Web-Based Window Shopping: A Learning Model in High School's Mathematics Curriculum

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***Abstract* – The post-pandemic adaptation demands technological innovations in sustainable learning to support mathematics curriculums. This research aims to develop the Web-based Window Shopping (WBWS) in high school mathematics curriculum with ADDIE procedure. The data were collected through interviews, questionnaires, and tests. The stages of research comprised analysis, design, development, implementation, and evaluation. The experts' validation test results showed that the aspects of materials and medium achieved an average score of 82,75%. Meanwhile, the trial test results showed that the developed WBWS is worth implementing, with the average percentage of effectiveness reaching 83,33%. The results suggest that the creation of WBWS as a web-based learning model for mathematics curriculum is not only feasible but also meets the educational needs of high school students. Teachers and students can use this web-based learning model as an alternative for implementing the independent curriculum on mathematics learning.**

***Keywords* – Window shopping, web-based learning, mathematics curriculum.**

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1. Introduction

Implementing Indonesia's Kurikulum Merdeka (Independent Curriculum) has brought significant change in the mathematics curriculum in schools. The national assessment remodeling as a minimum competence assessment positively responds to mathematics curriculum remodeling in schools [1]. Dynamically, the change will affect students' critical thinking and ability to solve mathematical problems [2], [3], [4], [5]. It supports a learning process in which the teachers focus on the student's thinking process [6], [7]. In its development, the remodeling comprised the selection of interactive-learning strategies adopted by teachers in teaching mathematics [8]. Therefore, it is essential to encourage various learning innovations in mathematics curriculums [9], [10], [11].

Various learning innovations in mathematics curriculums operate through the development of mathematics learning media [12], [13], [14], [15]. Qohar *et al*. [12] developed an Android-based game application for mathematics learning to support the implementation of a mathematics curriculum. Asmianto *et al*. [13] developed an Android-based e-module for learning trigonometry. Moreover, Setiyani *et al*. [14] designed an e-module using the Kvisoft Flipbook Maker application to support students' creative and mathematical thinking. Furthermore, Florensia & Suryadibrata [15] developed a visual mobile game to increase students' interest in mathematics and promote independent and accessible learning.

One of the innovations of the learning model in mathematics curriculum is a web-based learning media. The web can effectively improve students' learning output [16], [17]. The digital integration between the web and the teaching-learning process facilitates mathematical knowledge assimilation and skill development.

This learning media can motivate students, facilitate materials delivery, engage learning atmosphere, provide a more efficient learning duration, improve learning quality, promote more flexible learning, and increase students' experience [18]. The media application in this learning process can provide a stable learning condition, make the learning activity more effective, and increase students' motivation. As a result, they can solve mathematical problems and elaborate their reasons virtually [19].

According to previous research and renovation of the mathematics curriculum in Indonesian secondary schools, web-based learning remains significantly underutilized. Moreover, the rapid post-pandemic development of information technology caused a transition in web-based mathematics learning during the implementation of independent curriculum. Meanwhile, students will need technological and mathematical skills for future careers [20]. Therefore, developing a web-based mathematical learning model is essential to implement the recently-remodeled mathematics curriculum.

2. Method

In this research, the development of WBWS in mathematics learning applied the modified ADDIE-modeled research and development [21]. The stages of research comprised analysis, design, development, implementation, and evaluation.

This research was conducted in high schools in Malang Raya and Universitas Muhammadiyah Malang (UMM), Indonesia. The subjects were the lecturers of the Mathematics study program of UMM, materials and learning media experts, teachers, and high school students. The students who participated in the trial test had different levels of mathematical skills. They were classified into high-skilled students, moderate-skilled students, and low-skilled students. This research aimed to identify the effect of WBWS on students with different levels of mathematical skills and their responses.

The data were collected through interviews, questionnaires, and tests. After finishing the trial test, the students were given a questionnaire. The questionnaire consisted of questions with the following indicators: the design of the learning medium is attractive; the convenience of using the learning medium; this medium facilitates the mastery of materials; the animation in the medium helps students to understand the materials; this learning medium motivates the students to learn the linear equation and linear inequality in one variable; the materials presented in the medium are easy to understand; the presentation of the materials in the medium helps the students answer the problems; the examples given are relevant to the materials; the font's style, model, and size used are simple and readable.

The quantitative data in this research were obtained from the validation sheet's calculation results of the developed learning media using the expert test with a 4-point Likert scale. The scoring comprised four aspects, with 4 for very good, 3 for good, 2 for fair, and 1 for poor. In the next step, the data were calculated using the following percentage:

$$P = \frac{(\sum X)}{N} \times 100\%$$

Notes:
P = score percentage
N = maximum score
$\sum X$ = number of answer scores

Developing the WBWS learning model is considered "feasible for the field test" if the experts state it as "valid" based on the assessment in the validation sheet. The criteria for validity are in Table 1.

Table 1. The validity criteria of the learning model

Percentage	Category
75 – 100	Valid/Feasible
50 – 74	Moderately Valid/Moderately Feasible
26 – 49	Less Valid/Less Feasible
< 26	Not Valid/Not Feasible

3. Results

Every stage of this research results applies the steps of the ADDIE model, comprising analysis, design, development, implementation, and evaluation. Below are the descriptions of the best results of each adopted stage.

Analysis

In this stage, the authors aimed to collect information regarding data collection in high schools, the availability of hardware and software, and the observation of existing learning models. The collected data were used to develop the WBWS learning model.

Furthermore, the authors analyzed the requirement to design the website. The analysis was initiated by conducting interviews with mathematics teachers in Malang Raya. The results showed that the learning model needed to be more frequently applied. The teachers were accustomed to using the lecture method. Moreover, they rarely used web-based learning media. They reported that students often needed help solving mathematics problems regarding linear equation and linear inequality in one variable due to low levels of critical thinking. The students needed help to convert mathematical problems to mathematical models.

Besides interviews, the authors conducted a document study by collecting information regarding the availability of hardware (laptop/computer) and software (the Internet). Most of the high schools in Malang Raya have proper computer laboratories and internet facilities. These infrastructures were significantly helpful for the research.

Design

The information from the analysis stage was used to design the WBWS learning model. The product designs are shown in the Figure 1 to Figure 4. The homepage consists of a login form for registered students. Initially, the students were asked to input their email addresses and password on the available panels.

Figure 1. Storyboard of login page

Figure 2. Storyboard of homepage

On the homepage, there are several headers, including "HOME" for returning to the homepage and providing instructions as shown in Figure 2, "COURSES" for displaying learning materials for the topics of internal and external tangents to two circles, "PRACTICE" for displaying problem examples, "PRODUCT" for displaying the menu of uploading product, "MALL" for displaying online shops where students can upload their products (work results) and comment on each other's products, and "ABOUT for displaying information about the researchers and developers.

In the "PRODUCT" header, a math problem is displayed, and students are tasked to solve it. They can submit their works by clicking the "UPLOAD" panel at the bottom part of the page, as shown in Figure 3.

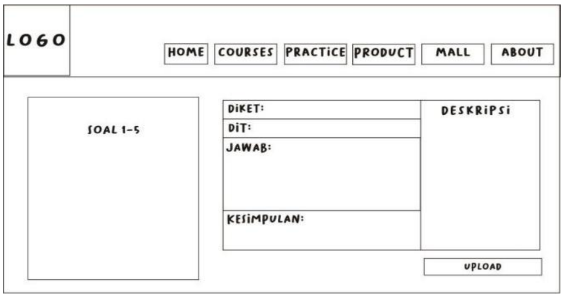

Figure 3. Storyboard of PRODUCT header

In the "MALL" header, the uploaded works are displayed. The product image and description will appear on the screen if a work is clicked. The description comprises an explanation of the problem-solving process and a comment section, as shown in Figure 4.

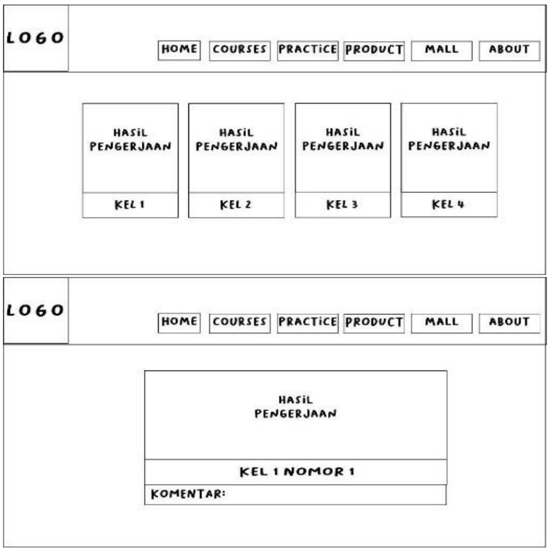

Figure 4. Storyboard of MALL header

Development

In this stage, the WBWS learning model was examined. Students clicked the Create New Account button on the login page and filled in their name, email, username, and password, as shown in Figure 5.

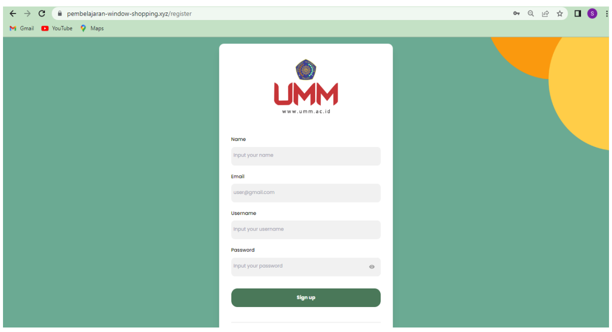

Figure 5. Create new account

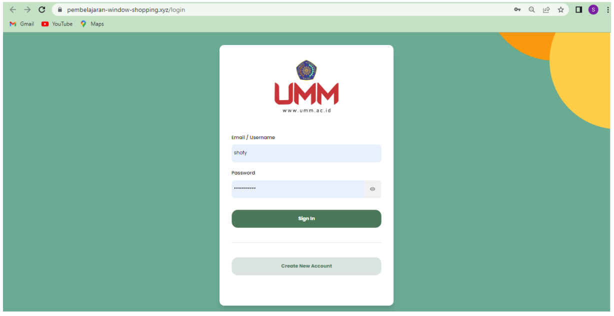

Figure 6. Sign in

Students logged in with existing accounts by filling in their credentials and clicking "Sign In," as shown in Figure 6.

The students were provided with several menus on the homepage, including HOME, COURSE, PRACTICE, PRODUCT, MALL, and ABOUT, as shown in Figure 7. The "HOME" header contains a website user guide, as shown in Figure 8.

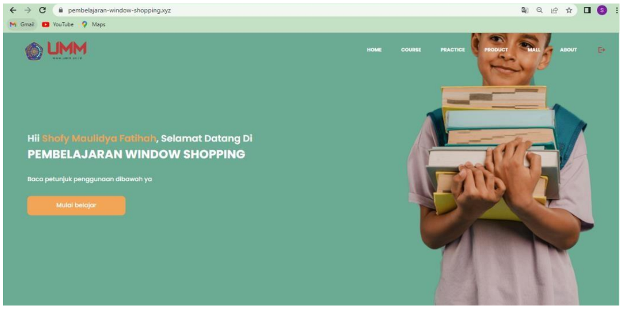

Figure. 7. Home

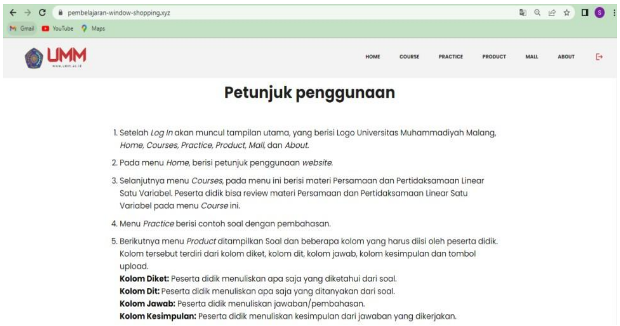

Figure 8. User guide in home menu

Furthermore, in the "COURSE" menu, as shown in Figure 9, students discovered the basic competence and learning objectives and materials. The linear equation and linear inequality in one variable topic were presented as learning videos. The videos, as shown in Figure 10, comprise five discussion videos. The first video discussed the definition of linear equation in one variable; the second video discussed the solving of linear equation in one variable; the third video described the application of linear equation in one variable in math problems; the fourth video elaborated the solving of linear inequality in one variable; and the last video discussed the application of linear inequality in one variable in math problems.

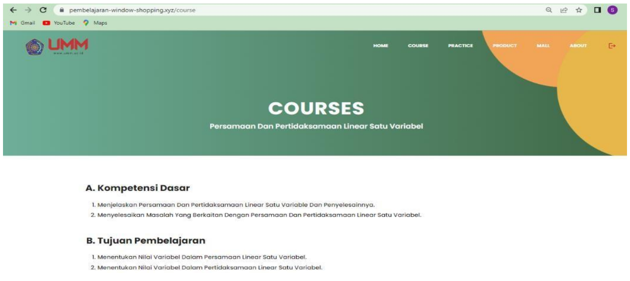

Figure 9. COURSE menu

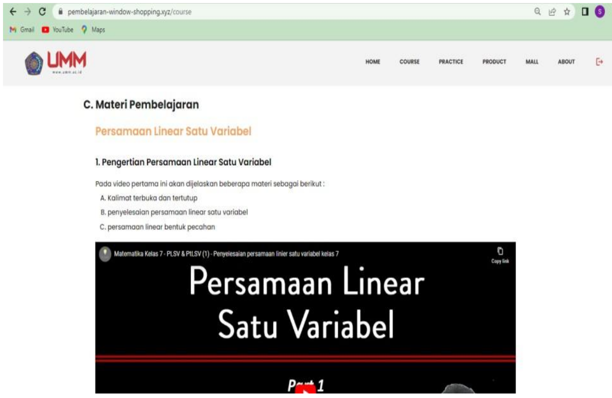

Figure 10. Learning material in video

The following menu is "PRACTICE," as shown in Figure 11. Where, students are able to study the examples of math problems and their discussions on the topics of linear equation and linear inequality in one variable.

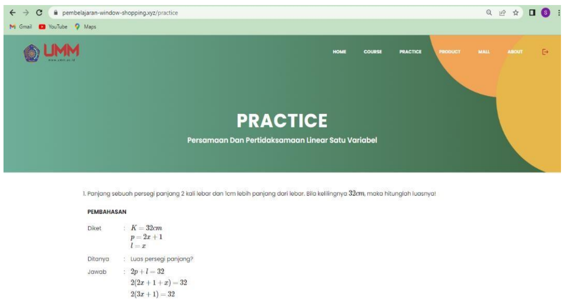

Figure 11. PRACTICE menu

In the "PRODUCT" menu display, as shown in Figure 12, the students filled in their group and member names and clicked the "Start Working" button.

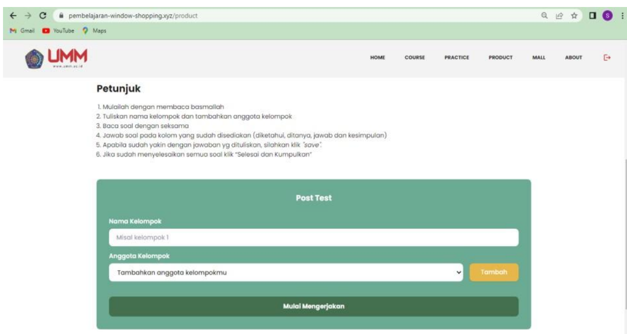

Figure 12. PRODUCT menu

Afterward, the students located the questions on the left side of the screen and columns of answers comprising key details, objective, answer, and conclusion on the right side. They found the same answer format for each question after they reached the last question. After answering the last question, they had to click the "Finish and Submit" button to upload their product, as shown in Figure 13.

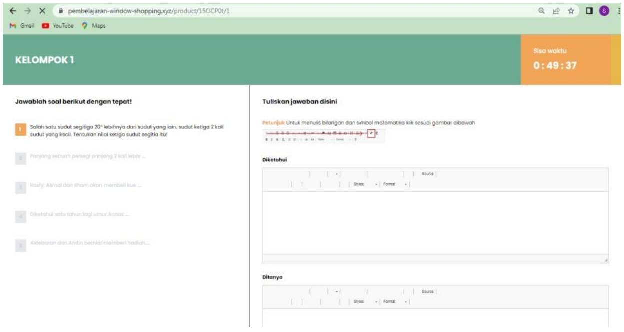

Figure 13. PRODUCT menu in the math problem-solving

After uploading their products, students could see the results in the MALL menu. In this menu, the task results were submitted in groups. The display of the menu is shown in Figure 14.

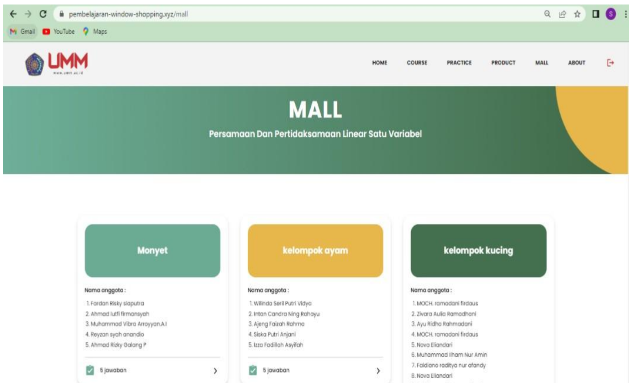

Figure 14. MALL menu

Once one of the groups' icons was clicked, the results were displayed, and students were allowed to post comments, ask questions, and give suggestions on each answer, as shown in Figure 15.

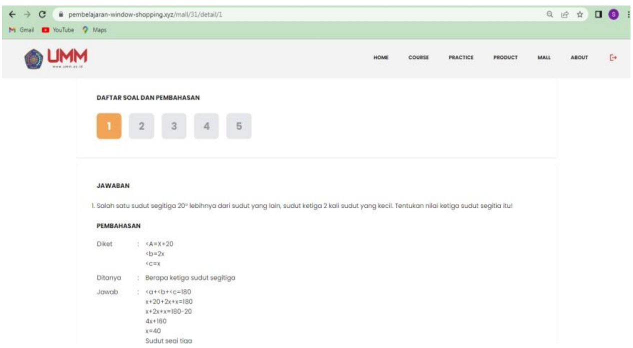

Figure 15. Students' work results in MALL menu

Moreover, the medium was validated by the lecturers of the Mathematics study program of UMM and high school mathematics teachers. The validators assessed the medium and provided suggestions to be used as references to improve the media before implementing it in class. Three lecturers validated the website, and the validation aimed to assess the developed website's quality, feasibility, and validity. The validation was conducted by filling out a questionnaire. Table 2 presents the results.

Table 2. Expert validation score

Indicator	Average Score
Aspects of the Materials	
Conformity between the materials and the basic competence	3.33
Conformity between the materials and the learning objectives	3.33
Scope of materials	2.67
Comprehensibility of the materials	3.33
Relevancy of the examples	3.67
Conformity between the questions and the materials	3.33
Conformity in the presentation of materials order	3.00
Conformity in the presentation of questions order	3.00
Conformity in materials supporting students' mathematical skill	3.00
Conformity in questions supporting students' mathematical skill	2.67
Aspects of the Medium	
Accuracy of font type	4.00
Accuracy of font size	3.67
Accuracy of font color	4.00
Readability of font color	4.00
Readability of script	4.00
Accuracy of language use	3.33
Clarity of the language	3.00
Congruence of color selection	3.67
Accuracy of image application	2.67
Accuracy of image layout	2.67
Accuracy of background selection	4.00
Convenience of navigation use	3.33
Accuracy of navigation layout	3.33
Accuracy of the navigation function	3.00
Conformity of media design	3.00
Convenience of media use	3.67
Medium's Effectiveness in supporting students' mathematical skill	3.00
Average Score	3.31
Score Percentage	82,75%

Based on the Table 2, the website validation results indicate a percentage of 82.75% and thus are valid and feasible to be tested on the students.

4. Discussion - Implementation

The step of implementation was conducted after the expert validation met the criteria. The WBWS medium was revised based on the experts' inputs. Afterward, the students participated in testing the medium. The students' mathematical skills ranged from high, moderate, and low. The medium was tested during an actual situation in the classroom. Meanwhile, the steps of the learning model were adjusted for online learning. The adjustment comprised: (1) the teacher formed several small groups and distributed the results in the website's user guide; (2) the teacher distributed the questions to all groups and displayed them on the website; (3) the teacher provided breakout rooms in Zoom to facilitate students in discussion and joined all the rooms to assists the students; (4) each group uploaded the work results to the website and they were assumed to open a shop; (5) the group members had individual tasks, such as monitoring the tasks submitted by the other groups and their own group and they were assumed to visit other shops and take care of their own shop; (6) students who were assigned as shopkeepers were asked to elaborate their works to the other visiting groups' members by replying the comments regarding their works and finally they formed a peer tutoring; (7) students assigned to visit other shops were entitled to obtain explanation and provide suggestions to other groups in comment section of the website; (8) after all the activities were done, the students returned to their rooms; (9) the students exchanged information based on their visit; (10) the teacher entered the rooms separately, checked the answers, corrected several issues, and commented on the groups' work results; (11) the teacher and students joined the main room and the teacher provided the students with feedbacks and corrections; (12) to assess their understanding, the students were individually tasked with the same questions that all groups received in the website.

After using the website, students were asked to complete a questionnaire regarding their opinions on using the WBWS medium. The results showed that the responses reached the percentage value of 83,33%. According to Table 1, WBWS is a valuable and effective tool for student use. The indicator of the questionnaire comprises: 1) the design of the learning medium is attractive; (2) the convenience of using the learning medium; (3) this medium facilitates the mastery of materials; (4) the animation in the medium helps students to understand the materials; (5) this learning medium motivates the students to learn the liner equation and linier inequality in one variable; (6) the materials presented in the medium are easy to understand; (7) the materials presentation in the medium helps the students answer the problems; (8) the examples given are relevant to the materials; and (9) the font's style, model, and size used is simple and readable.

Evaluation

In the ADDIE development model, the evaluation stages include formative and summative. The first one was conducted once a week when a stage was finished, and the latter was conducted at the end of the activity. Summative evaluation is the last step to measure the objectives. The evaluation results serve the purpose of offering valuable feedback that informs significant revisions.

The WBWS medium was improved based on expert validation and student trial. Moreover, its strengths and weaknesses were evaluated for sustainable improvements. The strengths include easy access from students' computers or smartphones, independent learning activities through personal accounts, and features supporting group tasks on mathematical problems and equations. Thus, this medium is practical in mathematics learning.

Window shopping as a group-based learning model allows students to increase their knowledge [22], [23]. Mustopa *et al*. [24] stated that as a learning model, window shopping helps students discover new insights and memorize real experiences. It significantly affects high school students' mathematical creativity [25].

The development results of this research confirmed that the previous researches conducted by Lin *et al*. [26], Azid *et al*. [27], and Aboraya [28] stated that web-based learning could be implemented in class and improve students' mathematical achievement and problem-solving skills. In addition, Le Phicon *et al*. [29], Sugiharni *et al*. [30], and Lisnani *et al*. [31] emphasized that a web-based learning environment supports students' learning process and positively affects mathematics teaching and learning. Moreover, Kefalis & Drigas [32] explained that through a web-based application, communication between students and teachers becomes synchronized, thus encouraging collaboration.

5. Conclusion

This web-based mathematics learning is ideal for teachers and students in high schools. The development of web-based learning is selected as one of the alternatives for learning model innovations in high school mathematics curriculums. Based on the validation results by the medium and materials experts, mathematics educators, and students' responses, the development of web-based window shopping is valid, effective, and feasible as a learning model in high school's mathematics curriculum.

From the validation results, further development is required, potentially using alternative models like online quizzes registered on the Play Store. This approach aims to ensure accessibility for all students.

The results of this development have a good influence on mathematics education in Indonesia because it provides opportunities for students to discover creativity and new activities. The development results can be used as a reference for teachers or policymakers regarding implementing mathematics learning. Teachers and students can use this web-based learning model as an alternative for implementing the independent curriculum on mathematics learning. In addition, this media can be used as a medium to ignite students' understanding and creative activities.

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