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Development of a Problem Based Learning Oriented Movement System Module with a Computational Thinking Approach to Improve Students' Critical Thinking Skills

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Abstract

The development of a Problem Based Learning-oriented Movement System module with a Computational Thinking approach to improving students' critical thinking skills is one of the efforts to improve this pedagogic competency. The purpose of this research is to analyze the validation of problem-based learning-oriented motion system modules with a computational thinking approach to improve students' critical thinking skills and analyze the feasibility of problem-based learning-oriented motion system modules with a computational thinking approach to improve students' critical thinking skills. This study used a Research and Development (R & D) design and the technique used was a one-shot case study. The research was conducted at MAN Salatiga with 71 research subjects divided into 2 classes. The results of the study are as follows: (1) the assessment by material experts obtained 85.67%, and 76.5% with very good and good criteria, and the assessment by media experts obtained 90% and 92.00% with very good criteria so that the media declared valid. The value obtained from students who used the module and then worked on critical thinking questions obtained an average value of 92.69 after being analyzed based on the predetermined Minimum Mastery Criteria (KKM). KKM value determined namely 75. The test results showed 98.59% of students passed the very high category, so it can be stated that the use of the Movement System module oriented to Problem Based Learning with Computational Thinking is approachable to improve students' critical thinking skills.

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INTRODUCTION

According to Law No. 14 of 2005, there are 4 teacher competencies namely pedagogic competence, professional competence, personal competence, and social competence. Some matters relating to pedagogical competence include the application of learning models, learning methods, learning resources, strategies and approaches used during the learning process in the classroom, and so on. Student-centered or student-centered learning needs to be implemented so that learning objectives can be achieved optimally. The development of information and communication technology in the 4.0 era also requires teachers to immediately implement the 2013 curriculum that has been designed by the government. The 2013 curriculum mandates teachers to apply 6 C skills (Critical, Creative, Communicative, Collaboration, Compassion, and Computational Thinking) as well as higher-order thinking skills (HOTS). The Problem Based Learning model is one of the learning models mandated by the 2013 curriculum.

The problem-Based Learning model is Problem Based Learning Model or Problem Based Learning (PBL) is a learning model that uses real problems in everyday life as a learning context for students to think about critical thinking skills and problem-solving skills (Problem Solving) as well as to acquire knowledge, facts, principles, and concepts that are the essence of the subject matter while Computational Thinking (CT) is a problem-solving method based on informatic logic like a computer machine, namely formulating complex problems to be simple and can be solved quickly, effectively. efficient, communicative, and collaborative. There are four key techniques in Computational Thinking, namely Decomposition (breaking larger and more complex problems) into smaller or simpler parts, (Kawuri et al., 2019)The application of Computational Thinking (computational thinking) can improve students' critical thinking skills. Learning the Problem Based Learning model will motivate students to think critically because when learning the syntax conditions students to discuss issues related to everyday life in society. This was disclosed (Saputro & Rayahu, 2020) in their research on the differences between the Project Based Learning (PjBL) model and the Problem Based Learning (PBL) model on students' critical thinking skills, both of which affect students' critical thinking abilities.

Motion Systems is the material for Biology Class XI specializing in Science, this material discusses Motion Systems with the following basic competencies: Analyzing the relationship between the structure of the organ-composing tissue in the locomotion system concerning bioprocesses and functional disturbances that can occur in the human locomotion system. This material is more abstract and sometimes causes misconceptions, so it is difficult for students to understand, this is indicated by the low value of the Motion System Material which is always below the Minimum Competency Criteria (KKM) so there is a need for an appropriate learning model so that learning objectives can be achieved properly and able to improve student achievement.. The Problem Based Learning learning model with the Computational Thinking approach is tried to be applied in class so that the learning objectives of the motion system material can be achieved and also able to improve students' critical thinking skills(Paul & Elder, 2014)

METHOD

This research is research and development or Research and Development (R&D). Educational development research (R&D) is a process used to develop and validate educational products. The results of development research are not only the development of an existing product but also to find of knowledge or answers to practical problems(Borg and Gall). The process of learning activities is carried out by applying the Motion System Module oriented to Problem Based Learning with a Computational Thinking approach to improve students' critical thinking skills. The research aims to analyze the validity and feasibility of the Movement System module oriented to Problem Based Learning with the Computational Thinking approach to the Motion Systems material to improve the critical thinking skills of class XI MIPA students. The research was conducted at MAN Salatiga. The research was conducted at MAN Salatiga with 71 research subjects divided into 2 classes. Implementation technique used in this research is a one-shot case study.

Table 1. One Shot Case Study Model

Sample	The treatment given	Results
Experiment Class	X	O

The validation of the Movement System Module has oriented to Problem Based Learning with a Computational Thinking approach to improving critical thinking skills and the feasibility test index value of teaching materials qualitatively according to Sugiyono (2015).

Table 2. Feasibility of teaching materials *M-learning (Mobile Motion)* android based

No	range	Criteria
1	81.25% < Validation Value ≤ 100%	Very valid
2	62.5% < Validation Value ≤ 81.25 %	Valid
3	43.75% < Validation Value ≤ 62.5%	Less valid
4	25% < Validation Value ≤ 43.75%	Invalid

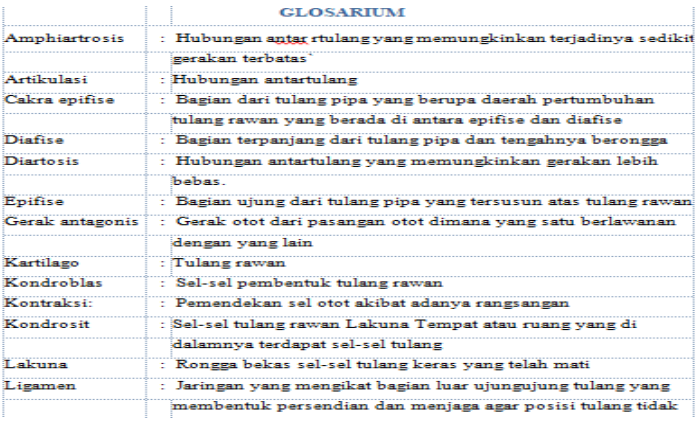
RESULTS AND DISCUSSION

Critical thinking skills are one of the skills of the 21st century. These skills are skills mandated by the 2013 curriculum. Teachers as educators are the key to educational success. Pedagogic competence is one of the competencies that must be mastered by teachers. Pedagogic competence relates to the learning process in the classroom. Learning models, learning methods, strategies, and learning approaches must be understood by teachers so that learning objectives are easily achieved. The Problem Based Learning model is a learning model that can improve critical thinking skills (Criticize Creative, Collaboration, Communication, Compassion, and Computational Thinking / 6C).(Kawuri et al., 2019) (Darise, 2019).

The result of this research is the development of a Problem Based Learning-oriented Movement System module with a Computational Thinking approach containing motion system material by incorporating problems in everyday life that are solved through computational thinking (Computational Thinking) in the evaluation questions.

The front cover page (cover), introduction, glossary, and learning materials 1, 2, and 3 can be seen in the image below.

Figure 1. Front cover page (Cover)



GLOSARIUM

Amphiartrosis	: Hubungan antar rtulang yang memungkinkan terjadinya sedikit gerakan terbatas
Artikulasi	: Hubungan antartulang
Cakra epifise	: Bagian dari tulang pipa yang berupa daerah pertumbuhan tulang rawan yang berada di antara epifise dan diafise
Diafise	: Bagian terpanjang dari tulang pipa dan tengahnya berongga
Diartosis	: Hubungan antartulang yang memungkinkan gerakan lebih bebas.
Epifise	: Bagian ujung dari tulang pipa yang tersusun atas tulang rawan
Gerak antagonis	: Gerak otot dari pasangan otot dimana yang satu berlawanan dengan yang lain
Kartilago	: Tulang rawan
Kondroblas	: Sel-sel pembentuk tulang rawan
Kontraksi:	: Pemendekan sel otot akibat adanya rangsangan
Kondrosit	: Sel-sel tulang rawan Lakuna Tempat atau ruang yang di dalamnya terdapat sel-sel tulang
Lakuna	: Rongga bekas sel-sel tulang keras yang telah mati
Ligamen	: Jaringan yang mengikat bagian luar ujungujung tulang yang membentuk persendian dan menjaga agar posisi tulang tidak

Figure 2. Glossary page

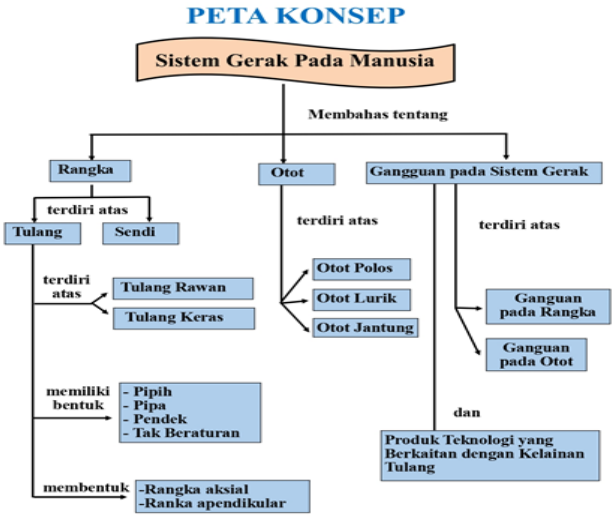
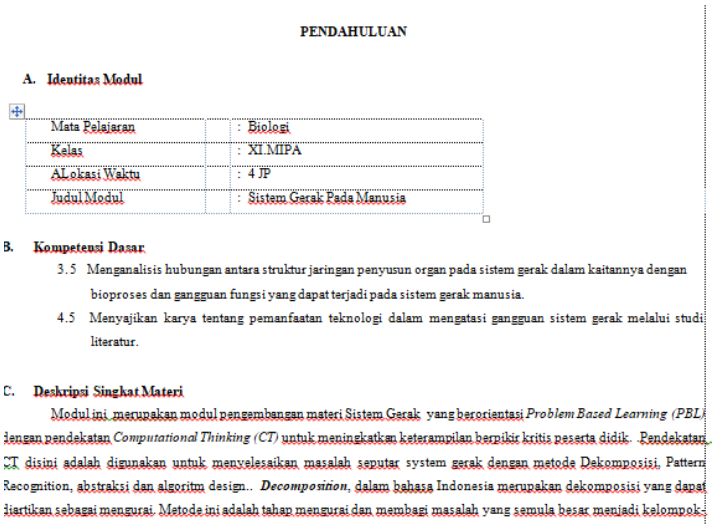


Figure 3. Concept map page



PENDAHULUAN

A. Identitas Modul

Mata Pelajaran	: Biologi
Kelas	: XI MIPA
ALokasi Waktu	: 4 JP
Judul Modul	: Sistem Gerak Pada Manusia

B. Kompetensi Dasar

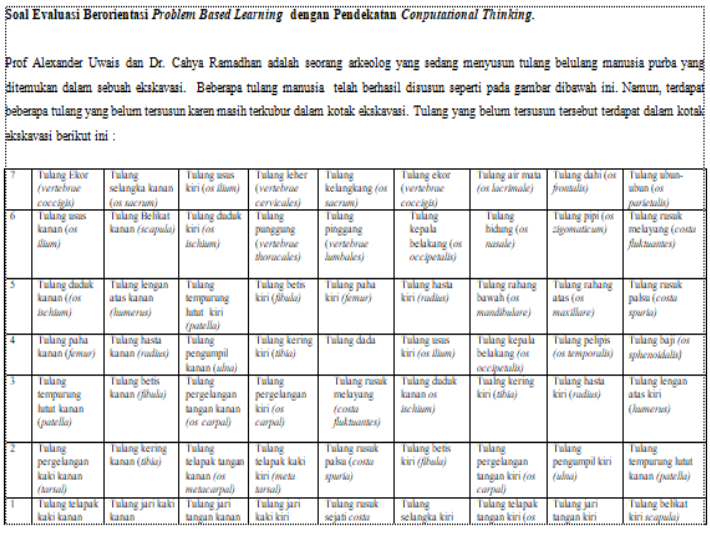
3.5 Menganalisis hubungan antara struktur jaringan penyusun organ pada sistem gerak dalam kaitannya dengan bioproses dan gangguan fungsi yang dapat terjadi pada sistem gerak manusia.

4.5 Menyajikan karya tentang pemanfaatan teknologi dalam mengatasi gangguan sistem gerak melalui studi literatur.

C. Deskripsi Singkat Materi

Modul ini merupakan modul pengembangan materi Sistem Gerak yang berorientasi *Problem Based Learning (PBL)* dengan pendekatan *Computational Thinking (CT)* untuk meningkatkan keterampilan berpikir kritis peserta didik. Pendekatan CT disini adalah digunakan untuk menyelesaikan masalah seputar system gerak dengan metode Dekomposisi, Pattern Recognition, abstraksi dan algoritm design.. ***Decomposition***, dalam bahasa Indonesia merupakan dekomposisi yang dapat diartikan sebagai mengurai. Metode ini adalah tahap mengurai dan membagi masalah yang semula besar menjadi kelompok-

Figure 4. Introduction page



Soal Evaluasi Berorientasi *Problem Based Learning* dengan Pendekatan *Computational Thinking*.

Prof Alexander Uwais dan Dr. Cahya Ramadhan adalah seorang arkeolog yang sedang menyusun tulang belulang manusia purba yang ditemukan dalam sebuah ekskavasi. Beberapa tulang manusia telah berhasil disusun seperti pada gambar dibawah ini. Namun, terdapat beberapa tulang yang belum tersusun karen masih terkubur dalam kotak ekskavasi. Tulang yang belum tersusun tersebut terdapat dalam kotak ekskavasi berikut ini :

7	Tulang Ekor *(vertebrae coccigis)*	Tulang selangka kanan *(os sacrum)*	Tulang usus kiri *(os illum)*	Tulang leher *(vertebrae cervicales)*	Tulang kelangkang *(os sacrum)*	Tulang ekor *(vertebrae coccigis)*	Tulang air mata *(os lacrimale)*	Tulang dahi *(os frontalis)*	Tulang ubun-ubun *(os parietalis)*
6	Tulang usus kanan *(os illum)*	Tulang Belikat kanan *(scapula)*	Tulang duduk kiri *(os ischium)*	Tulang punggung *(vertebrae thoracales)*	Tulang pinggang *(vertebrae lumbales)*	Tulang kepala belakang *(os occipetalis)*	Tulang hidung *(os nasale)*	Tulang pipi *(os zigomaticum)*	Tulang rusuk melayang *(costa fluktuantes)*
5	Tulang duduk kanan *(os ischium)*	Tulang lengan atas kanan *(humerus)*	Tulang tempurung lutut kiri *(patella)*	Tulang betis kiri *(fibula)*	Tulang paha kiri *(femur)*	Tulang hasta kiri *(radius)*	Tulang rahang bawah *(os mandibulare)*	Tulang rahang atas *(os maxillare)*	Tulang rusuk palsu *(costa spuria)*
4	Tulang paha kanan *(femur)*	Tulang hasta kanan *(radius)*	Tulang pengumpil kanan *(ulna)*	Tulang kering kiri *(tibia)*	Tulang dada	Tulang usus kiri *(os illum)*	Tulang kepala belakang *(os occipetalis)*	Tulang pelipis *(os temporalis)*	Tulang baji *(os sphenoidalis)*
3	Tulang tempurung lutut kanan *(patella)*	Tulang betis kanan *(fibula)*	Tulang pergelangan tangan kanan *(os carpal)*	Tulang pergelangan kiri *(os carpal)*	Tulang rusuk melayang *(costa fluktuantes)*	Tulang duduk kanan *os ischium)*	Tualng kering kiri *(tibia)*	Tulang hasta kiri *(radius)*	Tulang lengan atas kiri *(humerus)*
2	Tulang pergelangan kaki kanan *(tarsal)*	Tulang kering kanan *(tibia)*	Tulang telapak tangan kanan *(os metacarpal)*	Tulang telapak kaki kiri *(meta tarsal)*	Tulang rusuk palsu *(costa spuria)*	Tulang betis kiri *(fibula)*	Tulang pergelangan tangan kiri *(os carpal)*	Tulang pengumpil kiri *(ulna)*	Tulang tempurung lutut kanan *(patella)*
1	Tulang telapak kaki kanan	Tulang jari kaki kanan	Tulang jari tangan kanan	Tulang jari kaki kiri	Tulang rusuk sejati *costa*	Tulang selangka kiri	Tulang telapak tangan kiri *(os*	Tulang jari tangan kiri	Tulang belikat kiri *scapula)*

Figure 5. Example of Computational Thinking questions to improve critical thinking skills

The validation carried out by material experts aims to analyze the feasibility of the content of the material or content in the module so that the researcher gets input which will later be used as teaching material so that the developed module is better and feasible for teaching materials in biology learning.

Table 3. Feasibility test of teaching materials by material experts

Validation	Presentation Results	Criteria
Validators 1	85.6 %	Very Good (Very Valid)
Validators 2	76.5 %	Good (Valid)

The feasibility test of teaching materials was validated by 2 validators. Validation by material experts I got a presentation value of: 85.6%% and validation from material experts II got a presentation value of: 76.5%, in a good category. This shows that the content of the material contained in the motion system module is oriented to Problem Based Learning with a Computational Thinking approach to improve critical thinking skills that can be used by students in the learning process.

The Movement System Module has oriented to Problem Based Learning with a Computational Thinking approach to improving critical thinking skills that are developed before being used and must be validated by media experts. Validation by media experts includes several indicators: Graphical Feasibility, media components, and Language Feasibility. The results of the validation by alhl media are presented in table 4:

Table 4. Feasibility test of teaching materials by Media Experts

Validation	Presentation Results	Criteria
Validators 1	93.9 %	Very Good (Very Valid)
Validators 2	92.8 %	Very Good (Very Valid)

Based on the validation results, the results of validation by media experts I get a presentation value: of 93.9%, and validation from media experts II get a presentation value: of 92.8%, this shows that the module developed has a high presentation, meaning that the module is very good or valid. PBL-oriented modules with the CT approach can be used by students because the aspects of graphic feasibility, learning media components, and language feasibility have been met. The results of the validation by the media experts above obtained an average score above 10, so if you look at the table of criteria, the PBL-oriented module with the CT approach is included in the "Decent" category.

Critical thinking ability tests are carried out by the way the researcher provides material in advance according to the indicators that must be achieved by students after completion, the researcher gives questions that refer to indicators of critical thinking ability, questions that are given to students in the form of computational thinking questions (CT) which later students can solve these problems according to indicators of critical thinking skills. The questions were given to 2 classes consisting of 71 students, the critical thinking skills given were in PBL oriented module with a CT approach so that students can solve problems by thinking computationally (CT)

Table 5. Percentage of critical thinking skills test results

Description	Amount	Percentage
Completed students	70	98.6%
Unfinished students	1	1.4 %

Based on table 5. the results of the critical thinking ability test show the suitability between the purpose of using the PBL-oriented motion system module with the CT approach and the learning objectives, which is shown by the student's completeness which is more than 75%, namely 98.6%. learners able to use mAnalyzing and solve problems encountered daily.

The use of the PBL-oriented motion system module with the CT approach to improving students' critical thinking skills has a very good effect as shown by the results of the percentage of students' completeness in working on critical thinking ability test questions.

This study has several limitations, starting from the limited number of samples, so researchers must use research methods that are suitable for the number of samples available. The implementation of the research was constrained because of school activities, namely the election of the OSIS chairman so the implementation of the pre-test and post-test was not conducive because the supervision of the

implementation of the test was not optimal. The next problem is that there are several inputs from the validator lecturer regarding the existence of a trigger question so that there is a case study of the problem that must be resolved.

CONCLUSION

Module eligibility problems-Based Learning-oriented motion system with a Computational Thinking approach to improving students' critical thinking skills, media experts and material experts declared valid and suitable for the learning process in class XI by media experts

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