Development of WEB-FIST (STEM-Based Physics Web) to Train Students' Critical Thinking on the Topic of Parabolic Motion

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Abstract

This research aims to describe the feasibility of Web-FIST media in terms of validity and effectiveness. the use of Web-FIST to practice students' critical thinking on the topic of parabolic motion. This study uses a research design model of Hannafin & Peck. The data collection technique used was the validity instrument, the pretest-posttest in the form of an essay, and the response questionnaire with the subject of 13 students of class X Mathematics and Natural Sciences in Senior High School in Tuban. The validity is reviewed based on the suitability of the following aspects:1) the web system, 2) the correctness of the content of the material, 3) the STEM approach, 4) critical thinking characteristics, 5) the material with the nature of physics, and 6) competency standards. While the effectiveness in terms of the results of critical thinking observations and student responses. Media validation was carried out by two media experts. Based on the data analysis that has been carried out, the results of the Web-FIST validity are 92.83% with a very valid classification (92.83%). The results of the effectiveness of using Web-FIST obtained an N-Gain of 0.6 with a moderate classification, while from the assessment of student responses an average value of 86% was obtained with a very effective classification. Based on the results of the data analysis, it can be concluded that the developed Web-FIST is suitable for use in the learning process and can train students' critical thinking about parabolic motion.

Keywords: Media, Web-FIST, Critical thinking Skills, Parabolic Motion

INTRODUCTION

The results of the Political and Economic Risk Consultancy (PERC) research in 2011 and 2012, show how low the quality of education in Indonesia is. Based on these data, Indonesia faces various problems regarding the low quality of education, which results in the nation's competitiveness still low (Baiti, 2018). Effective learning can grow some characters, abilities, knowledge, and ethics from several aspects. The learning stage can be used in informal learning activities. Learning media is an important part of learning (Sulistyowati & Rachman, 2017). According to Hariyono (2017), media is interesting, fun, and able to facilitate and can meet the needs of a student in learning physics concepts. This is in line with the rule that 21st-century learning requires students to have knowledge, skills, and attitudes, as well as mastery of technology (Kemendikbud, 2017).

The quality of human resources is strongly influenced by the quality of education in a country, if the quality of education increases, the quality of human resources will also increase (Elisabeth et al. 2021). Over time, rapidly growing knowledge has influenced educational activities (Septarini & Kholiq, 2021). According to Schooner, et al (2017), critical thinking skills are skills that need to be used and included in 21st- century education. However, there are.

Obstacles to achieving 4C skills such as the Lack of students' critical thinking skills in solving problems, students tend to imitate what they hear from teachers, but the concepts taught Lack of ability to understand (Sudiantini, 2018). On the other hand (Sofiyah, 2016) indicates that critical thinking skills require logic and reasoning in problem-solving. Included are critical thinking abilities in one aspect of higher-order thinking skills. Critical thinking can be defined as a process to understand and reflect on a problem in detail, being open in terms of arguments, and having different perspectives. Critical thinking ability is very important and needs to be taught and developed. Critical thinking skills must be based on several aspects such as the steps in analyzing, examining, and evaluating arguments (Fuad, et al. 2017).

From the above overview, it can be emphasized that students need critical thinking skills when learning. These problems can be overcome with more advanced or modern teaching support media so that the material explained by the teacher is easy to understand and also helps the teacher in delivering the material. In general, the media is a distributor of information, and learning aids to convey material accurately and thoroughly (Mahyudin, Wati, & Misbah. 2017).

Discussing technology, Physics is a branch of science that has three essences, namely products, attitudes, and processes. Another understanding of physics is the science that studies the problem of symptoms, the formation of nature, and its properties (Dewi & Anggaryani, 2020). Physics material is material that is interrelated with everyday life (Astuti, et al 2017). One of the physics materials that require in-depth conceptual reasoning is Parabolic Motion which is taught to class X SMA/MA students.

The STEM approach is an approach (approach) that can help students gain new knowledge (Permanasari, 2016). According to (Zaim, 2017) the steps of the STEM approach are observing (observing), asking (questioning), gathering information/trying (experimenting), reasoning (associating), and communicating (communicating). The steps possessed by the STEM approach are in line with the demands of the 2013 Curriculum. These demands are oriented towards the development of world globalization so that they contain several aspects, including advances in information technology. These demands are oriented towards the development of world globalization so that they contain several aspects, including advances in information technology.

Learning support media used is website development media as physics learning. According to (Doyan A, 2014) Physics learning web is used by teachers in delivering material, and there is a significant difference in increasing concept mastery, students who receive learning through the web have better conceptual mastery than students who get conventional learning.

This can be seen from the above explanation The use of the web is anticipated to help students comprehend abstract physics information, repeat the challenging sections of the curriculum, and receive reinforcement through reading learning resources like electronic school books, articles, and practice questions that have been created by the teacher. (Doyan A, 2014). The existence of learning tools such as Web-FIST is very necessary because it provides convenience in delivering Parabolic Motion material. This research focuses on the feasibility analysis (Validity and effectiveness) of the Web-FIST (STEM-Based Physics Web) which was developed to train critical thinking on the topic of Parabolic Motion.

METHOD

This study uses the Hannafin & Peck model development research. The research subjects used 15 students from class X SCIENCE, as a trial sample of the product being developed. Referring to Tegeh et al (2014) Hannafin & Peck's model has three main stages, namely 1) needs assessment, 2) design stage and 3) development and implementation. These three stages involve an evaluation and revision process. Here's a chart from the Hannafin & Peck model.
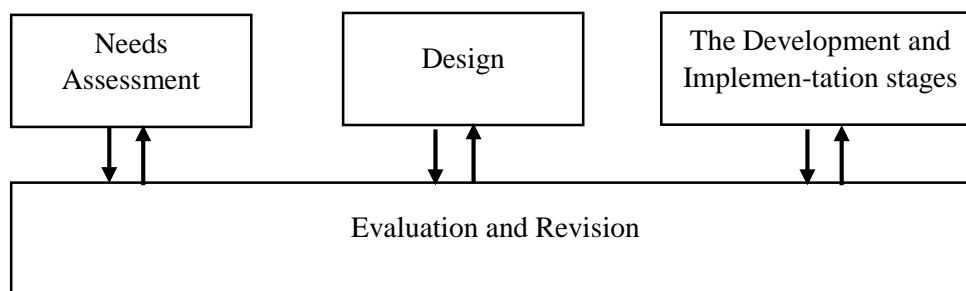
Figure 1. Hannafin and Peck models (Tegeh et al, 2014)

The first stage in this research is a needs assessment, where the researcher analyzes the needs needed in media development. According to Martin et,al. (2013) that the series of activities carried out are 1,) Analysis related to problems, 2) Analysis related to students, 3) Analysis of learning objectives, and 4) Analysis of learning settings.

At the design stage, the researcher compiles the material along with some animations and videos from the right sources, after that makes an attractive physics web home display and produces a web-FIST draft which will be further evaluated by media and material experts lecturers. The next stage is the development and implementation of the revised web-FIST media product according to the advice of media and materials expert lecturers, where video objects, animations, and material points are integrated into a website that has been developed and is ready to be implemented, after passing through the three stages of the product, the evaluation does not escape. and revisions to 2 expert lecturers.

The research parameters in the form of validity, practicality, and effectiveness using a 4-point Likert scale, namely 1) Less, 2) Enough, 3) Good, 4) Very Good with criteria > 60% will be declared valid. Use the Likert scale to complete the validations performed by subject matter experts, as shown in Table 1.

Table 1, Criteria for the score of the validity sheet (Riduwan, 2010)

Score	Description
1	Poor
2	Avarage
3	Good
4	Very Good

The scores are then added up, and the percentage of eligibility is calculated using the equation:

$$\%(\text{ percentage})=\frac{total\ score}{max\ score} \times 100\%$$

The results of the analysis of the validity sheet are used to determine the validity of the developed Web-FIST media, using the Likert scale interpretation criteria in table 2.

Table 2, Interpretation of Likert Scale Scores (Riduwan, 2010)

Percentage	Description
0%< x ≤20%	Very Less
21%< x ≤40%	Less
41%< x ≤60%	Enough
61%< x ≤80%	Good/Valid
81%< x ≤100%	Very Good/Valid

The research instrument on the effectiveness of the web-FIST learning media uses the results of the impact analysis effectiveness sheet of the students' responses and pretest-posttest with 12 physics essay questions. The analysis of the implementation of the web-FIST was carried out using the Guttman scale with the provisions of the answer "Yes" If you receive a value of 1 and answer "no", you will receive a value of 0 (Riduwan, 2013).

The score obtained from the observations is calculated as the average score using the following formula:

$$\text{N Gain} = \frac{posttest\ score - pretest\ score}{ideal\ score - pretest\ score}$$

The findings of gain calculation are converted into the standards in Table 3.

Table 3. N-Gain Criteria (Hake in Apriyana et al., 2019).

Standard value	Criteria
$N - gain > 0,7$	High
$0,7 \geq N - gain \geq 0,3$	Currently
$N - gain < 0,3$	Low

RESULTS AND DISCUSSION

web-FIST (STEM-Based Physics Website) is The media generated from this research, discussing the problem of parabolic motion. This website was developed to practice critical thinking skills. This Web-FIST contains Parabolic Motion material and is accompanied by videos related to critical thinking indicators, which can motivate students to make learning more exciting and diverse. The following are some of the features of web-FIST which can be seen in Figure 2 and Figure 3 which have been developed by researchers.
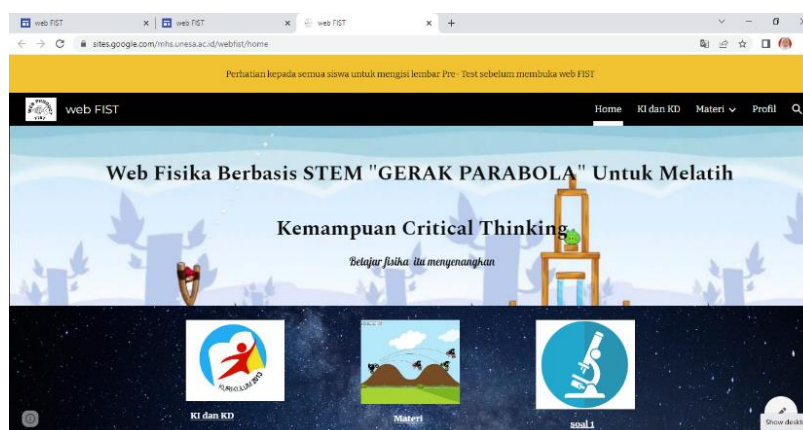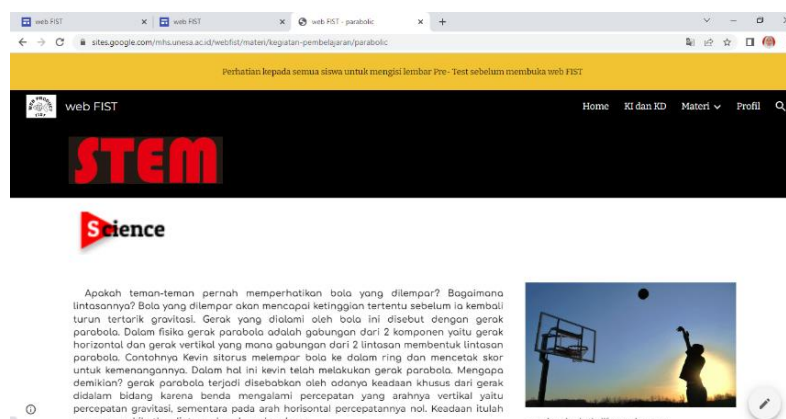

Figure 2. Web-FIST home screen
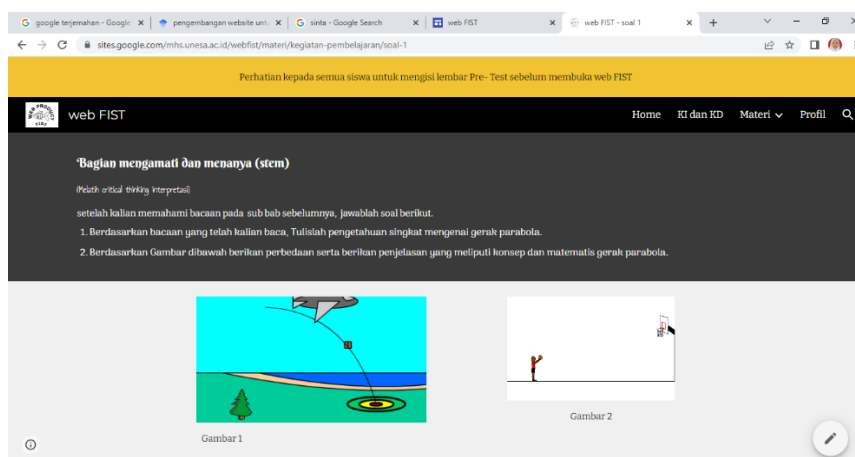

Figure 3. *Web* STEM Screen

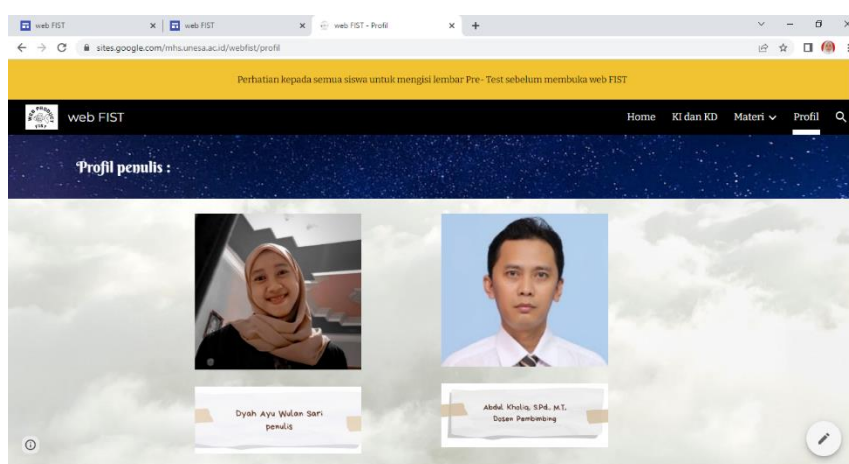**Figure 4.** Critical Thinking Section Web View

Figure 5. Profile view

Based on the data obtained, the Web-FIST (STEM-Based Physics web) has the following validity data.

Table 4. Web-FIST validation results

Aspect	Total	Percentage	Criteria
The suitability of the learning Web system	43	89	Very valid
Authenticity of Content on Web-FIST	23	95	Very valid
Web-FIST Suitability with Aspects of the STEM Approach	32	100	Very valid
Web-FIST Compatibility with Critical Thinking Skills	21	87	Very valid
Suitability of the Material with the Nature of Physics	15	93	Very valid
Competency Match	45	93	Very valid
Avarage		92.83	Very valid

According to the data obtained, table 3 shows that the Web-FIST (STEM-Based Physics web) shows validity in several aspects. 1) The suitability aspect of the web system is 89% with very valid criteria, 2) the truth of the content of the material is 95% with very valid criteria, 3) 100% STEM approach aspect with very valid criteria, on the aspect 4) 87%

critical thinking suitability with very valid criteria, in aspect 5) the suitability of the material with the nature of physics is 93% with very valid criteria, in aspect 6) the suitability of competency standards is 93% with very valid criteria, and the resulting average is 92.83% with very valid criteria.

Table 5. Results of the Effectiveness of Critical Thinking Students

Components	Score	
	Pretest	**Posttest**
Lowest Score	40	70
Highest Score	70	100
Average	59,2	83,8
N-gain	0,60	
Category	Currently	

According to the results obtained, the N-Gain score obtained from the increase in critical thinking skills of Web-FIST Students are specially designed to promote student critical thinking about parabolic motion topics properly. From table 5 the N-Gain value is 0.6 which is categorized as currently according to the interval table (Hake in Apriyana et al., 2019). Web-FIST media can train critical thinking skills seen in the increase in students' posttest scores.
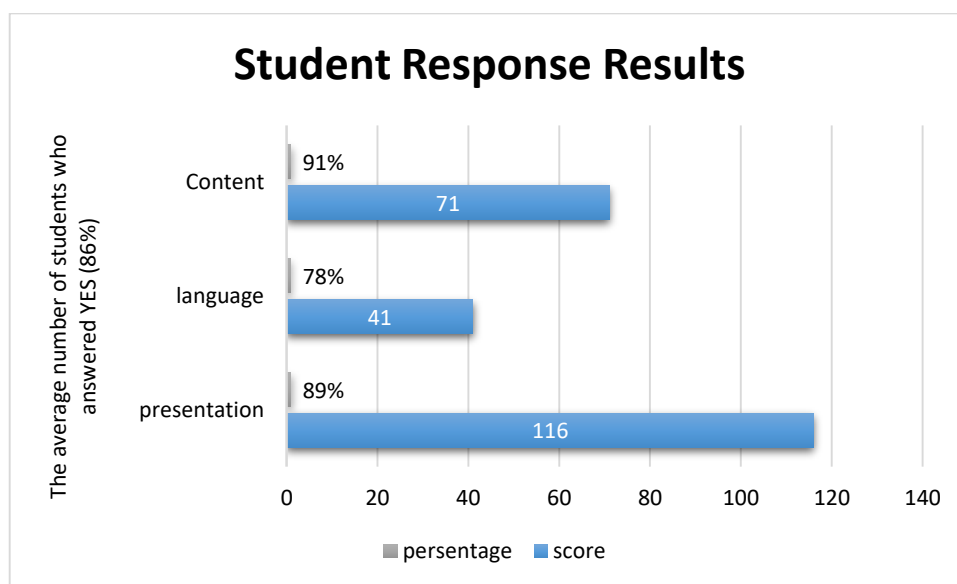

Figure 4. Effectiveness Response Results

According to the results obtained, it shows that 86% of students think that Web-FIST (STEM-Based Physics web) is not difficult to operate, besides that the data results show effectiveness in several aspects, namely aspects of presentation, language, and content. In the presentation aspect, which includes display problems, and media content such as videos and animations, students answered "Yes" with a percentage value of 89%, proving that the presentation aspect was interesting according to students. In the linguistic aspect, including the problem of writing sentences or several statements, it shows a percentage value of 78% with 41 children answering "Yes". In terms of content, including learning activities based on STEM, they can train their ability to understand, analyze, and conclude 71 students answered "Yes" with a percentage value of 91%.

This is in line with (Arsi, Febrianti., 2014), that research "Development of Web-Based Physics learning media for Class X High School on the subject of dynamic electricity" the website can be used in class X physics learning, and the site itself can be utilized as a

learning asset. students and the website has met the material eligibility requirements of 91.35% and 83.8% of media, it can be interpreted that the website is very worthy to use. And several of these studies are supported by (Sania, and Kholiq., 2021). Website development media is very effective for learning physics face-to-face or online, as well as the aspect of increasing students' critical thinking. According to (Sujanem et al, 2009) the use of Web-FIST can be utilized as a learning medium that can be accessed easily by students anywhere and anytime.

CONCLUSION

Based on the results of the above analysis and discussion, the Web-FIST (STEM-Based Physics web) can conclude to practice students' critical thinking on the topic of parabolic motion is declared feasible because 1) The results of the Web-FIST media validation assessment get an average value of 92.83% and categorized as very valid, 2) Results of web-FIST effectiveness assessment media through of the N-Gain calculation obtained an interval value of 0.6 which was categorized as moderate, while from the assessment of student responses an average value of 86% was obtained in the very effective category.

RECOMMENDATION

Web-FIST media can be used as a learning medium to display parabolic motion material. This media helps train students' critical thinking based on the STEM approach, and the media can be tested using a wide scale.

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