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Cultivating Marginalized Children's Scientific Literacy in Facing the Challenges of the 21st Century

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Abstract

The demand for a human capital workforce based on knowledge has been rising in the 21st century. Given the low level of scientific literacy and the large gap between marginalized and mainstream students, the purpose of this study is to determine the impact of Learning Outside the Classroom (LOC) approach in cultivating scientific literacy among marginalized students in remote Sarawak, Malaysia. The LOC module was designed based on constructivist, contextual and behaviourist learning theories. This study employed quasi-experimental with pre-test post-test, non-equivalent control group research design. The treatment group experienced learning with the LOC module while the control group was taught using conventional methods. In the treatment group, teaching and learning (T&L) processes occurred outside the classroom using learning materials from their surroundings. Students are required to work together in groups to carry out investigative activities. Through this study, marginalized students are able to learn science in the context of the real world and realize the application of scientific concepts in their daily lives experiences. It is hypothesized that this approach will stimulate meaningful learning that will significantly lead towards increased level of scientific literacy skills among marginalized students and hence equipped them with necessary knowledge to face challenges in the 21st century.

Keywords: Learning Outside the Classroom (LOC), Module, Marginalized children, Scientific literacy

Introduction

All societies in the world have ways to educate their people because education plays an important role in producing human capital. This is to ensure they become full participants that are capable of utilizing the knowledge and skills that can contribute to the society. Through education, individual's gap can be reduced and the level of competence among learners can also be increased (Min & Mi, 2015). As the number of low-skilled jobs in the employment market decreases, the importance of educational qualifications increases drastically especially in the 21st century. Every citizen needs to be able to make decisions that affect individuals, communities, regions, countries and the world, especially decisions that need a science education based on an understanding interdependency (UNESCO, 2010). Citizens need to critically evaluate the quality of scientific information and concept towards the claims made in the name of science in order to make decisions and choices that relate to their daily life and about the natural world. In short, we need to develop scientifically literate learners from young. Thus, science has to be seen as a must learned subject and knowledge in school since a very early aged. This is to prepare the learners to face the future that requires knowledge and skills of science in job application that is highly competitive (Trilling & Fadel, 2009) in the 21st century.

Despite the importance of science education nowadays and various efforts taken by the Ministry of Education (MOE) in Malaysia, marginalized learners still showed low and unsatisfactory level of education performance (Asnarurlkhadi, Maria, Zahid, Mariani, & Hanina Hallimatusaadiah, 2007; Nur Bahiyah, Maryati, Azman, & Mohd. Najib, 2013; Ramle, Wan Hasmah, Amir Zal, & Asmawi Mohamad, 2013) compared to mainstream learners. This

scenario according to Subahan (2009) and Subahan, Lilia, Saemah, Halimah and Rozlina (2011) includes science subjects. Although some programs that have been carried out can be considered successful, the level of science education among marginalized learners still lags behind. This is in line with the situation faced by other countries such as Canada, Taiwan and New Zealand (Bamhardt, Kawagley, & Hill, 2000; CCL, 2007; Kidman, Chiung, & Abram, 2013; Kuo, 2008; Meyer & Crawford, 2011; Stewart, 2009). In order for Malaysia, a developing country to become a developed country based on science and technology, all communities including those marginalized should have a high level of science education. This is a way of moving towards building and creating a scientifically literate community. Hence, marginalized learners should strive to improve themselves through science education so as not to be left behind in this development. Through education, marginalized learners will be able to and can move forward in adapting themselves in this new era of society. Therefore, we are obliged to increase efforts to ensure that marginalized learners have access not only to appropriate education but also to a scientific culture.

As Brianzoni and Cardellini (2015) stated, many learners are often not interested in school science. Therefore, factors that seek to promote participation and interest of marginalized learners in learning science in Malaysia should be studied so that a nation of scientifically literate citizens, including marginalized communities can be realized. According to Ma'rof and Sarjit (2008), marginalized learners in Malaysia have a very deep feeling for the environment and love of learning activities involving the environment. Conducive and comfortable learning environments will likely lead to the enactment of meaningful learning among marginalized learners in science. Therefore, the Learning Outside the Classroom (LOC) module was produced by researchers with the application and implementation of activities based on the environment in order to create alternative pedagogy among teachers in the process of the teaching and learning (T&L) of science. According to Rannikmae (2016), implementing and acknowledging the need for new pedagogies in science education has become extremely important to create opportunities for learners to be actively involved in learning in a motivated way. Thus, intervention or modules that can enhance the level of science academic achievement in primary schools is needed to cultivate scientific literacy among marginalized learners in facing the challenges in the 21st century. Therefore, scientific literacy among marginalized learners in this study is measured through science achievement by using Achievement Tests (AT).

Theoretical Framework of the LOC Approach

The LOC module used in this study applied learning theories such as behaviourist learning theory, cognitivist learning theory, constructivist learning theory and contextual theory. Behaviourist learning theory such as Thorndike Theory (1898) and Skinner's Operant Conditioning Theory (1953) emphasizes behavioural changes that can be observed and measured. In addition, the Cognitivist Learning Theory based on Vygotsky (1978), which emphasizes information processing in the mind will also be included in this module. A contextual approach that stimulates a person's mind to find meaning in context by making meaningful and relevant relationship to their environment will also be applied. Needham's Five Phase Constructivist Learning Theory (1987) was used for the sequence of information presentation during the T&L process, which involves the orientation phase, eliciting ideas, restructuring of ideas, application of ideas and reflection. Table 1 below describes the phases, purpose and examples of the activities, which were included in the module. With these, it is able to create a learning environment that stimulates and motivates marginalized learners in learning science.

Table 1. Needham's Five Phase Constructivist Model

Phase	Purpose	Examples of Activities
Orientation	To attract students' attention and interest	Experiment, video and film show, demonstration, problem solving, Song
Eliciting Ideas	To be aware of the students' prior knowledge	Experiment, small group discussion, concept mapping and presentation
• Restructuring of ideas, explanation and exchanging ideas • Exposure to conflict ideas • Development of new ideas • Evaluation	To realize the existence of alternative ideas, ideas need to be improved, to be developed or to be replaced with scientific ideas; To determine the alternative ideas and critically assess the present ideas; To test the validity of present ideas; To improvise, develop or to replace with new ideas; To test the validity of new ideas.	Small group discussion and presentation Discussion, reading and teacher's input Experiment, project and demonstration
Application of ideas	To apply the new ideas to a different situation	Writing of individual's report on the project work
Reflection	To accommodate ones idea to scientific ideas	Writing of individual's report on the project work, group discussion, personal notes

The instructional design model used is based on the Morrison, Ross, Kalman and Kemp (MRKK) Model (Morrison, Ross, Kalman, & Kemp, 2013). This model became the basis for the development of the module prepared by the researchers in this study. It has nine major elements arranged in an oval shaped cycle rather than in a linear form. This means that the instruction can start anywhere deemed appropriate and it has no starting point or ending point. The process of review and evaluation will take place as an ongoing basis to improve instruction. The MRKK Model is shown in Figure 1.

In addition, an LOC module emphasizes a science T&L process that occurs outside the classroom, as the teacher is required to bring the marginalized learners to where they can be close to the natural environment. This approach is a little different from the conventional method practiced by teachers in remote areas where the T&L process always occurs in the classroom. It will give the learners a more comfortable feeling and a feeling of being close to the natural environment because nature is an important element in their daily lives. Therefore, learning activities involving the natural environment will be of interest to them (Ma'rof & Sarjit, 2008) and also create a condusive learning atmosphere for marginalized learners. Elements of the LOC module are shown below in Table 2.

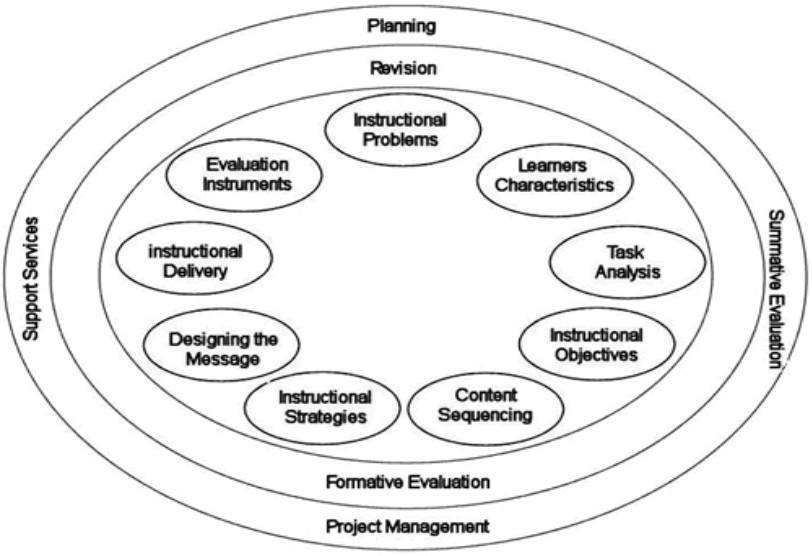

Figure 1. MRKK Model

Table 2. Components of the LOC module

Application of ideas (25 minutes)	**Activity 1.3** ***Hands-on activity*: Plants need water to live.** • Teacher tells students that they will conduct an investigation about the basic needs of plants that will involve water. • Teacher elicits students' prior knowledge about plant cultivation: *T: Who can tell me how to cultivate plants properly?* *S: Take seeds / plant and put it into the ground. Then add water.* • Teacher lets students explain the process of planting. If found to be incorrect, the teacher can show the proper process. • Teacher divides students into groups (2-3 people or at the discretion of the teacher). • Each group appoints a team leader. • Teacher shows students the materials / equipment needed to carry out the investigation for each group. • Students start the investigation activity.	Early preparation: • Germinate the seeds into seedlings (1-2 weeks before activity). • Dry the soil a few weeks earlier. • Place dry soil in a container. ** Contextual*

According to Smith and Sobel (2010), the LOC approach in the process of the T&L can help to build a dynamic knowledge base and explore the skills and abilities of learners. However, this LOC approach is not emphasized and applied in existing modules for

marginalized learners in Malaysia (CDD, 2013). This contextual and outside classroom approach can be an alternative to the T&L process that can be implemented in schools. Science will be more interesting for marginalized learners and hopefully have a positive impact on the academic achievement of science. The conceptual framework discussed can be visualized as shown in Figure 2 below.

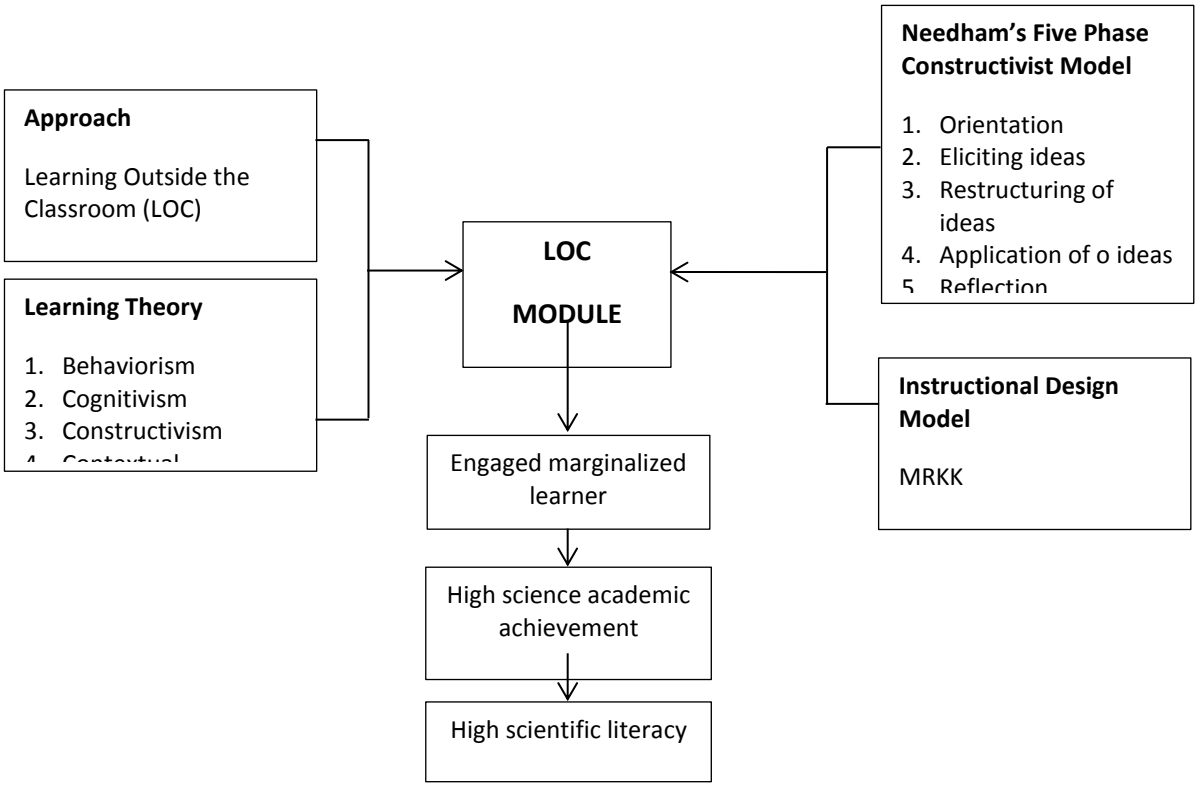

Figure 2. Conceptual Framework

Objectives

We proposed an approach that enables marginalized learners to learn science in the context of the real world and realize the application of scientific concepts in daily life experiences. Thus, this study aimed to determine the impact of the LOC science module toward cultivating scientific literacy among Year Two marginalized learners in remote Sarawak, Malaysia through using AT. It is believed that with the use of this module, it will stimulate meaningful learning that will reflect in AT and this will significantly lead towards increased level of scientific literacy skills among marginalized learners and hence equipped them with necessary knowledge to face challenges in the 21st century.

Methodology

Research Design

This study employed quasi-experimental research of the pre-test post-test, non-equivalent control group design. Both the treatment and control group were assessed with pre- and post-tests as shown in Table 3.

Table 3. Pre-test / post-test, non-equivalent control group design.

Group	Test	Intervention	Test
Control	Pre-test	Conventional	Post-test
Treatment	Pre-test	LOC science module	Post-test

Two schools served as a control group using conventional teaching methods and two other schools as treatment group using the LOC science module during T&L. Based on a preliminary analysis of the difficulty level of topics in Year Two science subjects that was administered earlier, the topic of 'Plant' was selected. Both the teachers and learners rated 'Plant' as the second most difficult topic in Year Two science subject after the topic 'Light and Dark' (Cindy & Kamisah, 2016).

Respondents

The respondents for this study were Year Two learners (8 years old) from four marginalized primary schools in a remote part of Sarawak, Malaysia. Thus, a total of 73 respondents participated in this study in which the control group consisted of 35 Year Two learners and the treatment group consisted of 38 Year Two learners.

Instrument

The instrument used in this study was AT, which was created by researchers. AT contained two sets of questions, namely pre-test and post-test, which are equivalent in the aspect of number of items, level of difficulty, the format and the scope to test learners' knowledge in the topic of 'Plants'. After the verification process by experts and the pilot test conducted, the number of items decreased from 15 to 10 in AT. The reliability for AT in this study showed a value of 0.711 using the Kuder Richardson approach. Items in AT showed a difficulty index between 0.50 to 0.84 and discrimination index between 0.31 and 0.88. Both indexes are based on Nitko (2004).

Analysis

Quantitative data obtained through AT before and after the T&L session in both the control and treatment groups were analyzed using descriptive statistics and inferential statistics. All data were compiled and summarized in table format for easy analysis reports and making presentations. Independent sample T-tests were conducted on the data collected during the pre-test to determine the level of homogeneity of the academic achievement between the two groups involved. Independent sample T-tests were also performed on the post-test to determine the impact of the LOC science module in enhancing marginalized learners' academic achievement in science.

Research Findings

Homogeneity of academic achievement

Homogeneity analysis of the level of academic achievement between the control and treatment groups using T-test Independent samples at the 0.05 significant level found that there was no significant difference between control and treatment groups with pre-test mean score of academic achievement, $t = -.085$ and $df = 63.95$, $p > 0.05$. The findings show the control and treatment groups were homogeneous in terms of academic achievement before the study was conducted. The homogeneity between the two groups

allows comparison to be performed on the impact of the LOC science module in the learning of "Plants" among marginalized learners. Table 4 shows the analysis of the Independent-sample T-tests of pre-test mean score for academic achievement according to groups.

Table 4. Independent T-test pre-test mean academic score

Dependent Variable	t	df	p	Mean Difference
Pre-test academic achievement	-.085	71	.932	-.293

Achievement Test

After five-weeks of intervention, post-test mean scores of AT in control group, M_c = 73.14 (SD = 11.21), showed an increase in mean score of 26.85, while the post-test mean scores of AT in treatment group, M_t = 76.84 (SD = 14.91), showed an increase mean score of 30.26. Table 5 shows the descriptive statistic of pre-test and post-test mean scores of AT according to groups. Although post-test mean scores of the treatment group exceeds the control group by 3.70, analysis of Independent-samples T-test showed that there is no significant differences in the post-test mean score of AT between the control and the treatment groups, t = -.870 and df = 71, p > 0.05 as shown below in Table 6.

Table 5. Descriptive statistics pre-test and post-test mean score of Achievement Test (AT) according to groups.

Group	Test	Mean (M)	Standard Deviation (SD)	N
Control	Pre	46.29	11.40	35
	Post	73.14	21.11	35
Treatment	Pre	46.58	17.60	38
	Post	76.84	14.90	38

Table 6. Independent T-test post-test mean score of academic achievement according to groups.

Dependent Variable	t	df	p	Mean Difference
Post-test academic achievement	-.870	71	.387	-3.699

Discussion

The result above showed that both LOC science module and conventional method respectively give equal impact in improving the academic achievement of marginalized learners. Hence, LOC science module is not more effective in improving the science academic achievement of Year Two marginalized learners in remote areas of Sarawak, Malaysia. Failure of the LOC science module to effectively increase academic achievement among marginalized learners in this study can be due to several reasons. One of the reasons may likely be due to the change of strategy or approach to T&L used by teachers in the treatment schools that create a negative impact on achievement of these marginalized learners. A drastic change from the conventional approach that is more teacher-centred to the implementation of activities that is more learner-centred in LOC module caused negative effect to the learners. This change has brought something new and unusual for these marginalized learners. According to Ayla (2016), such changes resulted in a negative impact among marginalized learners in Turkey.

Another reason may be related to the environment of these marginalized learners' lives. Their community is in a very remote area where they are practically surrounded by jungle. According to Asnarulkhadi et al. (2007), Ma'rof and Sarjit (2008) and Nur Bahiyat et al. (2013), knowledge about environment and plants are important elements in their daily lives. Moreover, Fatan Hamamah, Nursuhana and Abbas (2009) also stated that marginalized communities around the world showed dynamic and unique knowledge about a wide variety of flora and fauna. With the familiarity of flora and fauna, it has contributed to the increase in academic achievement of marginalized learners in the T&L session of 'Plant' even though a conventional teaching method was used in the control group. The familiarity of plants helps the marginalized learners to be able to follow the lesson effectively. It is still able to convey information to marginalized learners effectively and successfully, hence increases their academic achievement in that particular topic.

Although our results showed that the LOC science module did not give a significant impact in improving academic achievement among marginalized learners, descriptive analysis indicated that the LOC science module is better than conventional method used. Therefore, modifications and improvements of the LOC science module can be conceived to overcome the weaknesses in order to give more significant and positive outcomes. Integration of local culture and environment factors in the curriculum might help to make the curriculum more relevant to the marginalized learners. As stated in Cindy and Kamisah (2016), modules that use suitable strategies and pedagogies with curriculum that integrates community's culture and environment can and should give a more positive effect in the process of T&L.

Conclusion

The LOC module used in this study was found to have no positive impact towards improving the science academic achievement among marginalized learners in Malaysia in the 'Plant' topic. Despite various programs and initiatives taken by MOE, science academic achievement among marginalized learners remains at an unsatisfactory level. This can be seen in the result of the year six examination, namely the Primary School Achievement Test (*Ujian Pencapaian Sekolah Rendah*, UPSR). With this result, this study found a significant issue of T&L in marginalized schools in Malaysia. Continuous low level of science academic achievement brings these marginalized learners to be at risk of being left behind in science education. The MOE, especially educators, feel concerned that it will lead and contribute to an increased dropout rate and the decline in science literacy among marginalized learners. Therefore, drastic measures and more practical intensive programs such as curriculum that integrates the environment and culture of marginalized people must be created so that marginalized learners can see the relevance of science learned at school in their daily lives. As reported by Ayla (2016), a review of the science curriculum that is more focused on matters relating to life directly affect the environment in the classroom and in turn have a positive impact on pupils learning in Turkey. In addition, the new curriculum for marginalized learners needs more focus on aspects of psychomotor and the affective domains than cognitive as practiced by mainstream learners. This is because marginalized learners are poor in cognitive aspects compared to mainstream learners. The main implication of this study is that alternative T&L practices beside the conventional one can be carried out by teachers and learners in marginalized schools. In conclusion, T&L problems faced in marginalized schools either by the teachers or learners need to be taken seriously and looked into so that the learning process of marginalized learners can be effectively carried out. The aim is to produce human capital that is scientifically literate among marginalized communities in the 21st century for a future that requires knowledge and skills in a job application that is highly competitive.

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