The development of ecosystem education game based on Baluran National Park for senior high school

D Alvionita[1], W Subchan[1] and M Iqbal[1]

[1]Department of Biology Education, University of Jember, Kalimantan Street No. 37 Jember, East Java, Indonesia

Email: Devialvionita.da@gmail.com

Abstract. This is a development research, as a contribution to answer the challenges in education field in this global era where technology is developing very rapidly. The purpose of this research is to develop learning media for senior high schools in the form of educational games based on Baluran. The subject matter of the media is the ecosystem. The methodology used is the 4D Model. The stages of the 4D model include define, design, develop, and disseminate. This research is currently at the develop stage, that is media trials on a small group scale. The results of quantitative analysis of the media validity showed an average 89.25% with very valid category. Based on these results, the learning media is Educational Game of Baluran National Park Ecosystem for senior high schools, can be used at the next stage, namely media trials on a large group scale and to determine the effectiveness of the media on the learning process in subsequent research.

1. Introduction

The aspiration of the nation to become an industrialised society depends on various fundamentals in the fields of science and technology. The success in one's achievement can be planned ahead of time as to lead the nation into comprising of a plural society with global knowledge [1]. With increasing knowledge and technological progress of society, our country requires learning skills that could help it keep pace with the development of science and technology. Education in the twenty-first century is the center from which all changes and developments arise [2]. Educational system plays crucial role on the development of nations, and the impact of early education empower knowledge acquisition [3]. Information technology in education needs a culture. This culture needs to be learned along with the use of hardware resources [2].

In line with this, the Biology curriculum and syllabus are designed to create a scientifically and technologically oriented students and later, workers. Important components contained in science subjects like Physics, Chemistry and Biology include the aspects of doing experiment. As students embark on the process of doing experiment in the lab, they have to face some constraints such as safety, time and cost. Due to these obstacles, some topics in Biology in which experiments are part of, have not been done at school [1].

Baluran National Park is one of the first five National Parks in Indonesia and considered as National Park in 1980 coincided at the World Conservation Strategy Day. Baluran National Park is located in Situbondo, East Java, and often called as 'Africa van Java' because it has savanna as major natural resources [4]. Therefore, Baluran National Park is often a target place for conducting field studies related to ecosystem material.

The results of interviews conducted by researchers with several biology teachers are that field studies have not been conducted related to ecosystem materials, monitoring of ecosystem materials only occurs with observations in the school environment, field studies related to ecosystem materials are needed, and It would be very good to develop interactive learning media such as educational

games that are specifically intended to advance ecosystem material that focuses on the introduction of ecosystem characteristics such as the characteristic of Baluran National Park ecosystem.

Serious Games have already proved their advantages in different educational environments [5]. The use of games in software engineering education is not new. However, recent technologies have provided new opportunities for using games and their elements to enhance learning and student engagement [6]. The use of serious games to support learning continues to expand across a range of educational and training settings [7]. Serious games involve applying game design techniques to tasks of a serious nature. In particular, serious games can be used as informative tools and can be embedded in formal education [8].

The interest in the use of serious games as learning resources for software process standards education and training has increased significantly in recent years. Serious games have potential as supporting tools for software process standards education, but that more research and experimental outcomes are needed in order to observe the full potential of serious games as learning resources [9]. Serious games have increasing popularity for training or educating individuals [10]. As argued based on another research, that the use of Baluran National Park as the basis of the game had a significant impact in improving students' skill of creative thinking [11].

2. Method

The methodology used is the 4D Model. The stages of the 4D model include define, design, develop, and disseminate. This research is currently at the develop stage, that is media trials on a small group scale. The define stage is the first stage, which is to determine the needs analysis [12]. The second stage is design [12]. Design is the stage of preparation to produce products that are ready to be validated. The design stage consists of formatting media designs, collecting media data, completing media layout designs, and creating the media that are ready to be validated [13]. The third stage is develop. Develop stage consists of media validation, media trials on a small group scale, and media revisions [14]. The media are validated by several experts, they are material expert, Baluran National Park ecosystem expert, learning media expert, and user expert (teacher). The media trial is conducted by nine students in the 4 Senior High School of Jember, with randomly selected. The revised material is obtained from the analysis of qualitative data that are from the result of media validation and media trial.

2.1. Data Analysis

Data collection techniques in this study are literacy studies, interviews, and direct observation in the field. The results of data obtained are qualitative and quantitative data. Qualitative data are obtained from the validator's comments and suggestions, while quantitative data are obtained from four levels of assessment with the criteria in Table 1. The validation criteria are as follows:

Tabel 1. Value of validation criteria

No.	Score	Description
1	4	If the validator gives a very good value
2	3	If the validator gives a good value
3	2	If the validator gives an enough good value
4	1	If the validator gives a bad value

Quantitative data obtained were analyzed using a four-degree percentage analysis technique. The data processing formula for each aspect assessed is as follows.

$$Pi = \left(\frac{xi}{yi}\right) \times 100\% \tag{1}$$

The data processing formula for all aspects assesed is as follows.

$$P = \frac{\sum_{i=1}^{n} xi}{\sum_{i=1}^{n} yi} \times 100\% \qquad (2)$$

Where :

P : The percentage value of all aspects (%)
Pi : The percentage value of the i aspect
Xi : The number of answers from the validator for the i aspect
Yi : The maximum number of values for the i aspect
n : aspects
I : 1,2,3,....n [15]

The results of qualitative data analysis are then converted to descriptive quantitative data, with processing the validator assessment results in the form of percent and then adjusting the validation criteria [16].

Tabel 2. The criteria of aplication validity

No	Validity Range	Validity Category	Conclusion
1.	$85{,}01\% \le vv \le 100\%$	Very Valid	Can be used without revision
2.	$70{,}1\% \le ev \le 85{,}00\%$	Enough Valid	Can be used with a minor revision
3.	$50{,}1\% \le lv \le 70{,}00\%$	Less valid	Recommended not to use because needs a major revision
4.	$01{,}00\% \le nv \le 50{,}00\%$	Not Valid	Should not be used, it needs a major revision

After validation process, if the score achieve 70,1% the development of media learning product can be arranged further.

3. Result

The 4D model as a model on development research method is not new in the field of education. For example, the 4D model is often used to develop learning media. The stages in 4D model are define, design, develop, and disseminate. This research is using the 4D model and currently on the develop stage that is a media trial on a small group scale. Define stage is to determine of needs analysis [12]. The steps of define stage are preliminary analysis, concept analysis, curriculum analysis, student analysis, and formulating objectivity. Data collection methods that used at the define stage are literacy studies and interviews.

The results of interviews conducted by researchers with several biology teachers are that field studies related to ecosystem materials have never been conducted, observation activites of the ecosystem materials only occurs in the school environment, field studies related to ecosystem materials are needed, and it would be very good to develop interactive learning media such as educational games that are specifically intended to advance ecosystem material that focuses on the introduction of ecosystem characteristics such as the characteristic of Baluran National Park ecosystem.

Biology is one branch of science that has the character in learning it is not enough knowledge but demands to be applied in everyday life so that helps humans get prosperity. Studying biology is not just gaining knowledge about living things, but also getting knowledge about methods of practicing this knowledge [18].

Serious Games have already proved their advantages in different educational environments [5]. The use of games in software engineering education is not new. However, recent technologies have provided new opportunities for using games and their elements to enhance learning and student

engagement [6]. The use of serious games to support learning continues to expand across a range of educational and training settings [7].

Based on this, as a series of processes for preliminary analysis, researchers aim to develop learning media in the form of educational games. This stage consist of concept analysis, curriculum analysis, and student analysis [13]. Concept analysis is to determine the material concept of the product to be developed [13]. Based on interviews conducted, researchers determine ecosystem material as a concept for developing media. The media developed by researchers is an ecosystem education game.

The next step is concept analysis. Concept analysis is to determine the material of the product to be developed [13]. Based on the results of literacy and interviews with researchers, ecosystem material is a concept material for developed learning media. One of the locations in Indonesia that have high diversities of ecosystems and it is ideal as an object of research related to ecosystem material is Baluran National Park. Baluran National Park was one of the first five National Parks in Indonesia and was considered a National Park in 1980 to coincide on World Conservation Strategy Day. Baluran National Park is located in Situbondo, East Java, and is often referred to as 'Afrika van Java' because it has savanna as the major natural resource [4]. Therefore, Baluran National Park is often a target place to conduct field studies related to ecosystem material. Thus, the learning media that researchers have developed is an educational game ecosystem based on the Baluran National Park ecosystem.

The next step after concept analysis is curriculum analysis. Curriculum analysis is to adjust the material of the product that to be developed with the curriculum [12]. Ecosystem material is in accordance with KI 3.10 and KD 4.10 2013 curriculum with revision. Where, the current curriculum is the 2013 curriculum with revision, so it can be seen that the ecosystem material is in accordance with the current curriculum.

The next step after curriculum analysis is student analysis. Student analysis is to determine the subject of the learner or population of research [12]. Ecosystem material on senior high school is for grade X students. The subject of the learner or population of this research is SMA Neger 4 Jember students for grade X. Several things are taken into consideration in terms of the selection of this development test place, that are 1) 4 Senior High School of Jember willing to be a place of research; 2) 4 Senior High School of Jember has never been a place for research trials in the development of leraning media, especially educational games; 3) equipment and places owned by 4 Senior High School of Jember are limited to only certain materials; 4) 4 Senior High School of Jember has adequate computer facilities so that it can support the implementation of product trials; 5) 4 Senior High School of Jember has never conducted a field study related to ecosystem material. The final step is to formulate goals as a result of the define stages. The second stage is design. Design is the stage of preparation to produce products that are ready to be validated. The design stage consists of formatting media designs, collecting media data, completing media layout designs, and creating the media that are ready to be validated [12]. The third stage is develop. Develop stage consists of media validation, media trials on a small group scale, and media revisions. The media are validated by several experts, they are material expert, Baluran National Park ecosystem expert, learning media expert, and user expert (teacher). The media trial is conducted by nine students in the 4 Senior High School of Jember, with randomly selected. The revised materials are obtained from the analysis of qualitative data that are from the result of media validation and media trial.

The learning media are validated by several expert, they are Baluran National Park ecosystem expert, ecosystem material expert, media expert, and user (teacher). The results of media validation produce two types of analysis, namely qualitative analysis and quantitative analysis. The results of the qualitative analysis will be used as material for media revision and the results of quantitative analysis will be confirmed and to find out the categories of developed media validity. The results of media validity in all aspects by Baluran National Park ecosystem expert reached 90% with a very valid category. The results of media validity in all aspects by material experts reached 90% with a very valid category. The results of media validity in all aspects by media expert reached 86.25% with a very valid category. The results of media validity in all aspects by user (teacher) reached 88.75% with a very valid category. Then, the results of media trials on a small group scale produce an average of

92.25% with a very valid category. The average results of overall media validity reached 89.25% with a very valid category. The result of Develop stage are shown on Figure 1. Quantitative Develop Stage Result and Tabel 3. Qualitative Develop Step Result.
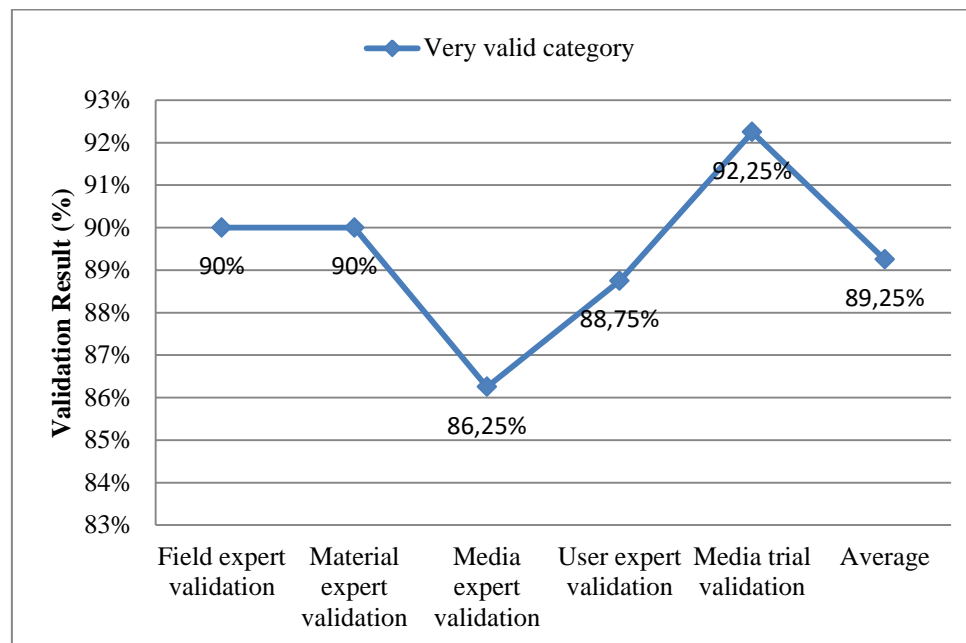

Figure 1. Quantitative Develop Stage Result

Tabel 3. Qualitative Develop Stage Result

Step	Intrument	Criticism and suggestion	Conclusion
Field expert validation	Instrument and rubric of field expert validation	For evergreen ecosystems it is better to show more flora species, so that they are more familiar with species diversity	Can be used with a minor revision
		A brief explanation was added related to endemic or exotic flora or fauna such as those found in savannah (Acacia nilotica) so that students could better understand	
Material expert validation	Instrument and rubric of material expert validation	The material is complete, but it is necessary to revise the picture that still looks similar, then for examples of flora and fauna given the final conclusions of the ecosystem presented	Can be used with a minor revision
Media expert validation	Instrument and rubric of media expert validation	The word "Trivia" is replaced by "Fact"	Can be used with a minor revision
		The map background menu should be changed to the road background	
		Fonts are made more popular	
User expert (teacher) validation	Instrument and rubric of user expert (teacher) validation		Can be used with a minor revision
Media trial small group scale	Student response questionnaire	The game is quite fun	
		The game is adding insight	
		I suggest an explanation in the game so that it is not too long to be easily understood and makes students not lazy to read, because today's millennials like texts that are not too long	

The results of the 4D stages that have been conducted are shown in Table 4. The Result of Research.

Tabel 4. The Result of Research

Stage	Step	Result	Conclusion
Define	Preliminary analysis	To Develop of learning media that appropriate and needed in this global era when technology is increasing rapidly	Define stage has been completed. The steps in the define stage are in accordance with literacy.
	Concept analysis	Ecosystem material	
	Curriculum analysis	Ecosystem material is in accordance with the current curriculum	
	Student analysis	Ecosystem material for senior high school in 4 Senior High School of Jember grade X	
	Objective analysis	The develop of learning media is ecosystem education game especially Baluran National Park ecosystem for senior high School	
Design	Storyboard design	Parts and components of the storydboard's framework included the media layout design using Microsoft Word	Design stage has been completed. The steps in the design stage are in accordance with literacy.
	Media manual book design	Manual book design framework including components, materials, and manual book layout design using Corel Draw 2018	
	Media data collection	The accumulation of all the data needed to create a education game as a learning media with its aspects and ready to use	
	Media design layout	Final design with all data collection ready to use for creating media includes photos and videos with the mobile phone application for editing process using Videoleap, Splice, and Quik	
	Design of the media	Using Corel Draw 2018 and Adobe Photoshop for design the picture with the animation, and using Adobe Flash CS 6 for create the educational game product, Final product as a *prototype* I	
Develop	Field expert validation	Very valid category (90%)	This research is currently at the develop stage, that is media trial on a small group scale. The media can be used to be continued at the next stages that are media trial at a large group scale to determine the effectiveness of the media and at the dissemination stage in subsequent research.
	Material expert validation	Very valid category (90%)	
	Media expert validation	Very valid category (86,25%)	
	User expert (teacher) validation	Very valid category (88,75%)	
	Media trial small group scale	Very valid category (92,25%)	

4. Discussion

4.1. Game content

Educative Game Criteria include; a. Learning 1) The program can be used for individual, small group learning. 2) The program has a clear topic. 3) The program has an appropriate approach and can adapt with students. b. Game content 1) The contents of the game has a correct and appropriate concept. 2) The program has material concepts. 3) The program has test questions; c. Interaction 1) The structure

of the program is flexible with users 2) The program has feedback on the input provided by the user; d. Feedback 1) Feedback is positive and does not discourage users. 2) Feedback is relevant to user response. 3) Corrective feedback. 4) Feedback has varied responses so it doesn't seem boring. 5) Feedback appears at the relevant time. 6) Feedback encourages children to try to get the right answer; e. Handling user issues can correct errors in input except the correct one [17].

Tabel 5. Game Content

Game Part	Describe
Game Introduction	The purpose of this game is to complate the section of "Book of collection" items. The items that must be completed on "book of collection" are collections of ecosystem characteristic on Baluran National Park, from doing adventure of the game.
	The main of the game play are just four stages from eight stages on this ecosystem education game. That stages are Season Forest Ecosystem for first stages, Evergreen Forest Ecosystem for second stages, Savana Ecosystem for third stages, and Mangrove Forest Ecosystem for fourth stages. Other stages are Ecotone Forest Ecosystem, Beach Forest Ecosystem, Coral Reefs Ecosystem, and Sea Grass Beds Ecosystem which are marely supporting material about the ecosystem information in Baluran National Park.
Abiotic Factor	At the beginning "To Know Abiotic Factor" sections, plotting activities are presented simply as a series of sampling technique activities in an ecosystem to know characteristics of the ecosystem.
	In this section, the available time is 5 minutes. Players will get extra points if they are able to finish before 5 minutes. The player must complete the measurement of the abiotic factor as an abiotic component using the tools that on the game provided. The tools are soil tester, thermohygrometer, anemometer, and lux meter. Abiotic factors that must be known by taking measurements using these tools are soil pH, soil moisture, air temperature, air humidity, wind velocity, and light intensity. For each activity that measures abiotic factors, the player is directed to use each tool step by step. Player is trained to always be thorough. Player is directed to read the tool and enter the number of measurements that have been made.
	If the player answers incorrectly during the process of entering the measurement results, there is a short notice that the player must re-enter the numbers correctly in accordance with the results.
Biotic Factor	Besides, at the beginning of the "To Know Biotic Factor" section, showed the flora and fauna that might be present in each ecosystem as biotic factors namely "Flora and Fauna". The aim of showing "Flora and Fauna" is as literacy material to read and recognize flora and fauna which can be used as material as objects that must be found in the next session.
	On the "To Know Biotic Factor" sections, player must be found one of nine until ten objects on page based on the scientific name's each object that showed with white color text continuously. Time is moving forward. If the player shows an object that does not match the white scientific name, the time will increase by 10 seconds.
	On the "To Know Biotic Factor" section, there are two help options, which in the first aid will reduce point 4 to see flora and fauna again with a maximum time limit of 10 seconds Then, second types assistance is to reduce point 2 to see 10 objects that must be present but only in the form of scientific names and local names with a maximum time of 10 seconds. After the player completes the "To Know Abiotic Factor" section and the "To Know Biotic Factor" section, the player is directed to follow the next session to watch a video about the ecosystem. The score will be showed and guide player to click "book of collection" button.
Evaluation	There are test questions related to the material obtained during the game. there are 20 test questions with 25 minutes available.

4.2. Learning Aspect

Knowledge space of a serious educational games (SEG) refers to all the relevant materials consisting of items to be learned by a player. Our framework considers the subjects in the low-level learning

category. Commonly, learners acquire this category of knowledge through recalling or repetitions. For instance, alphabet learning (i.e. visual appearances, pronunciations and constructions) by repeatedly looking at, listening to and trying to write them [19].

a) Individual learning

As a learning media for senior high school, the ecosystem education game is designed for individual learning with the purpose, students can learn independently and increase their curiosity to complete each exercise that have been provided. The core material about ecosystems is explained by the teacher in the learning process. The learning process uses this media is for supporting ecosystem material, which give the players some experience and introduce a simple field experiment about ecosystem material.

b) Material Concept

The media concept material consists of two types namely "To Know Abiotic Factor" and "To Know Biotic Factor". The first concept is "To Know Abiotic Factor" which is to know the abiotic factors in an ecosystem. There are several stages in the introduction of field activities including showed the introduction of plotting activities as a sampling technique and the introduction of measurement of abiotic factors in an ecosystem. The material learning contained in this concept is primarily to measure abiotic factors. Several measuring tools that are introduced by the media consist of 1) Soil tester to measure soil pH and soil moisture, 2) Thermohygrometer to measure temperature and humidity of the air, 3) Anemometer to measure wind velocity, and 4) Lux meter to determine the intensity of light. Also presents a description of these tools starting from photos and parts of the tool, the function of the tool, how to use the tool, and how to read the measurement results.

c) Evaluation

There are test questions related to the material obtained during the game. there are 20 test questions with 25 minutes available. In addition, the score details obtained from each stages in the game are presented. Also presente are the answer keys of the available test questions and the explanation of the answers between the players answering correctly or answering incorrectly on each test item. There are also help options when working on test questions, among others, there are 18 points that can be exchanged for help options. The forms of help options available are points owned by players, which can be exchanged by looking at ecosystem descriptions according to the number of points exchanged.

4.2.1. Game Content

Game content space of an educational game refers to all the playable games generated by an entertainment game engine to facilitate the learning defined via knowledge space for a player. Game content is known as elements and objects of a game that the player interacts during a game session [19].

a) Challenge

The challenges inherent in learning media include: 1) "To Know Abiotic Factor" section. Players must be able to complete all abiotic factor measurements in each ecosystem. The time available in this section is five minutes. If player is able to complete the measurement before time runs out, player will get an additional score. 2) "To Know Biotic Factor" section. Players must find the object image based on scientific names that are written in white. The seconds in this section go forward, who are able to finising the game faster more then five minutes, they will get an additional score. If the answer is wrong, the time will increase by ten seconds.

b) Strategy

In addition to completing challenges that players get at each stage, there are points that can be exchanged for help options so they need a strategy to finish the game well. Points and help options are available in the "To Know Biotic Factor" section where there are eighteen points that can be exchanged for two types of assistance. The first aid is by exchanging four points with the help of returning to see "Flora and Fauna" with a maximum time of ten seconds. "Flora and Fauna" contain the flora and fauna that may be present in the ecosystem, and are displayed in the form of original photos and scientific names and local names of each flora and fauna. The second aid is to exchange

two points for assistance in the form of seeing the scientific names and local names of all object sought in the ecosystem with a maximum time of ten seconds. The strategy that needs to be set by the players in this section when experiencing difficulties is to consider carefully the loss of points with the assistance obtained, where the maximum time to see help is ten seconds and if the player answers incorrectly, the time will increase by ten seconds.

4.2.2. Feedback and Interaction

The feedback contained in this learning media are diverse, accurate and in accordance with the response given by the media to player input. The feedback contained in this media among others are 1) in the section "To Know Abiotic Factor" where if the players enter the measurement results are still not right there is no reduction in the score, there are sentences to continue to try to answer correctly. Thus, feedback of this type will not make students give up and become discouraged. 2) in the section "To Know Biotic Factor" there is the concept of increasing time if the player answers wrong where, the concept of time in this section is seconds of time progressing. This can increase the enthusiasm of students to compete in order to be able finish the game quickly and do not have to add time when they have answered incorrectly.
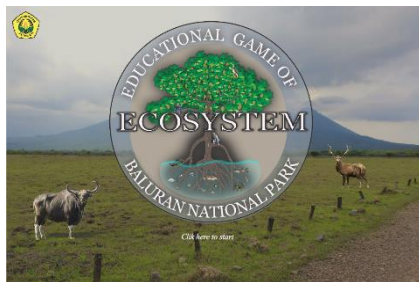

Figure 2. Game Introduction On the opening page, that is the starting page when the media "Educational Game of Baluran National Park Ecosystem" is opened. It will appear the media's logo image and Jember University's logo image. If the text of "click here to start" has been clicked, it is guide player to start playing the game.

Figure 3. Part of Abiotic Factor In addition, informations about the tools such as functions, parts, and how to read the measurement results of the tools are considered for each stage on the "Instruction" button for helpful instructions.
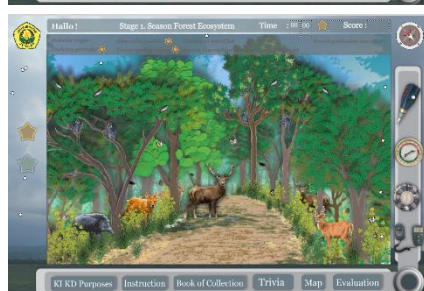

Figure 4. Part of Biotic Factor The special thing in this section, there is star-marked objects, where if the object is found, a brief description and classification will appear regarding the object. The star-marked object may be endemic flora and fauna or unique to the ecosystem.

4.2.3. Media Manual Book

Media manual book is used to facilitate users they are teacher, to apply the media during the learning process. The media manual book contains brief descriptions and parts of the media, simple platform specifications that can be used to install media, how to install media, material contained in the media, test questions and answer keys contained in the media, score details, and lesson plans as plans implementation of media learning when used in the learning process in class.

4.3. Media Trial

At the beginning of the learning process, the teacher gives an opening greeting as well as an introduction. The teacher gives an explanation related to the learning objectives and activities to be carried out. The learning media used is educational game. The teacher gives an explanation related to educational game. Students listen to the teacher's explanation carefully. The learning process using the educational game learning media runs smoothly. The students look focused and concentrated while the learning process using learning media took place. Some students raise their hands when they want to ask something. Class conditions can be well controlled and students are not noisy during the learning process. The students complete each exercise contained on the learning media independently.

The learning process uses learning media Educational Game of Baluran National Park Ecosystem trains students to learn more independently. In the learning media there are instructions and explanations at each stage so that students can easily follow each instruction and able to solve each problem on their own. The use of language contained in the media, uses Indonesian which is the national language so that it is easy for students to understand. Some of the concepts contained in the media to improve student independence during the learning process include 1) There is a "Instruction" button as a help button that contains game instructions such as the stages to be followed during the game, description of measuring tools available in the game, concepts and rules prevailing during the game, and displayed with pictures and their explanations. 2) In the evaluation section, there are detailed scores, the results of the answers to the test questions and the answer keys so that students are able to evaluate themselves independently.

Other concepts contained in the media are to increase student enthusiasm and pleasure when learning by using learning media in the form of educational games, learning materials can be packaged more interestingly, using semi-real animation concepts, displaying real photos and videos related to the material presented, and accompanied by a pleasant educational game's backsound does not make discordant when heard by the player. Learning to use educational game learning media gives students an extraordinary and memorable experience. A simple simulation of introducing field activities related to ecosystem material is presented, for example the measurement of abiotic factors. The introduction of activities to measure abiotic factors to determine the characteristics of an ecosystem, starting from the sampling technique that is plotting technique and the introduction of measuring instruments used ranging from description, how to use, and how to read the measurement results. Based on the results of researcher's interviews with several Biology teachers, field activities in the fulfillment of ecosystem material have never been conducted and only make observations in the school environment. The introduction of field activities contained in the media, will provide a memorable experience, moreover not all schools have tools such as those found in learning media in an effort to fulfill the ecosystem material.

The results of media trial on a small scale group show the level of media validity from the average of students response is 92.25% with a very valid category. The following is an analysis of media validity, this media namely Educational Game for Baluran National Park Ecosystem as a learning media is very valid. The next stage is the develop stage, which media trial at a large scale to determine the effectiveness of the media and at the last stage is the dissemination stage in subsequent research.

5. Conclusion

The 4D model as a model on development research method is not new in the field of education. The stages of the 4D model include define, design, develop, and disseminate. Stages of media development research using the 4D model have been carried out until the media trial process is on a small group scale. The results of data analysis show that the educational game, namely Educational Game of Baluran National Park Ecosystem as a learning media for high school is very valid and can be used at next stages that are media trial on a large group scale and to determine the effectiveness of the media at the develop stage and continued to the dissemination stage on subsequent research.

Acknowledgments

References

[1]   Muhamad M, and Ahmad A 2012 Virtual Biology Laboratory (VLab-Bio): Scenario- Based Learning Approach *Procedia - Social and Behavioral Sciences* **69** pp 162-168

[2]   Hamidi F, Meshkat M, Reazaee M, and Jafari M 2011 Information technology in education. *Procedia Computer Science* **3** pp 369-373

[3]   Kayimbasioglu D, Oktekin B, and Haci H 2016 Integration of Gamification Technology in Education. *Procedia Computer Science* **201** pp 668-676

[4]   Wianti K, 2014 Land Tenure Conflict in The Middle of Africa van Java (Baluran National Park) *ScienceDirect* **20** pp 459-467

[5]   Fernandez C, Cano A, and Morata A 2019 Lessons learned applying learning analytics to assess serious games *Computers in Human Behavior* **99** pp 301-309

[6]   Souza M, Veado L, and Moreira R 2018 A systematic mapping study on game-related methods for software engineering education *Information and Software Technology* **95** pp 201-218

[7]   Moizer J, Lean J, and Aquila E, 2019 An approach to evaluating the user experience of serious games *Computers & Education* **136** pp 141-151

[8]   Aydan U, Yilmaz M, Clarke P, and O'Connor R, 2017 Teaching ISO/IEC 12207 software lifecycle processes: A serious game approach *Computer Standards & Interfaces* **54** pp 129-138

[9]   Calderon A, Ruiz M, and O'Connor R 2018 A multivocal literature review on serious games for software process standards education *Computer Standarts & Interfaces* **57** pp 36-48

[10]   Menekse G, Cagiltay N, and Ozcelik E 2015 Personality Type Indicator Models in Serious Games: A case study in a Surgical Navigation Game *Information Technology Based Higher Education and Training (ITHET) IEEE International Conference* pp 1-4

[11] Putra P and Iqbal M 2016. Implementation Of Serious *Game*s Inspired By Baluran National Park To Improve Students Critical Thinking Ability *Jurnal Pendidikan IPA Indonesia* **5** pp 101-108.

[12] Karimah R 2014 Development of Physics Snake and Ladder Learning Media for Class VIII Junior High School / MTs Students *Journal of Physics Education* **2** pp 1-6.

[13]   Alfianika N 2015 *Research Methods of Indonesian Language Teaching* (Yogyakarta : Deepublish)

[14]   Sutarti T and Irawan E 2017 *Tips for Success in Granting Development Research Grants* (Yogyakarta: Deepublish)

[15] Pratiwi D, Suratno, and Pujiastuti 2014 Development of Biology Teaching Material Based on SAVI Approach (Somatic, Auditory, Visual, Intellectual) in the Subject of Respiratory System Class XI Senior High School in Increasing Student Motivation and Learning Outcomes *Education Journal of Unej* **1** pp 5-9

[16] Akbar S 2013 *Learning Instrumental Instruments* (Bandung: PT Remaja Rosdakarya)

[17]   Rohman N and Mulyanto B 2010 Building Educational Game Applications as Children's Learning Media *Journal of Computech & Bisnis* **4** pp 53-58

[18] Pantiwati Y 2016 The Nature of Authentic Assessment and Its Application in Biology Learning *Journal of Mathematics and Sains Education* **1** pp 18-27

[19] Rosyid H, Palmerlee M, and Chen K 2018 Deploying learning materials to game content for serious education game development: A case study *Entertainment Computing* **28** pp 1-9