Deceiving the Queen: Integrating Jambinese Traditional Honey Gathering into Science Learning

(Memperdayakan Sang Ratu: Mengintergasikan Pengambilan Madu Tradisional Jambi Dalam Pembelajaran Sains)

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Abstract. *Traditional honey gathering is performed by most Malay communities in Jambi Province, Indonesia. The process of honey gathering is not merely taking honey, and other associated products such as wax, but has also developed into an important cultural ritual, and even become a part of the identity of the Jambi Malay community. Traditional honey gathering also involves values and local knowledge that can enrich science teaching and learning. This study aims to reveal the science content of traditional honey gathering in Jambi. Data were collected through participatory observations as well as a literature review. The results show that the traditional honey gathering can be integrated into teaching to create more meaningful science learning, especially in junior high school. The integration can be implemented by employing constructivist based learning models that are adjusted to the students' conditions and the environment around their schools.*

Keywords: local knowledge, traditional honey gathering, science learning

Abstrak. Pengambilan madu secara tradisional dilakukan oleh sebagian besar masyarakat melayu di Propinsi Jambi. Prosesi pengambilan madu tidak semata-mata hanya untuk mendapatkan madu atau pun produk lain yang terkait madu seperti malam (lilin), tetapi sudah berkembang menjadi budaya bahkan menjadi identitas masyarakat Melayu Jambi. Pengambilan madu secara tradisional juga mengandung nilai-nilai dan pengetahuan yang dapat diintegrasikan dalam pembelajaran sains. Penelitian ini bertujuan untuk menyingkap aspek ethnosains dari tradisi pengambilan madu pada masyarakat Melayu Jambi. Data dikumpulkan melalui observasi partisipatif, wawancara mendalam (in-depth interview), serta kajian literatur. Hasil penelitian menunjukkan bahwa pengambilan madu tradisional dapat diintegrasikan untuk menciptakan pembelajaran IPA di SMP yang lebih bermakna. Dalam implementasinya, pembelajaran dapat dilakukan dengan model-model pembelajaran yang berbasis konstruktivisme, sesuai dengan kondisi siswa dan lingkungan di sekitar sekolah.

Kata kunci: Pengetahuan lokal, pengambilan madu tradisional, pembelajaran sains

I. INTRODUCTION

People who have lived and interacted with nature and the surrounding environment over long periods of time tend to develop and hold local knowledge related to their environment, culture, spirituality and nature; these are frequently interconnected with one another (Gadgil, M, F. Berkes, dan C. Folke. 1993; Lemus, J. D., Seraphin, K. D., Coopersmith, A., & Correa, C. K. 2014). Such knowledge is generally passed on orally from generation to generation, and becomes an important part of the cultural identity of a community. Some terminologies commonly used to refer such knowledge include local knowledge, indigenous knowledge, traditional knowledge, local ecological knowledge, and local wisdom (e.g. Aikenhead, G. S., Brokofsky, J., Bodnar, T., Clark, C., Foley, C., Hingley, J., & Strange, G,2014; Beaudreau & Levin, 2014; Cruikshank, 2014;

Huntington, H. P., Quakenbush, L. T., & Nelson, M, 2017; Windia, W., Sedana, G., de Vet, T., & Lansing, J. S, 2017).

In everyday life, children learn local knowledge spontaneously and naturally. The learning is not performed through a systematic structure; instead, it is integrated into local traditions and daily activities done by the children within their family (e.g. Hun, 2002). The learning is also performed through their interaction with the surrounding environment, including the communities. For example, children learn the knowledge while helping their parents working in the gardens, fields, rivers, sea, or forest. On particular occasions children are also actively involved and participate directly in various local traditions (rituals) held by their communities. Although local knowledge learning is spontaneous and traditional, the learning also employs a scientific learning process involving observing, questioning, trialing, and communicating knowledge about the subject being studied. The learning process through interaction with the surrounding environment is corroborated by the social cognitive theory promoted by Bandura, A (2001), as well as the Vygotsky's learning and social construction theory (MacBlain, 2018).

Indonesia is rich in both biodiversity and cultural diversity (Loh & Harmon, 2005). The country is inhabited by different ethnic groups that span from Aceh Province in the west to Papua Province in the east. These diverse ethnic groups have rich traditions, cultures, and local knowledge. This knowledge is not only important in the social life, culture, and economy of people in their respective areas, but also have potential to support the development of more meaningful science learning in school. The integration of local knowledge with science learning is not only in terms of learning content, but also in its delivery including the learning approach, strategies, methods, and models. Science learning can therefore be designed and developed by taking into account the peculiarities of natural, social, and cultural settings in each region. One of the Indonesian traditions (cultures) that bears science learning values is Jambinese traditional honey gathering. The tradition is commonly practice by local communities who still have strong attachments to forests including the *Orang Rimba* and the people of Pelepat. The first group mainly lives in the forest of Bukit Dua Belas National Park, whereas the second group lives in the district of Bungo. Both are in the Province of Jambi, Central Sumatra Indonesia. Traditional honey gathering is rich in local knowledge that has the potential to enrich science learning in class. For example, people employ knowledge about insect behavioral responses to light to gently expel swarms of bees, including the queens, from their hives to facilitate access to the honey.

The bees develop hives on several tree species that are locally known as *sialang* (beehive tree). In contrast to cultivated bees that are dominated by *Apis melifera*, wild honey producing bees in the tropical forest of Jambi are mostly dominated by species of *Apis dorsata* and *A. cerana*. Interaction between the *Orang Rimba*, the *sialang*, the bees, and the surrounding ecosystem over long periods of time has gradually developed into local knowledge and traditions, as well as a harmonious relationship between humans and nature. The *sialang* and honey bees are not merely regarded as animals and plants that can be exploited at the will of people, but are also personified as creatures who are in need of recognition and appreciation. Local people treat the both bees and trees with courtesy (Hariyadi, B., Subagyo, A., & Asra, R. 2005). People treat *sialangs* as if these trees were human beings who also need to be cared, loved, and respected. Traditional education systems, such as the pesantren (Ma'arif, 2018), have been implemented in many parts of Indonesia for centuries. The pesantren implements a boarding system and mainly focus on Islamic studies and daily life education. However, science learning in Indonesian schools mostly employs materials and instructional designs adopted from the West. Some teachers are unable to connect resources around schools to enrich the science learning to teach in the classroom relevant to the local context of the school. As a result, students often find it difficult to understand science as taught in school, and it is not surprising that some students are unfamiliar with science subject matter despite attending classes. In addition, the science knowledge learned in school is mostly at a low cognitive level. Students have difficulties in connecting knowledge acquired at school with observations about their everyday life. Students also are not challenged to develop their potential ability and creativity in

relation to science. In short, science learning becomes unattractive and less meaningful. Given these conditions, it makes sense that mastery of science by Indonesian students is still at the lowest level: Indonesian achievement in the Program for International Students Assessment (PISA) in 2015 was better in previous assessments, but was still at the lowest levels, below Mexico and Thailand.

Indonesia's richness of natural resources and cultural traditions mean there is very great potential for connecting students' daily lives with science learning in school. Avery (2013) observed that the use of local knowledge in science learning can encourage students to boost their academic potential. Moreover, Avery and Kassam (2011) assert that science learning that links with students' everyday lives will develop students' capability to connect between science in class and realities encountered outside the class. In turn, the integration of local knowledge in science learning will improve students' mastery of scientific concepts. Local knowledge-based learning also reinforces student cultural identities (Mudaly & Ismail, 2013), which creates more contextual and meaningful learning (Sumarni, W., Sudarmin, Wiyanto, & Supartono, 2016).

Given the multiple ways in which incorporating local knowledge is important for science learning, we analyzed the science learning content of the honey gathering tradition commonly practiced by the native *Orang Rimba* and *Pelepat* people of Jambi, Indonesia.

2. RESEARCH METHODS

This research is an ethnographic study designed to reveal local knowledge about traditional honey gathering, as performed by the communities in Jambi province, Sumatera, Indonesia. Data were collected through participatory observations and a literature review. The participatory observations were performed by taking a part in several traditional honey gathering rituals in the communities of Pelepat and Orang Rimba. The first community comprises local people living in the district of Bungo who make a living mainly through rubber agroforestry. The latter community is an indigenous group of people who still practice hunting and gathering in Bukit Dua Belas National Park, in the sub district of Air Hitam. Information obtained during the participatory observations was recorded in field notes for further analysis. Before undertaking the participatory observations, the first author had worked and developed a close interaction with both communities while conducting ethnobotanical research. The field data were collected in several visits between 2002 and 2015.

A literature review was carried out to understand relevant current issues in science education for junior high school students in Indonesia. Furthermore, we analyzed science subjects in the current curriculum for junior high school (2013 curriculum) mandated and stipulated by the government of Indonesia. The collected data then were summarized and visualized to reveal any associations between the Jambinese traditional honey harvesting and the contents and syllabus of the junior high school science curriculum.

3. RESULTS AND DISCUSSION

3.1. Traditional Honey Gathering

Traditional honey gathering has been carried out by the traditional Jambinese communities for generations. Honey is produced by bees that nest on particular tree species (*sialang*) that grow in natural forests and agroforests. Honey gathering is not simply taking honey produced by bees in the wild; instead, it has evolved into a locally important tradition and cultural identity for the Jambinese society, especially those who still live in or around natural forests. Honey gathering is undertaken only by a small group of people who have expertise in taking the honey. The tradition also involves the other community members who live around the forest where the *sialang* occurred.

During honey gathering, bees are gently expelled from the hive [using light] to enable the gatherers to access the honey without being stung.

Honey gathering is only carried out on particular dates defined by the lunar calendar. This is because local honey gatherers understand well that honey bees are light loving insects; this knowledge of bee behavior is employed to define the dates when honey gathering will be most productive. Gathering is performed only on completely dark nights with no moon, because the presence of moonlight may stimulate the bees to fly around the beehives, thus disrupting the honey gathering process.

The procession of traditional honey gathering is a challenging and high-risk job. Therefore, gathering is normally carried out only by selected qualified male villagers who have long experience and extensive knowledge about honey gathering, and who show courage by encountering several challenges. These include the risk of falling when climbing tall trees in the dark, and interference or possible attack from the swarms of bees. A honey gatherer must also understand local community traditions and cultures, given that honey gathering is recognized as a locally important ritual. This is expressed through an oral tradition in the form of rhymes. The tradition of honey gathering encodes noble values and moral messages that are culturally important for the surrounding society.

In general, the honey gathering activities consist of three main parts: preparation, gathering the honey, and distributing the obtained honey. The preparation stage includes coordinating among the team of honey gatherers to define which person will lead the gathering stages, defining a date to perform the gathering, as well as preparing a variety of required tools such as rope, wooden rungs, hammer, honey container, and *tunam* (bark to produce torch). Honey gathering itself consists of installing wooden rungs in the *sialang*, climbing the trees, shaking the flaming *tunam* to produce a type of fireworks that lures bees out of their beehives, taking honey from the honeycomb, and finally carrying the honey down to the base of the tree. The gathering process is contained within a procession during which rhymes (incantations) and chants are produced by the procession members. These begin before the honey gatherer steps on the site around the *sialang* and lasts until the end of the procession. Chanting is performed at each transition step of the honey gathering procession, for example prior to climbing the *sialang*, when entering the canopy of the *sialang*, and when taking honey from the beehive.

The last stage of the honey gathering is to distribute the honey to the gathering team members and the communities. The procession concludes with closing rhymes performed by the leader of the honey gatherer, shortly before the group leaves the *sialang*. The closing rhymes are an expression of farewell and thanks, especially to the swarm of bees, along with a promise and hope that the team will come back on another occasion. More details about the processions of honey gathering traditions can be seen in Hariyadi *et al*. (2005) and Rizqah (2015).

3.2. Science Learning Content of the Jambinese Traditional Honey gathering

The procession of traditional honey gathering contains a number of relevant materials to support local knowledge-based science learning. Moreover, the tradition also bears a number of positive educational character values such as honesty, discipline, creativity, cooperation, responsibility, and social and environmental concerns. Outside science, the tradition could also be integrated to enrich other subjects, such as social science, English and Indonesian literature.

Although the tradition of honey gathering is rich in science educational values, however, most junior high school teachers, as well as their students, are unaware of honey gathering and thus barely connect it with science learning and teaching in schools. Therefore, here we analyze the science content and values contained within each stage of the traditional honey gathering process.

3.2.1. Determining a particular individual *sialang* to be harvested.

Honeybees usually nest on certain tree species such as *kedundung* (*Spondias cytherea*) and *kempas* (*Kompasia excelsa*). Whatever the species; any tree that hosts beehives are locally recognized as *sialang*. Determining the particular site of a beehive tree requires a deep understanding about the vegetation (habitat) where the *sialang* commonly occurs, and traditional honey gatherers are able to determine the location of *sialangs*. Naturally, *sialang* grows either in the forest interior or in the forest edge. With increasingly widespread forest destruction in Jambi province, *sialang* can now only be found in the forest interior. *Sialangs* may still occur in the forest margin but they are no longer inhabited by bees because the surrounding ecosystem has degraded significantly. Identifying which tree is considered a *sialang* also requires a good understanding about the diversity of plant (tree) species.

In contrast to this local knowledge, the same process of identifying *sialang* locations using modern scientific approaches uses a geographic approach, such as identifying the coordinates of each individual *sialang* site. Modern scientific instruments such as a GPS (global positioning system) device could be used to help determine the exact coordinates of any *sialang*. Modern science also employs plant morphology and taxonomy in order to identify the species of *sialang*.

Local knowledge and practices of marking a particular *sialang* site can be linked to and enrich the learning of Indonesian geography including the location and distribution of *sialang*, potential use, climate and flora and fauna. These topics are discussed in the social science class in the grade 8. Moreover, the knowledge and practices can also enrich the topic of solar system and life on earth, which is a topic in science class in the grade eight (see Table 1).

3.2.2. Determining the date to gather the honey.

Ideally, honey gathering is performed just before the end of the flowering season of various plants around the *sialang*. Honey is produced as a result of mutual interaction (symbiotic mutualism) between the bees that receive a food source and different plant species in the vicinity that receive a pollination service. Selecting an appropriate date for gathering ensures a high honey yield, but this requires a comprehensive understanding about the periodic plant cycles (phenology) of plant species around the *sialang*.

To determine the date of honey gathering, a honey gatherer consults the lunar calendar to ensure that the gathering taking places in a completely dark night with no moonlight. Kamshory and Shafi'i (2014) state that at the time of conjunction (new moon), the moon is not visible entirely due to the dark side of the Earth is facing the moon. This phase is called the new moon. In this phase, the sun, the earth and the moon are aligned. A side of the moon facing the earth receives no radiation from the sun. A completely dark night will ease to expel bees from their beehives. The way local people determine the date for gather the honey is supported by materials discussed in the science class of 8^{th} grade, particularly for the topics of solar system and life on earth (Table 1).

3.2.3. Preparing several tools to gather honey.

Several tools are required to gather honey: *enyor* rope, *kemenyeng* rope, wooden rungs, *sengkorot* (climbing tool), *andim* (hammer), *temalang* (container), and *tunam* (firework bark). *Enyor* rope is used to take the *temalang* (container) containing honey up and down from the *sialang*. *Kemenyeng* rope is used to tighten the *temalang*. The *enyor* and *kemenyeng* ropes are made of rattan (mostly *Calamus javensis* Blume). The wooden rung is made of bamboo or hardwood that will be plugged into the *sialang* trunk. The rungs are commonly made from bamboo or wood species such as

Carallia brachiata [Lour.] Merr. *Sengkorot* is a tool to facilitate gatherer climbing the *sialang*. *Sengkorot* is usually used in gathering honey in a relatively low tree, thus it does not require *lantak*. *Sengkorot* is usually made from the bark of several tree species. The *andim* (wooden hammer) is used to help plug the *lantak* on to the trunk of *sialang*. *Andim* is commonly made from strong and durable wood such as *Kempas* (*Koompassia excelsa* (Becc Taub.) and *Bulian* (*Eusyderoxylon zwagerii*). A good *andim* can be used for many years. *Temalang* is a container to transport the honey down from the *sialang*. The bowl shaped *temalang* is made from the bark of *gaharu* (*Aquilaria malaccensis* Benth). Lately the traditional *temalang* has been replaced with a plastic basin. *Tunam* is a material used to produce flame by hitting it on the *sialang* branch repeatedly. *Tunam* made from the barks of several plants, such as *senyanyah* (*Piper* sp.) and *batang tunom* (*Scaphium affine* Pierre). To make the *tunam*, a piece of bark of about 1 meter in length is pounded, dried, and then tied up. *Tunam* also equipped with straps that will be attached on the back of the waist of a honey gatherer who climbed the *sialang*.

These tools are mostly made from plants species commonly found in the local forest - each tool requires plants with specific properties. For example, *enyor* rope requires a flexible but strong wood - several species of rattans meet the requirement. Other tools such as *andim* and *lantak* require hard and strong woods. Suranto (2012) suggests that timber strength is positively correlated with its specific gravity value. *Temalang* requires materials that are spacious and robust, but elastic and not easily torn. A material that meets these criteria is the bark of *gaharu* (*A. malaccensis*). Dealing with wood elasticity, the value of Modulus Elasticity (MOE) indicates the elasticity of a material's behavior, wherein the strain caused by the addition of the load will be lost if the workload is removed (Kistiani, 2006). It is therefore essential for honey gatherers to have knowledge about the properties of various plants that can be used to produce the required tools. Local knowledge about these plant properties can be connected with the associated materials learned in science class particularly for the topic of material properties and their utilization in grade eight (see Table 1).

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3.2.4. Installation of *lantak*.

The *lantaks* are embedded into the *sialang* trunk, usually in the afternoon on the same date of honey gathering. Local people believe that the amount of water that comes out from the *sialang* trunk when the *lantaks* are installed indicates the amount of honey that will be obtained. Installing the *lantaks* injures the *sialang*, so before *lantak* are installed, honey gatherers usually sing rhymes to ask permission and entreat the tree. A strong push is required in order to embed the *lantak* into the *sialang* trunk properly. Installing a tapered *lantak* will generate high pressure when it is beaten with the *andim*. A tapered *lantak* has a cross-sectional area which is much smaller than the cross sectional area of its base. By providing the same amount of force, the pointed part of the *lantak* can produce a greater pressure than the pressure generated by the blunt *lantak* (Kistiani, 2006), therefore the *lantak* can be properly stuck into the *sialang* trunk. The process of installing as well as the working principles of the *lantak* can be connected to the topic of motion in living and nonliving things and simple machine discussed in the 8th grade of science class as presented in Table 1.

3.2.5. Climbing the *sialang*.

For a tall tree, climbing is done with the help of *lantak*, whereas for a relatively short tree, the climbing is done with the help of *sengkorot* (not using *lantaks*). Before climbing, the *tunam* is set alight. *Lantak* and *sengkorot* are simple technologies that facilitate tree climbing by the honey gatherers, and decrease the amount of energy needed to climb the *sialang*. To reduce the load on any one individual *lantak*, multiple *lantaks* are used, such that the weight of the climber is distributed across more than one *lantaks*.

The use of *lantak* and *sengkorot* can be associated with the concept of inclined plane that reduces the minimum force required to lift an object (science topic in the grade 8; Table 1). This occurs because the required minimum force is equivalent to the multiplication of the object weight force by the cosine value of the angle of an inclined plane used to lift the object. Although the total mass moved is the same in both cases, the force needed to lift objects will be smaller if aided by an incline plane (Serway & Jewett 2004; Isnaini, 2015).

3.2.6. Shaking the *tunam* fire.

The lit *tunam*, this bark is shaken on a *sialang* branch next to the beehive to produce sparks that act like fireworks and float down from the tree. The glowing embers in the moonless night attracts bees to leave the nest. The working mechanism of *tunam* can be linked to the topic of light in the science class of 9th grade. The movement of the bees towards the embers can be attributed to the concept of photo-taxis which is an automatic movement of an organism toward or away from the light. Insects can see light wavelengths from 300-400 nm (near ultraviolet) to 600-650 nm (orange) (Rahmawati, A., Winarti, S., Tristianto, D, 2012). Knowledge of insect behavior in response to light is also used for other purposes - for example, rice paddy farmers using light traps to attract insect pests away from their fields.

Another important bee behavior is its social behavior. These particular honey bee species are social creatures, with hives that contain of three castes: the workers, the queen and the drones (e.g. Zayed & Robinson, 2012). Worker bees are female but do not undergo reproduction. The queen is female, with a larger body size than that of the workers; she mates and lays eggs. Drones are male, have a larger body size than the workers, and mate with the queen. The workers and the queen both have stings, but males cannot sting. Most members of bee colony are workers, and have roles that changing with age. In addition to feeding the larvae in waxy incubation chambers, worker bees also provide royal jelly, special food for the queen larvae (Pavel, C. I., Mărghitaş, L. A., Bobiş, O., Dezmirean, D. S., Şapcaliu, A., Radoi, I., & Mădaş, M. N, 2011). Learning about bee social behavior can enrich the topic of systems and organization of life discussed in the grade 7.

3.2.7. Harvesting the honey.

The honey gatherer takes the honey shortly after most of the swarming bees have left the beehives. The gatherer the honeycombs using a *sembilu* - a blade made from split bamboo. Local people avoid using metal knives to cut the honeycombs and prefer to use the *sembilu*. Reasons for this could be that dropped a metal knife while working in the dark could injure people standing under the *sialang*; the use of a *sembilu* reduces this risk. Moreover, using the *sembilu* also prevent any possible reaction between iron (in the metal knife) and honey which could reduce its quality. Reactions between honey and metal (iron) can also cause corrosion (the degradation of metal due to reduction oxidation (redox) reaction between metal and various substances in the environment) and produce undesirable compounds. An example of a common redox reaction is the rusting of an iron. In this reaction, the iron undergoes oxidation, while the surrounding environment (air and oxygen) is reduced. The practice of honey gathering in this step can be connected to the topic in the science class especially the changes of objects around us (grade 7) and material properties and their utilization (grade 8).

Honey gatherers are aware about the sustainability of bee population. A small part of the beehives is left on the *sialang* to help recover the bee population. The recovery process is related to the concept of growth and development. The bee larvae inside the beehives will grow into mature bees that are able to reproduce thus assure the sustainability of the bee populations. The explanation of this practice can be connected with the topic of reproduction in animals (grade 9).

When taking honey on the *sialang*, a honey gatherer throws down part of the bee larvae and the beehive into the bush around the *sialang* with the intention of sharing them with other forest

ecosystem components, including tigers. At a glance, it seems there is no relationship between the tiger and the honey, because tigers are predatory. However, the link between tigers and bees is apparent when considering the food chain and food web. Tigers are keystone predators that maintain the balance of tropical forest ecosystems. If the tiger populations are much reduced, or even extinct, this could disturb the forest ecosystem by allowing the population of herbivores (tiger prey) to increase in the absence of predators. The diversity and abundance of flowering plants might then be disrupted by higher herbivore populations. Finally, an additional link between honey production and the wider ecosystem is that honey production is only sustained if bees can get sufficient quantity and quality of nectar from the surrounding forest. These explanations can be connected to discussions about the topic of interactions among living things with the surrounding environment (grade 7).

3.2.8. Taking down the honey from the tree.

The honey is placed in a *temalang* (container). Taking down the honey from the *sialang* is facilitated by the use of rope. The process of taking down the honey might be done repeatedly, especially when the gatherer gets a great quantity of honey. To facilitate and reduce the heavy burden, the rope to take down the honey is anchored on a higher branch that serves as a hoist. The amount of honey produced in each tree varies greatly, ranging from tens of kilograms to more than a ton, depending on the state of bee colonies. Therefore, the use of simple technology such as the rope is very helpful to bring down honey from the tree.

The process of taking down the honey from the tree can be linked to the concept of a simple machine (grade 8). The principle is to change the direction or magnitude of a force. Serway and Jewett (2004) explain that simple machines utilize a unit of force acting against the force load. Ignoring the frictional forces that arise, the work done by the load will then be equal to the work done on the load. The work produced is the result of force and distance. The amount of work required is constant. However, the amount of force required can be reduced by applying less force on a longer distance. It can be concluded that an increase in distance will reduce the force needed.

3.2.9. Sharing and the use honey and bee larvae

Although individual *sialang* trees are privately owned, the honey produced by bees hosted in the tree is regarded as common property. The honey gathering team distributes the collected honey equally among the three main parties: the *sialang* owner, the gathering team, and the people who observing the honey gathering. All people who observe the honey gathering, even children, will be given honey. The proportion of honey distribution among the three parties may vary across different regions (ethnic groups). This practice of sharing honey can be connected to the topic of social interactions in social science lessons (grade 7).

The taste of honey is determined by the types of flower, which are the sources of nectar. For example, honey produced from *meranti* flowers (Dipterocarpaceae sp.) is reddish and somewhat bitter. Honey derived from durian flowers is blackish with astringent taste. The Indonesian National Standard (01-3545-2004) recognizes eight important physical properties of honey including (i) water content, (ii) hygroscopic properties, (iii) thermal properties, (iv) color, (v) optical rotation, (vi) electrical conductivity, (vii) density, and (viii) viscosity (Apriani *et al*., 2013).

In addition to daily consumption, honey is also commonly used for health purposes, cosmetics and pharmaceuticals. Besides honey, other bee products are royal jelly, pollen, propolis, and wax. Royal jelly is thought to be beneficial in maintaining human stamina and accelerating recovery from various diseases. Propolis can be used to promote wound healing and treat skin diseases. Wax produced by bees is widely used in the pharmaceutical and cosmetics industries. Moreover, bee larvae in the honeycomb are interesting objects for studying the life cycle of honey bees. The

diverse products derived from the bees could also be linked to the discussion of material properties and their utilization (grade 8).

3.2.10. Leaving the *sialang*.

The leader of the honey gatherer team is the person who stays longest in the gathering site. He is the earliest person who arrives at the gathering site and also the one who leaves the *sialang* last. Before leaving, the leader chants closing rhymes (mantra) which express his gratitude, farewell, and hope that his team will return soon in the near future. The rhymes indicate the commitment of the honey gatherer team to conserve the *sialang* as well as the bee ecosystems to ensure sustainable honey production. The local practice of honey gathering that pays attention to sustainability can be used as an example in the discussion of environmentally friendly production process (grade 9).

3.2.11. Protection of *sialang*.

Sialang is culturally a very important tree for the traditional Jambinese people. The presence of the *sialang* is highly protected, and felling of *sialang* is prohibited. The Orang Rimba community of the Bukit Dua Belas National Park customarily protects the *sialang*. One who cut down a *sialang* will be charged a *bayar bangun*, an equivalent fine to that imposed on one who commits murder (see Hariyadi & Harmoko, 2014).

Protecting the *sialang* also means protecting swarms of bees and the forest around the tree. The bees have an essential role in maintaining the balance of forest ecosystems around the *sialang*. The bees interact with various plant species in the forest in the form of symbiotic mutualism: on one side the bees get nectar from the plants which they process into honey, and on the other side the forest plants are pollinated by the bees. The bees therefore ensure the sustainability of reproduction by many forest plants, and are not just linked to the *sialang*. Taking into account that the *sialang* is a home for the bees and protecting it therefore also helps the life of other plants around the *sialang*. Interactions among bees and the *sialang*, as well as the other living creatures, fits with the main point in the topic of interaction of living things with the surrounding environment (grade 7).

In addition to science learning values, traditional honey gathering is also rich in character educational values such as solidarity, courage, skill, tenacity, discipline and ethics. Characters of togetherness and mutual cooperation can be seen in any steps of the honey gathering, starting from the preparation stage until the closure of the gathering procession. The activities are performed together by a team in which its members have specific roles and responsibilities. The gathered honey is also distributed proportionately by considering the level of participation in the honey gathering procession. Characters of bravery, skill, tenacity and discipline are portrayed by the profile of *sialang* climber, who must overcome a variety of challenges in order to be able to take the honey. To be a honey gatherer one should have knowledge, skill and audacity to deal with the bees. Characters of courtesy are shown by the stages of honey gathering that follow a number of specific rules. The *sialang* and bees are not merely regarded as animals and plants, instead, the bees are personified as "a princess" who needs to be treated with courtesy and ethically.

3.3. Integrating the traditional honey gathering into science learning

Education keeps changing over time, following the development of science and technology as well as the flourishing culture. Education is a process of transferring cultural values. However, education is also a reflection of recent cultural values. The transfer of cultural values is very effective through education. In this case, the main purpose of education is to develop students' potential and pass noble cultural values onto the students. From the student's perspective, education

is an effort to develop their individual potential of, including cognitive, affective, and psychomotor aspects. From the cultural point of view, education is a process of inheritance of noble cultural values. Therefore, education puts humans as cultured creatures (Herusatoto, 2008)

The government of Indonesia released the most recent school curriculum in 2013, including for junior high school. One of the 2013 curriculum objectives is to encourage science teachers to understand the importance of local cultures and wisdoms. However, there are many obstacles that inhibit the implementation of the new curriculum (Rumahlatu *et al.*, 2016; Wayan, 2017). For example, the science teachers still encounter problems in teaching science in a way that actualizes the values of local wisdoms and cultures. If such conditions persist, then students will not care about, nor feel proud of, their local traditions and cultures. Therefore, it is crucial for junior high school teachers to be able to develop science learning based on the local environmental and cultural setting. Science learning presented by the teacher should contain materials that really support the achievement of standards and basic competencies. Teachers need to identify the required standard and basic competencies, and then determine the appropriate learning material to be delivered. Each standard and basic competency may require a different learning material.

Jambinese traditional honey gathering can be connected to almost all science learning materials in junior high. Some of the materials are categorized as very relevant, as presented in Table 1. A science teacher could sort out the most suitable materials from the honey gathering tradition to be integrated into his/her learning science. This should also create more meaningful and joyful learning by considering the students' socio-cultural and environmental conditions.

Table 1. Science content in the 2013 Indonesian Curriculum for junior high school that has associations with the Jambinese traditional honey gathering

Grade	Content in the 2013 Curriculum	Association with the Jambinese Traditional Honey Gathering Practices
VII	Science objects and their observation	This section introduces students to the objects studied in science. The tradition of gathering honey can be used as the objects in applying simple scientific methods (observing, associating, and communicating). It also trains students' awareness in observing objects and events occurred in the surrounding environment.
	Objects classification	This section identifies the characteristics of living and non-living objects and their classification procedures, analyzes the differences between living and nonliving objects as well as the shape of non-living matter (solid, liquid and gas), and differentiates among elements, compounds, and mixtures. Learning objects for this section can be attributed to several objects around the honeybees as well as the *sialang*.
	Classification of living things	This section introduces objects in the natural environment and identifies the characteristics of living things and their classification procedures. Learning can be done by taking a number of living things associated with traditional honey harvesting.
	Systems and organization of life	The lesson in this section introduces students to the hierarchy of life and the concept of living systems. Learning about the organization of life can be attributed to the behavior and social systems of honey bees to give an idea about the life and regularity of a life system
	Changes of objects around us	This section discusses the changes of materials in the nature and the various methods to separate a mixture. Learning can be done by observing physical and chemical changes related to honeybees such as the reaction between honey and metal, beeswax and honey. Students can also do experiment by

Grade	Content in the 2013 Curriculum	Association with the Jambinese Traditional Honey Gathering Practices
		applying various methods to separate honey mixture produced by the wild honey bees.
	Interaction of living things with surrounding environment	Learning can be done by explaining the importance of interaction and also the types of interactions associated with the bees. Honey is a product of various interactions including symbiotic mutualism interaction between bees with various species of nectar-producing plants. Another interaction occurs between bees that use twigs in the creation of beehives. Interactions also occurr between individual bee species, both in one caste (class) and between different castes.
VIII	Motion in living things and objects	An understanding of the concept of motion in both living and non-living things can be attributed to bees that can perform distinctive movements in accordance with their habitat as well as their physiological and morphological adaptation suit for such movement.
	Skeleton, muscles and simple machine	Discussion can be attributed to the principles of simple machine and the parts of the skeletons (muscles) involved during honey gathering, for example when climbing a *sialang* tree using *sengkorot* and *lantak*, as well as in the process of lowering honey from the tree using *enyor* and *kemenyeng* rope.
	Structure and function of plant tissues and their uses	Discussion about the structure and function of plant organs (structures and tissues of roots, stems and leaves) and its utilization can be done by taking the *sialang* tree species as an example or object of observation. The explanation of the use of plant structure can be done by connecting the structure and function of the tissues of *sialang* and as well as the other plants associated with bees.
	Material properties and their utilization	The discussion about material properties and their utilization can be done by connecting them to a number of tools for gathering honey. For example the characteristics of plant tissue suitable for making *tunam*, *andim*, *sengkorot*, and *lantak*.
	Digestive system	Discussion on this material can be linked (added) to the use of honey as a nutrient-rich diet of minerals and vitamins. If possible, learning can be done in an experiment to test the nutritional content of the honey. The use of virtual-based media can give an idea of how honey can be absorbed by the digestive system and eventually become a source of energy.
	Additive and addictive substances	Discussion of additives may use honey as an example. Honey is a good sweetener and rich in natural nutrients. In addition to sweeteners, the use of honey can also increase the nutrient content in food. Honey is not only consumed directly, but also used as a mixture of food, beverages, and cosmetics. Honeycomb also produces beeswax which is used as material for beauty industry and medicine.
	Transportation system	Discussion of the transportation system can be linked to the transport system of tree species of honeybee hosts (*sialang*). Such plant is capable of transporting water and nutrients from the soil to the high *sialang*. A more detailed discussion is performed for organs and tissues that play a role in the plant transportation system
	Hearing organs and sonar systems in living thing	Learning on this material can be attributed to the hearing sense in bees and the use of sonar and odor by the bees to provide information about the existence of food sources.
	Vision organs and optics	Discussion on this material can be enriched with the sense of sight and optical devices in bees. The way in which local

Grade	Content in the 2013 Curriculum	Association with the Jambinese Traditional Honey Gathering Practices
		people drove the bees from their nests using light at pitch black night can also be attributed to the properties of the bees' sense of vision.
	Solar system and life on earth	Discussion on this material can be attributed to marking a certain position on earth as well as determining the day (date) to gather honey. Besides requiring an understanding of the prime season of the various plant species around the *sialang* tree (phenology), the determination of the day to gather honey is also associated with the movement of the earth and the moon against the sun. The traditional honey gathering takes place only on dark nights. At the moment of conjunction (new moon); the moon is not visible entirely because the dark side of the moon is facing the earth. In that phase, the sun, the earth, and the moon are in parallel positions. The side of the moon that accurately faces the earth causes the moon to not get any lighting from the sun so that it will produce dark nights in the other hemisphere.
IX	Reproduction in plants and animals	Learning on this material could be related to reproduction in honeybees, including the social system of honeybees by sex and their respective duties. Reproduction in plants can be done by observing reproduction patterns on *sialang* tree species as well as on the species of nectar-producing plants sucked by the honeybees. The discussion of plant reproduction not only focuses on wild plants, but also on cultivated plant species close to the life of the students.
	Human population and the environment	Learning on this material addresses the impact of population growth on the environment including environmental degradation caused by industrial and domestic waste, the depletion of clean water, the reduced availability of clean air, and the reduced availability of space and agricultural land. Learning can be attributed to the diminishing population of *sialang* as well as the nectar-producing plant species due to the conversion of forest areas into other land uses, especially plantations and settlements. The change is a further impact of the growing human population.
	Composing element of objects and living things	Learning on this material can be done by analyzing up to the smallest parts of non living objects, including various objects (equipment) used in harvesting honey. A similar discussion can be made of the constituent components of living things in the ecosystem of honey bees in the forest such as bees, *sialang* trees, and other surrounding plant species.
	Inheritance in living things	The study of the characters inheritance can be done by taking examples from honeybees or flowers that are the source of nectar to explain the characters inheritance of Mendelian, especially monohybrid and dihybrid crossing.
	Food biotechnology	Learning on this material can be linked to the use of food biotechnology using honey as an alternative healthy food
	Environmentally friendly technology	This section discusses the basic understanding and basic principles of environmentally friendly technology. The process of producing honey is an example of environmentally friendly technology. Bees will produce honey with good quality and quantity when the environment is in good condition too. Students can explore various technologies to produce other products that are environmentally friendly.
	Soil and the living survival	The material in this section includes the role of soil and soil organisms, the relationship between soil organisms and the formation of soil texture and structure. Students will study the

Grade	Content in the 2013 Curriculum	Association with the Jambinese Traditional Honey Gathering Practices
		process of soil formation, the factors that affect the process of soil formation and soil composting components. The discussion can be enriched with several species of bees and insects that naturally have a role (ability) in the process of soil formation.

Table 1 indicates that traditional honey gathering is rich in science values that can be employed to facilitate science learning. Almost every step of the tradition can be connected to the content of science learning in junior high school. For example, for the subject of solar system and life on earth (Class VIII), the science learning can be attributed to the way the traditional Jambinese societies determine the date to gather honey. Besides science, the tradition can also be used to enrich the learning in other subject such as social science. For example, the topic of Indonesian resources as well as ethnic and cultural diversity discussed in junior high school grade 7 is very relevant with the tradition.

Integrating local knowledge such as the tradition of honey gathering will connect between the social science context around the life of students and natural science (Diegues, 2014). Moreover, the use of such local knowledge will also develop students' positive attitudes towards science (Fasasi, 2017). The population of *sialangs* is declining due to rampant forest conversion to other land uses throughout Jambi province. Engaging the science learner with traditional honey gathering will not only maintain the tradition, but may also help to conserve the local forests, by increasing appreciation of the forests by students who may not normally interact with them. The tradition is only able to be performed as long as the forests are in good condition. To be able to produce honey, the bees need space in the *sialang* tree to host their beehives as well as good and abundant nectars from various flowers around the *sialang*.

The tradition of honey gathering could be integrated into science learning by applying some teaching methods adapted to the learning material, students' condition, and the school environment. A science teacher should select a learning method (model) and the media in accordance with the material to be taught. Dublin, R., Sigman, M., Anderson, A., Barnhardt, R., & Topkok, S. A. (2014) integrate local knowledge in learning science through science competitions (science fairs). In doing so, teachers facilitate students to develop science projects based on local scientific knowledge, which are then entered into a competition. Learning can be enhanced by applying the relevant learning models such as discovery and inquiry, problem-based learning and project-based learning. Students are directed to conduct observations and discussions within their groups as a process to find a concept.

Another approach that can be used to integrate tradition into science learning is Science, Technology, and Society (STS); teaching science and technology in the context of human experience. STS approach is very suitable for integrating domains of concepts, process skills, creativity, attitudes, values, implementation and linkages between areas of study (curriculum) in learning, and assessment of science education (Lestari N.M.E., Syahruddin, Jampel, I.N, 2013). The STS approach is implemented by linking science and technology to their usefulness in society. In the STS approach, students actively participate to define the purpose, the planning procedures, the information collection, as well as the evaluation of learning activities that will be carried out. The approach allows science teachers to observe benefits for students after learning science. Concepts that have been acquired during the learning process can be applied by students in everyday life; therefore the science learning objectives can be achieved optimally.

Another learning model the context-based learning - can be applied to integrate honey gathering traditions into science learning. Cobern (2012) introduces the concept of contextual constructivism whereby the learning is performed by accommodating the cultures and beliefs of the learners. To

do so science learning is formatted in such a way as to ease the student's understanding of the subject. Glynn and Winter (2014) suggest four prerequisite conditions for the contextual learning model, including: an active collaboration among students, a high level of class activities, a link between the science and the context around the students' life, and the incorporation of science materials with other content and skills to be achieved. Furthermore, Glynn and Winter emphasize that the strategies of contextual teaching and learning ease teachers in confronting any challenges encountered in introducing science to students. Suryawati, E., Osman, K., & Meerah, T.S.M. (2010) report that the contextual learning strategies improve student abilities in solving science problems.

In addition to context-based learning, information communication technology (ICT) is powerful tool to integrate local knowledge and wisdom into science learning. Kamshory and Shafi'i (2014) argue that ICT is an efficient and effective way to convey information. Things that are abstract or difficult to imagine in the student's mind can be presented and simplified through a computer simulation. By employing ICT, the tradition of Jambinese honey gathering can be integrated to science learning in urban schools far from the *sialang* forest. Student may also do exercises and virtual experiments using simple programs to instill and reinforce science concepts to solve everyday problems. ICT has great potential to improve the quality of learning, especially in presenting scientific phenomena. In this way science concepts can be applied easily in everyday life. Science is the basis of technology development, whereas technology supports the development of science. Science is employed in discovery activities that reveal and obtain explanation of objects and/or natural phenomena. Moreover, science is also being used to find an invention, for example to find simple tools to meet the needs of the community. Sari, J.S., Kartimi, & Fitriah, E (2015) suggest the use of discovery and inquiry learning model to capture explanation of objects and natural phenomena. Taking into account that successful science learning is influenced by many factors, teachers should wisely select the approach, media, and/or model of learning that matches the delivered material contents.

4. CONCLUSIONS AND SUGGESTIONS

Traditional honey gathering conducted by communities in Jambi community contains a number of materials that can facilitate the creation of more meaningful science learning. The tradition also contains values of positive educational characters such as diligence, cooperation, and openness. To integrate local knowledge, such as the honey gathering tradition, science learning requires creative teachers who are aware and concerned about the local knowledge. Integration of local knowledge into science learning can be performed by using various learning models in accordance with the condition of students and the surrounding environment. The traditional practices could be better taught mainly through context-based teaching and learning practices. This research is still explorative. To effectively implement the integration of local knowledge of traditional honey gathering into science learning, the next research agenda should develop methods, models, media as well as science learning trials about the Jambinese traditional honey gathering integration in science classes.

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