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Development of an Educational Training Game for Ear Sensitivity of Intervals

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ABSTRACTS

This study aims to build a game to help beginner musicians in the process of training ear sensitivity to intervals without involving the teacher in the training process. The software development uses the Multimedia Development Life Cycle (MDLC) method. A software is built in the form of a game that can train the ear's sensitivity to intervals, share knowledge related to intervals, randomize questions and validate answers without involving the teacher in the learning process. The average respondents' answers related to the application were positive. It can be concluded that the development of the application can help users in training the ear sensitivity to intervals and increase the user's knowledge of music theory, especially related to intervals.

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1. INTRODUCTION

In the world of music, the pitch interval is the distance between one note and another (Levine, M. 2011). Interval is what builds music, when we listen to music, we listen to intervals (Willis, G. 1998). A musician, both beginner and expert must know the pitch interval. The ability to identify the intervals of the notes heard is very helpful in musical activities. An ear that is sensitive to pitch intervals is a musician's most valuable asset (Pavlik, P. I., et al., 2013)

Games are fun entertainment media that can be played to fill spare time. Games can also be used as fun learning media, commonly called educational games (Jubaedi, A. D., & Putra, R. E. 2018) (Arsenault, D. 2009). A fun learning process for what is learned can make the subject matter more interesting and facilitate the delivery of the subject matter

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(Pradana, A. G. 2019). The use of educational games in learning can improve the quality and disruption in the learning process as well as train the user's ability to solve problems, find solutions, think quickly and improve (Limin, S. 2022), (Ardiningsih, D. 2019).

A good musician has an ear that is sensitive to changes in pitch. Beginner music generally knows the concept of solfge (do, re, mi, fa, sol, la, si, do) but does not yet have a good ear. The ear's sensitivity to pitch intervals can develop over time. Development may be aided by ear or ear repair exercises (Willis, G. 1998). The music learning process, in this case ear training, requires a teacher who can determine questions randomly and dynamically and correct errors during the learning process. To have someone who teaches can cost a lot of money, especially face-to-face learning during a pandemic can pose a danger of spreading Covid-19 (Santoso, A. M. H. 2022). The need to do social distancing complicates the process of learning music, especially in terms of ear training.

By using educational games as learning media in terms of ear training, you can learn to automate the randomization of questions dynamically as well as the process of correcting errors in social distancing conditions. The use of educational games can also reduce the cost of learning music. Several studies related to games for ear training or music theory have been carried out.

In a study entitled "Adventure Game as Learning Media for Introducing Music Interval and Ear Training to Kids" discusses the use of games as an educational medium for musical intervals and ear training for children (Rizqyawan, M. I., & Hermawan, G. 2015). Another study that discusses ear training with the title "Development Of Interactive Quiz Games as a Formative Evaluation Instrument in Music Theory Course" builds games for student understanding in music theory courses (Haditama, I., et al., 2016). Several previous studies built desktop-based singleplayer games with 2D graphics. However, in studies, input from users is still in the form of a multiple-choice quiz. Ear training exercises by singing or humming can help the ear hear better intervals. Therefore, it requires input in the form of sound through a microphone so that the learning process can be more effective (Willis, G. 1998).

The software method that will be used is the Multimedia Development Life Cycle method or abbreviated as MDLC. MDLC was chosen as the development method because educational games are part of interactive multimedia so MDLC is the right method for developing this software (Afrianto, I., & Furqon, R. M. 2018).

2. METHOD

In this study, the methodology used includes three stages in Fig. 1, with the following explanation:

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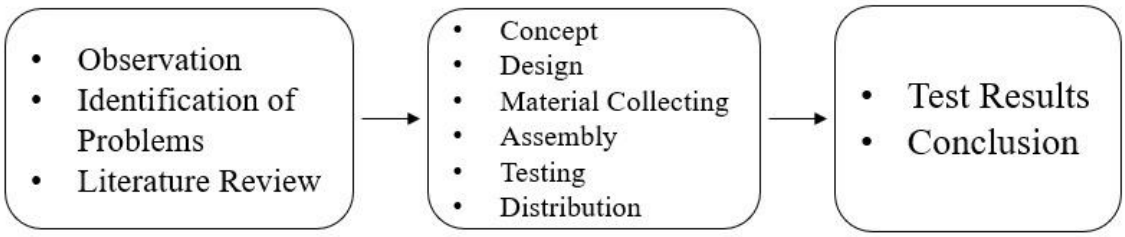

Fig. 1. Research Methodology

2.1. Data Collection Stage

At this stage, data is collected that will be used in research. The data collection process begins with conducting a literature study related to research and technology in the field of music, especially research that integrates technology in the field of music. Literature study was conducted to find out what research has been done, expand knowledge and widen the range of ideas. Next is the observation stage, which will carry out the problem identification process from the results of these observations.

2.2. Educational Game Development Stage

The approach used in the development of educational games is the Multimedia Development Life Cycle (MDLC). In this approach to the six stages that need to be carried out, the stages are (Mursid, R. 2018), (Laksamana, D.J., et al 2021):

i) Concept

The first stage is the concept, in this study raised the concept of educational games with the theme of outer space for learning music theory and training ear sensitivity.

ii) Design

The second stage is the stage where the design is carried out, both menu, character and storyboard designs.

iii) Material Collecting

The third stage is the stage for collecting material, the material collected is in the form of audio, images, and data.

iv) Assembly

The fourth stage is the development stage where the components are built into a complete system.

v) Testing

The fifth stage is the testing stage, the testing process will be carried out at this stage.

vi) Distribution

The sixth stage is the distribution stage, in order to disseminate research on this educational game to be useful for the community.

The activities of the MDLC approach can be seen in Fig 2.

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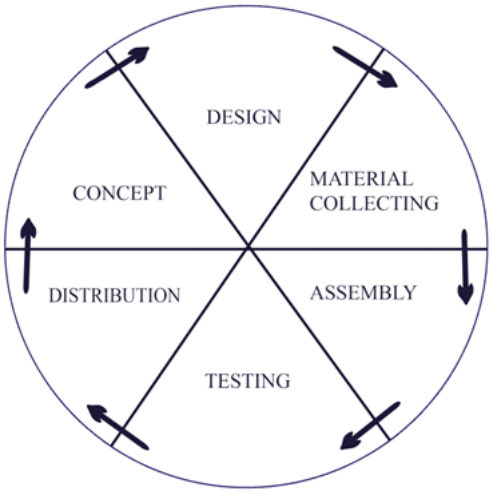

Fig. 2. MDLC Approach

2.2.1. Concept

The game that was built is a game that helps beginner musicians in the process of training ear sensitivity to tone intervals. The game built is a Desktop-based training educational game with 2D (2 Dimensional) graphics. The related description of the game built as follows:

i) The game will play questions in the form of interval sounds with the same root in each question
ii) Players guess the sound by providing input in the form of the same interval sound through the microphone
iii) The game will calculate the player's score on each level
iv) The next level will be unlocked if the player reaches a minimum score of 75%
v) Each level has a different difficulty
vi) The material to be taught and trained is part of the C Major scale
vii) Game is a training which must be done repeatedly.

2.2.2. Design

The design stage is the stage of carrying out the specifications of the game that is built. The system design built is:

i) Storyline Design

A spaceship pilot assigned to collect precious space rocks. Spaceship pilots must sail through the vast darkness of outer space in order to collect the precious stones needed by the main ship. Players will play a spaceship character.

ii) Level Design

The levels are divided into seven sections. Each level will practice different pitch intervals. Players will start the game from level 1. The next level will be unlocked when the player has reached the minimum score. The minimum score that needs to be achieved to unlock the next Level feature is 75%, 75% is obtained from the national completeness target (Yusuf, M. 2019), (Aldwell, E., et al., 2018). The list of tone intervals that are trained at each level can be seen in Table 1.

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iii) Storyboard Design

Displays a series of notes vertically, spaceship characters, space rocks as a hint of tone intervals. The game will play a matter of tone intervals in the form of sound. If the player activates the HINT feature, a stone will be displayed which is an indication of the tone that must be played. If the player does not activate the HINT feature, the rocks become invisible. Players will provide input in the form of sound through the microphone. The character of the aircraft will move up or down according to the input frequency of the tone from the user. The lowest "do" tone represents C3. The storyboard design can be seen in Fig 3.

Table 1. Intervals in Each Level

Level	Trained intervals
1	Unison, Major Second
2	Unison, Major Second, Major Third
3	Unison, Major Second, Major Third, Perfect Fourth
4	Unison, Major Second, Major Third, Perfect Fourth, Perfect Fifth
5	Unison, Major Second, Major Third, Perfect Fourth, Perfect Fifth, Major Sixth
6	Unison, Major Second, Major Third, Perfect Fourth, Perfect Fifth, Major Sixth, Major Seventh,
7	Unison, Major Second, Major Third, Perfect Fourth, Perfect Fifth, Major Sixth, Major Seventh, Perfect Octave
8	Ghundul-Ghundul Pacul Song

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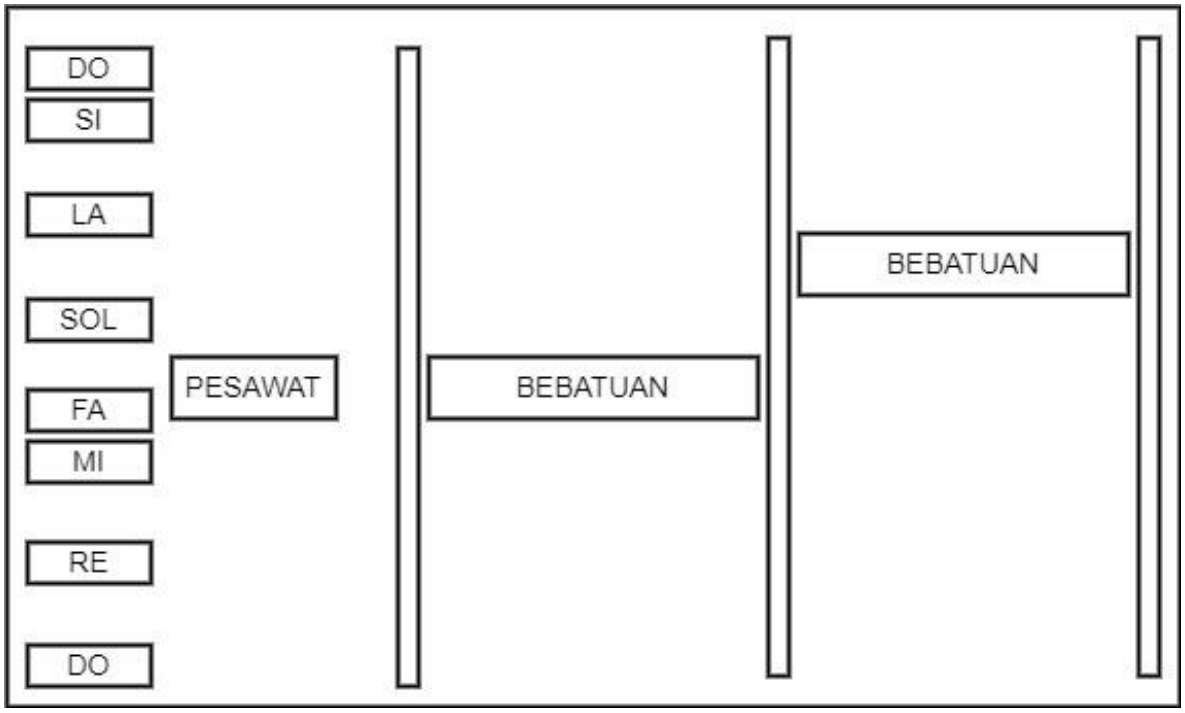

Fig 3. Storyboard Design

iv) Gameplay Design

This part is a gameplay where players will be trained to be sensitive to their ears when faced with obstacles. Players will be represented as a spaceship that blocks the vast darkness of outer space. In this mode, the player must capture as many spaces precious stones as possible. Players will set the spaceship's flight path with sound through the microphone. The movement of the spaceship will refer to the input tone (frequency) provided by the player.

v) Scoring Design

The score at each level will depend on how many intervals the player can guess correctly. The total predictable interval will be divided by the total number of questions at each level. The scoring calculation formula can be seen in Formula (1).

$$S = \frac{B}{N} \times 100\% \quad (1)$$

With the following variables:

S = Score players at that level.

B = Number of correctly guessed intervals in the level.

N = The total number of questions in the level.

vi) Character Design

Players will play a spaceship character, and the questions played will appear as space aids if players use the hint feature. The character designs used in the game can be seen in Table 2.

2.2.3. Material Collecting

The material collecting stage is the stage of collecting materials or assets used in the process of developing educational games. The assets collected can be seen in Table 3.

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Table 2. Character Design

No	Name	Figure	Information
1.	Pesawat Luar Angkasa		In-game player character
2.	Bebatuan DO-SI		Characters for DO to SI tone hints with different colors

Table 3. Assets used

No	Name	Information
1.	PLAY Button	PLAY Button Asset to enter SELECT window
2.	QUIT Button	Asset QUIT Button to leave the game
3.	BACK Button	Asset BACK Button to return to the previous window
4.	HINT TIDAK AKTIF Button	Inactive HINT Key Asset indicates that the HINT feature is not active
5.	HINT AKTIF Button	The active HINT Key Asset indicates that the HINT feature is active
6.	SCORE Button	SCORE Button Asset to display the jSCORE jendela window
7.	GO Button	Button Asset to display the jGO jendela window
8.	Laser Biru Soal	The limiting asset for segment markers of voice questions
9.	Laser Kuning Jawab	Limiting asset for voice input segment marker
10.	Laser Hijau Jawab Benar	Limiting asset for voice input segment marker, voice input marker from correct player
11.	Laser Merah Jawab Salah	Limiting asset for voice input segment marker, voice input marker from wrong player
12.	Tombol LEVEL 1-8	Key Asset LEVEL 1-8 to display the jLEVEL1-8 . window
13.	Papan Penjelasan	Explanation Board Assets to display explanatory information on each level

2.2.4. Assembly

The assembly stage is the implementation stage or combining assets and designs into a complete game that is ready to use. The main menu interface, or the first display in the game can be seen in Fig 4. Figure 5 is a level selection interface with a hint feature tool.

Figure 6 is the interface that appears when the user has selected a level. The content level interface also displays the materials at that level. The levels that have been taught will be trained on the main game interface. The main game interface is shown in Fig 7.

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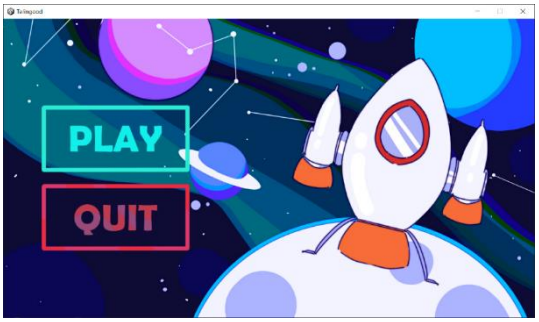

Fig. 4. Home menu interface

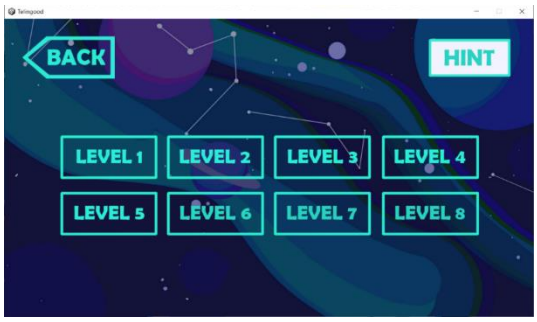

Fig. 5. Level selects menu interface

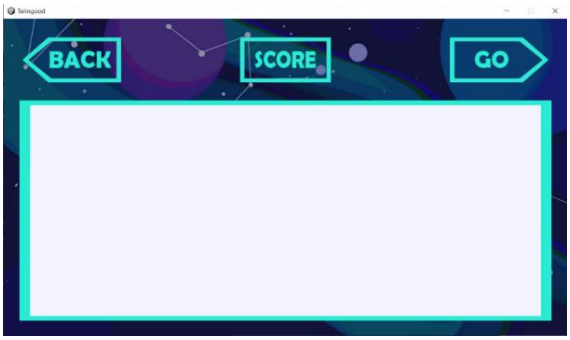

Fig. 6. Level material interface

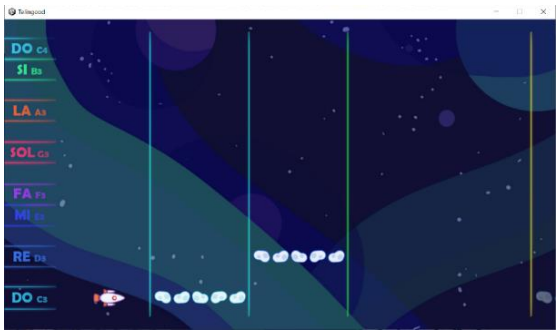

Fig. 7. Main game interface

After the user completes the main game, the score obtained by the user will be saved by the system which can be viewed again on the score interface. The score interface can be seen in Fig 8.

Fig. 8. Score interface

2.2.5. Testing

The testing stage is the stage of testing the game that was built. The tests carried out are blackbox testing, musical instrument testing and beta testing.

2.2.6. Distribution

The distribution stage is the stage where the game will be uploaded to Google Drive which users will download later.

2.3. Conclusion Drawing Stage

The conclusion stage is the stage where conclusions will be drawn based on responses from users who have played the game that was built.

3. RESULTS AND DISCUSSION

The games that have been built will be tested using the blackbox method, then musical instrument testing and beta testing will be carried out which will involve users. The first test is blackbox testing which aims to find functional errors or bugs in the game. Testing the main components in blackbox can be seen in Table 4.

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The next test is the testing of musical instruments, this test is carried out to test whether the musical instruments used can be received well by the game that is built. If the sound can be processed properly, the spacecraft will move up or down following the given sound frequency. The results of testing musical instruments can be seen in Table 5.

The next test is beta testing, this test will involve users as respondents who will answer the questions that have been provided previously. The questions that have been provided can be seen in Table 6.

Respondents will answer the questions in Table 6 with multiple choice answers with their respective weights, the weight of each answer can be seen in Table 7. The results of beta testing for games that have been built on previously prepared questions can be seen in Table 8.

Table 4. Blackbox test results

No	Tested components	Testing Scenario	Test results
1	Home Menu	Buttons on the start menu	Succeed
2	Menu Select Level	Buttons on the level menu	Succeed
		Selecting LEVEL 1 to LEVEL 2	Succeed
3	Level Menu	The buttons on the level menu	Succeed
4	Gameplay	Move the plane with the microphone	Succeed
		Answer the questions correctly	Succeed
		Answering questions incorrectly	Succeed
		The buttons on the level menu	Succeed
5	Score	Save Game Score	Succeed
		View game score	Succeed

Table 5. Musical Instrument test results

Musical instrument	C3	D3	E3	F3	G3	A3	B3	C4
Nylon Stringed Guitar	✓	✓	✓	✓	✓	✓	✓	✓
Steel Stringed Guitar	✓	✓	✓	✓	✓	✓	✓	✓
Guitalele	✓	✓	✓	✓	✓	✓	✓	✓
Human Voice	✓	✓	✓	✓	✓	✓	✓	✓

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Table 6. Beta testing questions

No	Question
1	Is by playing this game your knowledge of music theory related to tone intervals increases?
2	Can the question of the interval of the tone played be clearly heard?
3	Is the ear training provided according to your skill level?
4	Can this game provide an understandable pitch interval theory?
5	Do you feel comfortable practicing ear sensitivity using this game?

Table 7. Question Weight

Weight	Information	Likert scale
3	Yes	0-33
2	Maybe	34-66
1	No	67-100

Table 8. Beta Test Results

Question	Score	Respondent	Scale Value	Results
1	83	93 (21 Yes, 10 Enough, 0 No)	89.25%	Yes
2	85	93 (23 Yes, 8 Enough, 0 No)	91.40%	Yes
3	75	93 (15 Yes, 14 Enough, 2 No)	80.64%	Yes
4	82	93 (22 Yes, 7 Enough, 2 No)	90.11%	Yes
5	80	93 (19 Yes, 11 Enough, 1 No)	87.91%	Yes

From the test results obtained 89.25% of users get new knowledge related to tone interval theory, 91.40% of users say the tone played can be heard clearly, 80.64% of users feel that the training provided is in accordance with their level of expertise, 90.11% of users can understand the given tone interval theory, 87.91% of users feel comfortable practicing ear sensitivity using this educational game.

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4. CONCLUSION

Based on the results of research, analysis, system design, and implementation and testing, it can be concluded that the game that was built can be an alternative tool that helps users or novice musicians to carry out the process of training ear sensitivity to tone intervals without involving the teacher in the learning process. Applications that are built can also provide a little insight into music theory related to tone intervals.

This ear sensitivity training educational game that has been built still has shortcomings, therefore the following are some acceptable suggestions for the development of this game, as follows:

1. Learning and training materials can be expanded by adding other scales such as minor scales.
2. Votes as a training question can be reproduced to increase difficulty and variety.

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