The effectiveness of integrated science textbook using networked model with example problem based learning to enhance students’ smog preparedness

Dina Trisia Irdayasa, Ahmad Fauzi’ and Usmeldi

Department of Physics, Faculty of Mathematics and Natural Sciences, Universitas Negeri Padang, Jl. Prof Hamka, Padang 25131, Indonesia

*ahmadfauzi@fmipa.unp.ac.id

Abstract. Preparedness is an important effort to reduce disaster risk. It can be measured through knowledge and attitude parameters. Previously, an integrated science textbook on smog theme using networked model with EPBL has been developed to enhance students’ smog preparedness. The aim of this research is to evaluate the effectiveness of textbook on the enhancement of students’ smog preparedness. Quasi experimental research with One Group Pretest and Post-test design was carried out with 38 seventh grade students assigned randomly as research subjects. The obtained data were analyzed using descriptive statistic, N-gain, and effect size. The result shows that more than 75% of all students achieved prepared and highly prepared level on both of preparedness parameters. The enhancement of preparedness on both of parameters based on N-Gain is in the moderate category. The effect size of textbook on the enhancement of students’ smog preparedness on both of parameters is in the moderately strong category. The implication of this research is that the developed integrated science textbook is effectively used to enhance students’ smog preparedness.

1. Introduction

The air pollution, or smog has become an annual problem for the past 20 years in various regions in Indonesia [1]. It’s caused by thick smoke, created by burning of forest and peat fires incident [2]. Some effects of smog are heavy air pollution [3] contributing to global warming [4], transportation and economic problem, respiratory diseases to the death [5]. The global impact is cross-border pollution in Southeast Asia [6]. Furthermore, smog affects the balance of Earth’s atmospheric systems [7]. In addition, the smog problem cannot be anticipated locally because its motion cannot be spatially limited. Besides, financially options such as artificial rain, as an effective way to get rid of smog, it costs a lot [8].

Preparedness is necessary considering the hazards and difficulties of smog control previously described. Preparedness is the capacity and knowledge developed by governments, professional organizations, communities and individuals that will influence attitudes and awareness in anticipating and responding effectively to the impacts of events or conditions danger that may or may occur [9]. Thus, the main parameter of preparedness are knowledge and attitude[10].

Student include individuals who must have disaster preparedness. Students who are in disaster prone areas should be provided with learning that starts from a comprehensive introduction to their region [11]. Thus, student have the provision to rehearse disaster preparedness within themselves.
Smog is a disaster phenomenon, it can be explained through Natural Science. The curriculum applicable in Indonesia mandates science learning in junior high school taught through contextual learning or relevant to the needs of students. Most Indonesian students are in hazardous areas affected by smog, so knowledge of the smog disaster becomes the needs of students.

There has been conducted a preliminary investigation on the level of students’ smog preparedness in Junior High School 13 Pekanbaru city, Indonesia. This region had been hit by the worst smog in Indonesian history and potentially to experiencing it again. The results of students’ smog preparedness analysis on attitude parameter is in prepared level. Nevertheless, the students’ smog preparedness level on knowledge parameter is in less prepared category. Therefore, it is necessary to enhance the preparedness of student to face the smog.

In order to enhance the students’ smog preparedness, there has been developed an integrated science textbook on smog theme. Learning materials combined to build themes in textbooks include heat and temperature, light and optical devices, environment pollution, and respiratory systems. These four topics taught refer to the steps in the Example Problem Based Learning model [12]. Furthermore, the four materials were integrated using an integrated model networked by Fogarty [13].

Effective is the condition of a high quality text book. Effectiveness is an analysis that measures the extent to which an intervention reaches the intended target [14]. The development of this textbook aims to enhance the student’s preparedness towards smog. Preparedness parameters consist of knowledge and attitude. Thus, the effectiveness of textbooks in this study focused on evaluating the effect of textbooks to enhance students’ preparedness towards smog in attitude and knowledge parameters.

So far, the effectiveness of high school physics integrated with smog textbooks [15] and teacher books [16] has been done. In both studies the effectiveness was reviewed from the enhancement of learning outcomes. However, there has never been a test of textbook effectiveness to enhance the preparedness of students. This research is the first and only research to discuss about it.

The focus problem in this research are: (1) what are the minimum criteria for classical preparedness achieved, (2) how much the enhancement is student preparedness towards smog before and after the textbook is applied, (3) how much the effect sizes of textbook on the enhancement of students’ smog preparedness.

2. Methodology Research

2.1. Research Design, Sample, and Instrument
Quasi experimental research with One Group Pretest and Post-test design has been used to evaluate the effect of textbooks on increasing students’ preparedness towards smog. The research was carried out for 15 class hour (15x40 minutes) during the school year 2017-2018. After a simple random sampling, the research was carried out with 38 seventh grade students during the school year 2017-2018 as research subjects from junior high school 13 in Pekanbaru city, Indonesia.

Important parameters of disaster preparedness are knowledge and attitude. Cognitive knowledge is an important object to form behavior [17]. Knowledge preparedness indicators consist of knowledge about disaster characteristics, the actions to protect your health from smog, and first aid when disaster strikes [18]. The attitude is divided into four levels that is receiving, responding, appreciating, and responsible [19]. In this research the student preparedness towards smog measured in knowledge and attitude parameters.

Instruments in the knowledge parameter are knowledge test sheet in the form of objective questions and essays on integrated science related to smog. Instrument in the attitude parameters is a self-assessment questionnaire undertaken to measure preparedness level of students. Furthermore, an expert team was formed to estimate the validity of the test being applied [20]. Two science teachers in junior high school, two science lecturers, and a language lecturer are the experts. According to the experts, the test questions are suitable for seventh grade students and the formulation is precise and
easy to understand, so the expert team formed confirms that the test is valid. The time set for pretest and post-test is the same - one class hour (40 minutes).

2.2. Data Analysis
The obtained data were analyzed using descriptive statistic, N-gain and effect size. Analysis of data preparedness within the parameters of knowledge and attitude processed through the following steps.

2.2.1. The Achievement Level of Classical Preparedness. In this steps, the descriptive statistic of the obtain data was describe by percentage of students who achieved prepared and highly prepared level. Interpretation of individual preparedness score obtained by student according to following criteria: (1) if 80 < Score ≤ 100 (Highly Prepared), (2) if 65 < Score ≤ 80 (Prepared), (3) if 55 < Score ≤ 65 (Almost Prepared), (4) if 40 < Score ≤ 55 (Less Prepared), and (5) if Score ≤ 40 (Not Prepared) [21]. Furthermore, learning outcomes are said to be effective if 75% of all students achieved the established criteria [22].

2.2.2. The Enhancement of the Students’ Preparedness. In this step, calculation of the enhancement students’ preparedness based on the value of pretest and post-test using N-Gain formulation [23]. Interpretation N-Gain score according to following criteria: (1) if n-gain > 0.7 (high), (2) if 0.3 < n-gain < 0.7 (moderate), (3) if n-gain<0.3 (low) [24].

2.2.3. Effect Size of Using Textbook to Enhance Students’ Preparedness. Previously, t-test value from paired sample t-test using IBM SPSS for the data of attitude and knowledge parameters was processed, then the Effect Size was determine based on t-test and degree of freedom value [25]. Interpretation of effect size value according to following criteria: (1) if μ < 0.15 (Ignored (very weak)), (2) if 0.15 ≤ μ < 0.40 (Weak), (3) if 0.40 ≤ μ < 0.75 (Moderate), (4) if 0.75 ≤ μ < 1.10 (Moderately Strong), (5) if μ ≥ 1,10 (Strong) [26].

The effectiveness of textbooks can be indicated by determining: (1) If 75% of all students achieved prepared and highly prepared level, (2) If the enhancement of students’ smog preparedness based on the N-Gain score is at least in the moderate category, (3) If the textbook effect on the enhancement of students’ smog preparedness based on the effect size value at least is in the moderate category.

3. Results and Discussion
The results of the students’ preparedness level on the attitude and knowledge parameter is shown in Figure 1. Figure 1 shows the level of students’ smog preparedness after learning process using the textbook. After learning with textbooks, all learners are prepared and highly prepared to face the smog in terms of attitude parameters. Moreover, the level of preparedness on the knowledge parameter increased to 53% highly prepared and 34% prepared. However, as many as 13% of students are still in the almost prepared level with index value below 65. Learning outcomes are said to be effective if 75% of all students is reach established criteria [22]. Based on the results, the textbook is in the effective category.

Furthermore, the enhancement of the students’ preparedness calculated based on the value of pretest and post-test was carried out using N-Gain test. Comparison between attitude and knowledge parameter within pretest, post-test and N-Gain is shown in Figure 2.
Figure 2 show comparison average of assessment result between attitude and knowledge parameter. N-gain obtained at attitude parameter is 0.37 and knowledge is 0.66. Both values are in the moderate category [24].

After obtaining the category of enhancement of preparedness, then determined the effect size of textbook to the enhancement of preparedness was carried out using effect size formulation [25]. In order to calculation of the effect size and the variables follow a normal distribution, a paired sample t-test between pretest and post-test was performed. The output of paired sample t-test is shown in Figure 3.

### Paired Samples Test

|       | Paired Differences |       |       | 95% Confidence Interval of the Difference |       |
|-------|--------------------|-------|-------|----------------------------------------|-------|
|       |                    | Mean  | Std. Error | Lower | Upper | T   | Df   | Sig. (2-tailed) |
| Pair 1| Pretest - Postest  | -7,5000 | 6,4723 | 1,04996 | -9,62742 | -5,3725 | -7,143 | .000 |

(a)
Paired Samples Test

| Paired Differences | Mean | Std. Deviation | Std. Error Mean | 95% Confidence Interval of the Difference | T | Df | Sig. (2-tailed) |
|--------------------|------|----------------|-----------------|----------------------------------------|---|----|----------------|
| Pair 1             |      |                |                 |                                        |   | 37 | .000          |
| Pretest - Postest  | -38.4747 | 14.22007 | 2.30680 | -43.1487 to -33.8007 | -16.679 |   |               |

(b) Figure 3. Output of Paired Sample t-test on (a) Attitude Parameter; (b) Knowledge Parameter.

Figure 3 shows that the value of t-test on attitude parameter is -7.143 and the knowledge parameter equal to -16.679 with degrees of freedom (df) equal to 37. Result of effect size test for attitude parameter obtained value equal to 0.77 and knowledge parameter is 0.94. Both of the value is in moderately strong category based on effect size category [26].

The Results of Effectiveness Textbook to Enhance The Students’ Preparedness are summarized in Table 1.

Table 1. The Result of Effectiveness Textbook on The Enhancement of Students’ Preparedness

| No | Effectiveness Test                                      | Result | Category         |
|----|---------------------------------------------------------|--------|------------------|
| A. | Attitude Parameter                                      |        |                  |
| 1  | The Achievement Level of Preparedness Classical.        | 11% prepared 89 % highly prepared (more than 75% of students is in prepared or highly prepared level) | Effective |
| 2  | The Enhancement of the Students’ Preparedness.         | Pretest : 79.93 Post-test : 87.43 N-Gain : 0.37 | Moderate |
| 3  | The Effect Size of Using Textbook to Enhance Students’ Preparedness. | 0.77 | Moderately Strong |
| B. | Knowledge Parameter                                     |        |                  |
| 1  | The Achievement Level of Preparedness Classical.        | 13% almost prepared 34 % prepared 53% highly prepared (more than 75% of students is in prepared or highly prepared level) | Effective |
| 2  | The Enhancement of the Students’ Preparedness.         | Pretest : 41.33 Post-test : 80.12 N-Gain : 0.66 | Moderate |
| 3  | The Effect Size of Using Textbook to Enhance Students’ Preparedness. | 0.94 | Moderately Strong |

Table 1 showed that before and after the learning with the textbook the level of preparedness of the learners on the attitude parameter is at the ready level. These levels are higher than the knowledge parameters that are at an almost ready level. The prior attitudes of these students are built on previous experiences of the attitude objects of smog phenomenon [18,27]. The smog phenomenon experienced by student, forms their mind, emotions, and behavioral processes in the face of the smog [28]. Thus,
the students who are in the area affected by smog must have a prepared level on attitude parameter, but not necessarily have knowledge preparedness at the prepared level towards disaster. Conversely, the enhancement of preparedness based on N gain on the knowledge parameter is higher than the attitude parameter. Basically, the individual confronted with known attitudinal objects has retained an evaluation in the memory [28]. After an individual is repeatedly stimulated by the attitude object, it will form an individual who has an established knowledge base, consisting of relevant of cognitive information and affective experience [29]. In addition, the formation of attitudes also takes a longer time than the formation of knowledge, making it easier to improve knowledge rather than attitude.

Textbooks developed in smog themes using networked model with EPBL. The results show that textbook implementation allows the formation of new skills in the form of preparedness towards smog. In line with [13] that the application of networked models in learning allows for the conversion of conceptions, problem solving, and the formation of new skills. Moreover, the application of the EPBL model in learning processed is used to acquire essential knowledge and concepts of the teaching unit based on real-world problems (in this case is the smog phenomenon) [12].

4. Conclusion
Effectiveness of development integrated science textbook on smog theme with networked model based on example problem based learning to enhance students’ smog preparedness was measured using descriptive statistic, n-gain, and effect size. The result shows that (1) more than 75 % of all students achieved prepared and highly prepared level, (2) the enhancement of preparedness on the attitude and knowledge parameters is in the moderate category, (3) the effect size of textbook to the enhancement of students’ smog preparedness on attitude and knowledge parameters are in moderately strong category. In addition, an integrated science textbook on smog theme using networked model with EPBL is effectively used to enhance students’ smog preparedness.

References
[1] Meiwanda, Geovani. (2016). Kapabilitas Pemerintah Daerah Provinsi Riau: Hambatan dan Tantangan Pengendalian Kebakaran Hutan dan Lahan. Jurnal Ilmu Sosial dan Ilmu Politik. 19 (3): 251-263
[2] Restiatur dan Suratman, Eddy. (2015). Effect of injured Acute Respiratory Infection (ARI) and Having Toddler in household to the willingness to pay of Smog Risk Mitigation in District of Pontianak and Pontianak City, West Kalimantan. Procedia - Social and Behavioral Sciences 211 (2015) 336 – 341
[3] Gusnita, Dessy. (2014). Pencemaran Smog (Asap Kabut) sebagai Dampak Aktivitas Antropogenik. Berita Dirgantara Peneliti bidang Komposisi Atmosfer. 15(2): 84-89.
[4] Ahmadi, Sidiq. (2012). Prinsip Non-Interference ASEAN dan Problem Efektivitas ASEAN Agreement on Transboundary Haze Pollution. Jurnal Hubungan Internasional 1(2):189.
[5] Syafizal. (2003). Dampak Kebakaran Hutan Terhadap Kesehatan Manusia Rimba Kalimantan. Fakultas Kehutanan UnMul. 8 (2): 63-70.
[6] Fujii, Yusuke; Iriana, Windy; Oda, Masafumi; Puriwigati, Astiti; Tohno, Susumu; Lestari, Puji; Mizohata, Akira; Huboyo, Haryono Setiyo. (2014). Characteristics of carbonaceous aerosols emitted from peatland fire in Riau, Sumatra, Indonesia. Atmospheric Environment. 87 (2014): 164-169
[7] Keywood, Melita; Cope, Martin; C.P. Mick Meyer; Inuma, Yoshi; Emmerson, Kathryn. (2015). When smoke comes to town: The impact of biomass burning smoke on air quality. Atmospheric Environment. 121 (2015): 13-21.
[8] Suryani, Anih Sri. (2012). Penanganan Asap Kabut Akibat Kebakaran Hutan di Wilayah Perbatasan Indonesia. Jurnal DPR-RI. 59-75.
[9] UNESCO/ISDR. (2006). Kerangka Kesiapsiagaan Individu dan Rumah Tangga dalam Menghadapi Bencana Alam.
7

[10] United Nation. (2008). Disaster Preparedness for Effective Response. New York and Geneva: United Nation
[11] Nurjanah, D. (2013). Manajemen Bencana. Bandung: Alfabella
[12] Jalani, Nor Hisam dan Sern, Lai Chee. (2015). The Example-Problem-Based Learning Model: Applying Cognitive Load Theory. Procedia - Social and Behavioral Sciences. 195 (2015): 872 – 880.
[13] Fogarty, Robin (1991). Ten Ways to Integrated Curriculum.
[14] Vlăsceanu, L., Grünberg, L., and Pârllea, D., 2004. Quality Assurance and Accreditation: A Glossary of Basic Terms and Definitions (Bucharest, UNESCO-CEPES) Papers on Higher Education
[15] Fibrianti, Widya. (2016). Pengembangan Buku Teks Fisika SMA Terintegrasi Materi Kabut Asap Berbasis Pendekatan Learning Cycle dengan Model Example Problem Learning. Tesis: Padang: UNP
[16] Ermisa, Jully. (2017). Pengembangan Buku Guru Fisika SMA Terintegrasi Materi Kabut Asap dengan Model Example Problem Learning. Tesis: Padang: UNP
[17] Soenaryo. (2002). Psikologi Untuk Keperawatan. Jakarta: Kedokteran EGC
[18] Raja, Zakarias Dedu Ghele; Hendarmawan dan Sunardi. (2017). Upaya Pengurangan Risiko dan Kesiapsiagaan Masyarakat terhadap Ancaman Bencana Tanah Longsor (Desa Ndito, Kecamatan Detusoko, Kabupaten Ende, Provinsi Nusa Tenggara Timur). Jurnal Lingkungan dan Bencana Geologi. 8(2): 103 – 116
[19] Notoatmodjo, S. (2007). Promosi Kesehatan: Teori dan Aplikasinya. Jakarta: Rineka Cipta
[20] Zekri A. M. Zouhor, Ivana Z. Bogdanovic, Sonja J. Skuban, Milica V. Pavkov-Hrvojevic. (2017) The Effect Of The Modified Know-Want-Learn Strategy On Sixth-Grade Students’ Achievement In Physics. Journal of Baltic science. 16(6):946-957.
[21] Nugroho, Ag Cahyo. (2007). Kajian Kesiapsiagaan Masyarakat dalam Mengantisipasi Bencana Gempa Bumi dan Tsunami di Nias Selatan. MPBI-UNESCO
[22] Sukmadinata, Nana Syaodih. (2012). Metode Penelitian Pendidikan. Bandung: PT Remaja Rosdakarya
[23] Meltzer, D.E. (2002). The relationship between mathematics preparation and conceptual learning gains in physics: A possible “hidden variable” in diagnostic pretest scores. American Journal of Physics. 70(12): 1259-1268.
[24] Hake, R. Richard. (2002). Relationship of individual Student Normalized Learning. Gains in Mathematics with Gender, High School, Physics, and Pre Test. Scores in Mathematics and Spatial Visualization.
[25] Jahjouh, Y. M. A. (2014). The Effectiveness of Blended E-Learning Forum in Planning for Science Instruction. Journal of Turkish Science Education, 11 (4): 3-16.
[26] Dincer, S. (2015). Effect of Computer Assisted Learning on Students’ Achievement in Turkey: a Meta-Analysis. Journal of Turkish Science Education, 12 (1): 99-118.
[27] Van Giesen RI, Fischer ARH, van Dijk H, van Trijp HCM (2015) Affect and Cognition in Attitude Formation toward Familiar and Unfamiliar Attitude Objects. PLoS ONE 10(10) 1-14.
[28] Fazio RH (2007) Attitudes as object–evaluation associations of varying strength. Social Cogn, 25(5) 603–637.
[29] Edwards K (1990) The interplay of affect and cognition in attitude formation and change. J Pers Soc Psychol, 59(2) 202–216.