Research Article

Connecting Students to Local Wisdom to Learn Science for Sustainable Development Goals: A Conceptual Framework

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Abstract.
Today science learning is not only for understanding science but also for explaining phenomena, solving relevant problems, and even developing the economy and its welfare (sustainable development). To achieve this goal, local wisdom-based learning is very strategic as a productive context in learning science, becoming an interception between science and the social dimension. Using a qualitative content analysis approach supported by the literature and the results of our previous studies, we conducted an in-depth study of a framework of local wisdom-based learning. The results show that local wisdom can be considered a socio-scientific issue, as it has an identical conceptual framework in learning. To study science, especially for sustainable development goals (SDGs), students need connections with scientific ideas and social concerns of local wisdom. IDEA Scaffolding principles can help students learn to connect with the locals' wisdom.

Keywords: connecting students, local wisdom, sustainable development goals, a conceptual framework

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1. INTRODUCTION

Socio-Scientific Issues (SSI) are science issues easily obtained from various social and digital media in people's lives in the digital era. Even though it contains elements of science, SSI is generally displayed macroscopically in language that is easily understood by the public [1]. As a result, elements of science, including the role of science in SSI, often need more attention because they are invisible [2–4]. SSI is often considered an intercept between science and social science which is considered controversial [3, 5–7]. Although controversial, SSI is considered a productive science learning context because apart from increasing critical thinking skills, it also triggers new studies to clarify

the truth of issues and solve related problems. Thus SSI-based learning requires an in-depth study that has the potential to develop science. Apart from being a productive context, SSI can also cause misleading [6, 8] and even scientific misconceptions [9], especially if the claims in SSI, especially hoaxes, are immediately considered accurate information without clarification.

Local wisdom is a productive learning context because it is well-known by the local community and is widely used in various social, economic, and cultural activities. Many studies, such as [1, 10] found that familiar context-based learning positively helps students learn science. Many abstract science concepts become concrete in context-based or real-world learning [1, 10, 11]. As a result, students who have difficulty operating their abstract thinking skills learn science more easily. Learning science through the context of local wisdom will also motivate students to study phenomena that occur in their surroundings. This motivation arises because there is a sense of belonging and the desire to maintain it after knowing much about local wisdom [12]. Local wisdom-based science learning helps students construct knowledge more efficiently and becomes part of a cultural preservation and community economic development program or Education for Sustainable Development (ESD). For ESD, the project-based learning model will be very strategic for use in the local wisdom domain.

Some local wisdom is indigenous, while others are not [12]. Local indigenous wisdom is passed down from generation to generation. In general, indigenous local wisdom contains many hereditary claims closely related to traditional culture, including the spirituality of indigenous peoples, which can be controversial, so it has great potential to improve student's critical thinking and argumentation skills. On the other hand, non-indigenous local wisdom is not hereditary but is well-developed in a specific area. Indigenous and non-indigenous local wisdom is developed to support community economic activities through scientific studies [12]. Many scientific disciplines involve indigenous local wisdom, such as science, social science, history, economics, cultural anthropology, art, sports, psychology, and spirituality. All these disciplines will be involved in learning if you want to understand and develop local wisdom.

In the framework of SSI-based teaching and learning [3, 13–15], SSI is used to develop knowledge, critical thinking skills, and problem-solving, even developing innovations in the context of local wisdom. Critical thinking skills, problem-solving, and creative thinking will develop if there is a connection between scientific ideas and societal concerns of local wisdom. The ability to connect with local wisdom is primarily determined by explaining all aspects of science and the context of local wisdom [1, 5]. Relevant prior knowledge and scientific thinking skills are essential in this condition.

1.1. A Framework of Local Wisdom-Based Teaching and Learning

From a socio-scientific issues-based science learning framework [3, 13–16], it takes three things to learn science from local wisdom, namely: 1) connection with local wisdom (science ideas and societal concerns), 2) ability to think in the context of local wisdom, and 3) synthesis of ideas and problem-solving. Connection with local wisdom will occur if there is a connection between scientific ideas and societal concerns. Connection with scientific ideas will occur if someone knows (science) relevant to SSI [5]. Science and social aspects are needed to explain local wisdom and develop thinking skills in the context of local wisdom [12]. Developed thinking skills will encourage the synthesis of ideas and problem-solving. The most crucial factor for learning science includes developing students' critical and creative thinking skills. After the connection, students will develop ideas within the framework of local wisdom.
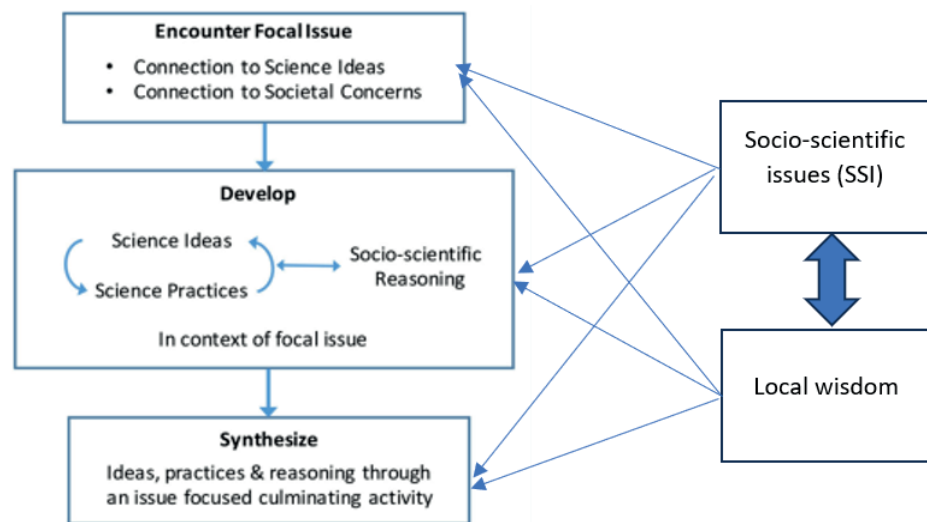
1.2. Science in Local Wisdom

Local wisdom is generally multidisciplinary, which includes science and other disciplines, such as history, economics, health, and even spirituality [3, 12]. However, in many ways, science does not stand out in local wisdom [4]. Relevant knowledge is needed to build connections with scientific ideas of local wisdom [5, 12]. That is why the ability to identify and explain aspects of local wisdom science indicates that students are connected to scientific ideas [17]. Connection with scientific ideas of SSI can indicate that a connection with the SSI context has also occurred.

1.3. Learning Science from Local Wisdom for Sustainable Development

Local wisdom, especially indigenous ones, is not only part of the culture or tradition of an indigenous community but also part of economic strength and environmental sustainability [12, 18]. To become part of the community's economic strength, local wisdom needs to be developed by involving aspects of science and technology relevant to local wisdom. This can only be done if there is a connection between science and social aspects of local wisdom [5].

2. RESEARCH method

This qualitative study uses content analysis, namely analyzing in depth a framework of SSI-based learning to be adapted into frameworks of local wisdom-based learning. This study uses the assumption that local wisdom is a form of socio-scientific issues as a productive context for learning science [12]. The SSI-based learning content analysis framework is used to connect students to local wisdom so that it can be used in local wisdom-based learning. The content analysis design used in this study is depicted in Fig. 1.

Figure 1: Conceptual framework of socio-scientific issues and local wisdom-based learning [3, 5] .

Figure 1 shows that the primary step to explain SSI, including local wisdom for learning science and developing innovation in the context of local wisdom, requires a connection with local wisdom. Connection with scientific and social aspects is the primary basis for developing a framework (reasoning) in the context of local wisdom and developing innovation in the context of local wisdom. Connection with local wisdom consists of two components: connection with scientific ideas and connection with the social aspects of local wisdom. Each local wisdom is unique [12], so scientific and social aspects also differ.

3. result and discussion

Based on SSI characteristics [1, 3, 5, 13–15, 18], local wisdom is a form of SSI. SSI and local wisdom are productive contexts, and some are controversial, so that they can trigger students' thinking tension. Therefore, the local wisdom-based learning framework is

conceptually synonymous with the SSI-based learning framework and innovation. The local wisdom-based learning framework is shown in Fig 2.
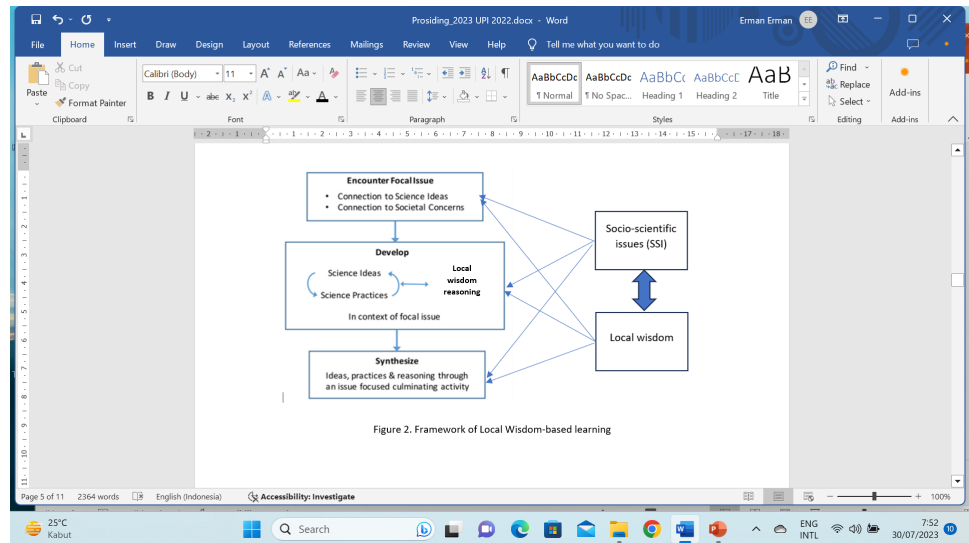

Figure 2: The framework of local wisdom-based learning.

Figure 2 shows that SSI and local wisdom require connections with scientific ideas and societal concerns in learning. In addition, for sustainable development goals (SDGs), critical thinking skills, problem-solving, and creative thinking must be developed for new innovations in local wisdom. Innovation will occur if the connection with local wisdom occurs meaningfully. The framework of local wisdom-based learning places local wisdom as a productive context for learning science. Several controversial matters in local wisdom require in-depth study involving science. Therefore, local wisdom has the potential to become a context for learning science and developing thinking and innovation skills for the SDGs, as shown in Fig. 3.
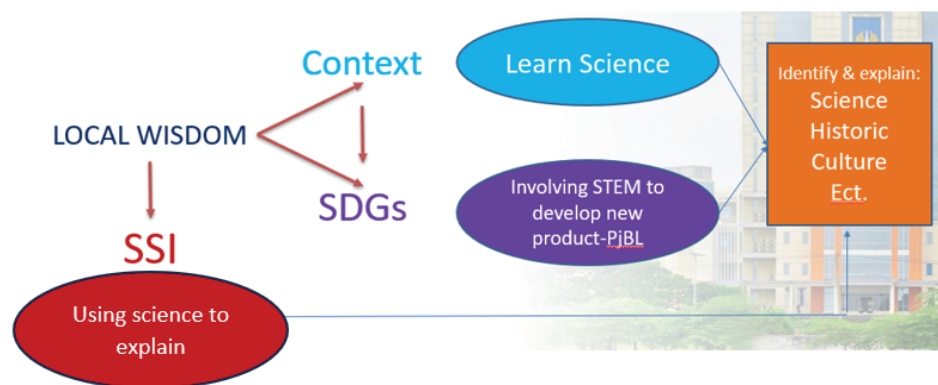

Figure 3: Local wisdom as a context-based learning.

Figure 3 shows that learning science based on local wisdom has two dimensions, namely, as a context for learning science and SDGs. As a context, science is learned

through local wisdom, which students are familiar with. Conversely, as SDGs, innovation in local wisdom involves STEM/STEAM, which is packaged in problem-based learning (PBL) and projects (PjBL).

3.1. Connection with Aspects of Science (Science Ideas)

Connection with SSI in SSI-based science learning has been developed with IDEA principles. Conceptually, the connection principle with SSI is identical to local wisdom, namely using the IDEA principle (identify, define, describe, explain, and apply) [5, 12], shown in Table 1. Table 1 shows that to connect with LW, and students must be able to identify, define, describe, explain, and apply aspects of LW science to explain LW, solve LW problems, and develop new ideas related to LW.

TABLE 1: How to connect students to science ideas of local wisdom.

Socio-scientific issues (SSI)	Connecting to science ideas	Local wisdom (LW)
Identify concepts, principals, laws, and theories related to SSI.	Identify	Identify concepts, principals, laws, and theories related to LW
Define concepts, principals, laws, and theories related to SSI.	Define	Define concepts, principals, laws, and theories related to LW
Describe concepts, principals, laws, and theories related to SSI.	Describe	Describe concepts, principals, laws, and theories related to LW
Explain concepts, principals, laws, and theories related to SSI.	Explain	Explain concepts, principals, laws, and theories related to LW
Apply concepts, principals, laws, and theories related to SSI to explain SSI, solve problems, and synthesize new idea of SSI.	Apply	Apply concepts, principals, laws, and theories related to LW to explain LW, solve problems related to LW, and synthesize new idea of LW for sustainable development

3.2. Connection with Social Aspects

The relationship between students and local wisdom is shown in Table 2. Table 2 shows that to connect with LW, and students must be able to identify, define, describe, explain, and apply the social aspects of LW to explain LW, solve LW problems, and develop new ideas related to LW.
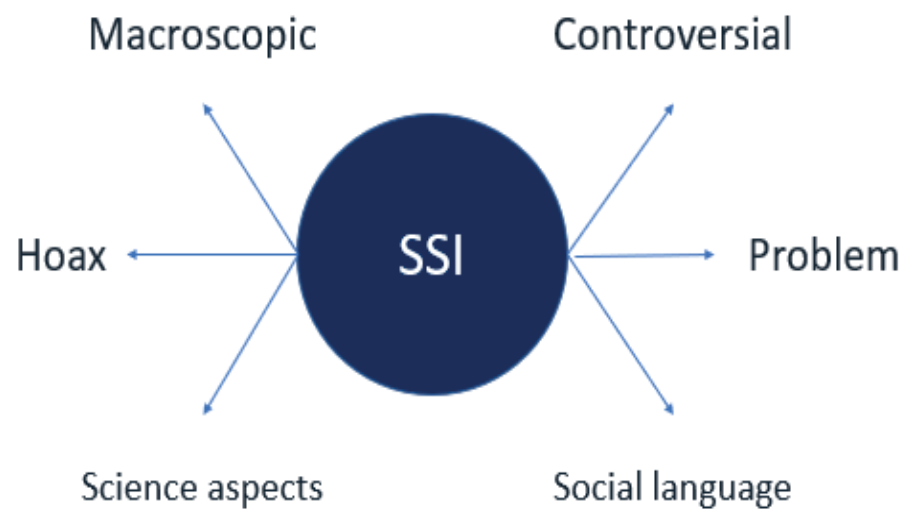
TABLE 2: How to connect students to social aspects of local wisdom.

Socio-scientific issues (SSI)	Connecting to social aspects	Local wisdom (LW)
Identify social aspects (including norms, etic, etc.) related to SSI.	Identify	Identify social aspects (including norms, etic, traditional skills, spiritual domains etc.) related to LW
Define social aspects (including norms, etic, etc.) related to SSI.	Define	Define social aspects (including norms, etic, tradition, culture, spiritual domains etc.) related to LW
Describe social aspects (including norms, etic, etc.) related to SSI.	Describe	Describe social aspects (including norms, etic, tradition, culture, spiritual domains etc.) related to LW
Explain social aspects (including norms, etic, etc.) related to SSI.	Explain	Explain social aspects (including norms, etic, tradition, culture, spiritual domains etc.) related to LW
Apply social aspects (including norms, etic, etc.) related to SSI to explain SSI, solve problems, and synthesize new idea of SSI.	Apply	Apply social aspects (including norms, etic, tradition, culture, spiritual domains etc.) related to LW to explain LW, solve problems, and synthesize new idea of LW for sustainable development

Conventional science learning that prioritizes understanding of the material (academic subject). Many students only try to memorize the material but need help understanding it and applying it in their social life [4, 5]. Students are generally not connected to the scientific and social aspects of LW [5, 7, 12]. Conventional learning based on material content cannot connect students with local wisdom. The results of research that we have done previously [1, 5, 12, 17, 19] found that students have difficulty explaining SSI even though they have studied the subject matter using books text relevant to the SSI. This difficulty occurs because the material student study is academic which is not functionally related to the SSI context studied.

Viewed from the perspective of cognitive and social constructivism, four factors cause the knowledge students learn from textbooks to be indirectly used in social life, especially to explain SSI and local wisdom. First, the material studied needs to be more relevant to the context of local wisdom. That is why in the framework of SSI-based learning [3, 13–15] it is required that students connect with local wisdom before the framework in the context of local wisdom is developed. Difficulties in explaining local wisdom and SSI generally occur because of a lack of knowledge relevant to the local wisdom [17, 19]. Second, the material is learned at the surface level or is only memorized so that student learning is not meaningful [12]. Third, students need help understanding

the material being studied due to their limited ability to think abstractly, critically, and creatively [12, 20]. Fourth, local wisdom and SSI are generally displayed on social media macroscopically so that the aspects of science that students should learn or need are not visible.

(Erman et al., 2020)

Ditinjau dari sudut pandang Natural science (IPA)	Dintinjau dari sudut pandang Suku Andean (Indigenous knowledge)
Penjelasan (Explanation)	**Penjelasan (Explanation)**
Hujan es terbentuk dalam awan cummulonmbus pada 5000-7000 m asl. Pengendapan partikel yang sesuai dengan massa jenis atau bobotnya masing-masing sehingga yang lebih ringan akan naik ke bagian atas. Dalam sebuah eksperimen, peristiwa ini bisa terjadi berulang kali melalui proses yang sangat dingin. Air yang sangat dingin berkumpul dan membeku, dan akhirnya jatuh dari awan sebagai hujan batu es (hailstone). Sebuah batu es dengan diameter 3 cm jatuh ke bumi dengan kecepatan 100 km/jam dapat menyebabkan kerusakan karena benturan.	Dewi (mother earth) akan membuat sesuatu (hujan es) untuk merespon atau sesuai dengan perbuatan manusia bagaimana memperlakukan atau menyembahnya. Jika disembah atau diperlakukan dengan baik akan membalasnya dengan kebaikan dan melindung manusia. Namun jika diperlakukan dengan buruk atau tidak disembah, maka akan memberikan bencana (musibah) kerusakan yang dapat membuat manusia menderita atau sengsara, seperti hujan batu es.
Hujan es jarang terjadi di area dengan sebaran yang sangat luas tetapi merupakan kejadian local yang sangat sulit diprediksi waktu kejadiannya.	Jadi, jika banyak darah manusia mengalir (musibah) maka kemungkinan ada hujan batu es. Secara bersama-sama kami harus bertanggung jawab dengan mengadakan ritual untuk menenangkan atau menghilangkannya musibah tersebut.

Figure 4: Characteristics of SSI and local wisdom.

Therefore, the connection between the knowledge already owned and contained in the context of local wisdom is needed to learn science through local wisdom [1]. Knowledge relevant to local wisdom will help students conceptually explain aspects of science. This will happen if student learning is meaningful, where knowledge can be constructed cognitively and used whenever needed. If you only memorize material or rote learning, including surface learning, you will have difficulty connecting with local wisdom [11].

To help students connect with local wisdom or learn through local wisdom, scaffolding is needed [5, 21], which we package as a framework of local wisdom-based learning in this study. This scaffolding is known as IDEA, namely identify, define, describe, explain, and apply [5]. Through IDEA Scaffolding, students will be guided by examples of identifying, defining, describing, explaining, and applying scientific concepts, laws, principles, and theories to explain and learn through local wisdom. IDEA principles are essential to help students learn through SSI and local wisdom. Identify aims to recognize all aspects of science (concepts, principles, laws, and theories) and related aspects of science in the context of local wisdom. To identify (I) these aspects of science, textbooks and the presence of local wisdom contexts that students recognize are needed. Each science's definition or description (D) needs to be done using textbooks or other learning resources that enable students to understand that aspect of science. Meaningful construction of knowledge will occur when students relate these aspects of science in the context of local wisdom at the explain (E) stage. Knowledge in the context of local wisdom that is constructed will be used to explain local wisdom and solve problems in the context of local wisdom, including developing innovations in the context of local wisdom for sustainable development and advancing the economy of indigenous peoples.

4. CONCLUSION

Local wisdom can be used to study science if it involves aspects of science that are relevant to the learning topic or curriculum. These relevant aspects of science need to be identified, described, and explained so that they can be used to explain local wisdom, including learning science, developing critical and creative thinking skills, and learning-oriented toward sustainable development. Scaffolding is needed by students by providing examples that use IDEA principles in learning. Initial knowledge relevant to aspects of science and social aspects of local wisdom is essential to connect with local wisdom, both for learning science and achieving the SDGs.

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