**Interactive NPC for Interactive Learning Media To Increase Student’s Knowledge on Indonesia’s Traditional Music**

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| **ABSTRACT** | | | |
| In the age of digitalization, society has become increasingly accustomed to the utilization of electronic devices. This phenomenon has also had a discernible impact on the gaming market, with an estimated population of over 1.1 billion gamers across the Asia Pacific region. This figure is anticipated to continue its upward trajectory, particularly in the context of the ongoing pandemic, which has compelled individuals to remain at home and conduct their activities primarily online. Consequently, the adaptation of educational resources to align with this digital era is imperative. The conducted research aim to develop an adaptation of educational resource through interactive media. This research propose the development of an interactive Non-Playable Character (NPC) capable of responding to inquiries pertaining to indigenous musical instruments. To assess the efficacy of our work, we have implemented two distinct evaluation methodologies. Firstly, we have assessed the accuracy of the proposed NPC. Secondly, we have administered a questionnaire to gauge the degree of satisfaction experienced by users when acquiring educational content through our proposed NPC. The results of our evaluation indicate that interactive NPCs can indeed be employed, albeit with a relatively modest impact on enhancing the interactivity of the educational process. Deploying interactive NPC as learning media is recommended for future research.  **Keywords:** Educational, Serious Games, Expert System, Non-Playable Character | | | |
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**INTRODUCTION**

In this contemporary digital age, the widespread utilization of cutting-edge devices, such as smartphones, has become a customary practice across diverse segments of society. This phenomenon has also exerted a significant influence on the proliferation of the gaming industry, not only within the confines of Indonesia but also spanning the broader Asia Pacific region. According to surveys previously conducted (Aspin, 2018), the Asia Pacific boasts a staggering population of over 1.1 billion gamers, spanning various gaming platforms. The recent event of COVID pandemic showed the education institution to not rely on face-to-face meeting, finding other method to deliver education is needed. Based on a survey conducted by (Jamaluddin et al., 2020) to ascertain the impact of distance learning on prospective educators, it is evident that future teaching candidates must adeptly navigate the current online landscape. The online environment presents unique challenges, such as limited bandwidth and varying levels of information technology proficiency. These challenges experienced by educators inevitably impede students' comprehension of the instructional content. Hence, there exists a pressing need for alternative pedagogical tools to facilitate students' comprehension, especially in the ongoing pandemic era.

Digital learning media holds immense potential for fostering active participation and stimulating creative communication (Buckingham, 2015). Among the array of digital learning media, educational games stand out as a promising avenue. While games traditionally serve as a source of entertainment (Alexander et al., 2013), they possess the intrinsic capability to deliver educational content in an engaging and enjoyable manner. The forthcoming research endeavors to develop an interactive educational game with the overarching goal of heightening students' enthusiasm for learning. To substantiate this premise, an evaluation will be conducted to gauge the level of learning comfort experienced by students during their engagement with the game.

The forthcoming research endeavors to develop Serious Games infused with educational elements centered around traditional Indonesian music as it’s educational material. The choice of traditional Indonesian music as educational content stems from the dearth of Serious Games addressing this theme. Prior to this research, most studies in this domain primarily concentrated on the development of quiz-style games related to traditional Indonesian music (Ramdhan et al., 2018; Silaban & Sukmayadi, 2023). The proposed research aims to introduce a RPG Genre combined with a Visual Novel-style conversation system. Whereas previous research usually utilize Quiz-like game as its main genre (Rahim, 2016; Yunanto et al., 2019) allowing players the freedom to engage in unrestricted interactions with non-playable characters (NPCs) with adopting the Expert System as the NPC’s main algorithm and NLP, especially POS-Tagging as algorithm to process the user’s input.

**FORMULATING THE PROBLEM**

Building upon the preceding introduction, problem formulation has been undertaken. The research aims to address the following inquiries:

1. Can a system combining the NLP Process with RPG-Visual Novel Genre be developed?
2. What is the performance evaluation of the developed system?
3. Is the developed system suitable for educational purposes?

**LITERATURE REVIEW**

Before designing research that can answer the problem that has been described, a literature study is carried out on similar research and past research that can help in any way.

***Expert System***

Expert systems have the capacity to assist individuals in decision-making across a broad spectrum, contingent upon the specific expertise they are designed to encompass. Research, as exemplified in (Munaiseche et al., 2018), has endeavored to facilitate human diagnostic processes related to ocular diseases. Additionally, in (Pramesti et al., 2016), an expert system has been devised to determine the type of eyeglasses an individual requires, predicated on the symptoms they present.

The application of expert systems extends beyond the realm of healthcare, as demonstrated in (Nurdiyanto & Kuncoro, 2016), where an expert system has been developed to provide recommendations concerning the quality of sugarcane. The diverse methodologies employed in expert systems have also paved the way for novel avenues of inquiry, as exemplified in the study conducted by (Al-Ajlan, 2015). This research delves into a comparative analysis between forward and backward chaining methods, employing a case study centered around the admission of new students. The findings of this investigation assert that the application of backward chaining is infeasible within the context of new student admissions. This arises from the inherent uncertainty regarding the acceptance or rejection of students at the outset of the admission process. Therefore, it becomes imperative to identify pertinent parameters, such as TOEFL scores and academic transcripts, that influence the admission decision-making process.

***Educational Games***

The development of educational games as a learning medium is a well-established research area, yet it remains perpetually open to exploration due to the absence of a universal model for educational games. The design of a game model invariably depends on the specific subject matter to be conveyed and the innovative approach of the game designer. Commonly, researchers tend to adopt a quiz-based format, where players are presented with multiple-choice questions to answer within their educational game designs.

Efforts to enhance this theme have also been made, as evidenced by research endeavors such as (Ramdhan et al., 2018). This study introduced games featuring instructional content related to traditional Central Javanese music, incorporating child-friendly illustrations to capture players' attention. In a similar vein, (Airlangga, 2017) designed a game centered around traditional Indonesian music, integrating auditory explanations and a visual game component that involves connecting images of musical instruments. Research that has been conducted by (Silaban & Sukmayadi, 2023) uses word wall as medium to deliver educational material of traditional music instrument.

In a distinct context, (Yunanto et al., 2019) conceived a game employing a battle quiz format for learning English grammar. In this game, players engage with a Non-Playable Character (NPC) to solve grammar challenges. Players must leverage their existing knowledge to address these grammar issues, while the game itself attempts to resolve the grammar problems using the POS-Tagging algorithm. These diverse approaches reflect the ongoing evolution of educational game design in catering to varied learning objectives and subjects. Research conducted by (Satria & Herumurti, 2021) develops an Educational Game in science and math for junior high school in the form of Role-Playing Game and harness the element of the genre to deliver the educational material. With same genre as previous study, the study that has been done by(Yew Ken et al., 2023) create a serious role-playing game that applies Cognitive Behavioral Treatment (CBT) for anxiety disorders.

***Part of Speech Tagging***

Part of Speech Tagging, often abbreviated as POS Tagging, constitutes a crucial natural language processing (NLP) technique that aids a system in comprehending everyday human language. Beyond selecting the methodology for implementing POS Tagging, the availability and organization of language corpora pose significant challenges. For certain languages, corpus availability is either non-existent or poorly structured, as is the case with the Indonesian language (Kang et al., 2018). In response to this challenge, research (Kang et al., 2018) employed the Kamus Besar Bahasa Indonesia (KBBI) as a surrogate for the Indonesian corpus. The ultimate evaluation yielded an accuracy level approaching one hundred percent, typically within the range of ninety percent. The researchers conducted a detailed analysis to discern the factors contributing to the decline in accuracy, notably attributable to ambiguous words and errors in word categorization.

***GameFlow***

GameFlow, originally conceived by Sweetser and Wyatt, serves the primary purpose of quantifying a player's enjoyment or satisfaction level while participating in a game. Over time, GameFlow has evolved to accommodate variations according to different game themes. For example, in a study conducted by (Fu et al., 2009), E-GameFlow was introduced to specifically measure enjoyment levels within educational games.

Sweetser and Wyatt's questionnaire encompasses seven key sub-sections. The "Concentration" sub-section assesses the game's ability to maintain players' focus and concentration throughout gameplay. "Clarity of Purpose" measures the game's effectiveness in communicating the player's objectives or missions clearly. "Feedback" aims to determine if the game provides appropriate rewards or acknowledgments commensurate with the player's efforts and achievements. The "Challenge" sub-section quantifies the level of challenge or obstacles presented by the game, contributing to player engagement. "Autonomy" measures whether players feel a sense of mastery over the game, whether consciously or unconsciously. "Immersion or Appreciation" evaluates whether the game can engross players to the extent that they temporarily forget their real-world surroundings. Lastly, "Social Interaction" examines the social relationships and interactions that occur among players during the game. In (Fu et al., 2009)'s research, additional sub-sections related to knowledge improvement were included, aimed at assessing whether players not only comprehend but also express interest in the educational material presented within the games.

Table 1. List of Standard POS-Tagging based on previous research (Dinakaramani et al., 2014)

|  |  |  |
| --- | --- | --- |
| Tag | Description | Example |
| CC | Coordinating Conjunction | And, but, or |
| CD | Cardinal Number | two, million, six |
| OD | Ordinal Number | Third, No-4 |
| DT | Determiner | The |
| FW | Foreign Word | Perubahaan Iklim |
| IN | Preposition | In, with |
| JJ | Adjective | Clean, long |
| MD | Auxiliary Verb | Must, Acceptable |
| NEG | Negation | Rejected, No |
| NN | Noun | Monkey, Wood |
| NNP | Proper Noun | Premier League |
| NND | Measurement Noun | Kilo, sheet |
| PR | Demonstrative Pronoun | This, There |
| PRP | Personal Pronoun | Me, they, us |
| RB | Adverb | Very, only |
| RP | Particle | -ing |
| SC | Sub coordinating Conjunctions | Since, only if |
| SYM | Symbol | IDR,+,% |
| UH | Interjection | Let’s go |
| VB | Verb | Design |
| WH | Question | Who, When |
| X | Unknown | … |
| Z | Punctuation | “…”, ? |

**METHOD**

Through the literature review that has been carried out previously, it was decided that several methods would be used in the educational game to be made.

***Educational Materials***

The educational game will focus on traditional regional music content. This choice of material is derived from its inclusion in the "Rangkuman Pengetahuan Umum Lengkap" (RPUL), a comprehensive general knowledge resource in Indonesia. Consequently, the educational material is not constrained by the educational level of its users. Two distinct approaches will be employed to gather the educational content. Firstly, insights will be gathered through interviews with experts in the field of music, particularly music educators at the junior high school level. Secondly, content will be sourced from the book titled "Album Alat Musik Tradisional Bengkulu, DKI Jakarta, Jawa Tengah, Jawa Timur, dan Kalimantan Barat," published by the Ministry of Education and Culture [19], along with research conducted by [20].

***System’s Algorithm***

The system being developed will draw inspiration from the functioning principles of an expert system, encompassing three key components: the user interface, the inference engine, and the knowledge base. The user interface takes the form of a text input box capable of processing user-generated text. To process user input, Part of Speech Tagging (POS-Tagging) will be employed. The POS-Tagging method chosen for this study has been adapted from a prior research effort (Kang et al., 2018), primarily due to the similarities between this research and the aforementioned study, both of which involve the Indonesian language. As part of our adaptation, the Kamus Besar Bahasa Indonesia (KBBI) will serve as a surrogate corpus. However, the tag categories used in this study will be those specified in the research's tag category (Dinakaramani et al., 2014), as outlined in Table 1. It's important to note that these tag categories in Table 1 were customized to align with the specific case study undertaken in this research. Modifications made to these categories are detailed in Table 2.

Table 2. Modification of POS-Tagging



The process of Part of Speech Tagging (POS Tagging) is elucidated as follows: It commences with the segmentation of input sentences provided by the players, achieved by splitting the sentences based on spaces. These segmented sentences are then compiled into an array for subsequent processing. The ensuing step involves matching the tagged words by comparing them with the tagging database. If a word is identified in the database, it is directly assigned the corresponding category and added to the input tag array. In cases where a word is not recognized by the system, the process proceeds to employ stemming techniques. Stemming involves deconstructing the word based on its affixes, which can be located at the front or back of the word. Once the system successfully identifies the word through stemming, it is assigned to the appropriate category and included in the input tag array. However, if the system is unable to identify the word through either direct matching or stemming, the word is categorized as "X," signifying that its classification cannot be determined. Following the POS Tagging process, the resultant input array is primed for further processing in subsequent phases of the system's operation.

Subsequent to the Part of Speech (POS) Tagging process, the data proceeds to be processed through the inference engine. For this research, the chosen inference engine takes the shape of Forward-Backward Chaining, a method designed to identify and evaluate various input tags provided by the user. The list of inputs that the inference engine will be capable of detecting is outlined in Table 3. The core processes of the inference engine are visually represented in Figure 1.

A black background with white squares

Description automatically generated

Figure 1. The flowchart of proposed algorithms. Started from user’s input to NPC’s output

The system initiates the interaction by requesting input from the user. The user's input is subsequently subjected to the Part of Speech Tagging (POS Tagging) process. Following POS Tagging, the categorized sentences are compared and matched with a traditional music database. This database comprises four primary attributes: Musical Instrument Name, Regional Name, Material (up to three materials), and How to Play. Additionally, the database may include other attributes like ID and a Description of the Musical Instrument.

When the system identifies a match with one of the attributes such as materials, origin, physical description, or how to play within the traditional music database, it activates the forward chaining algorithm. The system then endeavors to ascertain the specific musical instrument that the user is seeking based on the provided attributes. If the search results yield more than two potential musical instruments, the system prompts the user for further details regarding the desired musical instrument.

Table 3. POS Tagging New Category

|  |  |
| --- | --- |
| Tag | Process |
| JJ | Used to describe physical form of musical instrument |
| NN | Used to define materials of musical instrument |
| VB | Used to define how to play the musical instrument |
| MSC | Used to define the name of musical instrument |
| PRV-WND | Used to define the origin of musical instrument |

This iterative process of requesting additional details continues until the search results are reduced to fewer than or equal to two potential musical instruments. Once the search results are narrowed down to two options, the system proceeds to recommend these choices to the user, allowing them to select the musical instrument they are looking for. The system is designed to recognize specific user inputs for processing, and the list of recognized input can be found in Table 4.

Table 4. User Input For POS Tagging Processing

|  |  |  |  |
| --- | --- | --- | --- |
| Origin | Physical Form | How To Play | Made From |
| Jawa Tengah | Round | Strum | Wood |
| Jawa Timur | Flat | Hit | Metal |
| Kalimantan | Long | Blow | Pelt |
| Jakarta | Tube | Swipe | Bamboo |

When the Part Of Speech (POS) Tagging process on the user's input identifies the "MSC" tag, which serves as the final result, the system activates the backward chaining mechanism. In this phase, the system seeks to identify other tags within the sentence. If the sentence contains additional question tags such as "how to play" or "origin of a musical instrument," the system will respond accordingly, providing information based on these specific questions. However, if the sentence does not contain these question tags, the system will proceed to display comprehensive details about the musical instrument that the user is inquiring about, offering a comprehensive description of the requested musical instrument.

***Evaluation***

An evaluation will be conducted to assess the system's accuracy, which has been designed using the Cohen's Kappa Method. Fifteen participants will be formally invited to pose inquiries about musical instruments to the system, with each participant engaging with the system on ten separate occasions. Participants will have the liberty to formulate their questions using phrasing of their choice. Prior to commencing the trial, participants will receive three specific instructions:

* Participants are encouraged to directly inquire about specific musical instruments.
* Participants are welcome to pose queries related to the characteristics of musical instruments.
* Participants are expected to construct their questions using appropriate interrogative sentence structures.

Throughout all the trials, the system's responsiveness was assessed by determining the ratio of successfully answered questions obtained by dividing the number of answerable questions by the total number of questions posed.

The second phase of the evaluation will involve the distribution of a questionnaire derived from E-GameFlow (Dinakaramani et al., 2014), specifically in the "Knowledge Improvement" sub-section. This questionnaire will be administered to fifteen respondents to gauge their level of satisfaction and enjoyment when using the developed application.

**RESULT**

The application that has been designed can be seen in figure 2. We have conducted the evaluations, and the results are as follows.

A screenshot of a computer

Description automatically generated

Figure 2. The final program. (Left) User interacted with NPC in Visual Novel Dialogue Style. (Right) User asked to input a question related to traditional music.

***Accuracy Test***

Each user will pose ten questions, and the system's ability to respond to these questions will be recorded. Based on the feedback and responses collected from the fifteen respondents, it is evident that the system achieved an overall accuracy rate of 68%.

***Questionnaire***

After posing their questions ten times, the respondents are given the opportunity to complete the questionnaire. The outcomes of this questionnaire can be reviewed in Figure 3.

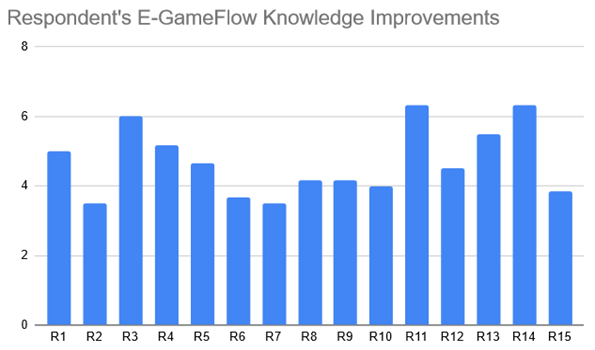


Figure 3. Result of Sweetser&Wyatt E-GameFlow Knowledge Improvements Dimension

Investigating the participant cohort, it becomes evident that the average level of satisfaction among respondents has been positively influenced, concurrently with an enhancement of their knowledge, as a result of engaging in the game. This observation is substantiated by the outcomes, where a significant majority of respondents scored 4.69 which is above 4, indicating their response to the questionnaire fell above the midpoint. However, it should be noted that none of the scores approached 8, suggesting that the game's capacity to markedly elevate knowledge levels may not have been perfectly realized. Consequently, we proceed to delve into an examination and discourse of several issues and insights unearthed during the course of this survey.

**DISCUSSION**

After the presentation of result, discussion regarding to the result are taken in place.

***Main Result***

While 68% are above 50% it is can be said that the accuracy of the inference engine are quite low, moreover if compared with previous similar research whereas the accuracy could reach 90 to 95%. Several factors contributing to the achieved system accuracy value have been identified. First, the system's lack of responsiveness to typos stems from the design of the POS-Tagging algorithm, which was adapted from a reference that primarily deals with formal articles. Consequently, the algorithm does not include error-handling mechanisms for typos.

Secondly, the inference engine algorithm swiftly verifies whether a word entered by the user is present in the database. If not found, the word is promptly removed, rendering it unrecognized. This approach was implemented to expedite the search process and prevent the search queue from becoming overly populated with variables. However, it has been observed that this practice has, in fact, reduced the accuracy of the system's responses. By limiting the system's vocabulary to only those words present in the musical instrument database, it has inadvertently constrained the program's ability to provide accurate answers in certain scenarios.

The survey results indicate that while respondents comprehend the intended purpose of the educational material within the game, a significant portion of them lack interest in delving deeper into the educational content. This diminished interest may be attributed to an unengaging gamification design and insufficient interactive information presentation. Some respondents have suggested that the educational explanations should be enhanced with visuals or audio elements, while others have expressed that the existing explanations are somewhat lacking in interest, thereby impacting the overall learning experience.

Apart from the questionnaire feedback, additional opinions from respondents were also scrutinized. Notably, several respondents highlighted an issue related to the Graphical User Interface (GUI) design. They found the font and background choices to be uncomfortable for reading. While this issue is not directly linked to the system's algorithm, it does impact the overall comfort of respondents during the learning process.

***Limitations***

Numerous limitations, which have impeded the progress of this research, have been identified and scrutinized. Firstly, Natural Language Processing (NLP) constitutes an antiquated method employed by a multitude of researchers for diverse purposes. Nonetheless, its specific application to Indonesian Language NLP for Non-Playable Characters remains infrequent, resulting in algorithms that are still in their nascent stages. Consequently, they exhibit certain limitations, such as prone to typos and an inability to discern words with similar sounds but distinct meanings, as exemplified by 'can' in 'canned food' versus 'can' in 'can do it.'.

Secondly, the NPC and the game environment that has been created in the research did not consider the online feature that commonly available in game, thus the effect of online is not considered during the research.

***Future Work***

The response to the issues outlined in the preceding section, the subsequent section outlines proposed solutions. The prospective remedies for future research are as follows:

* To enhance accuracy, refinements can be implemented within the POS-Tagging algorithm. In addition to stemming or root word identification, the system can be augmented to seek the nearest root word as an approximation in cases of typographical errors by users. Furthermore, a change of the inference engine algorithm could be the answer to increase the accuracy of the game.
* To expand the music database possessed by the NPC (Non-Playable Character), it is imperative to broaden the sources of music data. The research conducted thus far has exclusively drawn from only two data sources. In the future, the augmentation of the database is essential, given the vast array of traditional music variations within Indonesia. Furthermore, the inclusion of traditional music from foreign regions is also a viable prospect that should be considered as a forthcoming endeavor.

**CONCLUSION**

Based on the research conducted, several key conclusions can be drawn:

* The system has been successfully developed and integrated into a game.
* Two comprehensive evaluations have been conducted on the game. The first evaluation yielded an accuracy rate of 68%, while the second evaluation, using the E-GameFlow "Knowledge Improvement" questionnaire, resulted in a score of 4.69.
* Based on the questionnaire analysis, it can be concluded that the developed game is deemed suitable to serve as an effective educational tool.

These conclusions encapsulate the achievements and areas for improvement in the system's development and performance.

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