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Cognitive process dimension in K-13 e-textbooks for 4th grade students

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ABSTRACT

Cognitive dimensions development is one of the objective of education. This research aimed to identify the structure, evaluate the focus, analyze the conformity toward the referred adoption standard, and evaluate the emphasis of thinking skill order of cognitive processes in the e-textbook for 4th grade students. Evaluation was carried out for the curriculum 2013 e-textbooks published in 2014, including theme 2, 3 and 4. Identification of cognitive process dimensions was carried out using revised Bloom's taxonomy, while the conformity was anayzed using Alzu'bi's preference. Statistical analysis was carried out with chi-square test. The result showed that the structure of cognitive dimensions in three examined e-textbooks were not consistent one another. Theme 2 emphasized on the high order thinking skill focused on the creating dimension. Theme 3 emphasized on the low order thinking skill focused on the understanding dimension. While theme 3 facilitated both thinking skill orders with a little tendency to the evaluating dimension. There was no conformity of the cognitive dimensions structure of the three themes toward the referred adoption standard. Statistical analysis showed that there was significant difference on the structure of cognitive dimensions between themes, and between each themes and the referred adoption standard.

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1. INTRODUCTION

In the education system, textbook is generally used as a media to transmit knowledge to the students. Unlike the general books, textbook is dedicated for educational purposes [1]. Textbooks contain information which acts as teaching material in the education management. Thus, the content should be different based on teaching themes, eduacation levels/grades, as well as teaching/learning objectives.

Understanding the education objective contained in the textbook is important in order to obtain clear outcome of teaching/learning activity. Within a textbook, a series of questions is generally integrated as an examination tool of students' achievement [2]. Thus, students' knowledge mastering could be evaluated wether it conforms the expected objectives [1].

Education objective includes the development of cognitive process dimensions of the students. B. S. Bloom, et al stated in their taxonomy classified cognitive dimensions into six development levels, including *knowledge*, *comprehension*, *application*, *analysis*, *synthesis* and *evaluation* [3]. This is known as Bloom's taxonomy. However, according to L. W. Anderson *et al*, revised the taxonomy to *remembering*, *understanding*,

applying, *analyzing*, *evaluating* and *creating* [4]. Basically, the revision changed the terms of cognitive aspect from noun to verbs.

Textbooks are arranged to develop students' cognitive process dimensions to a certain level based on the educational grade. Each educational grade should be provided with particular target of cognitive achievement as the representation of teaching/learning objectives. Thus, the government needs to put create a standard of cognitive ability achievement at each educational grade. As example, the cognitive dimension development of 4th grade students should be emphasized on aplying and *analyzing* dimensions [5].

The cognitive development as the representation of teaching/learning objective is expressed in the evaluation or examination sections within a textbook. Thus, it should be well formulated. Inappropriate formulation will cause misleading of objective achievements [6]. Moreover, there would be a high possibility of inconsistency between textbooks at respective grades.

In the arrangement of textbooks, the authors need to put a serious concern on the critical thinking aspects [7]. The authors need to create questions with appropriate proportion of expected cognitive dimension achievement. However, without a standardized objective it would be hard for the authors to formulate an appropriate set of questions.

Currently, the global the adoption standard of Bloom's taxonomy does not exist. However, according to [8] the proportion of cognitive dimensions should be decreased along with the increasing cognitive levels. Based on the original Bloom's taxonomy, the referred adoption standard should be 22% of *knowledge*, 20% of *comprehension*, 18% of *application*, 17% of *analysis*, 13% of *synthesis*, and 10% of *evaluation*. However, this proportion should be evaluated due to the revision of Bloom's taxonomy.

Currently, the curriculum used in Indonesia is the curriculum 2013 (K-13). The curriculum emphasizes character building to the students [7]. In the K-13, cognitive ability development is carried out through thematic approach [9]. However, the thematic approach is only implemented in the elementary school. This can be seen from the textbooks published by the Ministry of Education and Culture.

In order to support the implementation of K-13, the government through the Ministry of Education and Culture had released electronic textbooks (e-textbook) as the learning materials. Currently, there are three editions of the e-textbooks, including the initial release published in 2014, first revision published in 2016 and the latest edition published in 2017. The books can be accessed in the website bsd.pendidikan.id.

Specifically for the elementary school, textbooks are devided into themes rather than subjects. Each theme of e-textbooks for elementary school students contain learning materials of several subjects integratively. Therefore, the students are expected to learn several subjects from the theme. There are 8 themes for the 1st to 3rd grade and 9 themes for the 4th to 6th grade. The increased themes number from the 3rd to 4th grade indicates the upgrade of education objectives. At this grade, students are generally in the age of 11 years old in which the cognitive development is increased from concrete operational stage to formal operational stage [10].

Even though the K-13 had been implemented for a quite long time, the information concerning the teaching/ learning objectives of cognitive process dimensions is still minimum, especially for the elementary school students in which cognitive development is crucial. In the meantime, currently there is no standardized objectives on the cognitive process dimension development of the education system in Indonesia, as well as in the K-13. Thus, a whole evaluation is required in order to map the objectives of education, especially in the development of cognitive process dimension of the elementary school students.

Based on the description above, this research was aimed to identify the structure of cognitive process dimension in the e-textbook, evaluate the focus of cognitive dimension development expressed in the textbooks, analyze the conformity of cognitive dimension proportions expressed in the textbook toward adoption standard of Bloom's taxonomy, and evaluate the emphasis of thinking skill orders expressed in the textbooks for the 4th grade students.

2. RESEARCH METHOD

The object of this reseach was the K-13 e-textbook for 4th grade students published in 2014 by the Ministry of Education and Culture. There were three book themes used in this research, including theme 2 (*Selalu Berhemat Energi*/Always Save Energy), theme 3 (*Peduli terhadap Makhluk Hidup*/Care for Living Things) and theme 4 (*Berbagai Pekerjaan*/Various Jobs).

The research was aimed to evaluate the learning objectives contained in the e-textbooks. Thus, the research was focused on the test sections of the textbooks. The research was carried out to evaluate all of the test questions contained in the e-textbook. The questions were identified for its target of cognitive dimension.

Identification was carried out using revised Bloom's taxonomy of cognitive process dimensions as explained in [4]. The classifications includes: *remembering*, *understanding*, *applying*, *analyzing*, *evaluating* and *creating*. Complete identification of cognitive dimensions expressed in each questions was carried out.

Thus, each question may contain several dimensions identified. However, only the highest dimension class was used in the further processing. Data analysis was carried out with chi-square test to compare the proportion of the structure of cognitive dimensions between themes. Instead of comparing the proportion between themes, comparison was also carried out to identify the appropriation of cognitive dimension structure of each textbook to the referred adoption standard as suggested by [8].

3. RESULTS AND DISCUSSION

Indentification of cognitive process dimensions is an important task to evaluate the objective of learning activity. Moreover, it is also important to provide feedback to the book authors as well as the questions designers in order to provide appropriate learning process to the students. Thus, improvements could be made up to the later editions of the textbooks.

The first parameter to be observed was the composition of cognitive process dimensions as the learning objective of the testbooks. Inventorization resulted as many as 330 items, 335 items and 304 items of questions were contained in respectively theme 2, theme 3 and theme 4 e-textbooks. The identification had been carried out to all three early published e-textbooks. Table 1 shows the composition of cognitive process dimensions adopted in the 2014 e textbooks for 4th grade students.

Table 1. Composition of cognitive process dimensions adopted in the 2014 e-textbooks

No.	Cognitive Dimension	Frequency		
		Theme 2	Theme 3	Theme 4
1.	Remembering	6^{a}	55^{b}	33^{b}
2.	Understanding	13^{a}	116^{b}	67^{c}
3.	Applying	28^{a}	72^{b}	55^{b}
4.	Analyzing	40^{ab}	31^{b}	57^{a}
5.	Evaluating	108^{a}	24^{b}	70^{c}
6.	Creating	135^{a}	37^{b}	22^{b}
	Total	330	335	304
	Average ± StDev	55 ± 53,53	55,83 ± 34,25	50,67 ± 19,15

Notation: different letters in the same row indicates significant difference at confidence interval of 95%

According to the identification result as presented in Table 1, there was an indication of different learning objectives between themes. As shown in the table, the domination of cognitive process in theme 2 was in the *creating* dimension, *understanding* dimension in theme 3 and *evaluating* dimension in theme 4. However, in theme 2 and theme 3, the deviation was quite high duet to the distant difference between the lowest and highest emergence frequency of the dimension. In the meantime, the composition of cognitive dimensions in theme 4 tended to be fairly distributed.

Statistical analysis showed that there was significant difference of the structures of cognitive dimensions. Chi-square analysis showed the value of 308,721 with the probability of 0,000. Detailed difference of the proportion of cognitive dimensions can be seen in Table 1. Based on the analysis result, as the whole structure all three themes were different significantly. Even though some dimensions had insignificant proportion differences. This can be considered as the initial indication of inconsisten learning objective.

Table 1 suggests that the focus of cognitive dimension development expressed in the e-textbooks was *creating* and *understanding* respectively for theme 2 and theme 3. As for theme 4, even though the frequency of *evaluating* dimension was highest, but the difference was not quite distant toward other dimensions. Thus, it could be suggested that the focus was unclear. Further analysis was carried out to compare the proportion of cognitive process dimensions adopted in the questions to the referred adoption standard. The standar used as the reference was [8]. Detailed analysis result is presented in Table 2.

Table 2. Proportion of cognitive dimension adopted in the 2014 e-textbooks in comparison to the referred adoption standard

No.	Cognitive Process Dimension	Proportion (%)			Adoption Standard of Bloom's Taxonomy[1)]
		Theme 2	Theme 3	Theme 4	
1.	Remembering	1,82%*	16,42%	10,86%*	22%
2.	Understanding	3,94%*	34,63%*	22,04%	20%
3.	Applying	8,48%*	21,49%	18,09%	18%
4.	Analyzing	12,12%	9,25%	18,75%	17%
5.	Evaluating	32,73%*	7,16%	23,03%*	10%
6.	Creating	40,91%*	11,04%	7,24%	13%

Notation: [1)][8]
*indicates significant proportion difference toward the adoption standard of Bloom's taxonomy

According to the analysis result as presented in Table 2, it could be suggested that all three themes of e-textbooks for 4th grade students published by the Ministry of Education and Culture in 2014 did not conform the adoption standard of Bloom's taxonomy by [8]. The analysis result showed the chi-square value of 332,316 with the probability of 0,000. According to the result, theme 2 had the most proportional difference compared to theme 3 and theme 4. However, the fact that none of the e-textbooks conformed the adoption standard suggested that the authors need to give serious concern in determining the learning objectives.

The last analysis was carried out to identify the emphasis of the e-textbooks on the thinking skill order. The six cognitive process dimensions could be grouped into two different thinking skill orders, including lower order thinking skills (LOTS) which consists of *remembering*, *understanding* and *applying* cognitive dimensions, and higher order thinking skills (HOTS) which consists of *analyzing*, *evaluating*, and *creating* congitive dimensions. Analysis result on the emphasis of thinking skill order adopted in the 2014 e-textbooks for 4th grade students is presented in Table 3.

Table 3. Comparison of thinking skill order adopted in the 2014 e-textbooks

No.	Theme	Lower Order Thinking Skills		Higher Order Thinking Skills	
		N of items	Proportion	N of items	Proportion
1	Theme 2	47	14,24%	283	85,76%
2	Theme 3	243	72,54%	92	27,46%
3	Theme 4	155	50,99%	149	49,01%

According to the result as presented in Table 3, it could be concluded that the emphasis of thinking skill development was varied between themes. The learning objective for theme 2 was emphasized on the higher order thinking skills. It was proved by the extremely higher proportion compared to the lower order thinking skills. While for theme 3, the emphasis was on the lower order thinking skills. The extremely higher proportion also became the evidence. While for theme 4, it seems like it was emphasized on both orders, or can be suggested as no specific thinking skill orders was emphasized in the learning objective.

According to the identification result, inconsistent structure of cognitive process dimension was found in three e-textbook themes studied in this research. It was suggested that the questions were built randomly without a determined objectives. Or, during the arrangement the authors did not refer to the basic competence defined in the regulation of Ministry of Education and Culture. Another possibility which caused inconsistency of cognitive dimension development objectives might be due to the composition of subjects contained in the e-textbook.

According to the regulation of Minister of Education and Culture no. 67 / 2013, the main competence between subjects are different [11]. The objective for some subjects are the *applying* dimension, while some other are the *creating* dimension as the highest achievement. Unfortunately, the detailed objective of cognitive dimensions achievement of K13 is not well studied.

Previous studies described the cognitive dimension development objective for 4th grade students partially. For example [12] stated that the materials contained in the natural science subject is focused on the *knowledge* dimension. As stated by [13], it is showed that the objective of Javanese subject was at most the *analyzing* dimension. Another research carried out for the 3rd grade showed the emphasize on *understanding* dimension [14]. This proved that cognitive dimension achievement was varied based on the grades and subjects. Based on the analysis result as presented in Table 1, it was found that the focus of cognitive dimension development was *creating* and *understanding* respectively for theme 2 and theme 3. According to [5], the education for 4th grade students should be emphasized on the *applying* and *analyzing* dimensions, plus *evaluating* dimension but at the simple stage. Therefore, none of the three themes of e-textbooks suited the suggestion.

According to the result, theme 2 was emphasized on the *creating* dimension. Referring to [5], this could be considered as inappropriate. It is because *creating* dimension is preferred for 6th grade and up. In the meantime, theme 3 which emphasized on *understanding* dimension was also inappropriate because it should be the objective for the 2nd grade students. Theme 4 was even more inappropriate since it had no emphasis of cognitive dimension development.

However, according to [15], there has been changes in education objectives between the 20th century and 21st century. Specifically, for the cognitive dimension development, the 20th century education focused on the *knowledge*, *comprehension*, and *application*, while the 21st century education focused on the *analysis*, *synthesis*, and *evaluation*. Thus, the focus of cognitive development was changed from the low order thinking skill to the high order thinking skill. Cognitive dimensions including *knowledge*,

comprehension, and *application* are considered as low order thinking skill (LOTS), while *analysis*, *synthesis* and *evaluation* are considered as high order thinking skill (HOTS) [16, 17].

What was mentioned by [15] is appropriate to the current condition. Nowadays, students are expected to be creative and proactive in class study. As the wide opened access to the sources of information, the students could learn and build their creativity outside the school. Thus, students should be given high order thinking skill questions in order to improve their logical and rational thinking style [18]. The structural composition of cognitive dimension identified from the e-textbooks for 4th grade students did not show any conformity to the referred adoption standard of Bloom's taxonomy suggested by [8]. Even thouth it's not the standard suggested by [3], it still could be used as a consideration in developing objective standard. Threfore, exact objective of cognitive dimension development should be developed as a standard as a derivate of education objectives.

According to M. A. Alzu'bi, it is suggested that adoption standard needs to be implemented in the development of examination questions [8]. Among the objective is to ensure that the questions do not clump into certain cognitive dimension. A research carried out by [19] showed that the high variation on the cognitive structure of questions created by the teachers. Suggested proportion of cognitive dimension for 4th grade students is 30% for *rembering* and *understanding* dimensions, 40% for *applying* and *analyzing* dimensions, and 30% for *evaluating* and *creating* dimensions.

Proportional leveling is required in order to provide qualified examination tool. Without a proportional leveling, there would be a significant difference between the prioritized cognitive dimension and the remaining dimension. For example, in the English textbook *Master Class* the emphasized cognitive dimension development was the *comprehension* (refers to *understanding* in the revised Bloom's taxonomy) dimension was represented by 51.8% of the questions. However, the lowest one that was *application* dimension only had the proportion of 3.7% [20].

The emphasis of thinking skill orders were varied between themes. In theme 2, it was emphasized on the high order thinking skill. However, in theme 3 it was emphasized on the lower order thinking skill. But, in theme 4, there was no specific emphasis of thinking skill order. However, this should be viewed from the specific theme's objectives. Each e-textbook theme contains several subjects in which the target of cognitive dimension development are different. Wether it emphasized on the high order thinking skill or low level thinking skill was depend on the accumulated objectives of each subjects. However, for the 4th grade students, the development of cognitive dimension should be on the high order thinking skill. At the age, the students should have achieved the *applying*, *analyzing*, and *evaluating* dimensions [5].

As stated by [21], suggested that the design of test instrumen should be emphasized on the *analyzing*, *evaluating*, and *creating* dimensions. Generally, high order thinking skill would only be represented in small portions in textbooks. For example, the *Master Class* textbook which was purposed for 10th grade students only contain 38.4% of HOTS questions [20].

Within the education system, examination is a tool used to help students achieve the desired outcome [2]. Thus, the questions should be created in accordance to the teaching/learning objectives. In order to match the expected outcome of education, the questions designing should involve all of the stakeholders [22]. Moreover, the questions designer should have appropriate knowledge and capability develop qualified questions. Therefore, evaluation and re-evaluation needs to be carried out during the arrangement of textbook, especially in the examination section. Unfortunately, evaluation and criticism on textbooks used in the education is rarely carried out. In the meantime, textbooks are used as the main reference in teaching/learning activities.

The difficulty level of teaching/learning materials are generally adjusted to the education level. Moreover, each educational grade should have certain cognitive dimension development objectives to obtain optimum potential of the respective grades [23]. Therefore, implementation of standardized adoption of Bloom's taxonomy should be acceptable. Unless a standard is applied, there will always possibility of decreased textbook quality. For example, [24] found that some cognitive dimension in the high order thinking skill was not facilitated in textbook. Textbook actuatlly had more potential in the education evaluation. Trough the utilization of Bloom's taxonomy, children's initial cognitive capability could be evaluated in order to formulate best education strategies [25]. Therefore, a more serious concern should be put in the arrangement of educational textbooks.

4. CONCLUSION

Thre was significant difference on the structure of cognitive dimensions between theme 2, theme 3 and theme 4 of 4th grade students, wehereas the proporion was increasing along with the increase of cognitive level in theme 2, inversed strcuture in theme 3, and fair proportion in theme 4. The focus ot cognitive dimension development in theme 2 was the *creating* dimension, in theme 3 was *understanding*

dimension, while in theme 4 was *evaluating* dimension. Among the three e-textbook themes, none had conformity to the referred adoption standard. The teaching/learning emphasis of theme 2 was on higher order thinking skill, theme 3 emphasized on low level thinking skill, while theme 4 facilitated both thinking skill orders fairly.

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