An identification of indigenous knowledge related to the thermal physics concept

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Abstract. A lot of indigenous knowledge is at risk of being lost and start marginalized as a result of globalization. It is essential to find ways to preserve it for the cultural and practical reason. The purpose of this research was to identify indigenous knowledge that related to the thermal physics concepts an incorporated into school curricula. A qualitative approach was used in this study. Five older adults from Samin community in Blora participated in a set of an in-depth interview. The results indicated that indigenous knowledge is related to the concept of thermal physics in the form of experience and beliefs to preserve traditions and cultural values in their daily lives. In this case, indigenous physics is a way of knowing and way of life.

1. Introduction

A lot of cultural values and local wisdom begin to be abandoned and are at risk of being lost as a result of the demands and development of globalization. Indigenous knowledge has been either neglected or even denied as it may be seen to be at the edges of scientific knowledge [1]. The indigenous community is continually struggling to maintain their rights, their tradition, and their knowledge. They have seen their knowledge eclipsed by western knowledge, imposed on them by western institutions [2]. Some people also criticize that indigenous knowledge should not be shared and studied as it would hinder non-indigenous people [3,4], it has a minimum strength and is not strong enough to understand nature when compared to the Western knowledge that produces proven, predictive, and precise knowledge [5]. One efficient way to strengthen and maintain a balance of social order within an educational context is by integrating indigenous knowledge through school learning [1,6–9]. An innovative new approach is required in the context of their societies and cultural knowledge, the background of children’s lives, including their daily activities, social, geographic environment, and their cultures [10]. Integration is a way for local knowledge to gain better space and access to school science, while at the same time to validate local communities to understand nature [11]. Indigenous cultures and knowledge are the tools that help students to conceptualize experience, to assist in
developing and enhancing their self-identities and confidence. In addition, this is also a way of introducing young people to appreciate the natural values.

Indigenous knowledge is scientific, deriving from empirical evidence of observations, but is often not explicitly scientifically constituted through a belief or doctrine of one who has power [1]. It is dynamic and continually influenced by innate creativity and experimentation as well as by interaction with the external systems. Indigenous knowledge in the community includes history, myth, legend, culture, art, sports, music, storytelling traditions, epics, folklore, games, proverbs, writing, language, scientific discoveries, social networks and life skills taking into account their spirituality, ontological realities, socio-cultural environment, and historical context [12–15]. This includes physics concepts taking into account the integrated nature of knowledge that the society acquires. Knowledge of physics and its method of investigation cannot be separated from people’s history, culture, and worldview [16]. All these are aspects of nature in which human being exist. Both pieces of knowledge have similarities, which needs to be developed to produce a synergistic and comprehensive contribution to the body of knowledge that students can provide and study. Indigenous physics knowledge is manifested in various forms of oral and practical knowledge. This becomes a challenging focus for educators and researchers to explore physics concept and to develop learning to keep it in synergy with the demands of the times. Students need to be introduced to cultural values contextually based on the wisdom of the surrounding culture to preserve the cultural meaning.

2. Method
A qualitative approach was used in this study. The subjects of research were five older Samin adults in Blora. The Samin community was chosen since the people still retain the cultural values of their ancestors. They live with their simplicity, uniqueness, honesty, and other positive behaviors [17]. The Samin community is famously innocent, as it is, and does not recognize the subtle limits of language. For them, the behavior of the person is more important than the eloquence of speech.

In this study, we report on individual interviews conducted to identify their indigenous knowledge that related to the thermal physics concepts an incorporated into school curricula. At the beginning interview, respondents were asked to explain about their experience from their childhood up to the present. Respondents were asked questions about the indigenous knowledge and link to the physics concepts to obtain further insight into how they understood and applied it. The interviewer tried to listen to their opinion and information that could be associated with the physics concept, particularly thermal physics. Issues related to other areas of science, such as biology, astronomy, and agriculture also surfaced during the interviews but were not pursued by the interviewer. The interview transcripts were analyzed to identify those ideas that could be related to the thermal physics concepts. The interviews were conducted in Java language, and audio was recorded. All of the transcripts were identified salient extracts of the conversations and translated them into English.

3. Results
In the following section, the respondent’s interpretation of the concepts is presented and compared with the physics explanation. This study revealed indigenous science related to thermal physics, namely convection, and thermal conductivity. In the extracts "R" refers to the Interviewer, while each respondent is identified by a number followed by a letter to indicate whether the conversation involves the concepts of convection (C), or thermal conductivity (Tc).

3.1 Convection
During the observation, it's clear that the Samin house still used wooden boards. The wooden board is aligned to be the wall of the house as shown in Figure 1. The Samin community house model is simple; its wooden house building, tile from ordinary clay, ground floor, and its model and architect is also elementary. This reflects the simplicity of life, both in thinking and daily routine.
The respondents were asked about why they use the wooden board as the wall in their houses. The responses to the question are shown below:

R : why do you use the wooden board as the wall of your house?
1C : Hmm... this house is our traditional house, I got from my parent...a wooden house is more comfortable... there is a gap between the boards, the wind can enter the house, so it does not feel hot
3C : ... The wind is flowing (angine sumilir)... the house is cooler (adem)
5C : hum..... the wind can alternate, the house is like breathing....
4C : ... The house also needs to breathe (ambekan), like a human...
R : But if the rainy season, do not you feel cold?
1C : ... It was colder than usual, but it was common...
3C : ... Hmm... it was common... at least in the house warmer than on the outside. Wooden Board can withstand cold.
2C : Hmm... the man is united with nature... the human body is warm... so no need to fear to feel cold.

The quotes above show that the respondents recognize the term hot (panas), cold (adem), the wind flow (angine sumilir), the incoming wind and the wind out. Physically, what is said by the respondent in physics concepts, namely, convection. Convection is the process where heat is transferred through a fluid (gasses and liquid) by the movement of heated particles of the fluid. The presence of airflow from high temperatures to low temperatures, causing the thermal equilibrium to create a sense of comfort for residents of the house. The Samin people do not understand about convection process but believe that there is air flowing in the house through the cracks in the wooden board wall. They know from their experience that using wooden boards make the room more comfortable and solution to the challenges of the changing weather.
3.2 Thermal conductivity

The respondents were asked whether the house is still grounded and the cooking stove is still using the brick which plasters by clay as shown in figure 3. Here are some interview results related to thermal conductivity concepts:

**Figure 3.** (a) The picture on the left is the ground floor of the house; (b) the right picture is a cooking stove with clay

| R   | Why is the house floor grounded? |
|-----|----------------------------------|
| 1Tc | The man (wong sikep) lives close to the ground, like a biological mother that should not be abandoned... |
| 2Tc | ... Our feet must touch the ground; this is our culture... the house feels comfortable and cooler |
| 3Tc | hmm... this is the tribal culture.. By touching the ground, our feet feel comfortable, The house also breathes through the ground... |
| R   | why do you also use clay as a coating on a furnace? |
| 1Tc | hum... the heat from the fire does not come out... So that we wouldn’t feel the heat while cooking. |
| 2Tc | The ground is like a mother, she will protect us from the fire... The clay absorbs heat... |
| 4Tc | I just follow the way of my parents... the clay keeps the heat... |

The interview results show that the Samin people appreciate the earth and nature in their daily lives. Soil characteristics that affect thermal conductivity are total porosity, the soil pore size distribution. Thermal conductivity is the measure of the ability of a material to conduct heat, how quickly heat migrates through it. The respondents understood that clay retained heat or absorbing the heat flowing from high temperature to low temperature. The effect of clay is to block the flow of...
hotness. This quote indicated that senior of Samin has practical knowledge of the insulating properties of clay. Physically, clay is a poor conductor of heat or insulator. It has a particle density, specific heat, and thermal conductivity more about 2.27 gr cm$^{-3}$, 0.22 Cal/gr$^\circ$C, and 0.15-1.8 W/mK respectively.

4. Discussion

In this paper, we identified two examples of indigenous knowledge related to the thermal physics concepts. There is proper alignment between the physics and the elder in practical knowledge. It was not surprising that the explanations did not conform to the standard physics concept. The description given is a manifestation of what they felt and experienced in life. Some of the answers given are a form of spirituality and doctrine. The concepts of physics in a Samin house or other technology in practice are more emphasized on cultural values to maintain tradition for their generations to live with simplicity. The Samin community had practiced living in harmony with the environment, and their ways of living were sustainable. Their knowledge shaped their value and attitude toward the environment.

This Indigenous knowledge study related to the concept of thermal physics has the potential to increase the knowledge and respect to the cultural values of Samin community. For example, people who use the wooden board as walls have a sense of comfort with a smoother air circulation than dwellings that use walls of brick with little ventilation. This knowledge is based on scientific principles and derived from experiments. Understanding of ‘physics’ and its methods of investigation cannot be separated from what’s history, cultural context and worldview, and experience that shapes the native people’s consciousness. Indigenous physics is experiential knowledge based on a worldview and culture that is fundamentally relational and deals with the harmony rather than with mechanical influences [4]. The Samin communities acquired physics concepts through their cultural values. Their diverse forms of knowledge, firmly rooted in their relations with the environment as well as in cultural attachment, have enabled them to maintain a sustainable practice and manage the natural resources, to preserve their environment and to enhance their resilience. In short, indigenous physics may also be perceived as a way of knowing and a way of living.

From an educational perspective, the identification of indigenous knowledge related to the physics concept provides an opportunity for the school curriculum designers to develop the relationship between the standard knowledge experienced by the student and the knowledge in the school [18]. The opportunity could give positive impacts on pupils’ interest in physics and to the indigenous knowledge. In the learning process, the application of physics concepts should be taken from both school science and indigenous science. Shizha argued that identifying Indigenous knowledge assists students, teachers, parents, and communities to reclaim and restore their voices in the process of educating [16]. The student needs to learn more from fieldwork in the local area. In this learning environment, students can justify their claim with evidence, experience, and reasoning. The physics educator also needs to understand how learners think, learn the concepts, use the information in the planning and structuring experiences for students’ learning. However, when explaining a phenomenon, teachers need an appropriate approach or strategy to avoid conflicts of knowledge among students. On the other hand, when scientific explanations differ epistemologically from cultural definitions, much more nuanced conversations between teacher and student will be needed to ensure cultural sensitivity [1].

5. Conclusion

The results of this study indicate that indigenous knowledge is related to the concept of thermal physics especially the convection process and thermal conductivity in the forms of experience and belief to retain their traditional and cultural values. In this case, indigenous physics is a way of knowing and way of life. The Samin communities acquire physics concepts through their cultural value and belief. The identification of indigenous knowledge related to the concept of physics
provides an opportunity for students to connect and fill the gap between their familiar experience and school science.

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