The International Seminar on Bioscience and Biological Education
IOP Conf. Series: Journal of Physics: Conf. Series 1241 (2019) 012039
doi:10.1088/1742-6596/1241/1/012039

Development of Bio-Monopoli of Human Musculoskeletal System as Learning Media for High School Students

R N Suwarno¹ and Suratsih²

¹,²Department of Biology Education, Faculty of Mathematics and Science, Yogyakarta State University

¹nuryanirika5797@gmail.com, ²suratsih@uny.ac.id

Abstract. The purpose of this study are: (1) to develop Bio-Monopoli, an educational game as learning media of Human Musculoskeletal System topic for High School students; (2) to find out the appropriateness of the Bio-Monopoli; and (3) to identify whether there is any difference in student's learning motivation pra-experimental and post-experimental using Bio-Monopoli. This was a ‘Research and Development’ (R & D) study referring to 10 Borg & Gall’s stages (1983). The study’s subjects are theorist, Biology teacher, media experts, and students of XI IPA of MAN 1 Sleman. Data collected by purposive random and incidental sampling technique using questionnaire. The data of the media’s appropriateness were analyzed descriptively. The data of student’s learning motivation were analyzed by Wilcoxon Signed Rank Test and N-gain calculation. The result shows that Bio-Monopoli is very good and effective according to the respondents based on media engineering, visual communication, and learning aspect. There is a significant difference of student’s learning motivation pra- and post-experimental using Bio-Monopoli. Learning motivation’s increase included in moderate criteria with 0.424 in N-gain score.

Keywords: Bio-Monopoli, learning motivation, Human Musculoskeletal System

1. Introduction

Education is an important world that cannot be separated from human life. The line is believed to be able to create educated and wise people who always develop in a positive line. Innovation in lessons is needed in the education. This is important for advancing the quality of education that not only emphasizes theory, but also must be directed at practical matters so that students become excited, have the motivation to learn, and are enthusiastic in welcoming lessons at school.

Learning is a process of behavior change as a result of interaction with the environment so that experience and learning outcomes are more meaningful [4]. Learning is also said to be a system because it has components that are interrelated with each other in order to achieve the stated goals. The component consists of objectives, topics and materials, methods, media and also evaluation. All components are interrelated and become an integral part of achieving learning success. Learning success is very much influenced by many of these factors and components, and one of them is the use of learning media.

Learning media is an important tool that is inseparable from the teaching and learning process in order to achieve educational goals [1]. Learning media is used in order to streamline communication and interaction between teachers and students in learning [13]. The use of learning media must be appropriate to facilitate learning or increase students' understanding of learning topics [14]. Facts on
the ground show that it is difficult for a teacher to choose the best media among the many available media. There was many studies on the effectiveness of various media, but there wasn’t many of them have explained their ability on certain learning situations. There is also no strong theoretical basis that determines what media is most suitable for certain learning topics. Every educational tool has its merits and shortcomings, but all can provide assistance according to the character of each.

Based on the results of interviews with Biology teachers and observations made by researchers in MAN N 1 Sleman, information was obtained that learning media was still rarely used in school learning. The Biology learning process in the classroom is more inclined to use the Leatoring method by the teacher. Whereas such learning causes the conditions of learning in the classroom to be not conducive. Students who do not understand the material presented by the teacher are finally crowded and passive in class, so they are not interested in participating in classroom learning. The majority of students lack high learning motivation in the Biology lesson of Human Musculoskeletal System.

Moreover, as we know, this Biology lesson contains various terms that are not easily understood. Likewise with the Human Musculoskeletal System which has been listed in the High School Biology subject for 2nd years students in accordance with the 2013 curriculum. There are Basic Competencies concerning [5]:

"Analyzing the relationship between the structure of the organ constituent tissue in the motion system and linking it with the bioprocess so that it can explain the mechanism of motion and function disturbances that may occur in the Human Musculoskeletal System through literature studies, observations, experiments, and simulations".

This material has characteristics including: organ structure and function using Latin which is difficult to remember; discuss complicated processes to understand; and involving various organ systems in carrying out their functions. It is not surprising that many students consider the subject matter of the Human Musculoskeletal System difficult to master due to these characteristics. The teacher revealed that only about 40% of students were active in learning and the rest just chatted, daydreaming, doing other tasks, even disturbing their friends. This has an impact on students's cognitive learning outcomes which are far below the KKM over the past few years, especially in bone and skeletal topics.

Based on these problems, one of the efforts that can be done to overcome these problems is to develop innovative learning media to increase student activity in learning activities, so that it is expected to bring about a more meaningful learning atmosphere. One solution is the need to develop educational game media. Educational games or *permainan edukatif* are games related to education. This is supported by research conducted by Rohwati (2012) that the use of educational games in theory and empirically in learning can improve student learning outcomes and activities [8]. One educational game media that can be used as an interesting and fun learning is a monopoly. Monopoly games are chosen because they include a game that is popular with children and easy to play. Monopoly is a medium that can train student's memory in mastering the learning topics, train and encourage the courage of students to express their opinions, and train mastery of concepts and understanding of learning topics [15].

A research results show that learning using monopoly as learning media is more effective than conventional learning methods called leatoring methods [12]. The results of Cahyaningrum's research in a journal entitled “Pengembangan Media Monopoli Smart Science Seri Interaksi Makhluk Hidup Dengan Lingkungan Berpendekatan Saintifik pada Siswa SMP” said that the classical completeness of students reached 100% which proved the effectiveness of monopoly smart science as learning media when used by students during the process learning [2]. Another study conducted by Lestari entitled “Pengembangan Media Pembelajaran Mochi Materi Reaksi Redoks pada Siswa Kelas X SMA Negeri di Pontianak”, was able to prove that the use of monopoly games gave positive results for increasing learning activities and student learning outcomes [6].

This study aims to: (1) develop *Bio-Monopoli*, an educational game as learning media of Human Musculoskeletal System topic for 2nd years students of science and mathematics programme; (2) find out the appropriateness of the *Bio-Monopoli*; and (3) identify whether there is any difference in
student's learning motivation pre-experimental and post-experimental using Bio-Monopoly. Based on the problems above, researchers conducted research "Development of Bio-Monopoly of Human Musculoskeletal System as Learning Media for High School Students"

2. Research Method
This research was designed as a research development (R&D) using Borg & Gall’s model.

2.1. Population and Sample
Population of this research was all 2nd years students of science and mathematics programme in MAN 1 Sleman (69 students). Some of them became subject of this research divided into three stages that are 3 students in preliminary field testing, 9 students in operational field testing, and 30 students in main field testing [11].

2.2. Development of learning media
Development of Bio-Monopoly was done by using Borg & Gall (1983) model which consisted of 10 stages that are: (1) research and information collecting; (2) planning; (3) develop preliminary form of product; (4) preliminary field testing; (5) main product revision; (6) main product revision; (7) operational product revision; (8) operational field testing; (9) final product revision; and (10) dissemination and implementation. Bio-Monopoly was applied had valid on validity test by expert judgement [11].

2.3. The instruments, data collection techniques, and data analysis techniques
The data collected by questionnaires form included two types of data, namely qualitative and quantitative data. Qualitative data in this study data on the process of developing Bio-Monopoly in the form of criticism and suggestions from media experts and experts of the topics. Quantitative data in the study is the main data that consist of: (1) data on the appropriateness assessment of Bio-Monopoly for learning media on Human Musculoskeletal System topic from experts of the topic, media experts, and 2nd year students of science and mathematics programme in MAN 1 Sleman, and (2) data on student’s learning motivation pre-experimental and post-experimental using Bio-Monopoly.

This questionnaire was used to obtain data from media experts, topic experts-lecture and teacher, and students as an evaluation for the Bio-Monopoly developed. The appropriateness data of Bio-Monopoly as a learning media and student’s learning motivation collected using a Likert scale with 4 categories. Data collection was carried out using purposive random and incidental sampling techniques. Qualitative data analyzed with descriptive analysis. Quantitative data analysis was carried out with different analysis.

2.3.1. Analysis of appropriateness of Bio-Monopoly
Data obtained from topic experts, media experts, and main field testing based on questionnaire sheets were analyzed using descriptive analysis techniques. The steps of analyzing the data are carried out [11]: (a) calculating the average score of each aspects, (b) converting the score to an ideal assessment criteria in four scales, (c) determining category based on four scales below.

| Average Score | Category   |
|---------------|------------|
| $X \geq 3.25$ | Very Eligible |
| $3.25 < X \leq 2.5$ | Eligible |
| $2.5 < X \leq 1.75$ | Poor |
| $1.75 > X$ | Very Poor |

2.3.2. Analysis of Students’s Learning Motivation Data
Students’s learning motivation data obtained that was converted from qualitative data into quantitative scores. Its analyzed using inferential statistics to determine whether there is any differences in
student's learning motivation before and after using "Bio-Monopoly". The next step, researchers calculated the increase in student learning motivation with the normalized gain (N-gain) formula. Normalized gain formulas used was [3]:

\[
\text{Standard Gain } <g> = \frac{\bar{X}_1 - \bar{X}_0}{\bar{X}}
\]

Information:
\( \bar{X}_1 \) = student learning motivation after learning
\( \bar{X}_0 \) = student learning motivation before learning
\( \bar{X} \) = maximum score

The Standard Gain value obtained from the calculation results was interpreted according to Table 2.

| \(<g>\) | Category |
|---------|----------|
| \(g \geq 0.7\) | High |
| \(0.7 < g \leq 0.3\) | Medium |
| \(0.3 > g\) | Low |

3. Results and Discussion

3.1. Development Bio-Monopoly as Learning Media

The first step is planning related to the determination of topic, subtopics and materials. The topic choosed was Human Musculoskeletal System topic and it was reviewed in accordance with the 2013 curriculum currently in effect. Researchers used book guidelines used by schools. The questions on the question card also were made in accordance with the standard competencies and basic competencies contained in the syllabus of the Human Musculoskeletal System topic for class XI SMA/MA.

The final result in this research and development is the educational game Bio-Monopoly as learning media of Human Musculoskeletal System topic for students of class XI IPA SMA/MA. The development of this product has been through the validation stage of topic experts, media experts, preliminary field testing, operational field testing, and main field testing. Based on the results of the preparation and improvements that have been made, the final product obtained from the modification of the monopoly game in general can be seen in Figure 1 and Figure 2 below.

![Figure 1. Supporting tools for the game Bio-Monopoly.](image-url)
These game tools consist of: a game board is equipped with plots of "Latin/Indonesian name for each bone on Human Skeletal"; game pieces 4 pieces; 2 pieces of dice; miniature of house & hotel (plastic material); 1 set of “Kartu Soal” or Question cards that contains questions and answers about the Human Musculoskeletal System topic for the students; 1 set of “Dana Umum” or General Fund cards; 1 set of “Kesempatan” or Opportunity cards; bone ownership certificates; and set game money as a value.

The media Bio-Monopoli is seen as appropriate based on expert judgment and student responses. Data from the assessment by experts can be seen from Figure 3 below.
Based on the graph above, it can be seen that the Bio-Monopoli is very good in terms of learning aspects and media aspects because the final average is greater than 3.25 according to figure 4. Data on student responses to the media Bio-Monopoli can be seen in the figure 4 below.

![Average results of Student Responses to “Bio-Monopoli”](image)

**Figure 4.** Average results of student responses to Bio-Monopoli.

Based on the graph above as well as the assessment guidelines above, the Bio-Monopoli is very eligible in all three aspects with a final average greater than 3.25. The Bio-Monopoli generally gets a positive response from students.

If studied further based on the findings in each test, this learning media has the following advantages. Bio-Monopoli can increase students's learning motivation in Human Musculoskeletal System topic especially on Skeletal and Bones to overcome students's boredom in monotonous learning. It can also familiarize students with the names of bones and other subtopic with the “learning while playing” concept so that it is more interesting. Bio-Monopoli can be used many times. This educational game creates interactivity for its users. Each player (students) can interact with each other, listen to each other, see, read, and practice with fun activities. Bio-Monopoli adapted various forms and ways to foster learning motivation in accordance with Sardiman, including giving numbers, prizes, competition, ego-involvement, knowing results, praise, punishment, desire for learning, interest, and recognized goals [10].

In addition to its advantages, research and development of educational game Bio-Monopoli cannot be separated from the existence of limitations. The limitations of the developing include: (1) the development is limited to Human Musculoskeletal System topic; (2) Bio-Monopoli does not discuss full of materials lesson, but only provides discussion about the practice of the question on “Kartu Soal”, maps of names of bones, and joints that are often less familiar to students; and (3) it was developed more based on the problems in MAN 1 Sleman.

### 3.2. Appropriateness of Bio-Monopoli as Learning Media

The appropriateness of learning media was obtained based on the assessment of topic experts, media experts, and students in each test. Appropriateness assessment includes three aspects, namely media engineering aspects, visual communication aspects, and learning aspects. The results of students's responses to preliminary field testing, operational field testing and main fields testing also determined the appropriateness of the learning media that had been developed. The students's response are still in the form of scores and need to be converted into grades with four categories with the conversion guidelines in table 1. After calculating the average score, the score is 68.20 out of 20 indicators. Based on table 2, this number exceeds 65.00, so that it falls into the "Very Eligible" category.
3.3. Students's Learning Motivation
Media in education is anything that can be used to deliver messages from the sender (teacher) to the recipient (students) so that it can stimulate students' thoughts, feelings, attention, and interests in such a way that the teaching and learning process can happen [9]. There are several practical benefits of using learning media for the teaching and learning process [1]. One of these benefits is that it can improve and direct students' attention. This can lead to student learning motivation, direct interaction between students and their environment, and the possibility of students to learn independently according to their abilities and interests.

Before analyzing the different test data, the normality test and variance test are done first. After testing for normality with the SPSS ver. 23. The result shows that the probability value is 0.016 and less than 0.05. This result means that H₀ is rejected and H₁ is accepted so that it is known that the data is not normally distributed.

The results of the calculation of the normality test showed that the data was not normally distributed, so the non-parametric difference test was used, namely the Wilcoxon Signed Rank Test using SPSS version 23. After that, the results of the analysis were as follows.

**Table 3. Results of Tests for Different Motivation of Students Before and After the Use of Bio-Monopoli with the SPSS version 23 program.**

| Null Hypothesis | Test | Sig. | Decision |
|-----------------|------|------|----------|
| The median of differences between pre and post equals 0. | Related-Samples Wilcoxon Signed Rank Test | .000 | Reject the null hypothesis. |

Asymptotic significances are displayed. The significance level is .05.

From the results of the analysis above, it is known that the probability value is 0.00. This value is less than 0.05 so that the conclusion is that H₀ is rejected and H₁ is accepted. That is, there are significant differences between students' motivation before and after using the Bio-Monopoli media in learning.

If the N-Gain value is calculated as explained in the data analysis, the result is 0.424. In accordance with table 3 regarding the standard Gain Value, increasing student motivation pre and post-experimental using Bio-Monopoli is included in the "Medium" classification.

The results of this study shows that Bio-Monopoli can improve and direct children's attention. This can lead to student learning motivation. Students can interact directly with their environment and can learn independently according to their abilities and interests. This is also in accordance with the theory put forward by Indriana which states that students will be more aroused and motivated to learn better if the media used to support students' interests and desires and facilitate them in learning effectively and efficiently [4].

4. Conclusion
Based on the research and development that has been carried out, it can be concluded that: Bio-Monopoli as new learning media of Human Musculoskeletal System was developed referring to 10 Borg & Gall’s stages (1983). It had been reviewed from the media engineering aspects, visual communication aspects, and learning aspects based on topic experts assessment, media expert, and the responses of MA students in the entire development stage are included in the categories "Very Good" and "Very Eligible". There is a significant difference between students's learning motivation of Human Musculoskeletal System topic especially on Skeletal and Bones before and after using Bio-Monopoli with a significance value of 0.00. The increase of students's learning motivation is included in the "Medium" criteria with the N-Gain value of 0.424.
Acknowledgement
This research would not have been possible without participation and super support of my advisor. I would like to thank him so much. I would like to thank MAN 1 Sleman which has given me permission to conduct this research.

Reference
[1] Arsyad, A 2011 Media Pembelajaran Edisi revisi (Jakarta: PT Raja Grafindo Persada) p 3
[2] Cahyaningrum, et al 2015 Pengembangan Media Monopoli Smart Science Seri Interaksi Makhluk Hidup dengan Lingkungan Berpendekatan Saintifik pada Siswa SMP. Unnes Science Education Journal 4(2)
[3] Hake dan Richard R 1999 Analyzing Change/ Gain Scores. http://www.physics.indiana.edu/~sdi/AnalyzingChange-Gain.pdf
[4] Indriana, D 2011 Ragam Alat Bantu Media Pengajaran (Yogyakarta: Diva Press) p 46
[5] Kemendikbud 2013 Peraturan Pemerintah RI Nomor 69, Tahun 2013, Topics: Kompetensi Dasar Materi Sistem Gerak pada Manusia dalam Mata Pelajaran Biologi SMA untuk kelas XI Kurikulum 2013
[6] Lestari, I 2014 Pengembangan Media Pembelajaran Mochi Materi Reaksi Redoks Siswa Kelas X SMA NEGERI DI Pontianak. Jurnal Pendidikan dan Pembelajaran. 3(12).
[7] Mardapi, D 2017 Pengukuran, Penilaian, dan Evaluasi Pendidikan (Edisi Revisi). Yogyakarta: Parama Publising.
[8] Rohwati, M 2012 Penggunaan Education Game untuk Meningkatkan Hasil Belajar IPA Biologi Konsep Klasifikasi Makhluk Hidup. Jurnal Pendidikan IPA Indonesia. 1(1):75-81.
[9] Sadiman, A. S., et al 2011 Media Pendidikan, Pengertian, Pemanfaatan, dan Pengembangannya (Jakarta: PT. Raja Grafindo Persada) p 46
[10] Sardiman A. M 2011 Interaksi dan Motivasi Belajar Mengajar (Jakarta: Grafindo Persada) p 92-95
[11] Setyosari, P 2012 Metode Penelitian Pendidikan dan Pengembangan (Jakarta: Kencana) p 215-225
[12] Susanto, A., Raharjo, Muji S. R 2012 Permainan Monopoli sebagai Media Pembelajaran SubMateri Sel pada Siswa SMA Kelas XIIPA. Jurnal Pendidikan Biologi. Volume 1 No.1.
[13] Wati, E. R 2016 Ragam Media Pembelajaran (Jakarta: Kata Pena) p 3
[14] Wena, L. A 2009 Pengembangan Perangkat Pembelajaran IPA SMP Berbasis Kooperatif Tipe STAD pada Tema Fotosintesis di SMPGiki-3.UNESA.E-Jurnal. 1
[15] Vikagustanti, et.al 2014 Pengembangan Media Pembelajaran Monopoli IPA Tema Organisasi Kehidupan Sebagai Sumber Belajar Untuk Siswa SMP.Unnes Science Education Journal 3 (2) (2014) ISSN 2252-6617.