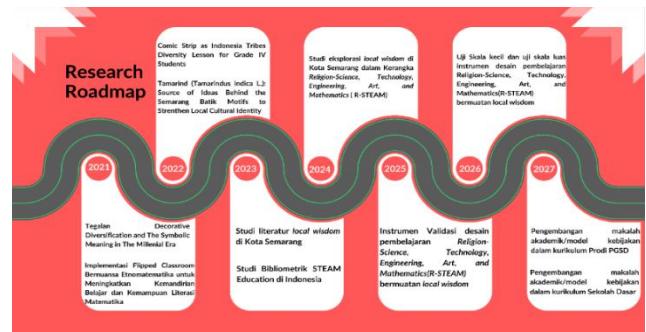


Figure 2. Research Roadmap

Based on the results of the literature review and bibliometric studies, the researcher formulated the research problem that became the focus of the study.

The data collection methods are Focus Group Discussion (FGD), observation, and in-depth interviews. Informants were selected using purposive sampling, with criteria including relevant knowledge and experience related to local wisdom in Semarang City, particularly regarding Lawang Sewu, bandeng presto, lumpia, and Semarangan batik, as well as education experts and cultural activists. In-depth interviews were conducted using a structured interview instrument, designed based on the research problem formulation to ensure consistent and comprehensive coverage of questions. This instrument includes a list of core questions that have been pre-designed, covering aspects of exploring local wisdom within the R-STEAM framework and the potential R-STEAM tools that can be identified.

After all data were collected and deemed to meet all research problem formulation requirements, the researcher proceeded with data analysis. The data analysis technique used is thematic analysis, where data is identified, coded, and grouped into themes relevant to the research question. Data analysis is conducted to uncover findings or patterns relevant to the research question. Based on the data analysis conducted, conclusions will be drawn to serve as recommendations. These conclusions and recommendations can serve as

the basis for future research. The stages related to the research method can be seen in Figure 3.

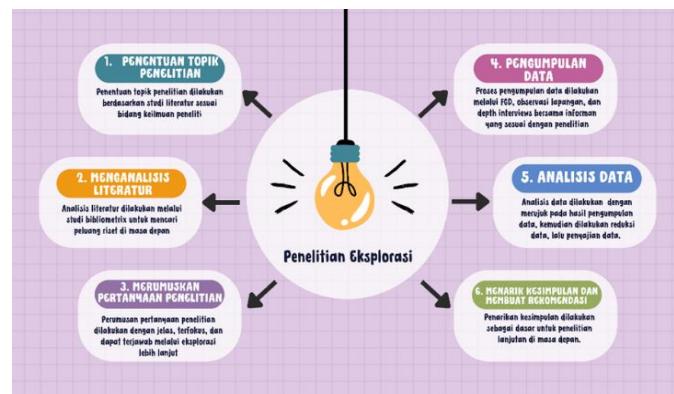


Figure 3. Research Stages

## Result and Discussion

Local wisdom in Semarang City refers to the practices and insights of the local community. This research focuses on three local wisdom practices: the historical building "Lawang Sewu", semarangan batik, and spring roll making. These local wisdoms in Semarang City include traditional ways that have developed over generations and have become an integral part of people's lives. This research uses exploratory research by conducting depth-interviews with three resource persons. The results of the interview are described in the following Table 1.

Table 1. the relationship between Semarang's local wisdom and the R-STEAM framework.

Local wisdom	R-STEAM
Lawang Sewu	The <b>religious</b> aspect is reflected in the Javanese philosophy of the pyramid roof shape. <b>Science</b> is seen in the choice of teak wood material that is tropical weather resistant. Colonial <b>technology</b> is seen in the use of electric generators and water pumps. <b>Engineering</b> is realized in the construction of the building with a knockdown system and chicken claw foundation. <b>Art</b> is present in the European-style architecture with curved elements and stained glass. <b>Mathematics</b> is applied in the geometry of the building, symmetry of door and window layouts, and structural calculations
Batik Semarangan	The <b>religious</b> aspect is reflected in the philosophy of batik motifs that are full of spiritual meaning. <b>Science</b> is present in the use of natural dyes from plants. <b>Technology</b> is realized in traditional batik-making techniques and tool innovations. Technique is seen in the manufacturing process that requires special skills. <b>Art</b> is reflected in the beauty of batik motifs and colors. <b>Mathematics</b> is present in the symmetrical and geometric patterns in batik motifs
Lumpia Semarang	<b>Religious</b> aspects are seen in the respect for ancestral traditions in recipes passed down through generations. <b>Science</b> is reflected in the selection and combination of nutritious ingredients. <b>Technology</b> is present in the adaptation of modern equipment for production efficiency. <b>Engineering</b> is realized in the engineering of ingredient proportions to maintain quality. <b>Art</b> is seen in the aesthetics of presentation and packaging. <b>Mathematics</b> plays a role in calculating the dosage of ingredients for flavor consistency.

For a more in-depth explanation of the relationship between Semarang local wisdom and R-STEAM will be explained as follows

### Lawang Sewu in the R-STEAM framework

Lawang Sewu is a historical building in Semarang City that originally served as the center of the

Nederlandsch-Indische Spoorweg Maatschappij (NIS) railway company. Based on the results of the depth-Interview, several interesting frameworks were obtained that can be drawn on the R-STEAM framework. Lawang Sewu is so named because this building has many doors even though this building actually does not have a thousand doors, but the ancient

Javanese people, when mentioning "many" to others usually mention "sewu". In fact, the original number of doors in Lawang Sewu is 920.

Lawang Sewu has five main buildings that were built in stages. The first building to be built was building C in 1904. Building C was built as a printing office for train tickets and also as a boardroom. Then continued the construction of building D in 1904 built for the guard house that helps maintain the security and operation of the main building. Furthermore, in 1907 building A was built which functioned as the administrative headquarters and operational management of the NIS railroad. Building E was built in the same year, 1907, which functions as an administrative space for NIS operational activities. Finally, building B was built in 1916-1918 which was used as an administrative office space. Interestingly, building A is used only for Dutch employees, while native employees cannot work in the area of building A. Based on some literature, it explains that during the colonial period, this discriminatory practice aimed to maintain the existing social hierarchy, where Dutch society was considered superior to indigenous people. On the other hand, it is also to be able to control and supervise indigenous people to collaborate and resist the Dutch community (Ariestadi et al., 2016; Zed, 2017)

In building D there are also pavilions and chairs. Building D is focused on the smoking area. Dutch society made a regulation that buildings for work must be separated from smoking areas. This was done for health reasons. (Safanta & Bachtar, 2020) also explained that the separation of the workspace from the smoking area was done to maintain worker productivity and health. Not only that, this is also done as a form of social control in public health management (Nasirin et al., 2023; Safanta & Bachtar, 2020). Another interesting point is that the toilets are only in building D. Dutch society has a view that toilets should not be integrated into the main building, but should have their own building. This policy was based on social and health norms prevailing at the time. The separation of restrooms from workspaces aims to keep workers clean and healthy. Research shows that the separation of sanitation facilities can reduce the risk of disease spread, which was a major concern for the colonial government in maintaining public health. Meanwhile, the term "izin ke belakang" used by the public to go to the toilet reflects the communication that developed at that time which considered going to the toilet as something that needed to be politely arranged (Misbahuddin et al., 2021).

In addition, Lawang Sewu is a mixture of European and Javanese styles. The door in Lawang Sewu is a symbol of custom with tropical adaptations in Java, so the door is designed with many holes for air circulation, and is made of teak wood. From a scientific perspective,

tropical areas such as Java are suitable for using teak wood as the right choice for building materials, because of the natural oil content that makes it resistant to weather, decay, and termites (Hardiman, 2012; Wiriantari, 2023).

In addition, the pyramid-shaped roof at Lawang Sewu has a lucky meaning, as it is believed to provide prosperity and harmony for everyone who respects it. In Javanese philosophy, the pyramid symbol is considered lucky because its pyramid-like shape is considered to have spiritual power, and the pyramid shape itself has the meaning of the concept of harmony and balance. In addition, the pyramid shape also symbolizes the relationship between man and God, with the top point of the pyramid pointing upwards is a symbol of connecting with God. This is the Javanese view of life to appreciate the balance between nature, humans, and spirituality (Rohmah, 2020; Utami, 2023). When viewed from an engineering framework, the angle of inclination on the pyramid roof has an influence on structural strength, especially to deal with strong winds, and heavy rain that often occurs in the tropics. While from the Art framework, a pyramid-shaped roof can create a play of light and shadow that adds to the visual dimension of the building when exposed to sunlight (Setiawan & Hartanti, 2014). The picture of the door, and the pyramid roof of Lawang Sewu can be seen in Figure 4.



Figure 4. Miniature Lawang Sewu Building

While the architectural style of Lawang Sewu was designed by Dutch architect, Cosmen Citroen with the use of towers to give a romantic impression, with simple curved architectural elements. Decoration technology such as marble, stone, and stained glass were imported directly from Europe, especially the Lawang Sewu Building A building is still original decoration imported from Europe. This shows the use of sophisticated transportation and logistics technology at that time to support development. The Lawang Sewu building also does not yet use concrete construction. This means that, from an engineering perspective, the building is

modeled after a single stone with one serial number with a knockdown, interlocking system. Building construction techniques like this allow for easier assembly and disassembly. Through the knockdown system, it certainly requires calculating the principles of symmetry and precise mathematical proportions to ensure stability and even load distribution, including the calculation of roof angles and slopes (Dewi et al., 2019). The interlocking/knockdown concept can be seen in Figure 5.

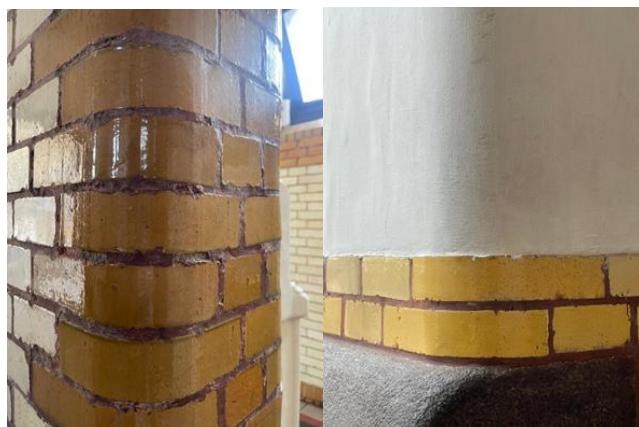


Figure 5. Knockdown Concept in Lawang Sewu Building

In the Dutch era, the technology used was advanced, including the use of generators for power generation to provide lighting and operate various equipment that requires electricity. Even water pump technology is advanced enough to support efficient water distribution to all parts of the building by making the twin towers in the lawang sewu building as a water reservoir. The use of water pumps and generators in the lawang sewu building certainly requires an understanding of the principles of physics such as pressure, fluid flow, and energy conversion in designing and operating this system properly. In addition, the Lawang Sewu building has a basement that functions as a "chicken claw" foundation. This Chicken Claw system is functioned because the construction of Lawang Sewu has not used building construction such as earth nails. This Chicken Claw foundation has a thickness of about 1 meter, with rocks imported from the slopes of Merapi which are believed to provide stability and resistance to earthquakes.



Figure 6. Chicken claw on the lawing sewu building

From a mathematical perspective, the Lawang Sewu Building shows a thorough application of mathematical principles. From basic geometry and symmetry to structural calculations, every element of the building is carefully designed to create visual harmony and structural stability. This application of math in architecture not only enhances the aesthetic appeal of the building, but also ensures its sturdiness and durability over time.

When viewed from a geometric aspect, the Lawang Sewu Building displays the use of the principles of Euclidean geometry commonly found in colonial architecture. The basic structure of the building consists of simple yet efficient geometric shapes, such as rectangles used in the floor plan of the building and its rooms, creating a practical layout, squares in the tiles used in combination with different sizes and colors, and circles and curves seen in the windows and doors, providing an attractive classical aesthetic. (Fisher, 2006) mentions that the use of geometric elements such as circles and arches in architectural design helps distribute loads evenly and increases the durability of the building structure. The application of this planar geometry allowed the building to stand strong for more than a century, creating a balance between aesthetics and functionality. On the other hand, symmetry also plays an important role in Lawang Sewu's structure. The layout of doors and windows exhibits reflective symmetry, where elements on the left and right sides of the building are reflections of each other. This symmetry creates a strong visual harmony while adding stability to the building. In addition, some parts of the roof and tower design exhibit rotational symmetry, which increases the durability of the structure and creates a sense of visual balance (Harris, 2004). Fisher (2006) Also emphasizes that symmetry in colonial architecture such as this is not only a matter of aesthetics, but also functional to maintain the stability of the building structure

#### *Batik Semarangan in the R-STEAM framework*

Semarangan Batik as an Indonesian cultural heritage can be explored through the R-STEAM framework to understand more about the values contained in it. In Semarang City itself, there is a location called "Kampoeng Batik" which is used as a center for batik craftsmen in the city of Semarang. The naming of "Kampoeng Batik" also varies, such as Kampung Batik Gedong, which means that the batik village area is located in a high building area, while the batik village wedhusan because there is a goat pen in that location. So the naming of areas in Semarang City is inseparable from the activities of residents.

Based on the depth-interview with the informant, he explained that there are two types of batik, namely

inland batik and coastal batik. Coastal batik is like Semarang, Lasem, and Pekalongan batik. Coastal batik also tends to have real images/motifs, for example bird motifs, meaning there is a head, wings, tail, and legs. Meanwhile, inland batik is in a palace or royal environment, with motifs that tend to be more abstract. Each motif in batik has a meaning and should not be arbitrary. In ancient times, from the birth of a baby to its burial, there was a procession and the use of batik was different for the process. UNESCO also explained that the recognition of batik cloth as cultural heritage because there are elements of local wisdom, philosophy, and meaning attached to a piece of cloth. The term is often called "pakem". For example, I like the parang motif which symbolizes chivalry, high spirits, that's why war troops during the royal period used the parang motif. Examples of Coastal and Inland batik can be seen in Figure 7.



Figure 7. Batik Pedalaman and Batik Pesisir

The informant also explained that in the batik he made, he used the basic foundation of "sidomukti" batik. Sidomukti batik is usually worn during the wedding procession, because the hope is that the household will become more noble, in the Javanese language "mukti". In using the basic foundation of sidomukti batik, the batik maker named his batik work "Rejomulyo", Rejo means to be, mulyo means noble. Batik creators add elements of Semarang city icons such as the icons of tugu muda, asem, and warak endok. The hope of the batik maker adding this icon element is so that this batik creation is not only for the official class who wears it, but all groups can wear it as long as they are able and can be able to glorify or prosper the citizens of Semarang, then they have the right to wear this batik, so that it can create moral responsibility in its users. An example of Rejomulyo batik innovation can be seen in Figure 8



Figure 8. Batik Innovation "Rejomulyo" from Batik Craftsmen

According to the source also explained that Semarangan batik has three phases. The first phase in the 1800s the motifs were heavily influenced by Dutch European culture. In the second phase in the 1900s, the motifs were heavily influenced by Chinese, Chinese Javanese, and Arabic. In the third phase in 2006, there was a revitalization that encouraged the emergence of new motifs that became the icon of Semarang, so there was Semarang batik, Semarang icon batik, indiscriminate batik, and Semarangan batik. Specifically for semarangan batik, the source explained that semarangan batik was not actually made in Semarang. So, in ancient times, Semarang batik makers only used to slant but could not color "mbabar", so they asked relatives in Pekalongan for help in the coloring process. Then someone fell in love when he saw the semarangan batik motif, so in love with the motif, the person called it "Ngaweo batik koyo wong semarangan kae lho" make try batik like the Semarang people. [In the end, it was reproduced by the Pekalongan people around 1900. So semarangan batik is originally a butterfly motif, not lawang sewu, tugu muda, or warak endog. This motif is an iconic Semarang batik motif. The semarangan batik motif is tanaha or seamrangan background tight, and smooth. The original semarangan batik motif can be seen in Figure 9.



Figure 9. semarangan batik colored (left) and semarangan batik undyed (right)

The batik-making process in Semarang City has begun to switch from using chemical colors to natural colors such as wood, leaves, and flowers. Natural colors have two processes, namely extraction and

fermentation. The extraction process is the process of taking dyes from natural materials such as plants, wood/roots, fruit bark, or leaves. Usually, noni roots and indigo leaves are often used as a source of color. The extraction process is usually done by boiling the ingredients in water. After boiling, the resulting solution will be filtered to separate the dye from the rest of the unused material. This process is important to obtain the desired color concentration for use in batik making, while the fermentation process is carried out to improve color quality. This process is a biochemical process involving microorganisms that can give richer, more durable colors to batik cloth. These two processes are very important in making batik with natural dyes because it is a legacy of ancestral traditions between generations to determine color quality.

Basically, the use of natural colors is certainly costly compared to chemicals. Even though natural materials, not a few still contain chemicals. For example, from weeds, fermentation or decay is carried out using limestone. After it becomes a paste, it is wrapped. From a scientific and mathematical perspective (the concept of comparison) the use for coloring is 1:1. 1kg of color is proportional to 1 kg of coconut sugar/brown sugar. So if the time is still colored or finished coloring the taste of the batik cloth will be sweet. The coloring results using this weed will produce a blue color. Meanwhile, for the extraction process such as wood, fruit bark, it is cooked in 8 liters or 9 liters until the cooking water is reduced to 1-2 liters. The remaining water is for coloring. The fixation or color locking uses alum, lime, limestone, and arbor.

Semarangan batik also contains various other mathematical elements that many people are often unaware of. These elements include geometry, symmetry, and repeating patterns, all of which can be analyzed from a mathematical perspective. This link between batik and mathematics not only adds to the aesthetic value of batik itself, but also shows the strong connection between art and science.

Semarangan Batik motifs often feature geometric shapes that can be found in various ornaments such as leaves, flowers, or other natural forms. Some typical motifs of Semarangan Batik, such as the asem and tugu muda motifs, depict geometrically identifiable shapes. For example, elliptical or circular leaf or flower motifs can be seen as examples of basic geometry. These geometric shapes underlie the learning of flat and spatial shapes in mathematics, which are often explained in various levels of primary education. In math, circles and triangles are basic shapes that are often found in batik motifs. The repetition of geometric shapes reflects the regularity of the pattern (Saragih, S, 2018). Each pattern is usually symmetrical about one or more axes, which reinforces the basic concept of geometry.

Symmetry is one of the important elements in batik art. In Semarangan Batik, many motifs show folding symmetry and rotary symmetry. For example, a flower or leaf motif symmetrically arranged from the center of the batik cloth shows folding symmetry. The concept of symmetry is in line with the concept of reflection in mathematics, where an image or shape can be reflected on a certain line or axis and still look similar (S. Rahayu, 2020). In Semarangan Batik, the element of reflection is evident in the repetitive and regular motifs, where one part of the motif is a mirror image of another part. This not only adds to the aesthetic balance of the batik, but is also a good material for teaching symmetry in mathematics in elementary schools.

While in the perspective of technology and engineering, it turns out that there are also arrangements in making batik. In accordance with UNESCO regulations, it must meet the requirements in terms of process, materials, tools. In the process requirements, namely the manual manufacturing process, natural materials, malam from gondorukem, and fat. While the material is the use of natural colors. Finally, there are only two tool requirements, namely canting tulis and canting cap. Apart from using both or one of these is not recognized by UNESCO. In the past, batik used charcoal or wood. However, nowadays it uses the innovation of using an electric pot to heat the night, and there are even electric canting. However, the use of electric canting is regulated by the Professional Certification Agency (LSP). So, competence is not only in skill knowledge and attitude, but also the use of tools. Electric canting has an inconsistent night melting process because good night can produce good batik products if there is consistency such as thickness. That happens when using electric canting. Then there is also canting cap which uses casted copper. However, this canting cannot be recognized because it uses a framework that has been assembled. Unfortunately, in its implementation, many violate it because they do not understand, even though there are already Indonesian National Work Competency Standards (SKKNI) which regulate tool standards, and work standards for making batik. When leaving the provisions, it means that the competency elements do not meet, meaning that the workers are not competent. The result will be doubtful.

#### *Lumpia and Bandeng Presto on the R-STEAM framework*

Lumpia, as one of Semarang's specialties, is not only a culinary icon, but also an Indonesian cultural heritage full of local values. As part of the city's cultural identity, spring rolls have long been the pride of the people of Semarang and are recognized by many people, both locally and internationally. Given the importance of lumpia in Semarang's culture, a deeper exploration of this food can be done through the R-STEAM (Religion-

Science, Technology, Engineering, Arts, and Mathematics based on local values) framework. Through this exploration, it is possible to understand more deeply the values contained in the process of production and distribution, as well as how modern technology and local culture synergize to maintain the authenticity of this traditional food.

Based on the depth-interview with the informant, it was found that the spring roll culinary business is run by the informant, a fifth-generation successor of a family business of Semarang spring rolls. The business has been running for more than a hundred years, dating back to the cultural fusion between Mbok Warsih, a native Javanese, and Kong Dayo, a Chinese descendant. The two combined local ingredients such as bamboo shoots with Chinese meat to create lumpia, which is now a culinary icon of Semarang.

The interviewee's involvement in his family business can be seen as a form of respect for the traditions and values passed down by his ancestors. He also explained that his business follows in the footsteps of the previous generation, from the first generation to the fifth generation. This shows the value of religiosity in maintaining traditions that have been passed down from generation to generation, which is also part of Semarang's local culture. According to (Geertz, 1960), many cultures in Indonesia maintain traditional values as part of family and community identity.

In terms of ingredients, today's lumpia has evolved to include fillings such as shrimp, eggs and bamboo shoots, which is different from the original recipe that only combined meat and vegetables. This is evidence of developments in food composition as consumer tastes change. The use of spring roll skins purchased from local suppliers that are not vacuumed aims to maintain the integrity of the texture. The spring rolls are sold in sizes according to the availability of the skins. The scientific aspect is seen in the use of ingredients or the composition of the food. According to research by (Astawan, 2012) changes in the composition of traditional foods often occur in response to developments in nutritional science and health needs as well as public tastes. In addition, other traditional methods that are also part of the science aspect can be seen in the consistency in the choice of traditional packaging "besek" which helps maintain its durability (Figure 10).

When viewed from the manufacturing process, it still maintains traditional methods and uses hands without modern tools, such as the use of mash for garlic. The process of making spring rolls by hand without the help of machines is maintained to keep the flavor that is considered more authentic. Despite the manual production process, some aspects of technology have been introduced to improve efficiency, such as the use of

gas stoves to replace oil stoves and the installation of exhaust fans to maintain air circulation during the cooking process. These simple technologies help optimize production without compromising product quality. This is in line with the findings in a study by (Mansyur, 2019) which showed that technological adaptation in small and medium enterprises in Indonesia can increase productivity without having to change the authenticity of the product.



Figure 10. Lumpia Packed in Besek

Furthermore, the key to maintaining the quality of spring rolls is process engineering and food structure, which focuses on the proportion of key ingredients such as bamboo shoots, eggs and shrimp. The interviewees mentioned that for one production, they use around 70-80 kilograms of eggs and 2 quintals of bamboo shoots, a composition that is not only set manually, but through mathematical approaches and engineering principles. Determining the amount of ingredients is very important to maintain the consistency of lumpia flavor and texture from one generation to the next. In line with Saksono's study (2020), engineering the proportion of ingredients in the traditional food industry is necessary to guarantee the same quality in every product, especially when the ingredients used are natural and can vary in quality.

In addition to ingredient engineering, aesthetics plays an important role in Semarang spring roll products. The art of forming and rolling spring rolls has been a hallmark passed down from generation to generation since the first generation of the family. The packaging of spring rolls using besek (woven bamboo containers) not only adds aesthetic value, but also serves to maintain product quality through optimal air circulation. The addition of beautifully arranged spring onion stalks, as well as the combination of pickles and chilies as a complement, further enriches the visual appeal and taste of spring rolls (Figure 11). Each type of spring roll is packaged differently; wet spring rolls are wrapped in banana leaves, while fried spring rolls are packaged using oil paper. In terms of durability, fried spring rolls can last up to 24 hours outside the refrigerator, while wet spring rolls only last 12 hours. However, if stored in the refrigerator, both fried and wet spring rolls can last up to one week. This aesthetically

pleasing packaging not only enhances the appearance, but also ensures that the integrity and flavor quality of the products are maintained. As stated by (Setyanto, 2015), aesthetic and functional packaging plays a significant role in attracting consumer attention and strengthening product identity.



Figure 11. The appearance of a spring roll ready for consumption

Apart from technique and aesthetics, mathematical calculation is also an important part of the spring roll production process. Although the interviewees said that they do not calculate the ingredients for each piece of spring roll in detail, the practical use of math occurs in determining the amount of ingredients in each production batch. In one wok, for example, they use 50 eggs and 4 kilograms of bamboo shoots, a quantitative approach that helps maintain a consistent ratio of ingredients. According to (Gagne, 1977), the application of mathematics in the food production process is an essential element to ensure consistent product quality, especially when production quantities are done on a large scale. Thus, through a combination of engineering, art and math, Vincent has managed to maintain the quality and identity of Semarang's signature spring rolls, while adapting to the challenges of modern production without losing his traditional roots.



Figure 12. Fried and wet spring roll display

Moving on to Bandeng Presto as a local culinary product, it not only represents the food aspect but also

encompasses local wisdom and innovation in food processing.

One important reference is the work of Nurhamidah et al., which discusses "Rebranding the Bandeng Presto Home Industry (IRT) During the Covid-19 Pandemic." In this study, it was revealed that rebranding and marketing strategies based on local wisdom have a significant impact on business sustainability, making this product a concrete example of innovation within the R-STEAM context (Nurhamidah et al., 2022).

Another study by Widiastuti et al. also highlights the importance of marketing education and branding for SMEs, particularly Bandeng Presto. The results of this community service initiative show a significant increase in marketing knowledge among business operators, demonstrating the application of local wisdom in an economic context (Tri Widiastuti et al., 2023).

Furthermore, Lalu and Nurmawanti in their study on ethnomathematics describe that the integration of local wisdom in education can optimize the learning process. Such an approach is relevant for exploring the scientific and technical aspects of Bandeng Presto processing, which is part of the broader culture in Semarang society (Lalu & Nurmawanti, 2023).

Finally, Muflihati et al.'s research on the challenges and development of the Bandeng Presto processing and packaging system highlights the importance of innovation and improving the quality of local products for competitiveness in broader markets. This research underscores the interaction between technology and local wisdom products (Muflihati et al., 2020). These references demonstrate how local products like Bandeng Presto are not only culinary representations but can also be seen as platforms for exploration across various disciplines within the R-STEAM framework.

Based on the findings of the exploration of lawang sewu and Semarang batik on the STEAM framework, the potential learning tools in learning in elementary schools using R-STEAM, especially learning geometry, comparison,

#### Geometry

The results of the search on the lawang sewu building ornaments produced two mathematical contents that have the potential to be used in learning mathematics in elementary schools. The first ornament is building E which consists of a block shape, a gable roof with a tile cover, and a door. Furthermore, there is a stained glass ornament that has a shape. The mathematical content contained in this temple artifact is Spatial Geometry. According to Vojkuvkova (2012), spatial geometry ability is a person's skill in understanding and constructing geometric shapes. The

representation of the geometry arrangement of the temple building can be seen in Figure 13.



Figure 13. E lawang sewu building (left) and sketch of E lawang sewu building (right)



Figure 13. stained glass orname

Representation of flat buildings in the form of lawang sewu building and stained glass orname can be associated with various geometry concepts such as area, perimeter, and height. Arranging buildings to resemble the shape of natural objects can also improve children's spatial geometry skills; the results of research by Ahsani et al. (2022) stated that children's spatial geometry skills can be improved by arranging objects. This can increase the child's sense of field and space. This research is also

supported by Pavlovičová et al. (2022) which states that spatial geometry ability can be identified from three activities, namely, (1) Arranging shapes based on shape; (2) Arranging shapes based on size; and (3) Arranging shapes based on weight. Potential props that can be used are props in the form of cubes, blocks, trapezoids, and pyramids. The child then arranges the props to resemble their original shape to calculate area, perimeter and height. The props can be made in various sizes so that children can be creative in arranging the shapes based on their profile, size, and weight. If there is an Augmented Reality (AR) technology facility, researchers can use it as an observation reference object for children.

#### Science (Healthy Food)

Lumpia is not only a delicious food, but also has high nutritional value. By understanding the nutritional composition and health benefits of spring rolls, students can better appreciate the food they consume and make healthier choices in their daily lives. Through spring rolls, we can teach healthy food by identifying the benefits of bamboo, including bamboo is a rich source of antioxidants to maintain cell health and prevent various diseases, and supports heart health.

Through learning healthy food, it can teach the composition of spring rolls, which are generally made of thin skin filled with various ingredients, such as vegetables, meat, or shrimp. Here are some of the nutritional components found in spring rolls:

- **Carbohydrates:** Spring roll skins contain carbohydrates that provide energy. One serving of spring rolls can contain around 133 kilocalories.
- **Protein:** If spring rolls are stuffed with meat or shrimp, the protein content will increase, which is important for the growth and repair of body tissues.
- **Fiber:** Spring rolls filled with vegetables are rich in fiber, which is good for digestion and can help maintain a healthy gut.
- **Vitamins and Minerals:** Vegetables used in spring rolls, such as carrots and cabbage, contain various vitamins (such as vitamins A and C) and minerals that are important for the body's health.

After the lesson, students can be directed to analyze the content of wet spring rolls and fried spring rolls. As part of the learning, students can be invited to make their own spring rolls. This activity is not only fun but also educational, as students can learn about:

- **Selection of Healthy Ingredients:** Discuss the importance of choosing fresh and nutritious ingredients.
- **Healthy Cooking Process:** Teach healthier cooking techniques, such as steaming or grilling, instead of frying.

## Conclusion

An Exploring the local wisdom of Semarang City through the R-STEAM (Religion, Science, Technology, Engineering, Arts, and Mathematics) approach demonstrates how local cultural, historical, artistic, and culinary values can be integrated with modern multidisciplinary learning methods. By applying R-STEAM to three key elements—Lawang Sewu, Semarangan batik, and Semarang lumpia—this exploration not only enhances understanding of science and technology but also strengthens cultural awareness and local identity.

Lawang Sewu, as a historic building, represents the richness of colonial architecture with deep historical value. Within the R-STEAM framework, Lawang Sewu becomes an ideal place to study mathematics in geometry, as well as the integration of religious values and art in building construction. Through this approach, students can understand how past architecture utilized mathematics and innovative building techniques. R-STEAM innovation tools can be applied here, such as through the development of Augmented Reality (AR) applications that allow students to explore building structures and understand architectural principles interactively.

Semarangan Batik, as a local artistic expression, reflects the beauty and philosophy of local culture. The use of R-STEAM here enables exploration of the art and technology of batik making, including the use of natural dyes and modern engineering techniques to create innovative batik patterns. Additionally, the mathematics and geometry found in batik patterns offer unique lessons in design rich with symbolic meaning. The development of R-STEAM tools such as digital simulations for natural dye experiments or mathematics-based batik design software can enrich the learning experience.

Lastly, Semarang's signature lumpia, as a local culinary dish, not only reflects a rich cultural heritage but also offers opportunities to learn about food science and technology in its production process. Within the R-STEAM framework, this exploration can encompass traditional food processing techniques, the health and nutritional aspects of the ingredients used, and innovative approaches to blending tradition with modern technology in the culinary industry, particularly in science education linked to healthy eating. For example, students can analyze the nutritional content of lumpia using simple scientific tools or design innovative packaging considering engineering aspects.

Overall, the application of R-STEAM in exploring Semarang's local wisdom at Lawang Sewu, Semarangan batik, and Semarang lumpia provides an opportunity to integrate cultural values, technology, and art with

modern education. This not only enriches the knowledge of the younger generation but also strengthens their love and sense of responsibility toward local cultural heritage.

For the Primary School Teacher Education Program (PGSD) and elementary schools, it is recommended to develop thematic learning modules based on Semarang's local wisdom. For example, a batik-based learning module that integrates art (pattern making), science (dye chemistry), and mathematics (motif geometry), or a Lawang Sewu module using AR technology for architectural exploration. The curriculum can be enriched with R-STEAM projects that encourage students to innovate while preserving local wisdom.

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