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Implementation Effort of Informal Science Education in Bengkulu, Indonesia: A Small Learning Center for Life Sciences

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ABSTRACT

Science education (SE) policies in Bengkulu are performed formally according to the national curriculum which was decided by the central government in Jakarta. These formal practices tend to ignore the principle of *free choice learning*, so informal science education (ISE) is also really needed as a complement to improve the quality of SE and conservation education (CE). This paper will describe implementation effort to pioneer ISE in Bengkulu during a period of five years (2014-2018). There were eight efforts as follows; Concept of ISE in accordance with local condition, Provide space for ISE activity, Build mini library including internet access, Compile simple laboratory tools, Manage life science training, Serving research needs in the field of life sciences, and Assisting to prepare scientific publications. The efforts resulted a Small Learning Center (SLC) for life sciences which was called "Sumber Belajar Ilmu Hayati" (SBIH) Ruyani with the following concept; (1) *Main goal of the effort*: (a) providing out-of-school experiences are synergistic with the experiences occurring within schools, and universities, (b) learning nature harmony from the facts. (2) *Key educational approaches*: Giving guidance for teaching, learning, research, and publication in life sciences. (3) *Audience targeted*: learner enthusiasts from junior high, high school, undergraduate, and graduate levels. There are still some limitations of the implementation efforts, but temporary results (work system, number of participant, and service quality) were useful as the complement to existing formal institutions. Thus, the SLC should be developed in order to make more real contribution for improving SE and CE.

Keywords: informal science education, life sciences, free-choice learning, conservation education

INTRODUCTION

Informal science education (ISE) is learning related to science that occurs in informal, out-of-school contexts. These contexts vary from visiting science centers and engaging with the exhibits and programs offered there, to watching a science program on TV, to researching a nature topic in the library or online, to participating in structured afterschool programs, and so on. It was summarized that learning in out-of-school contexts means learning that is self-motivated, voluntary, guided by the learner's needs, and interests, learning that is engaged in throughout his or her life (Dierking *et al*., 2003). As the concept of ISE emerged it was called Public Understanding of Science (PUS), and the current ISE at National Science Foundation (NSF), which is one the largest of ISE project development in the USA, is a direct descendant of the PUS program

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created at NSF. Many ISE project still follows the PUS concept or model, which is premised on the ides that science, scientist, and other experts know and should determine that public needs learn. Explain science to the public, the reasoning goes, and both science and scientist will enjoy greater support, enhanced quality of life, and world leadership in science and technology. Most PUS activity involved exhibits, lectures, media broadcast, and public programs through which the public is informed about science and expected to embrace it (Bonney *et al*., 2009; Kalenda, 2015).

In Bengkulu, Indonesia, we naturally and traditionally practice ISE, but it has not yet become the discourse or policy of educational authorities that the ISE is the important complement of formal education. In general, education policy in Indonesia seems to be understood only one option is formal education, meanwhile it is known that the time of children in their school is only around 15% from 24 hours. There is a change of culture in Bengkulu, from education as a necessity of life to education as a lifestyle or social prestige. Recently in Indonesia is very popular with the academic degree as a product of formal education, the matter of competence that was built may be a second priority. Those facts are certainly not profitable. It is need immediately to reorient the "culture of learning" that education as a necessity of life, not just for lifestyle. Science education (SE) at the levels of elementary school to university in Bengkulu does not focus on biodiversity. Fieldwork is rarely included as an instructional technique at any educational level, and there is little focus on local conservation issues. Furthermore, science learning is presented without giving students direct experience of natural phenomena. Science learning activities in schools are similar to social sciences because in schools there is no laboratory equipment available, or unskilled teachers manage school laboratory activities. This condition causes students from the biological sciences in Bengkulu difficult to understand molecular principles, genomics and proteomics (Bogyo, 2007; Ruyani *et al*., 2005), which may be applicable to high biodiversity in Bengkulu.

Young people in Bengkulu still understand that price of a tree in the forest from the volume of wood to be had, as their parents usually do. They still find it difficult to understand that the natural chemistry of trees and other inherent species has a much higher price. The destruction of tropical forests due to illegal logging, plantation expansion, and mining activities continues as supported by corrupt behavior from local authorities. Both ordinary and educated people in Bengkulu find it difficult to believe that economic development can be done in harmony with the principles of biodiversity conservation, which is then called *green economy* (Djajadiningrat *et al*., 2011). *Green economy* is not going to happen in a society without good science education. Formal science education held in schools and universities are of course important, but nevertheless ISE or free-choice learning is the right solution for existing science education conditions. Based on the above considerations; a form of ISE as complement for improving the quality of SE and conservation education (CE) in Bengkulu should be initiated, and then be developed. Then the form of ISE will provide invaluable evidence for the importance of the unique and complementary aspects of informal/free-choice learning.

METHODS

Concept of ISE in Accordance with Local Condition

We believed that ISE as an alternative to improve the quality of SE and CE in Bengkulu. Bengkulu condition is not the same as well as other provinces in Indonesia, it is necessary to design the concept of ISE in accordance with the objective condition of Bengkulu. The first author, in addition to studying a number of literatures on SE, CE, and ISE, also conducts direct correspondence with activists and local or international agencies concerned with the implementation of ISE. From October 2011 to November 2017 the author conduct some correspondences with four international ISE experts, namely; (a) Prof. Catherine Matthews, principal investigator of Herpetology Education in Rural Places and Spaces (The HERP Project), The University of North Carolina at Greensboro, USA. (b) Dr. Ellen McCallie, Division of Research on Learning, National Science Foundation, Arlington, USA. (c). Prof. Lynn D. Dierking, Institute for Learning Innovation, Portland, USA. (d) Dr. Patricia G. Patrick, Columbus State University, Columbus, GA, USA.

In addition to correspondence via e-mail, the first author also had the opportunity to have direct discussions with the four experts on various aspects of ISE in Bengkulu (Matthews; McCallie; Patrick), Jakarta (McCallie), Kuala Lumpur (Dierking), Greensboro (Matthews), Washington DC (Matthews), thus strengthening the motivation to formulate the concept of ISE in accordance with the local condition, in Bengkulu. The first author and Matthews documented their discussion about ISE into a book chapter entitled "A Comparative Look at Informal Science Education & Environmental Education in Bengkulu Province, Indonesia & North Carolina, USA" (Ruyani & Matthews, 2017; https://link.springer.com/chapter/10.1007/978-

3-319-50398-1_20). The chapter later was gathered together by Patrick with a number of other chapters into one book entitled "Informal Preparing Science Educators. Perspectives from Science Communication and Education", Springer International Publishing AG, ISBN 3319503960 (https://www.springer.com/us/book/9783319503967).

Provide Space for ISE Activity

Since 2003 the first author (as a lecturer of Developmental Biology at the Department of Biological Education, Bengkulu University) noted that some university laboratories in Bengkulu have not served the optimal needs of both learning and research. These facts are due to the limited laboratory costs from the government, and there is no good governance practice yet. For example, laboratory service hours are the same as the general secretariat office. In Bengkulu city, there are many new school buildings being built, but most schools have not understood that laboratory and field activities are the important part of science learning. Seven years ago the local government of Bengkulu city will build a Small Learning Center (SLC) for students according to the spirit of "*Bengkulu Kota Pelajar*" (Efendi & Megasari, 2005). But until now the SLC was not available due to a change of leadership, and an inappropriate local political atmosphere. This condition causes students from the life sciences in Bengkulu are not easy to understand molecular principles, such as genomics and proteomics, which may be applicable to understand the important of high biodiversity in Bengkulu. The SLC space for ISE pilots is difficult to obtain support either from formal education institutions or local government; further donations from personals or private donors are required.

Build Mini Library Including Internet Access

This initiating ISE as an alternative to improve the quality of SE and CE in Bengkulu, while the short-term target is how to improve the quality of biological research for undergraduate students in Bengkulu. We have collected a number of student theses from biology, chemistry, medicine, education which was supervised by the first author since 2004. We also received a prize of biological science books from retired lecturer of School of Life Sciences and Technology (STIH), Bandung Institute of Technology (ITB), Bandung, Indonesia. The materials are stored in special cabinets as ISE collections, and are freely accessible to anyone in need. The presence of mini libraries is expected to help students do the best biological science research, based on the potential of local biodiversity with standard research technology. Furthermore the mini library needs to be equipped with the device for easy internet access.

Compile Simple Laboratory Tools

Conservation of biodiversity, phytochemical, and ethno medicinal plant are natural resources-based research that will potentially be a local advantage of Bengkulu, if activities are conducted with standard research technology. The standard research technology in the field of biological science that is still relatively new in Bengkulu is genomics and proteomics research. Both molecular researches are still considered on aspect of technology and capital-intensive. Laboratories belonging to formal educational institutions in Bengkulu, especially state-owned, have not been able to routinely serve molecular research because the system of procurement management materials and tools those are not flexible. As a solution to the existing conditions, the core ISE began to assemble a number of simple tools and materials so that basic molecular research, such as proteomics and genomics, could be carried out, and young people in Bengkulu began to recognize and understand the research approach.

Manage Life Science Training

The first author had life science research experience using proteomic techniques (Ruyani *et al*., 2003; Ruyani *et al*., 2005), and stored a number of tools and materials for protein separation through 1- and 2-dimensional electrophoresis, an initial step towards proteomic research. Proteomics techniques are used to understand the mechanisms of physiology and biochemistry by comparing the presence of qualitatively and quantitatively certain proteins derived from cells or tissues under different conditions (http://www.expasy.ch). It is known that protein is a functional gene product, so its existence will reflect the actual condition of the isolated cell or tissue (Sarto *at al*., 1999). Young people in Bengkulu need to understand the molecular principles, proteomics and genomics, which may be applicable to high biodiversity in Bengkulu. Formal education available in Bengkulu, including Bengkulu University, is not easy to provide the specific training services needed. Under these circumstances, training in basic proteomic techniques is deemed necessary to be carried out informally in Bengkulu.

Prof. Matthews and the first author manage the Sumatran turtle conservation project which was funded by the Partnerships for enhanced engagement in research (PEER) project, entitled "Developing science and learning research capacity of Bengkulu University in ex situ conservation of Sumatran freshwater and terrestrial turtles" financed the US government (http://sites.nationalacademies.org/pga/PEER/PEERscience/PGA_168049) for three years. Furthermore, since February , 2018, they have also received overseas cooperation research funds (PKLN) from the Government of Indonesia for three years research activities entitled "Initiating informal science education and conservation education at the campus of Bengkulu University: Herpetofauna project-based learning". The second project requires immediate initiation of creating early experience in herpetofauna research at Bengkulu University with the spirit of free-choice and project-based learning.

Serving Research Needs in the Field of Life Sciences

Every student in the undergraduate (S1) and postgraduate (S2) program in the life sciences available at several universities in Bengkulu are obliged to conduct research as a prerequisite for their graduation. The final research assignment for the S1 is called a skips (6 credits), while for the S2 is called a thesis (12 credits). In accordance with the condition of Bengkulu, a part of their research theme based on existing biodiversity, and potentially will become a local advantage. A number of laboratories in several formal education institutions, some universities, in Bengkulu have not been able to meet the needs of places, tools and materials for young researchers of life sciences. As a result of these conditions the completion of life science research becomes longer with limited innovation. The presence of the initiating ISE that provides services to the needs of life science research will be an alternative solution for research activities in Bengkulu. The service not only helps provide tools and materials, but also technical guidance from experienced laboratory staff.

Assisting to Prepare Scientific Publications

Some biodiversity-based life sciences research in Bengkulu has the potential to be local excellent, and also becomes an alternative incentive for the conservation of natural resources. However, the results of the research usually stop until they are required to graduate from S1 or S2, and very few of these academic works have been successfully published. Despite the latest policy available in Indonesia which respects publications on national journals and international journals (https://www.scimagojr.com/journalsearch.php) as one of several considerations for the promotion of academic positions, the policy has not yet been welcomed because of publication culture at some formal education institutions are still very limited. The publication culture may be improved, as a solution, with assisting to prepare scientific publications through the initiating ISE.

RESULTS AND DISCUSSIONS

Matthews and the first author had a long discussion about the concept of ISE is in accordance with the conditions of Bengkulu. During the period of 1981-2007, conservation education in Bengkulu was to be integrated into the curriculum in relevant subjects from elementary school to high school (ages 5–18). In the years 2007–2013, the central government gave school districts autonomy over how to offer conservation education. Then, in 2013, given the national curriculum and a goal of reducing the number of subjects taught in schools, the government again recommended that conservation education be integrated into other subjects. During three decades of formal conservation education, only memorization of concepts and principles was stressed. Changing behaviors of students was difficult to achieve because the students heard only limited explanations of conservation in classrooms. Teachers found it difficult to offer students opportunities for observation, field practice, lab practicals, project work, internships, or adventure activities. Teacher readiness was also generally inadequate. Therefore, formal education in Bengkulu does not yet make a real contribution toward young people's appreciation and knowledge of natural resources, nor does it have much of an effect on their conservation-oriented attitudes and behaviors (Ruyani & Matthews, 2017). Finally they agreed that this initiating ISE is not enough just a written discourse, but it is absolutely necessary some real delivery of SE services for young people in Bengkulu. On the basis of that consideration, and then Ruyani established the initiating ISE, the Small Learning Center (SLC), which was called as "Sumber Belajar Ilmu Hayati" (SBIH) Ruyani (**Figure 1**).

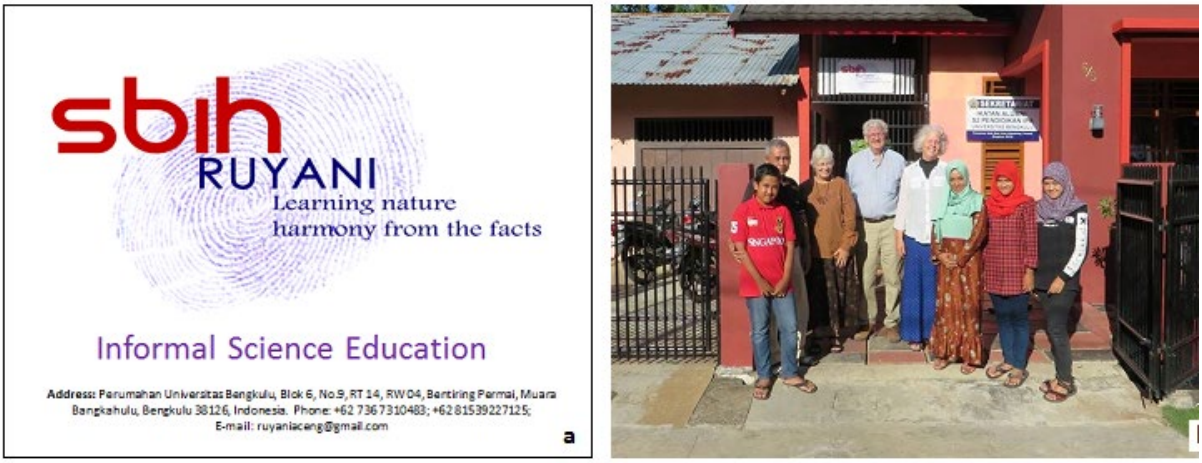

Figure 1. Sumber Belajar Ilmu Hayati (SBIH) Ruyani as the initiating ISE in Bengkulu city (a). Prof. Matthews (three from the left) and two of her colleagues (John Grove and Ann Somers) visited the initiating in Bengkulu (b). (https://www.facebook.com/pages/category/Science/SBIH-Ruyani-331235467270906/)

SBIH Ruyani was established with the following concept formulation; (1) *Main goal of the effort*: (a) provides out-of-school experiences are synergistic with the experiences occurring within the business community and schools and universities. (b) provides direct experience of natural phenomena, and the through evidences, subjects studied strive to understand the proses of nature, (c) a center for emerging scientist in Bengkulu, Indonesia. (2) *Organization involved in the effort*: (a) Graduate School of Science Education (GSSE), Faculty of Teacher Training and Education, Bengkulu University, (b) Alumni association of GSSE, and (c) Science Teachers at Teachers Association of Indonesia (PGRI). (3) *Key educational approaches/strategies employed*: Providing guidance for teaching, learning, research, and publication in the life sciences. (4) *Audience targeted*: Subjects studied at elementary school (elementary), junior high school (SMP), high school (SMA), strata-1 (S1), and strata-2 (S2).

There is a tradition of dichotomous science that does not necessarily occur in one area of the same science, such as; biology and biology education. What is the difference between biology and biology education? A similar dichotomy arises also in matters relating to the criteria of professional competence; *scientist identity* and *science teacher identity* (Varelas *et al*., 2005). This initiating ISE seeks to gradually reduce the dichotomous tradition through cross-disciplinary cooperation. Becoming a good scientist and a good communicator are the two essential things in science education. Many scholars began to make a relationship between a good scientist and a good communicator by expanding the paradigm of the traditional-formal to informal science education. The initiating ISE is an informal institution that provides public services in accordance with the needs so that then comes the term "free-choice learning" (Falk, 2005). Although ISE is an informal institution, public service as a social transaction needs to be guaranteed that no party is harmed. On that basis the initiating ISE will then need to be listed on the legal institution in Bengkulu according to the rules.

SBIH Ruyani as the initiating ISE in Bengkulu city occupies two houses belonging to the Ruyani family with a land area of 20x80 m^2 and having address at Perumahan Universitas Bengkulu Blok 6, No. 9 (**Figure 1.a**), Bengkulu 38126, Indonesia. The distance between SBIH Ruyani and Bengkulu University is about 9 minutes' drive by car. The initiating ISE has a mini library that collects; 144 undergraduate student research reports, 32 graduate student research reports, and 716 textbooks on life sciences. The library is also equipped with Wi-Fi devices so that learning subjects can access the latest data via the internet. SBIH collects a number of tools and basic materials so that it can provide experience of genomic or proteomic research (Ruyani *et al*, 2015). The initiating ISE also provides test animals, mice (**Figure 2**), for phytochemical and ethno medicinal plant research. Up to September 2018 successfully recorded 102 students conducted research on SBIH Ruyani with details based on; (a) gender, 23.5% male, 76.2% female, (b) educational level, 69.6% undergraduate, 30.4% graduate, and (c) field study, 31.4% chemistry, 36.3% biology, 32.3% medicine (**Table 1**).

Figure 2. Students recognize mice as test animals in biological science research (a). Needs of proteomic engineering experience cannot yet be served by formal education institutions in Bengkulu; SBIH Ruyani tried to serve these demands (b)

Table 1. Distribution of gender, educational level, and field study of undergraduate or graduate student who did academic activities at SBIH Ruyani during the period of 2014-2018

Activity in the year	Total	Gender		Educational level		Field study		
		Male	Female	Undergraduate	Graduate	Chemistry	Biology	Medicine
2014	7 (100 %)	3 (42.9)	4 (57.1)	5 (71.4)	2 (28.6)	3 (42.9)	3 (42.9)	1 (14.2)
2015	8 (100 %)	1 (12.5)	7 (87.5)	0 (0)	8 (100)	2 (25.0)	6 (75.0)	0 (0.0)
2016	13 (100 %)	3 (23.1)	10 (76.9)	7 (53.8)	6 (46.2)	9 (69.2)	0 (0.0)	4 (30.8)
2017	29 (100 %)	5 (16.0)	24 (84.0)	18 (72.0)	11 (28.0)	10 (40.0)	10 (40.0)	9 (20.0)
2018	45 (100 %)	12 (26.7)	33 (73.3)	41 (91.1)	4 (8.9)	8 (17.8)	18 (40)	19 (42.2)
Total	**102 (100%)**	**24 (23.5)**	**78 (76.5)**	**71 (69.6)**	**31 (30.4)**	**32 (31.4)**	**37 (36.3)**	**33 (32.3)**

Although herpetofauna is listed in the curriculum of junior and senior high schools, but the appreciation of the people of Bengkulu concerning this group of animals is still low. Herpetofauna is considered to have no economic value, so there is no animal or no problem. This fact will certainly only change gradually through a planned education package, as in this study. The education package in the form of Herpetofauna Basic Training (HBT) was offered through social media, and has been successfully volunteered by 37 young people aged 19-22 years. Then the selection was carried out through interviews to capture the strongest motivation from them choosing HBT as "free-choice learning". Through a successful selection, 20 prospective HBT participants were chosen with a background in biological sciences 14 (70%) and non-biological fields 7 (30%). HBT introduced both theoretical and basic skills *in door* with trained speakers and instructors. Participants were then divided into four groups, each of which carried out door activities with instructor guidance at four locations at the campus of Bengkulu University in April 2018. Participants and instructors succeeded in collecting data on herpetofauna from four different locations, and through the process of identification and recapitulation of data on the outdoor activity recorded 23 herpetofauna species consisting of 12 species of Anura, 8 species of Serpentes, and 3 species of Sauria (**Figure 3**; Kamsi *et al*., 2017).

Figure 3. Herpetofauna Basic Training (HBT) is an activity of a research project entitled "Initiating the informal science education and conservation education at the campus of Bengkulu University: Herpetofauna project-based learning" funded by the Government of Indonesia for three years (2018-2020)

Some of the collected data in SBIH Ruyani were analyzed and rewritten in accordance with the written rules that apply to international reputable journals and indexed by Scopus (https://www.scimagojr.com/journalsearch.php). Two manuscripts have been successfully published in reputable international journals, namely; (a) "Preliminary studies on therapeutic effects of ethanolic extract of *Tylophora villosa* leaves against paracetamol-induced hepatotoxicity in mice" (https://doi.org/10.1016/j.jtcme.2017.08.005; Ruyani *et al.*, 2018a) in the Journal of Traditional and Complementary Medicine, and (b) "Protective Effect of Leaf Ethanolic Extract Etlingera hemisphaerica Blume Against Mercuric Chloride Toxicity in Blood of Mice" in the Journal of Dietary Supplements (https://www.ncbi.nlm.nih.gov/pubmed/29451842; Ruyani *et al.*, 2018b). The two international publications revealed the fact that two plant species, *Tylophora villosa* and *Etlingera hemisphaerica*, have the potential as future medicinal plants.

It can be concluded that phytoconstituents of ethanolic extract of *Tylophora villosa* leaves (E2TL) had therapeutic effect against paracetamol (PC)-induced hepatotoxicity (PCIH) of *Mus musculus* by inhibition of radicals and lipid peroxidation (Ruyani *et al*., 2018a). Furthermore, the results of *Etlingera hemisphaerica's* research showed that $HgCl_2$ (5 mg/kg bw) administration increased leukocytes and decreased erythrocytes; meanwhile, $HgCl_2$ administration followed by leaf ethanolic extract *Etlingera hemisphaerica* (LE3H; 0.39 mg/g bw) treatment protected the amount of blood cells as well as the control. $HgCl_2$ administration showed a new 125 kDa protein and caused overexpression of 48 kDa protein; this protein profile could be protected by LE3H treatment as in the control condition. LE3H indicates potential protective effects against $HgCl_2$ toxicity in blood of *M. musculus*. Therefore, dietary supplements of LE3H may be useful for protecting persons who are exposed to $HgCl_2$ (Ruyani *et al*., 2018b). Furthermore, the two plant species, T. villosa and E. hemisphaerica, might be an example explanation that economic development can be done harmoniously with the principles of biodiversity conservation, which is called green economy (Djajadiningrat *et al*., 2011).

CONCLUSION

Informal science education (ISE) is really needed as a complement to formal education to improve the quality of science education (SE) and conservation education (CE) in Bengkulu city. SBIH Ruyani is the initiating ISE designed in accordance with the condition of Bengkulu. The activities for five years have shown tangible results (work system, number of participants, and service quality), SBIH Ruyani should continue to be developed in order to make a real contribution to the improvement of SE and CE in Bengkulu.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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