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RESEARCH ARTICLE

THE DEVELOPMENT OF A COMPUTATIONAL BASED LEARNING MODEL TO IMPROVE COMPUTATIONAL THINKING ABILITY IN PHYSICS LEARNING IN THE SENIOR HIGH SCHOOL

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Abstract

The purpose of this research is to produce a valid Computational Based Learning (CBL) model to improve computational thinking skills. The research design that will be used is the design development of Research and Development Borg & Gall. The results of the validation of the Computational Based Learning (CBL) learning model were carried out by 3 validators with an average score of 90.25% with a very valid category. The results of computational thinking skills have also increased, as evidenced by students being able to identify and decide important things from the data information provided (Abstraction), combine existing physics concepts (Generalization), get formulations from combination results (Decomposition), use computer programs (applications) to represent in graphical form (Alghoritm), and find, identify and fix syntax errors (debugging). Then from the observations made, it was stated that the ability of students to experience a significant increase in scientific literacy and computational thinking after the implementation of the Computational Based Learning (CBL) learning model.

Introduction:-

Physics is a branch of science that has a very large role in the progress of science and technology. Physics is also a subject that can grow students' problem solving abilities [1]. The target of learning physics in the era of the industrial revolution 4.0 towards the era of society 5.0 must pay attention to the characteristics of students according to the challenges of the 21st century. Characteristics of students in the era of the industrial revolution 4.0 which will lead to the era of society 5.0 demands many abilities that must be possessed, especially in problem solving skills [2] and Computational Thinking. Computational Thinking (CT) is a skill that involves the process of 'solving problems, designing systems, and understanding human behavior, by drawing on basic computer science concepts [3]. Computational thinking is also one of the eight practical skills of science and engineering that are essential in the teaching and self-development process of students and along with the development of NGSS [4].

Learning physics according to the revised 2013 curriculum in the era of the industrial revolution 4.0 which will lead to the era of society 5.0 requires students to build and find their own knowledge so that they can solve physics problems and think computationally. Characteristics of students in computational thinking starting from

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abstraction, generalization, decomposition, algorithms, and debugging. One way to improve students' skills related to computational thinking in physics learning in high school is to develop an effective and efficient learning model, in addition to being able to improve computational thinking skills.

Based on the literature review also conducted by Shute et.al., the indicators of computational thinking (Computational Thinking), namely abstraction, generalization, decomposition, algorithms, and debugging [5]. Based on previous research conducted by Wetzel stated that the students' abstraction indicator skills were still lacking. Both Medova et.al also stated that students experienced problems in the algorithm process because on average students made graphs without abstraction so that students had difficulty in associating concepts with actual situations. Furthermore, Tran also stated that students must be able to discuss solving complex problems with debugging and algorithms so as to find optimal solutions and be able to associate concepts with the outside world [6]. In addition, based on research Ridlo et.al also concluded that the ability of students related to abstraction, decomposition, and alghorithm is still low on a Likert scale of 2.2 – 2.4 out of 5 [7].The research objectives are detailed as follows, first to describe a valid Computational Based Learning (CBL) model in improving Computational Thinking abilities in physics learning in high school.

Joyce and Weil suggested that every learning model have elements as following , Systematic is stages activity of that model . System social is situation or prevailing atmosphere and norms in that model . Principle reaction is pattern activities that describe how the teacher should see and treat the participants educate , including how should teacher give response to them . Principle this give instruction how should be teachers use rule game that applies to each model. System supporter is all the necessary means , materials , and tools for do the model . Impact instructional and accompaniment is results learning achieved _ direct with method direct the participants educate on the expected goals . Whereas impact accompaniment is results study others generated by a _ learning as consequence creation atmosphere experience learning _ directly by participants educate without briefing direct from teacher [10].

Following Syntactic Computational Based Learning (CBL) Model, Phase 1 Analyzing of Problems (Analysis problem), at the stage this participant educate analyze problem science given by the teacher. This stage use theory study Cognitive , according to Piaget that the learning process actually consist from three stages , namely : assimilation , accommodation , and equilibration [11]. Phase 2 Finding of Fact, on Step this participant educate by individual find existing facts _ in problem science that has given . This stage using Learning Theory Discovery (Bruner), According to Bruner that activity will study good if student could find alone conclusion from Theory or topics studied [12] . Phase 3 Defining of Idea At stage this participant educate released for disclose opinion or idea about various kinds of solving strategies problem and design design solution problem . Stages this using Kolb 's Learning Theory of pole thinking / thinking is where is the child or participant educate study from results thinking and focus on analysis logical of ideas, systematic planning , and understanding intellectual from situation or things he faces [13].

Phase 4 Modeling (simulation), at stage this participant educate simulate results findings fact with help technology computing like MS. Excel for produce chart connection between variable existing quantity . Stages this using learning theory Cybernetic Landa, Lev N. Landa states that the learning process must be accompanied with processing information good by think algorithmic nor heuristics . Phase 5 Communicating, At stage this participant educate communicate within class . Before participant educate communicating in class , participants send results the simulation online through Google Classroom and participants educate other give comment to results the simulation that has been sent . Stages this based on Learning Theory Constructivist Social , constructivist social review method individual interact with the teacher or participant educate other for build knowledge [14]. Phase 6 Assessment (Assessment) and Strenghning (Consolidation) , at stage this participant educate To do evaluation from his friends and teachers. Then , participants get stabilization right answer and no appropriate from the teacher. Stages this based on learning theory constructivist social also gives opportunity for participant educate for each other evaluate and improve understanding with method disclose ideas and sharing understanding with participant educate other .

System Social System social in the CBL (Computational Based Learning) model is formation capable individual cooperate one with others with condition participant heterogeneous students . Principle Reaction , Principle reaction in the CBL (Computational Based Learning) model, the teacher gives opportunity to each individual for disclose opinion as much as possible with solving strategy problem faced _ In LKS, the teacher functions as an

evaluator and manager learning like guide and evaluate participant Educate / tutor in determine the solution strategy creative problems , Effective and efficient . System Support , all the necessary facilities , materials and tools for implement the learning model . Impact Instructional , Impact direct in the learning model this is could realize destination learning namely : increase ability participant educate in think computing and literacy science. Impact Accompaniment , Impact accompaniment or impact no directly is ability work same between participant educate ; participant average educate could objective To do assessment , criticism , control , give repair between friend .

Methods:-

This type of research is Research and Development (R & D) development research (Sugiyono, 2014). The research development design used in this development research is design (Borg & Gall, 1989), which includes ten steps, namely preliminary study, planning, initial product development, limited test, revision of limited test results, field test / large group test, revision of results. field trials, feasibility tests, revision of the results of the feasibility tests, dissemination and implementation.

The data obtained from the validation results of the CBL (Computational Based Learning) model, syllabus validation sheets, RPP validation sheets, THB validation sheets by experts (lecturers). The data obtained are descriptive and quantitative. Descriptive data comes from suggestions and comments from validators. Quantitative data comes from the assessment of aspects of the assessment using a check-list (√) with the following criteria:Score 1, if the validator gives a bad rating.Score 2, if the validator gives an unfavorable assessment.Score 3, if the validator gives a good rating. And score 4, if the validator gives a very good assessment.The data obtained from the validation results will be analyzed using the percentage data analysis technique.

$$V = \left(\frac{T_{s_e}}{T_{Sh}}\right) \times 100\%$$

Information:

V = Percentage rating level

T_se = Total empirical score obtained

T_sh = Maximum total score (Akbar, 2013)

To analyze the magnitude of the increase from the application of the CBL learning model to student learning outcomes, N-Gain analysis is used.

Results And Discussion:-

This research is a development research that produces new product innovations in the form of learning models. The research instrument has gone through the validation stage by three expert lecturers. The resulting product is a valid Computational Based Learning (CBL) learning model guide book. Based on the literature study that has been carried out, the learning model developed has referred to the learning needs that are tailored to the student's character. The learning model is packaged in the Computational Based Learning (CBL) Learning Model which focuses on being able to improve computational thinking better and more evenly.

The data obtained from the validation results were analyzed to determine the validity of the Computational Based Learning (CBL) learning model. Data validation results by validators can be seen in Table 1.

Table 1:- Computational Based Learning (CBL) Model Validation Results.

No	Rated aspect	Validator Rating (in %)		
		Expert 1	Expert 2	Expert 3
A	**Supporting Theory**			
1	Relevant learning theory to support the ***Computational Based Learning (CBL) Model***in improving critical thinking skills and scientific literacy	100.00	100.00	75.00
Average		100.00	100.00	75.00
category		Very Valid	Very Valid	Valid
B	**Learning Model Structure**			
2	background _developmentmodel declaredclearly (Page 1)	75.00	75.00	100.00
3	The purpose of model development is clearly stated	100.00	100.00	100.00

4	Instructional impact and accompaniment impact inlearning is clearly stated	100.00	100.00	100.00
5	The principles of reaction in learning are statedclearly	75.00	75.00	75.00
6	Social system in learning is expressed byClear	75.00	75.00	75.00
7	Support System in learningdeclaredclearly	100.00	75.00	100.00
8	Approach use learning is statedclearly (Page 15)	100.00	75.00	100.00
9	Learning steps are clearly stated	100.00	100.00	100.00
10	Evaluation and assessment clearly stated	75.00	75.00	100.00
Average		88.89	83.33	94.44
Category		Very Valid	Very Valid	Very Valid

The data in Table 1 shows that the percentage of the validation results of the Computational Based Learning (CBL) learning model for the supporting theory aspect obtained an average of 91.67% and the structural aspect of the learning model obtained an average of 88.89%. The average result of the validation of the Computational Based Learning (CBL) learning model as a whole is 90.25%, the category is very valid so that the learning model can be used.

Table 2:- Data Result of Student Test.

	Total students	Average	N-Gain	Category
Pretest	15	23.20	0.79	Tall
Posttest	15	80.60		

Table 2 shows that the average student test results at the posttest were higher than the students' scores at the pretest. The average pretest of students is 23.24 while the average posttest of students is 64.30. Normalized gain (g) resulted in a score of 0.59 in the medium category.

Computational Based Learning (CBL) learning model can be seen from the validation results by experts on several aspects, including aspects of supporting theory and the desired structure of the learning model. Based on the results of expert validation in Table 4.1, it is known that the highest assessment on the supporting theory aspect is 91.67% very valid category and the lowest assessment is on the structural aspect of the model 88.89% very valid category. The average overall validation result is 90.25% with a very valid category so that it can be used for development tests.

Based on the validation results, the Computational Based Learning (CBL) learning model has a syntax consisting of six stages, namely Phase 1 Analyzing of Problems (Problem analysis) , At this stage students analyze the science problems given by the teacher. This stage uses cognitive learning theory. According to Piaget, the learning process actually consists of three stages, namely: assimilation, accommodation, and equilibration . Phase 2 Finding of Fact, At this stage, students individually find the facts in the given scientific problem. This stage uses Discovery Learning Theory (Bruner). According to Bruner, activities will learn well if students can find their own conclusions from the material or topic being studied. Phase 3 Defining of Idea At this stage students are freed to express opinions or ideas about various problem-solving strategies and design problem-solving designs. This stage uses Kolb's Learning Theory about the thinking pole, which is the pole where children or students learn from the results of their thoughts and focus on logical analysis of ideas, systematic planning, and intellectual understanding of the situation or case they face .

Phase 4 Modeling (simulation) , at this stage students simulate the findings of the facts with the help of computational technology such as MS. Excel to generate a graph of the relationship between the existing quantity variables. This stage uses Landa's cybernetic learning theory, Lev N. Landa states that the learning process must be accompanied by processing information both in algorithmic and heuristic thinking . Phase 5 Communicating , At this stage students communicate in class. Before students communicate in class, participants send their simulation results online via Google Classroom and other students provide comments on the simulation results that have been sent. This stage is based on Social Constructivist Learning Theory, social constructivists review the way individuals interact with teachers or other learners to build knowledge [14]. Phase 6 Assesing (Assessment) and Strenghning (Consolidation) , at this stage students make an assessment of their friends and teachers. Then, participants get confirmation of the right and wrong answers from the teacher. This stage is based on social constructivist learning theory which also provides opportunities for students to evaluate each other and improve their understanding by expressing ideas and sharing understanding with other students.

Social System The social system in the CBL (Computational Based Learning) model is the formation of individuals who are able to cooperate with one another with heterogeneous student conditions. Reaction Principle, The reaction principle in the CBL (Computational Based Learning) model is that the teacher gives an opportunity for each individual to express as much opinion as possible with the problem-solving strategies encountered in the LKS, the teacher functions as an evaluator and learning manager such as guiding and evaluating students/tutors in determining creative, effective and efficient problem solving strategies. Support System, All the facilities, materials and tools needed to implement the learning model . Instructional Impact, The direct impact of this learning model is to be able to realize the learning objectives, namely: increasing students' abilities in computational thinking and scientific literacy . Accompaniment Impact, Accompaniment impact or indirect impact is the ability to cooperate between students; On average, students can objectively assess, criticize, control, and provide improvements between friends .

Conclusion:-

Based on the results of the research that has been done, it can be concluded that the Computational Based Learning (CBL) learning model is valid for physics learning in high school with an average score of 90.25% from three validators with a very valid category.

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