Learning Outcomes Analysis in Middle School Science Using an Adaptive Curriculum Approach with PCTS Model

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Abstract. This article was created to analyze the learning outcomes (CP) of Middle School Science in the Merdeka Curriculum using an adaptive curriculum approach using the Problem-centered Thinking Skill (PCTS) model into learning objectives (TP) and learning objectives flow (ATP). PCTS is a learning approach that focuses on developing critical thinking skills and problem-solving. The method used in this study is a qualitative method using a descriptive approach. Data is collected with a documentation study through reduction, presentation, and conclusion. The results of this study are in the form of matriculation of Science Learning Outcomes which are analyzed into TP and ATP accompanied by an analysis of Learning Objectives that are relevant to the implementation of this PCTS model. The conclusion that can be drawn from this research is that in the Merdeka Curriculum, the Government through the Kemdikbudristek only regulates up to the learning outcomes of each phase of education, the rest of the schools and teachers can analyze the CP into TP which is adjusted to the characteristics of students and the cultural environment around the school so that it becomes an embodiment of an adaptive curriculum for each educational unit.

Keywords: Science Learning Outcomes, Adaptive Curriculum, PCTS Model.

1 Introduction

One of the characteristics of the Merdeka Curriculum that the Kemdikbudristek recently roled out is the existence of an element of decentralization which gives teachers the freedom to design their own TP, ATP, the structure of the material to be taught, and even the depth of the material to be explored in learning with students. In this Merdeka Curriculum, the government through the Kemdikbudristek only divides the education levels into several phases and provides learning outcomes for each of these phases. Learning outcomes are a set of competencies that are expected to be mastered by students at the end of the learning phase.

According to the Kemdikbudristek, the Freedom to Learn Program will be a step forward in learning that focuses on improving the quality of human resources. It is not

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only set as a solution to answer future challenges but also provides new colors and steps in teaching and learning activities that encourage students to think and work more freely.

The Freedom to Learn Program is a policy that is considered transformative in the world of education, of course, there will be various changes felt by teachers. Technology is advancing at a staggering pace and the Internet is making knowledge immediately accessible to the public [1], [2]. The way we learn needs to change to adapt to the availability of large amounts of knowledge [2]. Students don't need to be knowledgeable in all areas of science, because the teaching emphasis has to change from memorization and practice to scientific reasoning and communication processes [3].

The teacher's role is no longer as a 'transmitter' of knowledge because knowledge is temporary and constantly changing with discoveries, but a facilitator for the construction of knowledge to develop new skills [4], [5]. Developments in cognitive psychology indicate the need for instructional design models that emphasize learners, learning processes, and learning environments to develop higher-order thinking skills [6]. The cognitive revolution in educational psychology is developing, because the need to understand the learning process is necessary [7]. In the learning process, a subject matter model is constructed for new information to be integrated with prior knowledge [8]. Exposure to various content representations in a learning environment can enable learners to actively build their understanding and think critically [8].

The Trend in International Mathematics and Science Study (TIMSS), which compares the math and science proficiency of pupils in grades 4 and 8, was also carried out. In the past four years, TIMSS has investigated several nations, including Indonesia. In reality, Indonesia was ranked poorly in the 2011 TIMSS rankings, even worse than the long-conflict-ridden nation of Palestine. The results of the 2011 TIMSS accomplishments are listed below [9].

Currently, scientific reasoning is taught and focuses on pedagogical inquiry-based learning methods to generate hypotheses, experiments observations, and evaluations [9]–[11]. However, this reasoning process is limited to only three styles of reasoning: inductive, deductive, and transitional reasoning [12], [13]. In addition, critical thinking models focus on evaluating traditional knowledge and skills [14]–[17]. A limitation of these models is that they do not focus sufficiently on higher-order thinking [15]. The importance of conducting this research is to develop an understanding of the reasoning processes and critical thinking strategies that teachers use for teaching to better understand what is needed to build new teaching models to help science students become more effective reasoners, achievers, and thinkers [18]. Several models of critical thinking have been used before [19]. However, this critical thinking model seems to be insufficient because the results of PISA and TIMMS seem to be getting worse (MOE, 2013). The model currently used in the i-Think Project [20] does not serve science specifically. In addition, 21st-century skills require students to be proficient in skills such as problem-solving. Therefore, models for critical thinking and problem-solving in science are needed.

One of the models that the author believes is capable of improving students' critical thinking skills is the Problem Centered Thinking Skill (PCTS) model, through this PCTS model it is hoped that students will get used to finding solutions to various

problems and internalize their understanding as a form of increasing students' critical thinking skills. This PCTS model will be well integrated into the natural sciences adaptive curriculum if the teacher is first able to analyze and construct the curriculum starting from learning outcomes, and learning objectives, to becoming a flow of learning objectives at each level of education. Therefore, on this occasion, the author will try to analyze the learning outcomes of junior high school science into learning objectives and the flow of learning objectives.

1.1 Adaptive Curriculum

A curriculum that has been altered and tailored to the needs, circumstances, skills, and limits of the pupils is called an adaptive curriculum. The design of learning programs is modified in an adaptive curriculum to meet the demands of each student with special needs. Objectives, content, procedure, and evaluation are the four primary facets of the curriculum that are subject to adaptive curriculum adjustment.

The curriculum development staff at the school modifies the curriculum. A curriculum that can adapt to the various educational demands of students is said to be adaptive. It was part of a movement that got started in the 1970s to make professional education more student-centered. [22] provided the following summary of the student-centered approach: The student is the main character or focal point. Under the guidance of a teacher, students can choose their learning objectives, select the most appropriate learning tools to help them reach these objectives, set their learning order and pace, and are in charge of evaluating their learning process. Students are not a homogeneous population, and their preferred learning styles, interests, and talents vary, which is something that adaptive curriculum acknowledges.

Providing a variety of educational opportunities and allowing students to choose those that best suit their learning styles [21] cater to different learning preferences. The adaptive curriculum that is embodied through the adaptive learning method is considered appropriate to apply. A learning strategy that encourages effectiveness and efficiency is adaptive learning. The teaching and learning process should be planned and carried out according to the needs of the students, and suitable learning resources should be made available. Additionally, this approach incorporates a prompt feedback and guidance mechanism for teacher and student communication. Gaps in understanding can be reduced because teachers will make sure students achieve mastery of the subject matter first before learning progresses to a higher level.

1.2 Model Problem-Centered Thinking Skills (PCTS)

In the old educational system, passive learning strategies that merely focused on memorization of topics were widespread. They have been taught to memorize textbook content without testing or challenging notions. Critical thinking became quite popular in Indonesia after the Reformation Era in 1998 when residents there fought for more freedom of expression. [22].

To assist our nation in advancing with changes, there is a need for more critical thinkers who can filter through various ideas and determine which ones are logically

suitable. Because of this, critical thinking is emphasized Indonesianesian curriculum. According to several surveys, students in Indonesia fall short of their peers in other Southeast Asian nations like Singapore and Malaysia in terms of critical thinking. [23], [24].

We must include more critical procedures in our curricula if we want to aid kids in developing their critical thinking abilities [26]. This is one of the practical abilities that can help people deal with challenges as they arise (Tahrir et al., 2020).

This PCTS model is a learning model that will explore the potential in dealing with problems, collaborate to solve these problems by constructing students' prior knowledge into new knowledge, communicating the results of their group work to get suggestions and corrections from other parties, developing new knowledge as the best solution for problems faced, and then apply that knowledge, reflect on it, and also try to create new knowledge from it individually. All stages in the PCTS model, especially the stages of applying, reflecting, and creating, are believed to be able to train students' critical thinking skills significantly.

1.3 Natural Sciences and Scientific Knowledge

Scientific reasoning techniques are used to create scientific knowledge. [25] which are carried out individually or in collaboration with other scientists. The high-order reasoning processes of science should not be neglected because science consists of scientific content, and scientific processes and reasoning [26]. Science is “a way of reasoning about phenomena, alone and in a community of peers [27].” In the construction of scientific knowledge, the scientific community communicates and collaborates using scientific processes [28], [29].

Therefore, science teaching must emphasize inquiry and communication processes to build knowledge [30]. Acquiring scientific knowledge must involve the scientific method and scientific reasoning. In teaching the scientific method, teachers must guide and challenge students at all stages of the scientific inquiry process, as well as focus on scientific inquiry [31]. This means that in acquiring scientific knowledge and practicing scientific methods, students will have sufficient knowledge and be able to reason and debate issues related to science (MOE, 2013).

Science teachers should not only teach facts but should emphasize the process of building scientific knowledge and values [25] in a collaborative environment to reflect the influence of the scientific community [27]. Because the teacher has different roles, he or she must acquire new skills to account for the impact of social, cultural, and individual differences on learning [5]. A culture of thinking must be instilled among teachers [32].

2 Method

This study uses a qualitative method with a descriptive approach which aims to provide an overview of the phenomenon being studied. The descriptive method can also be interpreted as a method that is useful for explaining existing phenomena and is

carried out according to the existing situation [33]. Therefore, this method is useful for obtaining a detailed illustration of the entire study.

This research was conducted at a junior high school in Bandung Regency in the Science Study Field during the even semester of the 2022-2023 school year, to be precise, from January to April 2023. The secondary data collection method in this study was carried out through library techniques. Library research can be defined as a data collection technique that involves sorting and collecting various information and data using library sources available in the library, both online and offline [34].

This collection of various data and information is used as a reference for the author in making matriculation analyses of learning outcomes into learning objectives, the flow of learning objectives for each level, as well as identification of relevant learning objectives for the PCTS model.

3 Result

After conducting studies from various sources, the author then tries to design an analysis of learning outcomes into learning objectives, the flow of learning objectives for each level, as well as the identification of relevant learning objectives for the PCTS model. Because the results of the CP to TP analysis for one phase D are quite long, I am attaching the matriculation of the analysis results to the supplement section.

After analyzing CP into all TP, the next step is to classify the subject matter for each level, and then the TP of one cluster is grouped into ATP for one phase D, namely the junior high school level, as follows:

Table 1. Subject Matter Matriculation

7th grade	TP	8th grades	TP	Grade 9	TP
The Nature of IPA, Scientific Method, and Measurement	PK.7.1, PK7, PK14	Elements, Compounds, and Mixtures, and acid-base properties	PK.8.2, P.8.3, PK8.1, P.8.29, PK8.30, P.8.31	Reproductive system and human coordination system.	P.9.1, P.9.2
Classification of Living Things and Characteristics of Substances and Their Changes	P.7.2, PK7.3, P.7.4, PK7.5, P.7.6	Life Organization System	P.8.4, P.8.7, PK8.5, PK8.6,	Inheritance	P.9.3, P.9.4, PK9.5
Ecology and Interaction of living things and their environment	P.7.7, P.7.8, P.7.9, PK7.10,	The structure and function of living things	P.8.8, P.8.9, P.8.10, P.8.11, P.8.12, P.8.13	Biotechnology	PK9.6
Pollution and Climate Change	PK7.12, P.7.13	Effort and Energy	PK8.14, PK8.15	Electricity	P.9.7, P.9.8, P.9.9, P.9.10
Motion and Style	P.7.15,	Pressure	PK8.16	Magnets and	P.9.11,

7th grade	TP	8th grades	TP	Grade 9	TP
	P.7.16, P.7.17, P.7.18			Electromagnets	PK9.12
Temperature and Heat	PK7.19, P.7.20, PK7.21, P.8.22	Simple Plane	P.8.17, PK18	Layer of Earth	P.9.13, P.9.14, PK9.15, P.9.16
Solar System	PK7.23, PK7.24, PK7.25, P.2.6	Vibration and Waves	P.8.19, P.8.20, P.8.21	Additives and addictive sub-stances	P.9.17, P.9.18, P.9.19, PK9.20
		Light and Optical tools	PK8.22, P.8.23, P.8.24		

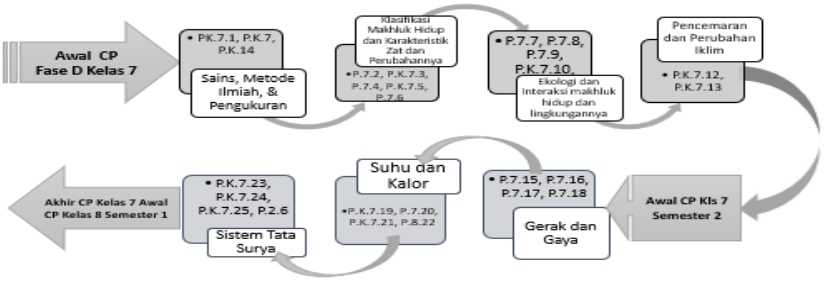

Fig. 1. Class 7 Phase D Learning Objective Flow

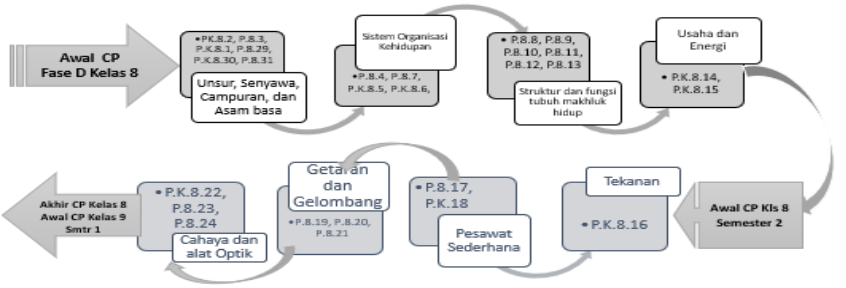

Fig. 2. Class 8 Phase D Learning Objective Flow

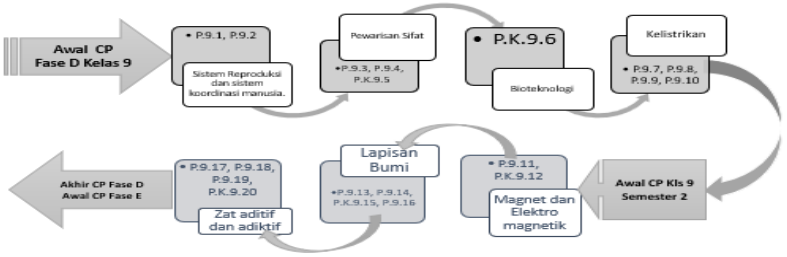

Fig. 3. Class 9 Phase D Learning Objective Flow

4 Discussion

The analysis of CP to TP and then ATP for each level for one Phase D above may be different from the results of analyses carried out by other teachers. It will certainly differ from one school to another. Even teachers in one school may need to make adjustments and modifications when changing students in the following year whose characteristics may also be different. But, like any curriculum analysis design, the subjects compiled should pay attention to the order of complexity from the easy to the more complex, from the concrete to the abstract.[21], [35]

When compared, the results of the CP analysis that the author has made, in the ATP preparation section and also the grouping of teaching materials by ATP arrangement and the grouping of teaching materials in the Science books published by the Ministry of Education and Culture compiled by Victorian Inabuy, et al, there are several differences. In the Science book from the Ministry of Education and Culture, the teaching material for grade 7 begins with Physics concepts in semester one and then Biology concepts in semester 2, while ATP and the grouping of teaching materials made by the author prioritize Biology concepts in semester 1 and concepts -the concept of Physics in semester 2. This is what the writer did because the writer assumed, for grade 7 students were still adapting after switching from elementary to junior high school so if they started with physics concepts with all the calculations of the mathematical formulas it was feared that students would be shocked and experience great difficulties then it will cause a bad impression for students towards science lessons, and consider science as a difficult subject.

Regarding the selection of several learning objectives which the authors consider to be suitable for using the PCTS model there may be differences in some cases and places, the authors believe that this PCTS module still opens the possibility of being developed in various other materials which in the above analysis may not be considered suitable for some learning objectives.[2], [36]–[38]

The difference in interpretation or analysis of CP provided by the Ministry of Education and Culture is a real manifestation of an adaptive curriculum [39]. The Merdeka Curriculum that is currently being rolled out gives each teacher the freedom to analyze and design their subject curriculum structure, This adaptive curriculum will be even more complete if packaged in adaptive learning as well, where learning is organized by taking into account the characteristics and needs learn students. And with this PCTS model where students' critical thinking skills are prioritized, it is hoped that it will be able to improve student learning outcomes, get used to solving various problems they face, and be able to compete internationally.[40]–[42]

It cannot be denied, that the reality on the ground is that there are still many teachers who experience difficulties when they are given the freedom to design their curriculum structure for their subjects through CP analysis into TP and ATP, but this does not need to be something to dampen the spirit of the Indonesian world of education which is currently evolving to make changes for the sake of the realization of a future generation that is competent and globally competitive through continuous and sustainable efforts to improve critical thinking skills.[43]

5 Conclusion

The conclusion that can be drawn from this article is that the Merdeka curriculum shows itself as an adaptive curriculum. The results of the analysis of learning outcomes in the application of PCTS to the implementation of the science curriculum in junior high schools which have been described above, is an alternative design of the phase D science curriculum, namely at the junior high school level.

Over time, this design will likely make changes, improvements, adjustments, or modifications to obtain the best and most appropriate curriculum design according to the characteristics of the needs of students at that time and in that place.

On this occasion the author would like to make several recommendations, namely, 1) the evaluation process in learning has a major influence on the accuracy of the teacher in determining the model and also the formation of student study groups, therefore this needs to be seriously considered by every teacher; 2) the PCTS model is very likely to be applied to other subjects besides the science study field, so it is highly recommended to develop the research results in this article by teachers of other study fields.

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