Development of blended learning based on website on fluid mechanics material to improve students’ creative thinking skills

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Abstract. This research and development was based on the need for using of web-based media, with the aims of (1) developing web-based media with fluid-mechanics material, (2) as a support system of a blended learning to improve creative thinking skills that are currently urgent and needed by students, (3) produce web-based learning media that can provide facilities for the efficiency and effectiveness in teaching and learning process. The method in this research development used the ADDIE (Analyze, Design, Development, Implementation, and Evaluation) model. The lecture material in this study is fluid mechanics on the website: vinnarai.com and its effectiveness was observed from the posttest and pretest, with the research object namely 70 physics education students, which conducted in Semester 111th 2019 at State University of Jakarta. The validation results from the media experts stated 85% of the web developed was very good for use and the validation from the material experts stated that 90% of the material presented was very feasible. The validity test on the instrument with fluid-mechanics material shows the value of the t-test results (6.80)> t-table (2.16) with 11 valid questions and 4 drop questions. Then the reliability test for the whole question are declared reliable with score r-count 0.73 > r-table 0.05, so the creative thinking skills instrument for this fluid mechanics material was reliable. The results of this study to improve creative thinking skills of students with 0.56 N-Gain ratings in the medium category. The conclusion of this study showed that the blended learning based on website has been used in the learning process was feasible to use and effective enough to improve students’ creative thinking skills.

1. Introduction
1.1. Background

In this era, education has driven changes from conventional learning towards online learning that can be accessed by using media. The development of this increasingly advanced education is in line with the development information and communication technology in the world. Which all educational information can be held by using computers, smartphones, tablets, laptops [8], through the internet without regulating distance, place, and time by anyone who needs it. Currently as a translation of technological development, we are in a blended era, including in the learning process, which supports the use of conventional and online systems become an efficient learning system called popular with blended learning. In the initial research by [19], it was shown that the increase of mechanical subject
outcomes from students self-directed learning by using online learning was the background for this research as a sequel to blended learning based on website.

The aims of this research were: (1) developing web-based media with fluid-mechanics material, (2) as a support system of a blended learning to improve creative thinking skills that are currently urgent and needed by students, (3) produce web-based learning media that can provide facilities for the efficiency and effectiveness in teaching and learning process. From the aims of this research, learning system also adjust to the current generation who are quite literate with technology. Students can accept the learning process using new technology quickly and easily [7]. It also supported one of the principles of learning to utilize information and communication technology as a medium to improve learning outcomes that were efficient and effective [10]. Learning media and learning models are two things which very important in an efficient and effective learning process, which was supported by blended learning. Blended learning models make students actively participate in the learning process both online and off-line together and increase students’ interest in learning [9]. Blended learning will provide comfortable to achieve learning targets with combining conventional learning with face-to-face interaction and tutorial self-directed learning with material provided by web-based learning [21].

Blended learning is also developed in higher education with a student-centered learning perspective with the effectiveness of critical thinking. Sarıtepeci and Yıldız through the results of their research to blended learning that has positive effect on student participation and increased learning motivation [14]. Learning activities that are expected to create creativity and can continue to be developed. Students become more motivated to continue to find out what has been obtained.

Because science learning prioritizes the creative thinking skills which more important for students. This skill needs to be continuously drilled, and it can be said that the basic of science is creative thinking skills. By thinking creatively, it enables students to be able to make computers and electronic devices, cure illnesses even building civilization on mars. It is important to think creatively as a key competency in the 21st century which has widespread effects. To improving student creative thinking skills, blended learning is effective, sufficient, and qualified for practicing the required competencies in science learning that requires creative thinking skill to solve all problems.

With this combination (blended), it is hoped that it can add to the advantages that exist in each type of learning which can maximize student learning activities. The learning process not only receives new information, but also processes and updates the existing and new information. Blended learning can help in training the students’ creative thinking skill in connecting various information of the subject matter. In addition, students only need to think about getting information, not just think about it.

1.2. Literature Review
1.2.1. Blended learning
In Independence studying on campus is indeed feasible and the learning system is already using blended learning. The role of technology used its strengths as a form of learning media that can increase the effectiveness of learning by combining teaching models.

Blended learning is a combination of conventional and online learning processes with the aims to make the learning process more flexible with limited time and space, by combining the strengths of the two learning processes [8]. Blended learning as an opportunity to utilize technological innovations that can be integrated in education with online learning systems collaborated with interaction and active participation in conventional learning [18].

Currently blended learning is growing, blended learning is done with offline and online by combining face-to-face learning interaction, print, audio, visual, audio visual, computer, and e-learning technology supported by internet networks that were also playing well. Learning by utilizing technology can create innovative learning and educators can also organize their teaching efficiently [20]. Especially in science learning groups such as physics, which need the creative thinking skill to understand the physics concepts, not only enough to learn in class. As research has been done by
Almasaied that blended learning in science learning, can produce skills with positive effects, also get a high level of attitudes and learning outcomes [1].

1.2.2. Website

Website is a collection of several interconnected web pages, website is contained on the World Wide Web (WWW) as a domain or subdomain. In the learning process, the web is a site that provides a variety of information which needed in the learning process that can be accessed through the internet network. Popular web-based learning is called web-based learning or web-based training which is an electronic technology with a collection of information in the form of web pages with internet access that facilitates the learning process [13].

The web can be used as a method of learning and teaching to deliver learning, interacting, or consulting material [11]. The learning process used the web can use time freely, lessons can be accessed on the web at any time and the learning process becomes more efficient.

Learning using web media does not mean learning only takes place outside the classroom using only web media, but rather combines it in one unit with face-to-face learning which aimed to increasing communication involvement and even training the creative thinking skill. In blended learning, using web-based learning system will strengthen conventional learning models through possible educational technology to be developed [6].

1.2.3. Creative Thinking Skill

Skills related to creativity in creative thinking must be integrated with each other for effective problem solving. In accordance with the explanation from Hwang & Sung there are four indicators in evaluating the creativity abilities of students which previously mentioned: 1) fluency: is the creativity of students in generating bright ideas, 2) flexibility (flexibility): is the skill with ability of students to respond the problems with initiative thinking, 3) uniqueness or originality: is the skill with ability of students to express new thoughts and ideas to solve problems, these new ideas are different from the others and look unique and 4) elaboration: is the skill with ability of students to provide detailed results obtained as a refinement of problem solving [17].

There are several threats that can make someone being not creative: 1) bad habits; 2) wasting time and energy; 3) unfavorable environment; 4) can’t handling the needs immediatly; 5) criticism from others; 6) fear of failure; and 7) satisfaction [2]. But all of that can be overcome with courage and self confidence and keep trying many things, it is possible that creativity can be sharpened.

1.2.4. Physics Material on Fluid Mechanics

Physics material on fluid mechanics is the science that explains nature phenomena where there was the fluid flows away. Through the results of experiments and research by physicists, it is found theories, concepts and laws that apply in physics which can explain how the universe processes by one of this was fluid mechanics. Fluid mechanics is a branch of physics that studies the substances which can flow and the forces affect them, and those fluid are liquid and gases. Fluid mechanics is divided into two matter, namely static fluid is a fluid that stationary or not flowing and dynamic fluid is a fluid that can flow [15]. Some examples of fluid applications are hydraulic jacks, submarines, aircraft lift, leaky water tanks and others.

1.2.4.1. The pressure described by \( P \ (N/m^2) \), is the ratio of \( F \ (N) \) the force that presses the fluid on a piston with \( A \ (m^2) \) is the piston surface area or is defined as follows:

\[
P = \frac{F}{A}
\]

1.2.4.2. Variation Pressure with depth
The total pressure $P$ experienced by a fluid with a certain depth is due to the pressure of the fluid above it $P$ and the air pressure from outside or atmospheric pressure $P_0$ of $1.00 \text{ atm} = 1.013 \times 10^5 \text{ Pa}$, which pressure is greater than $g \cdot h$.

$$
\sum F = PA\mathbf{j} - P_0 A\mathbf{j} - Mg\mathbf{j} = 0
$$

$$
PA - P_0 A - \rho Ahg = 0
$$

$$
P = \rho hg + P_0
$$

(2)

The total pressure $P$ experienced by a fluid with a certain depth is due to the pressure of the fluid above it $P$ and the air pressure from outside or atmospheric pressure $P_0$ of $1.00 \text{ atm} = 1.013 \times 10^5 \text{ Pa}$, which pressure is greater than $g \cdot h$.

1.2.4.3. Barometer is a pressure measurement, used to measure atmospheric pressure, invented by the Italian physicist Evangelista Torricelli (1608-1647).

$$
P_0 = \rho H \rho gh \rightarrow h = \frac{P_0}{\rho H \rho gh} = \frac{1.013 \times 10^5 \text{ Pa}}{13.6 \times 10^5 \frac{\text{kg}}{\text{m}^3} (9.80 \frac{\text{m}}{s^2})} = 0.76 \text{ m}
$$

1.2.4.4. Buoyant Forces is the upward force exerted by a fluid on a partially or completely submerged object, Archimedes' principle states that the magnitude of the buoyancy exerted by the fluid is the same as the amount of fluid displaced.

$$
B = \rho_{\text{fluid}} g V
$$

(4)

This statement is known as the Archimedes principle.

$$
B = (P_b - P_t)A = (\rho_{\text{fluid}} gh)A = \rho_{\text{fluid}} g V
$$

(5)

Total force acting on an object in the fluid is zero or in an equilibrium state if the density of the object is equal to density of the fluid, this equilibrium can be defined as follows:

$$
\frac{V_{\text{fluid}}}{V_{\text{obj}}} = \frac{\rho_{\text{obj}}}{\rho_{\text{fluid}}}
$$

(6)

1.2.4.5. Fluid dynamics The dynamic pressure in the fluid mechanics is proportional to the kinetic energy

$$
P = \frac{1}{2} \rho V^2
$$

(7)
In aeronautics, dynamic pressure is an addition to static pressure to provide a total pressure that can be measured at the point of stagnation [3]. In the ideal flowing liquid model, the following four assumptions are made:

a. In nonviscous liquids, internal friction is negligible. Viscous force does not occur by an object moving in the fluid.

b. Stable flow. In stable (laminar) flow, fluid velocity at each point remains constant.

c. The liquid cannot be compressed. The density of liquids which cannot be compressed is constant.

d. In irrotational flow, the fluid does not have the angular momentum rotation followed by the fluid itself

\[ A_1 v_1 = A_2 v_2 = \text{constant} \]  

(8)

1.2.4.6. Bernoulli equation

\[ P_1 - P_2 = \frac{1}{2} \rho v_2^2 - \frac{1}{2} \rho v_1^2 + \rho g y_2 - \rho g y_1 \]

Bernoulli equation expressed by:

\[ P + \frac{1}{2} \rho v^2 + \rho g y = \text{constant} \]  

(9)

2. Research Method

In this development study used the ADDIE (Analyze, Design, Development, Implementation, and Evaluation) model research method with one-group pretest and posttest research designs. The ADDIE model is used to develop practical educational designs [12]. Giannakas, Papasalouros, Kambourakis, & Gritzalis recommend the ADDIE model as one of the right IDMs (integrated databased management system) to design learning experiences in using online learning including web-based learning to improve students' skills [4].
The following procedure is used in ADDIE proposed by [16]:

1) Analysis
The first step in ADDIE model development is needs analysis. Collection of information related to what is needed in this development. The results of the needs analysis were recorded through a questionnaire on 70 physics education students in 2017 in Semester 111 in 2019 at Jakarta State University.

2) Design
In this research, the development of web-based with ADDIE models designed with the characteristics of blended learning is expected can improve the creative thinking process specifically on the learning objectives of understanding the concepts of fluid mechanics.

3) Development
In this third step, the material from fluid mechanics subject for blended learning based on website is produced and developed on the web http://vinnarrai.com.

4) Implementation
The fourth step in ADDIE model is implementation. For this step, blended learning is implemented by the instructor in class according to the teaching and learning plan.

5) Evaluation
In ADDIE model, evaluation is a process of correction that is carried out at each stage, namely improvements at the analysis, design, development and implementation stages. This evaluation is also related to the assessment of experts, namely media experts and material experts, improvements were made as part of the feasibility study to perfect blended learning based on website.

### 3. Result and Discussion

Need analysis starts from determining the selected research object namely 70 respondents of physics education students in semester 111th 2019 at State University of Jakarta, then completing the questionnaire as a need analysis of the selected object to determine the need for the development of web-based media as a complement to the learning process in class or blended learning. The results of the needs analysis are shown in the table 1 below:

| Questions:                                                                                                                                                                                                 | Results | Yes | No |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|-----|----|
| Do you use the internet in learning?                                                                                                                                                                         |         | 70  | 0  |
| Do you often use web-based learning resources? Is learning in the classroom effective in understanding the material                                                                                      |         | 62  | 8  |
| Is learning in the classroom effective in understanding the material?                                                                                                                                          |         | 41  | 29 |
| Do you do creative thinking in study of fluid mechanics?                                                                                                                                                     |         | 23  | 37 |
| Is it necessary to develop web-based media as an additional source of learning?                                                                                                                             |         | 69  | 1  |

Students always use IT (information technology), as evidenced from 70 (100%) students have used the internet as learning media. 88.5% of students use web media as a learning resource because it is more effective with unlimited use of time even though the learning process 58.5% of students claim to be effective in class. The meaning from the results of need analysis above, utilize information and communication technology as a medium to improve learning outcomes that were efficient and effective, matching and relevant with former research [10].

Then the selection of fluid mechanics material, it was because of the students have unsatisfactory values in the material, they have not mastered the concept thoroughly so that students find it difficult to work on fluid mechanics questions with a level of creative thinking, in this questionnaire as many as 52.8% of students claim not to understand the concept of fluid mechanics well. From 70 students, 69
students (98.5%) said that they needed to develop web-based media as an additional source of learning.

At the design stage, development of learning resources is displayed on the web vinnarrai.com as part of teaching material. At the development stage, the teaching of fluid mechanics material has been systematically compiled in accordance with the competencies, and equipped with pretest and posttest questions as research instruments for knowing the effectivity and improvement of creative thinking skills with the implementation phase that will be done in class. Evaluations are carried out at each steps as needed, the validation from material experts and media experts are the final evaluation result.

As a reference validation assessment conducted by media and material experts that refers to assessments by Likert scale intervals, to measure opinions, perceptions and behavioral criteria about a problems or an event that can be seen as the following intervals [16]:

| Interval (%) | Criteria    |
|--------------|-------------|
| 0 – 20       | Very bad    |
| 21 – 40      | Bad         |
| 41 – 60      | Enough      |
| 61 – 80      | Good        |
| 81 – 100     | Very good   |

On the web, learning resources that will be displayed have been through the validation process by material experts, with an average assessment of 90% and an evaluation of the lack of breadth of material content due to time constraints. The results of the material expert validation are shown in table 3 below:

| Aspect                                      | Validator 1 | Validator 2 |
|---------------------------------------------|-------------|-------------|
| Accuracy of material                        | 89%         | 91%         |
| Delivery of material                        | 90%         | 90%         |
| Language usage                              | 92%         | 88%         |
| Basic Competencies on Curriculum            | 91%         | 89%         |

The development of web media used in this research can be easily accessed through the web site vinnarrai.com, with an attractive web design and is easily applied by students, because previously students were also familiar with using the web as a learning resource. Students can download material and practice questions through this website which used in the learning process in class. Here is the front page of vinnarrai.com:
After the web learning media product is finished, and teaching materials are implemented on the web that are adapted to the capacity of the learning process in the classroom or used as a support for blended learning, media validation is done by interviewing techniques, on the developed web interface media experts provide suggestions and input. Data obtained by an average of 85% from the results of the validation of media experts in table 4 are as follows:

**Table 4. Validation results of media expert.**

| Assessment Object       | Expert 1 | Expert 2 |
|-------------------------|----------|----------|
| Web design              | 83%      | 80%      |
| Easy of use             | 87%      | 89%      |
| Interactive Media       | 85%      | 86%      |

Before doing a pretest to students to measure the creative thinking skills on fluid mechanics material in this study, it was tested with 15 essay questions to measure the validity of this instrument using the product moment test and instrument reliability test using the Alpha Cronbach test in the development of blended learning based on web as a complement to the learning process in this class and in table 5 shown the results of the validity and reliability tests of the instrument.

**Table 5. The Results of validity test and reliability test of creative thinking skills instrument.**

| Validation               | Reliability |
|--------------------------|-------------|
| 11 valid questions       | 0.90 reliable |
| 4 drop questions         |             |

Based on the results of the validity test on the instrument with fluid-mechanics material shows the value of the t-test results (6.80)> t-table (2.16) with 11 valid questions and 4 drop questions. Then the reliability test for the whole question are declared reliable with score r-count 0.73 > r-table 0.05. With this data, it was known that this creative thinking skills instrument to be used was considered feasible in this research. 11 essay items are valid from the results of the development of the instrument to see the improvement of students’ creative thinking skills. Table 6 shows the lattices of the development of creative thinking skills instruments.

**Table 6. Creative thinking skills instrument lattices.**

| Types of creative thinking skills | Indicators of creative thinking skills                        | Question number |
|-----------------------------------|----------------------------------------------------------------|-----------------|
| Fluency                           | Answering questions more than one answer.                      | 1, 6, 9         |
| Originality                       | Give answers other than the usual.                             | 2, 7, 8         |
| Flexibility                       | Answering various questions.                                   | 3, 10,          |
| Elaboration                       | Developing a question answers to solve the problem             | 4, 5, 11        |
After a revision of the learning media from the criticisms and suggestions given by experts, then a pretest was conducted. Respondents consisting of 70 Physics Education students in semester 11th conducted a pretest with 11 essay questions on fluid mechanics material to determine their level of creative thinking skills. This pre-test was carried out before the introduction of web media as a support of blended learning. With an overall average value of 54.74, the results obtained from this pretest are still relatively low. The answers written by respondents from the essay also do not meet the criteria for creative thinking indicators, where the answers given are still standard, such as entering numbers directly into memorized formulas, cannot answer variations of questions and cannot develop answers to questions for problem solving.

After the pretest was carried out, respondents were introduced to the web media which was as a support of blended learning in this study. It seemed that the students were quite enthusiastic using the web, as can be seen in the following documentation:

![Image](image_url)

**Figures 6.** The enthusiasm of students using the web vinnarrai.com

From the figure 6. The enthusiasm of students using the web vinnarrai.com, this result study matching and relevant with former research that students can accept the learning process using new technology quickly and easily [7]. New technology make students enjoy their study.

Then the posttest was conducted with the same instrument to the respondents after studying the material of fluid mechanics via the web, the results obtained from the posttest after studying the material from the website were quite satisfactory with the average results of all respondents 81.43. It is seen that there is an increase in more systematic response patterns and an increase in the criteria for creative thinking skills which can also be seen from the answers. To find out the effectiveness of using the website in increasing creative thinking skills on fluid mechanics material as a learning medium that complements this blended learning, the results can be seen from the N-Gain table as follows:

\[
N - Gain = \frac{Score \ Posttest - Score \ Pretest}{100 - Score \ Pretest}
\]  

(10)

**Table 7.** Reference values for the N-Gain category

| N-Gain Score | Category   |
|--------------|------------|
| N-gain ≤ 0,30| Low        |
| 0,30 < N-Gain < 0,70 | Medium |
| N-Gain ≥ 0,70 | High       |
Table 8. Results of N-Gain students' creative thinking skills.

| Class              | n   | Average | Category      |
|--------------------|-----|---------|---------------|
| thinking skill     | 70  | 54.74   | 81.43, 0.56   |

From the result of pretest was 54.74 and post-test was 81.43, there was improvement of creative thinking skill of students in the class by using blended learning. This result also matching with the research which has been done by Almasaeid that blended learning in science learning, can produce skills with positive effects, also get a high level of attitudes and learning outcomes [1].

Based on the data that has been obtained and the results of N-gain calculations, the N-gain score is 0.56 that are on "medium" category. The results of this research is a development of blended learning can improve students' creative thinking skills on fluid mechanics material with web media as a support for the learning process.

4. Conclusions
The use of web media in blended learning on fluid mechanics material is effective in improving students' creative thinking skills. The results of the effectiveness of the N-Gain test proved that the instrument for creative thinking skills was 0.56 (medium category) for physics education students in semester 111th 2019 at State University of Jakarta. So, the blended learning based on website has been used in the learning process was feasible to use and effective enough to improve students' creative thinking skills.

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