Promoting health education through biology: The effectivity of a 5E-learning scenario on nutrition and digestive system topic towards high school students’ health literacy

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Abstract. As one of the sustainable development goals (SDGs), good health and wellbeing needs to be supported especially through science education program. Therefore, this research is aimed to examine the effect of a 5E learning scenario in biology instruction on nutrition and digestive system topic towards high school students’ health literacy. This was a quasi-experimental research that involved two groups of students from a public high school in Bantul region, Yogyakarta, Indonesia. One group played as a treatment group who learned the topic using 5E learning scenario, whilst another one as the control group who was taught by lecturing method. Pre-test and post-test instruments were employed to collect students’ health literacy data and analysed descriptively towards its indicators as well as statistically using Wilcoxon and Mann U Whitney. The findings show that the treatment group’s health literacy skill is significantly better than the control group (0.00; p:0.05). Therefore, it is concluded that the 5E-learning model implemented in this research evident more effective in fostering students’ health literacy.

1. Introduction
As one of the sustainable development goals (SDGs), achieving the good health and wellbeing remains a big issue in some countries, including Indonesia. Besides struggling on non-communicable diseases (NCD), Indonesia is also facing the double burden of malnutrition across all age group of population [1]. For instance, about a quarter of adolescent girls and boys were stunted, whilst other groups (about 5% of girls and 11% of boys) were thin, and around 11% of both genders were obese [2]. Furthermore, during a period of 1993 to 2014, one-third of adults were overweight by which its prevalence was doubled in the decade [3], [4]. On the other hand, the prevalence is counted approximately 10% in the group of children aged 6-12, and about doubled from 7% in children aged 13-18. Those studies asserted that lifestyle and habit related to food consumption and physical activity showed as main factors to coexistence of those problems and require a serious concern to resolve.

Besides a good policy on national health program and its implementation, health education also plays an important role to support in raising the awareness and understanding about nutritional-related health status [5]. This role may also be applied in science education program, especially through biology instruction. A basic assumption to this idea is that, in biology, food and nutrition intake, as well as physiological processes of those are a part of essential themes in biology discourse [6]. According to Indonesian national curriculum, at grade 11 in particular, it is a special topic about structure and function of digestive system, food intake and physiological mechanism, as well as health issue and disease related...
to the system. This topic focuses on the development of students’ knowledge about biological concepts of digestive system, nutrition and food physiological mechanism, and also skills that could be useful in dealing with health issues, including to analyze health problem. These such knowledge and skills could be defined as health literacy.

Health literacy is a set of cognitive and social skills that lead an individual to access, understand, and use health information in achieving the sustainability of health status [7]. The Partnership for 21st Century Skill stated that health literacy is one of the essential interdisciplinary themes of academic discourse that should be involved in contemporary education [8]. Moreover, in align with this important agenda, there are four learning and innovation skills that also need to be considered in preparing future students. The skills are creativity, critical thinking, collaboration, and communication skill. It could be noted that there is a strong relationship between health literacy, learning and innovation skills in and for the 21st century, and the challenges of science education practice [9]–[11]. However, it is still a lack number of studies on the field of health literacy in or through science education. Therefore, the way science education practice in Indonesia may have an influential contribution in promoting health education and achieving health literacy is remaining a potential topic in science education research. Dealing with this challenge, developing and examining particular instructional design in biology classrooms in promoting health education as well as health literacy is required to be carried out.

Amongst a distinct studies and literatures that discussing potential learning strategies in supporting health literacy in science education, Bybee [12] is an instance that accentuate the advantage of the 5E-learning model prospectively. It is basically a learning model that derived and developed by the Biological Science Curriculum Study (BSCS) [13], which comprises of five components of instructional phases, including: engage, explore, explain, elaborate and evaluate. A few numbers of research e.g [14]–[18], for instance, indicate that a continuum of students’ abilities, such as scientific process skills, conceptual understanding, information processing skills, and also argumentation, communication and attitude, can be potentially promoted and developed by this model. Regarding the challenge of health education in science education practice, moreover, it is assumed that a well-designed of the 5E-learning scenario may support students’ health literacy achievements.

Based on above described background, this research focuses on its objective to examine the effect of the 5E-learning model on nutrition and digestive system topic towards students’ health literacy. The research question that led this research was: how effective is the 5E-learning scenario on nutrition and digestive system topic towards students’ health literacy?

2. Method
A quasi-experiment method with non-equivalent pre-test post-test group design [19] was employed in this research. Two groups of grade-11 students (N=65) in a public high school in Bantul region, Yogyakarta, Indonesia, were chosen as participants in this study. Of these groups, one group (N=32) played a role as the experiment group who learned using 5E-learning scenario, and one another (N=33) as the control group who was taught mainly using lecturing approach. However, these both groups learned the same topic about nutrition and digestive system.

According to the national curriculum, the topic focuses on the development of students’ knowledge about biological concepts of digestive system, nutrition and food physiological mechanism, and also skills that could be useful in dealing with nutrition health issues. Regarding the difference of teaching strategy implemented as the treatments of the research, the control group was taught basically using the common strategy implemented by teacher, as described in Table 1. For the experiment group, a 5E-learning scenario which comprises of five phases of instruction as aforementioned [12] was implemented during nine hours of instruction (i.e four meetings). Across these learning hours, the learning scenario for the experiment group is summarised in Table 2. It should be noted that for supporting students in their learning, two student worksheets were developed and provided to the students.
Table 1. Learning scenario implemented for the control group

| The phase of the instruction | Learning scenario |
|------------------------------|-------------------|
| Introduction                 | The teacher showed an image of an obese and providing questions to engage students to the learning topic, and continued by explaining the main objectives of the topic |
| Observation and discussion 1 | Students were doing an observation to digestive system chart as well as other instructional media and discussed the observation results |
| Discussion 2                 | Students discussed any possible nutritional disorders or disease guided by a worksheet provided. |
| Explanation and evaluation   | The teacher explained the relevant concepts of the topic and were doing evaluation to students’ achievements |

Table 2. 5E-learning scenario implemented for the experiment group

| The 5E-phase of the instruction | Learning scenario |
|-------------------------------|-------------------|
| Engage                        | To engage students at the beginning, teacher provided a malnutrition issue and ask the students giving their opinion. It was expected that students are aware about the malnutrition problems in their daily live and be able to reflects the issue related to biology discourse. |
| Explore                       | In a group of four or five, guided by student worksheet provided, students were assigned to explore the nutritional status of their body by measuring their body mass index and basal metabolic rate. These activities were to led students gathered the scientific data as the basis and underpinned the discussion that carried out in the next phase. |
| Explain                       | In this phase, group-students presented and discussed their exploration results by comparing the data each other. Teacher engaged the students to relate the data to the basic problem of malnutrition. Teacher also explained the basic concepts of digestive system and physiological mechanism related to food intake and nutrition. |
| Elaboration                   | Supporting students to construct more insightful knowledge, additional activity was managed in this phase. The activity was arranging, counting and discussing the daily menu for each student by which the balance nutrition is considered. Based on the data gathered in the exploration phase (i.e body mass index and basal metabolic rate), students were encouraged to aware and think about the best food intake to fulfil their daily energy needs. |
| Evaluate                      | In this last stage, teacher and students reflected the learning scenario together, by evaluating learning activities had been done, reassuring the biological concepts comprehend, and making the conclusion and getting the value of the discourse. |

To examine students’ health literacy, pre-test and post-test were administered to both groups at before and after the instruction. The test instruments were developed as an essay-formed items and were examined by experts’ judgement for their validation. These items are corresponded to critical thinking indicators [20]: namely: elementary clarification, advance clarification, and the basis for the decision. As theoretical views described above, these critical thinking indicators were used as a framework for
examining students’ health literacy since its indicators are in line with the health literacy dimensions [7], [9]. It should be noted that the indicators are considered to the context of nutrition health issues of the discourse. The items are: 1) advance clarification about factors that may cause malnutrition, (item no.1), 2) elementary clarification towards basic information and knowledge of nutrition status and measurements, as well as digestive metabolism (item no. 2, 3, 4), and 3) the basis for the decision toward the relationship between nutritional disorder and food consumption (item no. 5). The range of score 0 to 3 was given to students’ answer based on the rubric developed.

Data analysis was conducted through both descriptive and inferential statistic methods. Descriptive analysis was used to describe the extent to which the patterns of students’ health literacy may (or may not) change for its each indicator, according to the item-scores achieved. For each item of test, students’ answers (of both the control group as well as the experimental group) were examined and scored, and further calculated its percentages towards class achievement (based on the number of students) [21]. Based on this analysis approach, it could be viewed the percentage of students (from each group of participants) who achieved score: 0, 1, 2, and 3 for each item of test, and this then represented as histograms as showed by Figures 1 to 4. The inferential statistical analysis was used to examine the difference of students’ health literacy achievement between the experimental group and the control group based on pre-test and post-test results. According to initial analysis of Levene’s test for homogeneity of variances to the pre-test results, it was shown that both control group and experimental group have had similar prior of health literacy skill (0.395; p>0.05). According to this result, for further analysis it is decided to compare the post-test results. However, since the requirements test for normality was shown that the data were not in normality criteria, the inferential analysis used was Wilcoxon and Mann U Whitney test [21].

3. Result and Discussion

This research focuses on the students’ health literacy in the context of nutrition health issue and digestive system that might be developed by students during their learning. In this section, the students’ health literacy data are presented descriptively as well as based on statistical analysis and further discussed.

3.1. The descriptions of health literacy dimensions

As aforementioned, students’ health literacy was examined using an essay-formed test consists of five items towards health literacy dimensions. Based on the pre-test and post-test results, the data show the extent to which the students’ health literacy dimensions may (or may not) change for its indicators, for both experimental and control groups.

Figure 1 and 2 represent the pre-test and post-test results of experimental group. Based on the figures, it is shown a big difference of score 2 achieved by students at the post-test which is much higher than the pre-test for the advance clarification dimension. However, for the same dimension, a few decreasing on score 3 precisely existed at the post-test. Interesting findings are appeared for the dimension of elementary clarification (item no. 2, 3 and 4). Whilst there are higher achievements at the post-test for the score 2 and 3 on item no. 2 and 4 (more than 70%), it is a double increased of score 0 at the post-test for item no. 3. This represents that more students did not successfully provide the answer that might be scored or even fully right for this item. Lastly, a significant achievement is shown for item no. 5, by which all students succeed to express the indicator of the basis for the decision at post-test compared to pre-test.

The trends of change of students’ health literacy achievement are also shown for the control group, as represented by figure 3 and 4. According to figure 3, at the pre-test, most students (more than 60%) were not be able to express their ability of advance clarification and elementary clarification (i.e item no. 1 to 4) as they got score 0 for these items. Contrary to these dimensions, more than half of students (60%) precisely have good ability on indicator of the basis for the decision. Compared to the post-test results, it is shown that the gain of score 1 and 2 are predominantly achieved for all health literacy indicators, with a slightly increased for the score 3.
Based on the description above, it can be stated that there are positive changes of students’ health literacy achievement viewed by each indicator for both group of research. However, reviewing the trend of changes occurred suggests that experimental group generally looks have a better achievement than the control group, except for item no. 3, respectively. To ensure how difference of the effectivity of the 5E-learning scenario toward students’ health literacy achievement compared to the control group, the statistical analysis was carried out and presented as follows.

### 3.2. Statistical analysis on students’ health literacy achievement

A non-parametric analysis that is Wilcoxon and Mann U Whitney test was applied to examine the difference of the students’ post-test mean value health literacy achievement between experimental and control groups. The result of the analysis is shown by Table 3 below.
Table 3. Wilcoxon and Mann U Whitney test result

| Test Statisticsa | Posttest |
|------------------|----------|
| Mann Whitney-U    | 133.000  |
| Wilcoxon         | 458.000  |
| Z                | -3.533   |
| Asymp. Sig (2 tailed) | .000*   |

a. Grouping variable: group

(’p < .001)

According to Table 2 it is obviously shown that there is a significant difference between experimental group and the control group regarding their health literacy achievement. This means that students’ who learned the topic through the 5E-learning scenario (i.e the experiment group) experience a better result on health literacy than the control group. Whilst the control group students expressed positive changes on their health literacy dimensions, the experiment group have much better gain. In regard to these results, the learning model applied to each group of students is suggested to have a strong influence on student learning activities [13], [15].

Particularly to experiment group, phases of learning activities based on the 5E-learning scenario implemented in this research provided a comprehensive and meaningful learning experience to the students. Besides learning to understand conceptual knowledge, recognizing the issue related to the topic which was provided at the engagement phase could give a contextual perspective to the students’ mind. This contextual basis of learning means really important in science learning as it could lead student mental experience during their learning [13], [15]. Furthermore, two designed activities in this study (i.e exploring the nutrition status in the explore stage and arranging the daily menu in elaboration phase) seemed to reinforce students’ skill especially on collecting, analysing, and interpreting the scientific information or data they obtained. These skills are related to critical thinking skill [20], and together with the explanation and discussion activities, students are supported to develop their communication and argumentation skills.

Perhaps, the only weakness revealed in this study is student skill on numeracy or mathematics, related to problem provided by item no. 3 of the test. Although they have had experienced to calculating body mass index and basal metabolic rate during the learning, the finding shows that it was complicated for students to apply mathematics formula to resolve the problem, and this implied to their answer of the test. Nevertheless, this weakness may need to support by more consideration. Thus, to sum up, all those achievements: contextual consideration, conceptual knowledge, processing information skill, as well as argumentation and communication skills achieved by experiment students during their learning using 5E-learning scenario can strongly be viewed as the health literacy dimension [7], [9], [11].

4. Conclusion
The findings revealed that the 5E-learning scenario could support students to develop their health literacy, as there are positive changes occurred to particular health literacy dimensions achieved by students. Despite of the weakness result occurred, hence, the 5E-learning model implemented in this research evident more effective in fostering students’ health literacy.

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