Cognitive learning outcomes of physics in national curriculum of Indonesia and International baccalaureate

D Lestari*, A S Budi and E Budi

Physics Department, Universitas Negeri Jakarta, Jakarta, Indonesia

*Corresponding author: diah.lestari2@yahoo.com; diahlestari194578@gmail.com

Abstract. In education system, a curriculum is needed as a set of plans on the objectives, content, and lesson materials and as a set of guidelines for the implementation of learning activities to achieve certain learning outcomes. Learning outcomes represent what a learner is expected to know, understand, and/or able to demonstrate at the end of period of learning and it is the forefront of educational change. National curriculum of Indonesia has been changed and renewed for multiple times these past years, while International Baccalaureate stands as a rigorous curriculum. This study examines senior year of high school students from national schools using National Curriculum of Indonesia and international schools using International Baccalaureate in Jakarta. A physics paper test was used to collect data about students’ level of learning outcomes in cognitive domain. The preliminary results of the research show that the aims, goals, and objectives of the curricula are different in terms of the cognitive learning. This study is describing as well as comparing the differences of learning outcomes using the Bloom’s taxonomy between grade 12 students from schools using National curriculum of Indonesia and grade 12 students from schools using International Baccalaureate which is focusing on the cognitive domain.

1. Introduction

Captivated by an observation about learning physics in two different curricula viz. national curriculum of Indonesia and International Baccalaureate, the inquiry to examine the learning outcomes between these two curricula arisen. Learning physics in high school means much more than memorizing a lot of independent definitions and equations [1]. Physics should be learned effectively so it will correspond to what they experience with the world. In order to contrive such learning, Redish (2003) pointed out three goals in Physics learning viz., concepts, coherence, and functionality. To equip the concepts, the students need to comprehend the ideas and definitions that correlate the abstract physics descriptions with the real physical world. Coherence is achieved when the students are able to integrate their acquired knowledge structure into their existing knowledge structure using their own way. Functionality can be seen when the students are able to do something with the physics content. At this point, a well organized cognitive learning outcome in the curriculum is needed to support the effective learning of Physics.

Bloom (1956) said that knowledge and development of intellectual skills are implicated in the cognitive domain [2]. Bloom made a hierarchy of cognitive domain of learning that involves learner critical thinking. Six successive levels are conceptualized to show the cognitive hierarchy: knowledge, comprehension, application, analysis, synthesis, and evaluation. This hierarchy was revised by Anderson and Krathwohl (2001) to make it more outcome-focused to the modern education learning. The revised taxonomy is ordered as follows: remembering, understanding, applying, analyzing,
evaluating, and creating. Using a paper test with multiple choice questions, this study measures only the four first level of the cognitive domain of learning outcomes.

As learning outcomes are statements of what a learner is expected to know, understand and be able to demonstrate after a completion of a process of learning [3], it is important to design the learning outcomes in order to generate an effective learning of Physics. This study is about analyzing two different curricula viz.: National Curriculum of Indonesia and International Baccalaureate as well as to find out whether the learning outcomes in the cognitive domain between both curricula are different. This research is impactful for academia especially in the field of curriculum research subjectively in physics.

Indonesia is one of the countries implementing national curriculum. The national curriculum is arranged by a team consists of Ministry of Education and Culture, National Education Standard Board, and education practitioners. Continuously looking for ways to improve the quality of education, Indonesia has been reformed as well as renewed its curriculum for multiple times e.g. in the year of 1947, 1952, 1964, 1968, 1984, 1994, 2004, 2006, and 2013. Generally, the latest curriculum comprises four elements of changes; they are (1) standard of graduate competencies, (2) standard of contents, (3) standard of processes, and (4) standard of assessment [4]. As a country with such big diversity, Indonesia has been undertaking national exam for its requirement for students to graduate from school to attain the educational equity. The national exam is in the form of paper test and it should be able to measure some specific learning outcomes.

On the other hand, International Baccalaureate (IB) is an international curriculum created by IB organization in Geneva, 1968. IB Diploma Program (DP) is a two-year programme (grade 11-12) represents itself as a rigorous pre-university course of study that strives to support students to be knowledgeable and inquiring, but also caring and compassionate [5]. Its educational philosophy shows conceptual comprehension and application to the learning content [6]. Assessment in IB DP consists of internal assessment and external assessment. Internal assessment weights 20% of the final score, is most likely in the form of paper and project, while external assessment is paper tests 1, 2, and 3 that weights 80% of the final score. It has maintained a commitment to a ‘well-rounded’ education [7] and by contriving an authentic package of curriculum, IB DP generates graduates that evidently focus on their university study. This is proven by some reputable university have special requirements for IB DP students.

This paper will give you the brief of the differences between national curriculum of Indonesia and International Baccalaureate, more focus on the cognitive learning outcomes. For the whole paper, I am only going to talk about these two curricula. For the record, this paper is not proving which curriculum is better than another.

2. Materials and Methods
The research method of this study is called exploratory sequential mixed methods [8]. It is a method when the researcher starts with qualitative research and then continued by doing quantitative research.

Appealing with a strong qualitative background along with relatively new to quantitative approaches, this study involves two-phase project in which researcher arises by exploring with analysis of the qualitative data followed by using the findings in a second quantitative phase. This approach results that the second database builds on the results of the initial database. The purpose of the strategy is to develop better measurements with a specific sample of the population and perceive if the data from the qualitative phase can be generalized to a large sample of the population in the quantitative phase. Simply put, this study was started with comparing the content of both curricula and found out that they have similarities and differences. Both curricula have the same syllabus outline, syllabus content, and learning outcome outline, but they have different draft of the approaches to the teaching and learning of physics. This finding issued an inquiry about the accomplishment of the cognitive learning outcomes between both curricula.
A research instrument was arranged in the form of paper test and get validated using construct validity. It is the way to validate research instruments by demonstrating how well the research instrument measures up to its claims. A paper test consists of 35 multiple choices questions was made by mapping it to the cognitive process dimension, structured by balance combination from both curricula. This instrument measure the first four level of the cognitive domain.

2.1. Data Collection
Paper tests were administered to sample population from the two groups. Group 1 is grade 12 students from high schools using national curriculum of Indonesia while group 2 is grade 12 students from schools using IB DP. Group 1 consists of SMA 8 Jakarta (13 students), SMA 21 Jakarta (38 students), and SMA 78 Jakarta (42 students); group 2 consists of Jakarta Intercultural School/JIS (39 students), Sekolah Pelita Harapan Kemang Village/SPH-KV (7 students), Mentari Intercultural School Jakarta/MIJS (8 students), Sinarmas World Academy/SWA (17 students), and British School Jakarta/BSJ (26 students). Seen from the number of participants between the two groups, this sample population is balance and measurable.

2.1.1. Sample and Population. Since I am comparing two different curricula, the population that meets this research is the school using national curriculum of Indonesia as well as the school using International Baccalaureate Diploma Programme. Analysis of taking 1 school for each type of curriculum yields a fact that it is not balance enough, because the reputation of the school could affect the result. Meaning the population used should be more than one school for each curriculum. The consideration of taking 3 national schools and 5 IB DP schools is to balance the number of population. The sample is 1 class from each school and the timing is at the end of the second semester. It is because at the second semester of grade 12, the students must have learnt all the physics content on each curriculum, so it is the perfect timing to measure the learning outcomes of both curricula.

3. Result and Discussion
After the instrument had been administered throughout the sample population, out of the total score of 35, the data acquired varies between 2 and 33.

![Average Score per School](Figure 1. Average score obtained by students from each school)

The result in the Figure 1 was obtained by calculating the average score for each school and it did not show the significant difference between the national and IB DP curriculum. This result then summarized by dividing the summation of score obtained by total number of students for each group to show the difference of average score between group 1 and group 2.
As shown in the Figure 2, IB students attained higher average score than national students. To exhibit the tendency of cognitive learning outcomes between the two groups, more calculation has done by dividing the summation of total score per cognitive domain by number of students per group and the result is displayed as Figure 3.

The tendency of cognitive learning outcomes can be discovered clearly from the figure 4. Group 1 overcome better in the C1 and it goes lower as the cognitive level increases. The range of this data reaches 34.1% showing that there are a big gap between C4 and C1. This fact generates the idea that national curriculum of Indonesia needs to be more concern on the higher cognitive levels for its learning outcomes. An integrated curriculum should be focus of higher-order thinking skills based on the cognitive taxonomy in order to achieve its learning outcomes [9]. The twelfth grade students in national school tend to memorize the definitions, formulas, and steps to solve some typical of questions. Once the type of question is modified, students encounter difficulties in solving it. As
mentioned before, learning physics is not enough by just memorizing formulas and definition, it is more about understanding the universe for the learner to be able to solve problems with their critical thinking.

Group 2 yields the other way around. C4 of this group has the highest percentage of average score and it goes lower as the cognitive level goes lower. The range for group 2 is 15.3% which is less than group 1 showing that group 2 is more stable in attaining its cognitive learning outcomes. This fact shows that IB DP curriculum accustomed to use higher cognitive level in their learning outcomes yet still be able to conquer the lower cognitive level. As cognitive learning outcomes alluded to the long-term results of learning, it is important for the curriculum used in physics learning to be more concern on this domain. It refers to the results of learning regarding the development of knowledge measured by standardized achievement, competency tests, specific tests of content understanding, and/or student performance [10].

Differences in tendency of the result of this study is herded by some factors from both curricula. Determinant factors were construed by Bryant et. al. [11] in the results of their qualitative study that IB DP students have higher cognitive learning outcomes because the curriculum supports their academic growth by equipping students with inquiry and research skills. Taking a glance at the script of the IB curriculum, its syllabus content is more like a guide for the teachers consists of the approaches to the teaching and learning of physics. The “nature of science” section gives specific example in context illustrating some aspects of the nature of science and gives guide to support teachers in their understanding of the general theme to be addressed. The “understandings” section gives the main general ideas to be taught. The “applications and skills” section gives the specific applications and skills to be developed from the understandings. The “guidance” section gives information about the limits and constraints and the depth of treatment required for teachers and examiners. The “international-mindedness” give suggestion to teachers about relevant references. The “TOK” section gives examples of theory of knowledge questions so that the students can be focus on the thoughts on the preparation of the TOK prescribed essay title. The “links” section link the sub-topic to other parts of the subject syllabus, to other Diploma Programme subject guides or to real-world applications. Finally, the “Aims” section refers to how specific group 4 aims are being addressed in the sub-topic. In national curriculum, the process of physics learning with a scientific approach and the attitude outcomes is intended to make students know about 'why'. The skill domain is intended to make students know about 'how'. Whereas, knowledge outcomes is intended to make students to know about 'what'. The final result of Physics learning is the improvement in the ability to be a good human being (soft skills) and to have the skills and knowledge to live which covering the aspects of attitudes, skills and knowledge [12]. Another factor is that IBO provides access to a website known as the ‘Online Curriculum Centre’ and provides a variety of publications, along with opportunities for involvement in the curriculum review processes. The IBO’s regional office provides workshops and organizes conferences [13] and by this, IBO can manage to align the cognitive learning outcomes all over the world.

4. Conclusion
The main finding of this research is that IB DP curriculum performs better than national curriculum of Indonesia in the learning outcomes specifically in higher level of cognitive domain. This finding notifies that the cognitive learning outcomes has something to do with the curriculum used. Moreover, this finding also notifies that national curriculum of Indonesia needs to pull through more on the higher level of cognitive domain for its learning outcomes. On the other hand, IB DP attained to cover all cognitive levels as a result of its curriculum that habituates the learners with higher level of cognitive domain.

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References
[1] Redish E F 2003 Teaching Physics with the Physics Suite (New Jersey: Wiley)
[2] Huitt W 2011 Bloom et al.’s taxonomy of the cognitive domain. Educational Psychology Interactive (Valdosta G A: Valdosta State University)
[3] Burke L 2014 Int. School J 33 47
[4] Prihantoro C R 2014 Int. J. Res. Stud. Educ. 4(1) 77
[5] Corlu M S, Capraro R M and Corlu M A 2014 Educ. Sci. 39 74
[6] Behrenbruch M and Harrison R 2013 IB J. Teach. Pract. 1(2) 1
[7] Doherty C A, Mu L and Shield P G 2009 Br. J. Sociol. Educ. 30(6) 757
[8] Creswell J W 2014 Research Design: Qualitative, Quantitative, and Mixed Methods Approaches-4th edition (California: SAGE)
[9] Larson, K and Kurtyka F 2017 English J 106 86
[10] Seidel T 2007 Rev. Educ. Res. 77(4) 454
[11] Bryant D A, Walker A and Lee M 2016 J. Res. Int. Educ. 15(2) 87
[12] Deng Z 2014 Educ J 41 85
[13] Ledger S 2014 Policy Implic. Res. Educ. 4 17