Implementation literacy strategies on health technology theme Learning to enhance Indonesian Junior High School Student’s Physics Literacy

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Abstract. The PISA results for Indonesian Students are lowest among Asian countries in the past two successive results. Therefore various Innovations in science learning process and its effectiveness enhancing student’s science literacy is needed to enrich middle school science teachers. Literacy strategies have been implemented on health technologies theme learning to enhance Indonesian Junior high school Student’s Physics literacy in three different health technologies e.g. Lasik surgery that associated with application of Light and Optics concepts, Ultra Sonographer (USG) associated with application of Sound wave concepts and Work out with stationary bike and walking associated with application of motion concepts. Science learning process involves at least teacher instruction, student learning and a science curriculum. We design two main part of literacy strategies in each theme based learning. First part is Integrated Reading Writing Task (IRWT) is given to the students before learning process, the second part is scientific investigation learning process design packed in Problem Based Learning. The first part is to enhance student’s science knowledge and reading comprehension and the second part is to enhance student’s science competencies. We design a transformation from complexity of physics language to Middle school physics language and from an expensive and complex science investigation to a local material and simply hands on activities. In this paper, we provide briefly how literacy strategies proposed by previous works is redesigned and applied in classroom science learning. Data were analysed using t-test. The increasing value of mean scores in each learning design (with a significance level of p=0.01) shows that the implementation of this literacy strategy revealed a significant increase in students’ physics literacy achievement. Addition analysis of Avarage normalized gain show that each learning design is in medium-g courses effectiveness category according to Hake’s classification.

1. Introduction
Science is observing the world, asking question and making discoveries. It is about developing experiments and increasing one’s knowledge and sharing knowledge with others. A majority of students view science as something that is unexciting, just boring facts that scientist know, and that students are required to learn [1]. According to observation which is done by Utami in 2011 on Indonesia students’ low study achievement and motivation in physics is reflected as the cause of difficulties in visualizing physics concept [2]. Based on physics learning questionnaire which is conducted by Alfiani in 2012 the low learning outcomes is caused by difficulties in understanding physics concepts as stated by 70.6% of total participants along with the analysis that shows student’s daily average mark at 50.4 is lower than minimum graduation standard at 65 [2].

The PISA results for Indonesian Students are lowest among Asian countries in the past two successive results. In 2012, Indonesia is in 64th of 65 participated countries [3]. It is lower achievement than PISA result in 2009 which is in 60th of 65 participated countries [4]. The PISA test is unique because
it develops tests which not directly linked to the school curriculum and provides context through the back ground questionnaires which can help analysts interpret the results. These question are merely described the science process skill of students and how it links to students’ cognitive comprehension. Jon Miller “defines ‘civic scientific literacy’ as (1) an understanding of basic scientific concepts such as the molecule and the structure of the solar system (2) an understanding of the nature of scientific inquiry, and (3) a pattern of regular information consumption, such as reading and understanding popular science books.

Many previous work proposed literacy strategies to enhance science literacy. Hobson suggests general physics courses for non-scientists both the public school and university level should be taught in a manner that inspires student understanding and enthusiasm, and is relevant to the cultural and social needs of students and society. Fisher et al, have proposed 7 specific instructional strategies and implemented these strategies to in all content areas that has had a positive impact on student achievement at Herbert Hoover High School. Fang and Wi have investigated the effects of an inquiry-based science curriculum that integrated explicit reading strategy instruction and quality science trade books on the development of science literacy among middle school students.

Recently Indonesia Ministry of education have published new policy on basic frame work and curriculum structure for secondary level in 2013 that is distinctly seen that the standard competence in the science content at secondary level deals with mastering scientific concept through understanding, describing, explaining, investigating, conducting experiment through scientific method and communicating the result. Indonesian Development curriculum requires improvement in the learning process. In standard process and secondary education policy, there’s 14 Principles of Learning transformation. Seven of them are:

- From the student are told become students find out;
- From the teacher as the only source of learning become students can learn from variety of resource;
- From textual aproach learning to scientific approach learning
- From content-based learning toward competency-based learning;
- From partial learning to integrated learning;
- From learning that emphasizes single answer to multi-dimensional answers
- From verbalism learning skills to applicative;

From this description, the new release Indonesian curriculum have met with efforts to make Indonesia Students performed better in next PISA survey’s result. Therefore various Innovations in science learning process and its effectiveness enhancing student’s science literacy and fulfilling Indonesian new Curriculum both standard content and process is needed to enrich middle school science teachers. In this paper we described the literacy strategies that proposed by previous works in term of learning design that promote physics literacy for Indonesian middle school. We design two main part of literacy strategies in each theme based learning. First part is Integrated Reading Writing Task (IRWT) is given to the students before learning process, the second part is scientific investigation learning process design packed in Problem Based Learning. These learning designs have been implemented and it has had positive impact on one junior high school in Bandung, west Java, Indonesia.

2. Strategy Literacy Previous Works

More specifically, Hobson suggest general science course both in public school and university level should: (1) be conceptual (non-algebraic) but numerate (2) use ‘interactive-engagement’ or ‘inquiry techniques (3) be focused on a few themes rather than encyclopaedic; (4) instil scientific habits of mind by means of a (5)devote 50% or more of its time to so-called ‘modern’ and (6) include societal topics such as energy resources and the environment.

Fisher et al has implemented seven defensible strategies e.g. read-aloud (or shared reading), K-W-L charts, graphic organizers, vocabulary instruction, writing to learn, structured note taking, and reciprocal teaching.
Fang and Wei\cite{10} investigate relative efficacy of the ISR curriculum in developing students’ fundamental sense and derived sense of science literacy when compared to the IS curriculum. The inquiry-based science curriculum (IS curriculum) consisted of six units related to the main textbook each focusing on a different aspect of the nature of science: (a) observing and generating problems and conducting background research and planning, (b) conducting experiments to find viable responses to the problems raised in the first quarter, (c) exploring scientists and science-related careers, and (d) exploring science-related through projects. The ISR curriculum is similar with inquiry-based science curriculum, but with the following two components of reading infused into it e.g Reading strategy instruction and Home science reading program. However, the previous studies didn’t describe operationally the literasy strategy implemented in learning process especially in junior high school. In this paper we would like to describe operationally how literacy strategies inserted in student science learning process.

3. Present study: literacy strategies on theme based learning

Literacy strategies have been implemented on health technologies theme learning to enhance Indonesian Junior high school Student’s Physics literacy in three different health technologies e.g. Lasik surgery that associated with application of Light and Optics concepts, Ultra Sonographer (USG) associated with application of Sound wave concepts and Work out with stationary bike and walking associated with application of motion concepts. Science learning process involves at least teacher instruction, student learning and a science curriculum. We design two main part of literacy strategies in each theme based learning. First part is Integrated Reading Writing Task (IRWT) is given to the students before learning process, the second part is scientific investigation learning process design packed in Problem Based Learning with effort to fulfill Indonesia new curriculum demand.

IRWT is a task given to the student before class learning process. It was our design to implement two of seven literacy strategies. (1) K-W-L\cite{4} chart (reading strategies) and (2) graphic organizer\cite{4} which contain four parts, those are:

- Part A: Reading, in this part student should read the given texts that related to learning theme
- Part B: Conceptual Construction, in this part, the student should fill the empty tittles and subtitles on the text then the student should make three question and answer the question related to the text. We design this part as implementation of the second literacy strategy\cite{4}, we use SQRW (survey, question, read, write) reading strategy instead of KWL chart.
- Part C: Concept Mapping, In this part student should fill half-empty graphics organizer which is the third strategy\cite{4} that filled with several key words from text content.
- Part D: Conclusion, in this part Students should make appropriate conclusion from the text

Problem based learning is a learning model which centers on student, develop active learning, skills of problem solving and field of knowledge, and it is based on understanding and problem solving\cite{10}. We choose Problem based theme learning because it meets Hobson suggestions\cite{5}. We also consider three of eight strategy suggested by Sherman, Richardson and Mark to use problem solving strategy to use in classroom setting that meet with the literacy strategies as follow:

- Establishing a context for interest incorporating problem solving in lessons,
- Starting with simple problems make it easy for students to solve next problem quickly as their confidence is raised and
- help students to reduce reading difficulties\cite{11}

We use Arrand’s Syntax for problem based learning 1) Orient student to the problem 2) Organized student to study 3) Asssist independent and group investigation 4) Develop and present artifacts and exhibits 5) Analyse and evaluated the problem solving process\cite{12}. In these syntax we insert Fisher’s
literacy’s strategies e.g. Read Aloud, vocabulary instruction, writing to learn, structured notetaking, and reciprocal teaching.

4. Topic appropriate to middle school theme based learning and its implementation and result

4.1 Stationary Bike vs. Walking for weight loss.
Seventh grade Indonesian Student it their first semester they have to study motion with constant velocity and acceleration. We choose Stationary Bike Vs. Walking for Weight loss theme based learning that associated to Motion topic (6 hour meeting) in two hour meeting in three consecutive day. Before learning process they are given IRWT. The text is from this article can be found at [http://healthyliving.azcentral.com/stationary-bicycle-vs-walking-exercise-9889.html](http://healthyliving.azcentral.com/stationary-bicycle-vs-walking-exercise-9889.html) last online accessed on 11/08/2015 translated into Bahasa. In first meeting, the teacher open the class, then ask one student to Read Aloud the Text on IRWT in front of the class. Then the teacher asked other student to write the term in the text that they don’t understand. In second meeting the teacher give them work sheet and ask all student to school’s gym. To explore stationary bike with its speedometer to fill their work sheet. Then all the student asked to come to the class. The teacher discuss their result and enhance the concept to avoid miss conception. And in the last meeting, Teacher divided the student in to three groups then teacher asked to solve this problem in groups: Suppose you are an exercise expert. Based on your reading and your exploration you are asked to make a suggestion to Mrs. A and Mrs. B that wants to lose the same weight. Mrs. A want to walk around her house and Mrs. B want to use her Stationary bike to lose weight. Each group are given Mrs. A’s home map with scale. The teacher asked each group to present their suggestion in front of the class and let the other group respond them. This learning design have been implemented to Indonesian Seventh grade of 38 students in Bandung-West Java. Physics literacy test on this theme was administered before (pretest) and after (post test) the implementation of this learning design. Paired t-tests conducted to analyze whether there were significant differences in students’ physics literacy before and after implementation of teaching with literacy strategies in this theme based learning. Table 1 shows the results of the paired t-test analysis.

| N  | Pre test | Post test | 95% confidence interval of the difference | T      | df    | Sig(2 tailed) |
|----|----------|-----------|-----------------------------------------|--------|-------|---------------|
|    | Mean     | SD        | Mean        | SD      | Lower | Upper |        |        |
| 38 | 3,26     | 1,267     | 7,63        | 1,303   | -4,937| -3,800| -       | 15,558 |

The results of this analysis shows that the mean differences before and after the implementation are statistically significant in improving student’s physics literacy \[t (37) = 3.32563, p <0.001\] shows that implementing literacy strategies in this theme based learning had a significant positive effect on enhancing student’s physics literacy. Using pre- test -post test data, we also calculated average normalized gain for a course as the ratio of the actual average gain to the maximum possible average gain \[^{[13]}\]. The calculated physics literacy’s average normalized gain for this learning is 0,63 which is in medium-g courses effectiveness category according to Hake’s classification\[^{[13]}\]

4.2. Ultra Sonography (USG)
Eighth grade Indonesian Student it their first semester they have to study sound wave and its application. We choose Ultra Sonography theme based learning associated to the topic (6 hour meeting) in two hour meeting in three consecutive day. Before learning process they are given IRWT. The text is from this article can be found at [http://www.healthline.com/health/ultrasound#Uses2](http://www.healthline.com/health/ultrasound#Uses2) last online accessed on 12/08/2015 translated into Bahasa. In first meeting, the teacher open the class,. The teacher ask the students what they know about sound wave like source of sound wave by asking one student to perform
one melodic sequential, ask the student the difference between loud and high tone. Does someone outside this class can hear his voice? Why? then ask one student to Read Aloud the Text on IRWT in front of the class. Then the teacher asked other student to write the term in the text that they don’t understand. The teacher divided the students into three groups. In the closing teacher ask at least one student in each group to install sound meter application that can be found in https://play.google.com/store/apps/details?id=kr.sira.sound&hl=in Last online accessed on 12/08/2015 in their android In second meeting The teacher give each group work sheet to investigate three main problem. What make sound lauder, high pitch? Does sound reflect regularly, what wave quantity change when sound wave is reflected? Does reflected sound wave the same when strike any materials? By giving them (1) two pipes that make One pipe can move radially installed in board with 360° protractor paper and reflected material that installed horizontally 0° and (2) a sound source that produce different frequency. They first asked to use this material to investigate does sound reflect regularly with the help of Sound meter in their android. The second one does reflected sound wave the same when strike any material by varying the reflected materials. Then all the student asked to come to the class. The teacher discuss their result and enhance the concept to avoid miss conception. And the last meeting, Teacher divided the student in to three groups then teacher asked to solve this problem in groups: can any sound wave pass through any material. What wave quantity that effect sound wave transmission? Suppose you are a health worker team you have been asked to use your scientific knowledge, data and communication skills to present this topic: By using sound wave we can detect organ inside our body to seventh grade students. The teacher asked each group to present in front of the class and let the other group respond them.

This learning design have been implemented to Indonesia Seventh grade of 38 students in Bandung West java. This learning design have been implemented to Indonesia Seventh grade of 38 students in Bandung, west java. Physics literacy test on this theme was administered before (pretest) and after (posttest) the implementation of this learning design. Paired t-tests conducted to analyze whether there were significant differences in students’ physics literacy before and after implementation of teaching with literacy strategies in this theme based learning. Table 2 shows the results of the paired t-test analysis.

Table 2. Result of the paired t-test analysis for USG- theme learning

| N  | Pre test | Post test | 95% confidence interval of the difference | T     | df   | Sig(2 tailed) |
|----|----------|-----------|------------------------------------------|-------|------|--------------|
|    | Mean     | SD        | Mean                                     | SD    | Lower Upper |             |
| 38 | 2,18     | 1,608     | 7,08                                     | 0,818 | -5,383 -4,407 | 20,320 37 | 0,000       |

The results of this analysis shows that the mean differences before and after the implementation are statistically significant in improving student’s physics literacy \( t (37) = 3.32563, p <0.001 \] shows that implementing literacy strategies in this theme based learning had a significant positive effect on enhancing student’s physics literacy. Using pre- test -post test data, the calculated physics literacy’s average normalized gain for this learning is 0,61 which is in medium-g courses effectiveness category according to Hake’s classification[13]

4.3. Lasik Surgery

Eight grade Indonesian Student it their first semester they have to study optics and its application. We choose Lasik surgery theme based learning associated to the topic (6 hour meeting) in two hour meeting in three consecutive day Before learning process they are given IRWT, Before first meeting IRWT is about Mirror and reflection, Second meeting about Lenses and refraction and Third meeting IRWT is about eye, eye defect and Lasik surgery The text is from this article can be found at http://www.allaboutvision.com/visionsurgery/lasik.htm last online accessed on 12/08/2015 translated into Bahasa In first meeting, the teacher open the class, then ask one student to Read Aloud the Text on IRWT in front of the class. Then the teacher asked other student to write the term in the text that they
don’t understand. Then the teacher divided the students into three groups, giving them worksheet and Optic kits to solve this problems: Use your scientific knowledge and data to find focal length of this curved mirror (concave and convex mirror). Then the teacher ask each group to present their solutions. In second meeting the teacher open the class, then ask one student to Read Aloud the Text on IRWT in front of the class. Then the teacher asked other student to write the term in the text that they don’t understand. Then the teacher divide the students into three groups, giving them worksheet and Optic kits to solve this problems: Use your scientific knowledge and data to find focal length of the given convex lens and determine the rule to produce image of an object using convex lens. In third meeting the teacher open the class, then ask one student to Read Aloud the Text on IRWT in front of the class. Then the teacher asked other student to write the term in the text that they don’t understand. Then the teacher divide the students into three groups, giving them worksheet and Optic kits to solve this problems: Using your optic kit as an eye model to explain eye defects and solution to improve eye sight. Then the teacher ask each group to present their result and an open discussion to connect their result related to Lasik surgery. 

This learning design have been implemented to Indonesia Seventh grade of 38 students in Bandung, west java. Physics literacy test on this theme was administered before (pretest) and after (posttest) the implementation of this learning design. Paired t-tests conducted to analyze whether there were significant differences in students’ physics literacy before and after implementation of teaching with literacy strategies in this theme based learning. Table 3 shows the results of the paired t-test analysis.

### Table 3. Result of the paired t-test analysis for Lasik Surgery theme learning

| N | Pre test | Post test | 95% confidence interval of the difference | T | df | Sig(2 tailed) |
|---|----------|-----------|-----------------------------------------|---|----|--------------|
|   | Mean | SD | Mean | SD | Lower | Upper |        |     |
| 38 | 2.45 | 1.427 | 7.66 | 1.169 | -5860 | -4.561 | - 16.264 | 37 | .000 |

The results of this analysis shows that the mean differences before and after the implementation are statistically significant in improving student’s physics literacy [t (37) = 3.32563, p <0.001] shows that implementing literacy strategies in this theme based learning had a significant positive effect on enhancing student’s physics literacy. Using pre-test -post test data, the calculated physics literacy’s average normalized gain for this learning is 0.67 which is in medium-g courses effectiveness category according to Hake’s classification.[13]

### 5. Conclusion

This study has shown that implementation of literacy strategies in theme based learning has the significant effect in improving middle school students’ Physics literacy. The increasing value of mean scores in each learning design (with a significance level of p=0.01) shows that the implementation of this literacy strategy revealed a significant increase in students’ physics literacy achievement. Addition analysis of Average normalized gain show that each learning design is in medium-g courses effectiveness category according to Hake’s classification. Physics Learning design in term Integrated Reading and Writing Task (IRWT) and scientific investigation learning process in Stationary bike vs. Walking to lose weight, Ultra sonographer and Lasik surgery themes based learning are just a few examples of Literacy strategies implementation to enhance Physics literacy’s Indonesian middle school students.

### Acknowledgement

We would like to thanks Science learning comunity (Lecture-Students-Science Teachers) for make this happen and Bandung junior high schools and all member that had participated in this study.
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