The development of textbook based on brain-based learning (BBL) in material organization system of life for the junior high school science

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Abstract. This study aims to develop textbooks on Brain-Based Learning in Materials Organization of Life for the Junior High School. 92.8% of 70 students from Tenth Junior High School said need an interesting picture book, 92.8% of 70 students require illustrative images that support the material, and 89.9% said need a book that helps remember long-term. The purpose of this study is to obtain a development process and textbook based on Brain-Based Learning (BBL) that Effectiveness for The Students Junior High School in science learning. Method tools are using mnemonic, comic strips, songs and images. This research was conducted in MT’s Nurul Huda Banyuwangi with research subjects of class VII A in the academic year 2019/2020. The type of this research is (research and development), using 4-D model Thiaagarajan, but only used 3 stages define, design, and develop. The technique of collecting data is by collecting test methods, teachers’ interview, questionnaire for teachers and students, and observation. The data analysis technique consists of effectiveness analysis by using N-gain and learning retention. The results shows that 31 students experienced an increase in learning outcomes from the low to the good category. Effectiveness can be seen from the difference in the pre-test and post-test in the N-gain test with 0.77 which indicates a high category. Retention results were obtained based on analysis of learning retention at 93.25 with a high category.

1. Introduction
The presence of the Industrial Revolution 4.0 is the development of increasingly sophisticated technology that can affect the way of thinking, behaving, and changing the character of students [1]. This can affect the world of education and learning. 21st Century learning emphasizes the importance of learning that embraces high order thinking skills or abbreviated as Higher Order Thinking of Skills (HOTS) [2]. Thus, innovation in education becomes a very important requirement [3]. Besides that good learning also emphasizes active students. Science education is also oriented towards a scientific approach. One way that can be used to deal with the advancement of science and technology is textbooks [4]. The main learning resources that can be used by teachers in the learning process are books [5].

The result students need assessment said 92.8% of 70 students from 10 Junior High School said need an interesting picture book, 92.8% of 70 students require illustrative images that support the material, and 89.9% said need a book that helps remember long-term. Therefore, they need a textbook that helps students’ needs to help remembering in the long-term, fun, and stimulate the brain.

Brain-based learning is as one of the development potentials of students’ brains, namely by implementing the concept of learning brain-based learning, namely creating a challenging learning environment, fun and creating an active and meaningful learning environment for students (Active Learning). The brain-based learning approach is a natural way and able to increase learning motivation to support and maximize learning and teaching [6]. Caine & Caine (1994) developed their 12 principles for brain-based learning in 1989 and recommend the following 12 principles for brain-based
learning. According to retention as an important part of the learning process is to measure the ability of students to store, hold and re-express the material well after a certain time interval when knowledge is needed [7].

The results of research related to the development of brain-based learning include, explaining that Brain-Based Learning has high level of effectiveness [8&9]. The same research has been conducted regarding brain-based learning in science education including the effect of the brain-based learning approach on short-term attitudes and motivation and long-term attitudes in eighth grade students [10]. Brain-based learning (BBL) can increase awareness in science education in Turkey [11]. That efforts to improve brain-based learning show an increase in retention in students because brain-based learning and researchers suggest further research related to new ideas in the use of technology [12]. The results of research using textbooks on the ability to think history can help students to identify and classify facts and make it easier to connect facts with other facts [13]. The application of brain-based learning with qualitative research shows very satisfying results [14].

The character of the material system of the organization of life has a range of material that is abstract so that a description is needed in order to be concrete [15]. In addition, there are difficult terms, so the methods are needed to help remembering the material in terms of pictures, abbreviations, and explanations needed by students when learning. Methods that can be used in BBL to stimulate dendrites and are able to store long-term memory such as mnemonics, comic strips, challenging puzzles, brain gym and brain music.

2. Methods
The research type is a research and development (R & D) using 4-D model Thiagarajan. The stage of the development, but only use 3 stages were used, define, design, and develop. Textbook development trials were done at Junior High School Nurul Huda Badean Banyuwangi. It was conducted in 2019/2020 academic year. The research subjects of this development are students of class VII A Junior High School Nurul Huda Badean Banyuwangi. In development stage, a limited trial was conducted with 9 students in one class consisting of 3 students with low cognitive level, 3 students with medium cognitive level, and 3 students with high cognitive level.

This research used one group experiment, which is a pretest and posttest design for one group. The sample of this study was 31 students of class VII. 31 students in one sample class were given a pretest about the system of life organization to measure the level of students' initial achievement and retention. The study was conducted three times. After that, students were guided by the teacher to learn the system of life organization from brain-based textbook based learning. Finally, students were given a posttest to measure their abilities after learning from textbook based-brain based learning that declined.

This type of research is (research and development), using the Thiagarajan 4-D model. The following stages are the definition, design, develop and disseminate [16]. Define stage consists of front-end analysis, learner analysis, concept analysis, task analysis, and formulating learning objectives. Design stage consists of criterion test construction, media selection, format selection, and initial design. Develop stage consists of a) limited trials involving 9 students, b) revisions, and c) field tests with all student at class.

The analysis technique used consist of effectiveness analysis with N-gain and learning retention. N-gain is used to analyze the achievement criteria before and after learning by calculating the difference between the post test score and the pretest score then divided by the maximum score difference minus the pretest score [17]. The pretest and posttest instruments consists of 30 multiple choice questions that were relevant to the life organization system material. Questions in accordance with indicators of retention ability and student science learning outcomes, namely data collection techniques in this study using the test method. Analysis of the data obtained from this research is qualitative and quantitative. Quantitative data were generated in the form of retention descriptions and student science learning outcomes. The effectiveness of textbook based on brain-based learning (BBL)
in material organization system of life was obtained from the pre-test, post-test data, and student learning retention formula.

Table 1. Criteria of Normalized - gain

| Skor N- Gain    | Criteria         |
|-----------------|------------------|
| 0,70 < N-Gain   | High             |
| 0,30 ≤ N Gain ≤ 0,70 | Medium           |
| N-Gain < 0,30   | Low              |

The learning retention data was obtained from result of the delay test conducted two weeks after the post-test by using the following formula. Quantitative data retention (R) and student learning outcomes have the following score criteria:

\[
R = \frac{\text{Retest}}{\text{Post test}} \times 100 \%
\]  

(1)

Table 2. The criteria of student’s learning retention

| Retention (%) | Qualitative Criteria |
|---------------|---------------------|
| R < 50        | Very Less           |
| 50 ≤ R < 60   | Less                |
| 60 ≤ R < 70   | Enough              |
| 70 ≤ R < 80   | Good                |
| R ≥ 80        | Very Well           |

(Source: Roediger and Karpicke, 2006).

3. Results and Discussion

3.1 Result of Textbook Based on Brain-based learning (BBL)

Textbooks in which provides an understanding of the life organization system material through a scientific approach for students to explore through the process of discussion, thinking, and experimenting with the help of teacher guidance so students can analyze and apply knowledge that will have an impact on cognitive abilities, namely retention and learning outcomes. Brain-based learning is learning that is aligned with the natural workings of the brain in learning. Students attention was to have motivation in learning, and not to win over suffering and order [19]. Brain-based learning is designed to accordance for the function of the human brain by using principle based on observations and previous research relating to humans [20].

The limited test only involved 9 students in class VII A which were heterogeneously selected based on their cognitive level; high, medium, and low categories. Based on the critics and suggestions from the subject teachers and observers, it appears that there are some needs to be improved that must be added to the large group. The learning process using of textbook in material organizational system of life based on brain-based learning (BBL) can be applied in large classes with revision from limited group.

The effectiveness of textbook in material organizational system of life based on brain-based learning (BBL) on learning outcomes and learning retention can be measured by experimental design using only one class for the data collection process in the form of student grades. The N-gain data from the effectiveness of student learning outcomes (pre-test and post-test) is 0.77 with a high category. Data result about the effectiveness of using textbook in material organizational system of life based on brain-based learning (BBL) was also obtained from learning retention measurements carried out 2 weeks after the post-test. The question given is the same question with multiple choice. The
learning retention data of students in class VII A Junior High School Nurul Huda Badean Banyuwangi can be seen in Table 3.1 below.

| Retention | Class | Total Students | Of Average | Category |
|-----------|-------|----------------|------------|----------|
| Field test | 31    | 89 ± 11.85     | High       |

3.1.1 Define
The stage of defining learning needs is done by analyzing the objectives and constraints of the material which includes front-end analysis, learning analysis, concept analysis, test analysis, in section of learning objectives. The following data are obtained related to the analysis of teacher and student needs on the material system of living organizations in living things.

3.1.2 Design
This stage is carried out to be approved and made an initial draft textbooks on living systems based on data-based learning according to the needs and input obtained from the definition. The design is carried out starting from the initial design of textbooks, construction of criteria tests, media selection, format selection, and initial design. Textbooks that have been compiled have advantages, namely mnemonic, comics, songs, guessing pictures, and crosswords. The following illustration is a brain based learning book that has been compiled. Here is a picture of a textbook on the material of living systems based on brain learning organizations.

3.1.3 Develop
This stage aims to obtain input and assessment so as to obtain information about the strengths and weaknesses of the books that have been developed. The purpose of the development phase in this research is to produce a draft of the development of textbooks on brain-based learning (BBL) life organization systems for science learning in SMP/MTs and good supporting instruments (valid, practical, and effective). The steps taken in developing the textbook are (1) compiling the initial textbook, (2) studying the initial textbook, carried out by the researcher along with the supervisor who includes the appropriateness of the content, language, presentation and graphic, (3) revising the textbook initial by revising the parts that need to be improved, (4) conducting field trials (field testing), to obtain direct input from the field of learning tools that have been prepared. The field test was conducted using brain based learning textbooks conducted in three meetings to get the students' post test scores. Retrieval of data in the form of ability to retention and learning outcomes using textbooks on brain-based learning (BBL) based life organization systems, namely in grade VII students of Junior High School Nurul Huda Badean Banyuwangi with a total of 31 student respondents. The following is a photo of the learning activities of research on the development of textbooks on the material system of life organization in living things based on brain based learning in grade VII students of junior high school.
Figure 1. pretest activity by students

Figure 2. learning using BBL Textbook

Figure 3. observations of animal cell with using textbook

The information in Figure 1, Figure 2 and Figure 3 shown the activity learning before using textbook with pretest and shown students using textbook in observation of plant cell.

Table 4. The Normalized Gain Using Textbook in Material Organizational Systems of Life Brain-Based Learning by Users

| Category | N- Gain Score Criteria          | Total |
|----------|---------------------------------|-------|
| High     | 0,70 < N-Gain                   | 27    |
| Medium   | 0,30 ≤ N-Gain ≤ 0,70            | 5     |
| Low      | N-Gain < 0,30                   | 0     |

Figure 4. Normalized Gain Using Students’ achievement at the pretest and posttest

The information in Table 4. Figure 4. shows the achievement N-Gain using textbook. 27 students in high category, 5 students in medium category and none student in low category.
Table 5. The mean of student’s posttest and retest

| Test   | N   | Class VII A |
|--------|-----|-------------|
| Posttest | 31  | 83.22       |
| Retest  | 31  | 77.44       |

Figure 5. The mean of students post-test and retest result

The information in Table 5 and Figure 5. shows the students’ retention of knowledge of the material slightly decreased after 2 weeks. This is indicated by the mean of post test 83.22 and retest 77.44. Furthermore, criteria of students’ retention can be seen in Table 6.

Tabel 6. The result of percentage calculation of student retention

| Retention (%) | Criteria     | Frequency of Student |
|---------------|--------------|----------------------|
| R < 50        | Very Less    | 0                    |
| 50 ≤ R< 60    | Less         | 0                    |
| 60 ≤ R< 70    | Enough       | 0                    |
| 70 ≤ R< 80    | Good         | 0                    |
| R ≥ 80        | Very Well    | 31                   |
|                | The number of students | 31 |
|                | Mean of retention percentage | 93.25% |
|                | Standart deviation | 0.01 |

Based on Table 6, it can be seen that criteria of students’ retention about organization system of life is very well with the mean percentage 93.25%. The result are obtained from the calculation of posttest an retest value of each student using textbook in material organozation of life based on brain-based learning that has been determinated. In addition, very small standart deviation (0.01) shown in the retention percentage of each student almost no difference.
### 3.2 Discussion of Textbook Based on Brain-based learning (BBL)

The discussion consists of development textbook in material organization system of life based on brain-based learning (BBL) in the form of product development validation consisting of validation, product, effectiveness using textbook, and practicality using textbook on BBL for Science Junior High School Nurul Huda Badean Banyuwangi.

The discussion on the development textbook in material organization system of life based on brain-based learning (BBL) begins with Define stage covering front and analysis by distributing questionnaires to Banyuwangi Science MGMP and se-karesidenan Besuki (Banyuwangi, Jember, Situbondo and Bondowoso) teachers. Then, it was obtained 27 respondents (teachers) from the questionnaires for teacher needs (need assessment) revealed that there were several teachers who knew about brain-based learning and had used textbook based on brain-based learning (BBL) in teaching and learning activities. However, most teachers using electronic school textbook in learning at class and worksheet. The reason teachers use the textbook is easy to apply and can be accepted by all students. But with this textbook, it turns out that it still cannot improve student learning outcomes, this is in line with the result of the interviews.

Based on the result of the questionnaires for students needs (need assessment) revealed that there 70 students’ interesting in learning to read, the level of students in absorbing material is different, student can't study with simple textbook in material organization system of life because many difficult word, abstract of material in cell level, need more illustration picture, flexibility of material in real, and more colour in textbook so that it caused their learning outcomes less optimal and the retention is still low.

The second stage in the development textbook in material organization system of life based on brain-based learning (BBL) is the design stage. This stage is carried out to be approved and made an initial draft textbooks on living systems based on data-based learning according to the needs and input obtained from the definition. The design is carried out starting from the initial design of textbooks, construction of criteria tests, media selection, format selection, and initial design. Textbooks that have been compiled have advantages, namely mnemonic, comics, songs, guessing pictures, and crosswords. The following illustration is a brain based learning book that has been compiled. Here is a picture of a textbook on the material of living systems based on brain learning organizations.

The develop stage is done to get result from the development textbook in material organization system of life based on brain-based learning (BBL) that can be used and in accordance with using textbook to be used. This develop stage consists of several step with limited trial test, test was implemented in the direct class involving 9 students divided into low, medium, and high cognitive levels. The result of product validation have the overall average validation of product in the form of textbook, syllabus, and pre-test and post-test questions that are 89.33 which means the developed textbook in material organization of life based on brain-based learning product are in the very valid and usable category.

Effectiveness textbook in material organization system of life based on brain-based learning (BBL) can be seen from the measurement result of the pre-test and post-test by using one class or one group. The effectiveness using textbook from the effectiveness data when it is calculated its N-gain value, the is 0.78 and included in the high category which means that textbook is effective. The student retention rate is 89 and belongs to the high category. High retention can be obtained from students’ understanding of a material concept because textbook in material organization system of life based on brain-based learning (BBL) accompanied with mnemonic, comic strips, brain gym, brain music and song. So that, textbook based on brain-based learning can increase learning retention.

The practicality textbook in material organization system of life based on brain-based learning (BBL) was obtained through teacher and student response questionnaires. Based on the student questionnaires responses which amounted to 31 students, it was found that the student response rate was 96%, which meant that the textbook was very practical. Based on result in the form of a positive responses, learning by using textbook in material organization system of life based on brain-based learning (BBL) can make student easy to understand the material, student very happy read book and get good motivation to study, make student enthusiastic learning, and can be accepted by students who
can remember for a long period of time obtained by learning outcomes well. This is because in the development of textbook in material organization system of life based on brain-based learning (BBL), student are always trained to remember material with sing a song and to do brain gym. Students Optimize in the activities learning of student is obtain if balance the work between the right brain and left brain using activities with brain gym [21].

4. Conclusions
Based on the results and discussion, the development textbook in material organizational system of life based on brain-based learning (BBL) used 4D research design, but only 3 stages were used, define, and design. Textbook in material textbook in material organizational system of life based on brain-based learning (BBL) is effective because it can improve student learning outcomes and learning retention. The ability to maintain and science learning outcomes in students increased from low to good at an average of 93. While the average value of the post test was 83.22 with a retest of 77.44. Textbook in material textbook in material organizational system of life based on brain-based learning (BBL) is practical because the results of student questionnaire responses regarding to the practicality of using textbook in material organizational system of life based on brain-based learning (BBL) showed very good results.

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