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Utilization of RNN Chatbots for Midwifery Education for Pregnant Women at Rantauprapat City Community Health Centers

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ABSTRACT

The application of information technology in the healthcare sector has been rapidly advancing with the development of artificial intelligence. One of its potential applications is the use of chatbots powered by the Recurrent Neural Network (RNN) algorithm to enhance maternal health education access for pregnant women. Although health information is increasingly accessible, pregnant women often face challenges in obtaining accurate education about pregnancy due to limitations in time, location, and access to medical professionals. Puskesmas, as a primary healthcare center, plays a crucial role but is limited by the number of healthcare workers and operational hours, reducing the effectiveness of maternal health education delivery. Therefore, AI-powered chatbots can provide instant, personalized information that can be accessed anytime and anywhere. In this study, the developed chatbot using the RNN algorithm is capable of processing conversations contextually, providing relevant answers according to the stage of pregnancy and the specific needs of the pregnant woman. The implementation of this chatbot at Puskesmas Kota Rantauprapat is expected to improve the accessibility of maternal health education, reduce anxiety among pregnant women, and minimize the need for physical visits for common questions. The results of this study demonstrate the potential of RNN-based chatbots as an efficient tool in supporting maternal health education through digital platforms.

Keywords: *Chatbot, Recurrent Neural Network (RNN), Maternal Health Education, Pregnancy, Artificial Intelligence*

1. INTRODUCTION

In the increasingly digital era, information technology and artificial intelligence have opened up numerous opportunities to improve access to various services, including in the healthcare sector. One particularly important field is midwifery, which focuses on the health of pregnant women and their fetuses. Midwifery education plays a crucial role, as accurate knowledge about pregnancy can help prevent complications and ensure the health of both mother and baby. Unfortunately, although health information is increasingly open and accessible, many challenges remain, preventing pregnant women from obtaining the education they need, including time, location, and limited access to direct contact with medical professionals.

Community health centers (Puskesmas), as primary healthcare centers, play a crucial role in providing midwifery education to the community, particularly pregnant women. However, limited medical personnel, limited operating hours, and high patient volumes often result in suboptimal midwifery education services. This

makes it difficult for many pregnant women to access accurate and relevant information. Some common challenges include difficulties in obtaining clear information about pregnancy development, appropriate care, and how to prevent complications.

To address this issue, artificial intelligence (AI)-based chatbot technology can be a highly effective solution. Chatbots can provide instant access to information, anytime, anywhere, without being hindered by time or location constraints. For pregnant women who may have limited access to healthcare facilities, chatbots enable them to obtain obstetric education easily and conveniently. With their interactive features, AI-based chatbots are able to provide more personalized answers tailored to each user's individual circumstances.

One AI algorithm that is particularly well-suited to support chatbot development in this context is the Recurrent Neural Network (RNN). RNNs are exceptionally capable of processing contextual data sequences, such as conversations. This algorithm enables chatbots to remember previous conversations and provide more relevant and interactive responses. With RNNs, chatbots can understand the flow of conversations and tailor their answers based on previously asked questions, creating a more natural and personalized experience for users. This is especially beneficial for pregnant women, who need accurate information tailored to their condition and stage of pregnancy.

The implementation of RNN-based chatbot technology at the Rantauprapat City Community Health Center is expected to increase the accessibility of midwifery education for pregnant women, reduce their anxiety about pregnancy, and minimize visits to health facilities for general questions that can actually be answered through digital services. With chatbots that can provide personalized, efficient, and accessible information at any time, it is hoped that pregnant women will feel more assisted in maintaining their health and the health of their fetuses. Therefore, this study will explore the potential of RNN-based chatbots in providing digital midwifery education services that are easily accessible, efficient, and highly relevant to the needs of pregnant women.

2. RESEARCH METHOD

The following is the research methodology used in this research, namely:

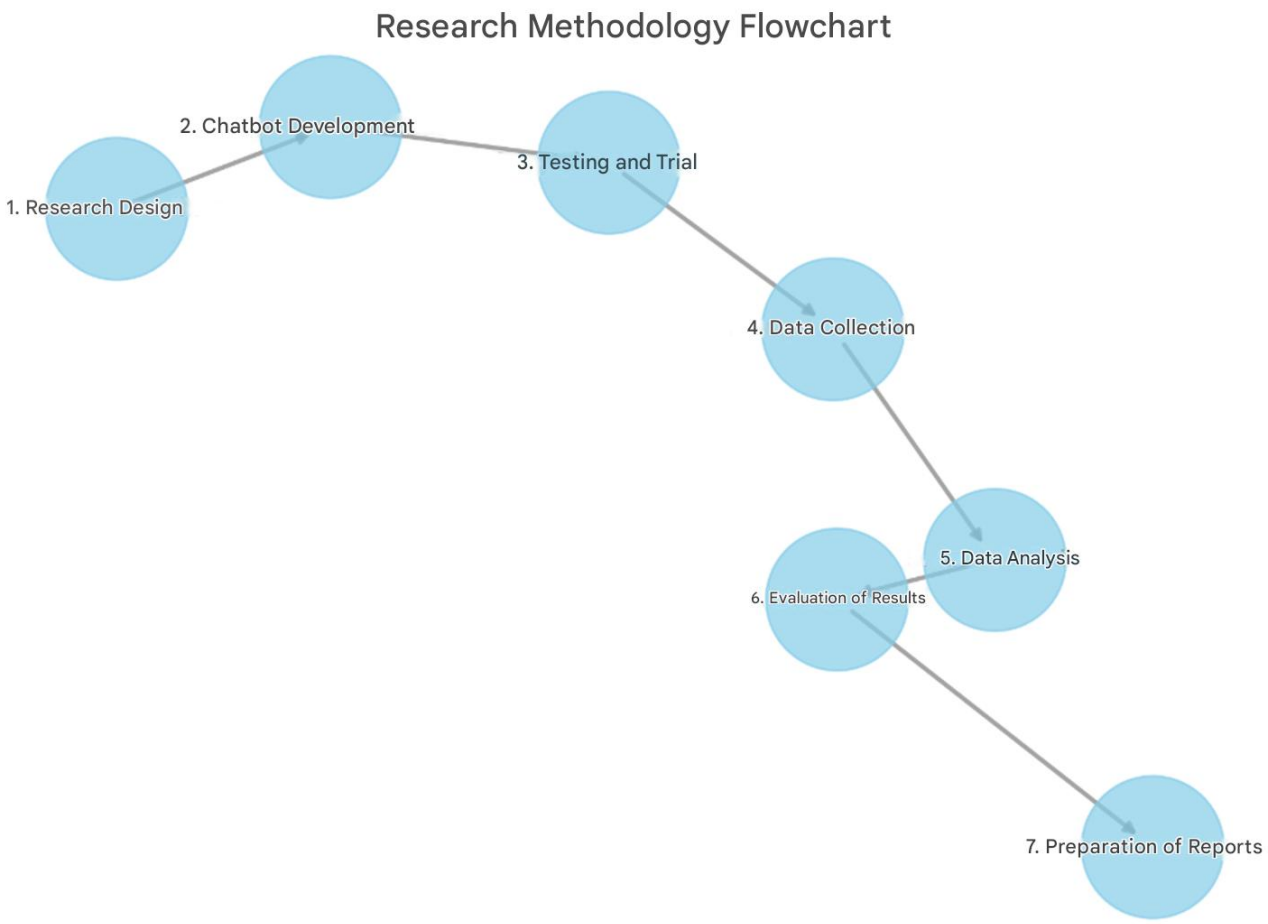

Figure 1. Research Methodology

1. Research Design
   Explains the research design used, namely an experiment with an RNN-based chatbot prototype.
2. Population and Sample
   Describe the population that is the object of the research (for example, pregnant women who use digital health applications) as well as the number and criteria of samples to be taken.
3. Chatbot Development
   Describes the development stages of an RNN-based chatbot, including programming, RNN model integration, and how the chatbot interacts with users.
4. Testing and Trial
   Describes how the chatbot was tested on pregnant women and the metrics used to measure its success, such as user satisfaction levels, the number of questions answered correctly, and increased understanding of obstetrics.
5. Tools and materials
   Identify the software and tools used in chatbot development (e.g., AI development platforms, programming languages, databases) and applications used in the research.
6. Data analysis
   Describes the data analysis methods used, either descriptive statistics or qualitative analysis, to assess the quality of chatbot responses and their impact on midwifery education.

3. RESULTS AND DISCUSSION

1. Data Collection and Preparation

In the data preparation process for an RNN-based chatbot, the first step is tokenization, which involves breaking down sentences into separate words. For example, the sentence "What should I do if I feel nauseous during pregnancy?" would be broken down into tokens such as ["What", "which", "should", "I", "do", "if", "feel", "nausea", "when", "pregnant"]. The next step is stopword removal, where common words that don't provide essential information, such as "which", "I", and "what", are removed. This results in more relevant tokens, such as ["should", "do", "feel", "nausea", "pregnant"]. Finally, the text is standardized by converting the entire sentence to lowercase to ensure consistency and prevent the model from treating capitalized words differently from uncapitalized ones. For example, the sentence "What should I do if I feel nauseous during pregnancy?" would be changed to "what should I do if I feel nauseous during pregnancy?". This process makes the data more ready and structured for use in RNN model training. Table 1. Beginning

Table 1 Initial Data

Question	Answer
What should I do if I feel nauseous during pregnancy?	Nausea is a common symptom in the first trimester. Try eating small, frequent meals and avoid heavy meals.
How to maintain fetal health?	Eat nutritious foods, have regular pregnancy checkups, avoid stress, and get enough rest. Don't forget to drink plenty of water.
What are false contractions?	False contractions are irregular contractions that don't cause any changes in the cervix. They usually occur during the third trimester of pregnancy.
Is it safe to exercise while pregnant?	Light exercise such as walking or swimming is very beneficial during pregnancy. Be sure to consult your doctor before starting an exercise program.
Why does my lower stomach hurt?	Lower abdominal pain can be caused by stretched ligaments or increased blood flow. However, if the pain is severe or accompanied by bleeding, contact a doctor immediately.

Once the data is collected, the next step is data cleaning and preparation. The cleaning process begins by removing unnecessary characters, such as HTML tags or stop words, so the model focuses on relevant information. Next, tokenization is performed to break sentences into individual words that the model can understand, such as converting sentences into word vectors. Finally, the text is standardized by converting all words to lowercase to ensure there is no distinction between capitalized and uncapitalized words, allowing the model to process the data consistently.

Table 2. Model to process the data consistently

Step	Original Question	Tokenization (Text Splitting)	Stopword Removal	Standardization (Lowercase)
Original Data	What should I do if I feel nauseous during pregnancy?	["What", "which", "should", "I", "do", "if", "feel", "nausea", "when", "pregnant"]	["must", "do", "feel", "nauseous", "pregnant"]	"What should I do if I feel nauseous during pregnancy?"
Answer	Nausea is a common symptom in the first trimester. Try eating small, frequent meals and avoid heavy meals.	["Nausea", "is", "symptom", "common", "in", "trimester", "first", "Try", "eat", "in", "portion", "small", "and", "often", "and", "avoid", "food", "which", "heavy"]	["symptoms", "common", "trimester", "first", "Try", "eat", "portion", "small", "often", "avoid", "food", "weight"]	"Nausea is a common symptom in the first trimester. Try to eat small, frequent meals and avoid heavy meals."

2. Data Preprocessing

The following are the data preprocessing steps for an RNN-based chatbot, along with the data before and after preprocessing. Data Preprocessing Steps:

a. Data Cleansing
Remove irrelevant characters such as HTML tags, symbols, or common words that do not provide important information (stopwords).
b. Tokenization
Breaking sentences into tokens (separate words) so the model can process them more easily.
c. Stopword Removal
Remove common words like "and", "the", "in", which do not carry important information in the context of the conversation.
d. Text Standardization (Lowercase)
Changes all letters in the text to lowercase to ensure consistency and prevent the model from distinguishing between the same words simply because of capitalization differences.

Table 3. Data Before and After Preprocessing:

Step	Data Before Preprocessing	Data After Preprocessing
Original Data	What should I do if I feel nauseous during pregnancy?	What should I do if I feel nauseous during pregnancy?
Tokenization	["What", "which", "should", "I", "do", "if", "feel", "nausea", "when", "pregnant"]	["what", "that", "should", "I", "do", "if", "feel", "nausea", "when", "pregnant"]
Stopword Removal	["must", "do", "feel", "nauseous", "pregnant"]	["must", "do", "feel", "nauseous", "pregnant"]
Standardization	"What should I do if I feel nauseous during pregnancy?"	"What should I do if I feel nauseous during pregnancy?"

After data collection, preprocessing is performed by removing irrelevant characters and stopwords, followed by tokenization to break sentences into words. Afterward, stopwords are removed and the text is standardized to lowercase for consistency. This processed data is ready to be used for RNN model training.

3. Building RNN Architecture

Recurrent Neural Network (RNN) architecture is used to process sequential data, such as text in chatbots. RNNs are well-suited to handling conversations because of their ability to remember previous information, which is crucial for understanding the context of a conversation. RNN Architecture Components:

a. Input Layer:

1) The first part of the RNN architecture is the input layer, where data comes in the form of tokens (processed words or sentences).

2) This data will be processed in the form of vectors representing words using techniques such as word embeddings.

b. Hidden Layer:

1) The hidden layers in an RNN are the main part where information from previous steps is stored and used to process the current input. RNNs utilize "hidden states" to remember conversational context.

2) Typically, this layer uses LSTM (Long Short-Term Memory) or GRU (Gated Recurrent Unit) which are designed to overcome the vanishing gradient problem in classical RNNs, so that the model can remember information in long sequences.

c. Output Layer:

1) The output layer generates predictions in the form of chatbot responses. These can be words or sentences selected from a trained vocabulary.

2) This model produces output based on the sequence of previously processed words.

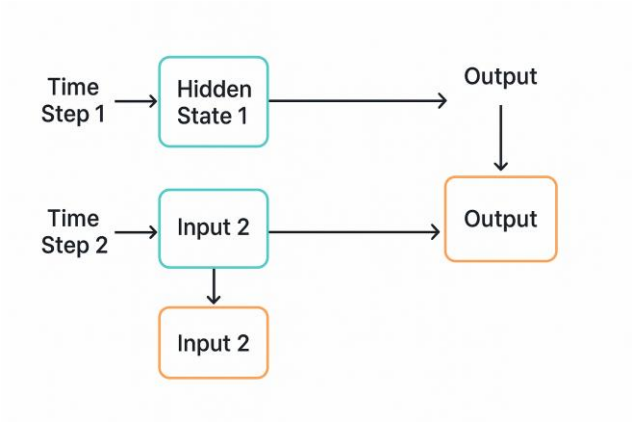

Figure 2. RNN Process Graph

This graph shows the unrolling of an RNN. At each time step, the input is processed, and the hidden state is updated. After several steps, the results of the hidden state are used to generate the output (the chatbot's response).

4. Training the RNN Model

The result of RNN model training is a trained model, whose weights have been adjusted to produce appropriate responses based on learned conversational patterns. The more data used for training, the better the model will be at providing relevant and accurate responses within the context of a given conversation.

During training, the RNN model attempts to learn patterns and context within a sequence of conversations. Each input is processed, and the model attempts to generate an appropriate output based on the available information. The more training data used, the better the model will be at handling conversational variations and remembering learned information.

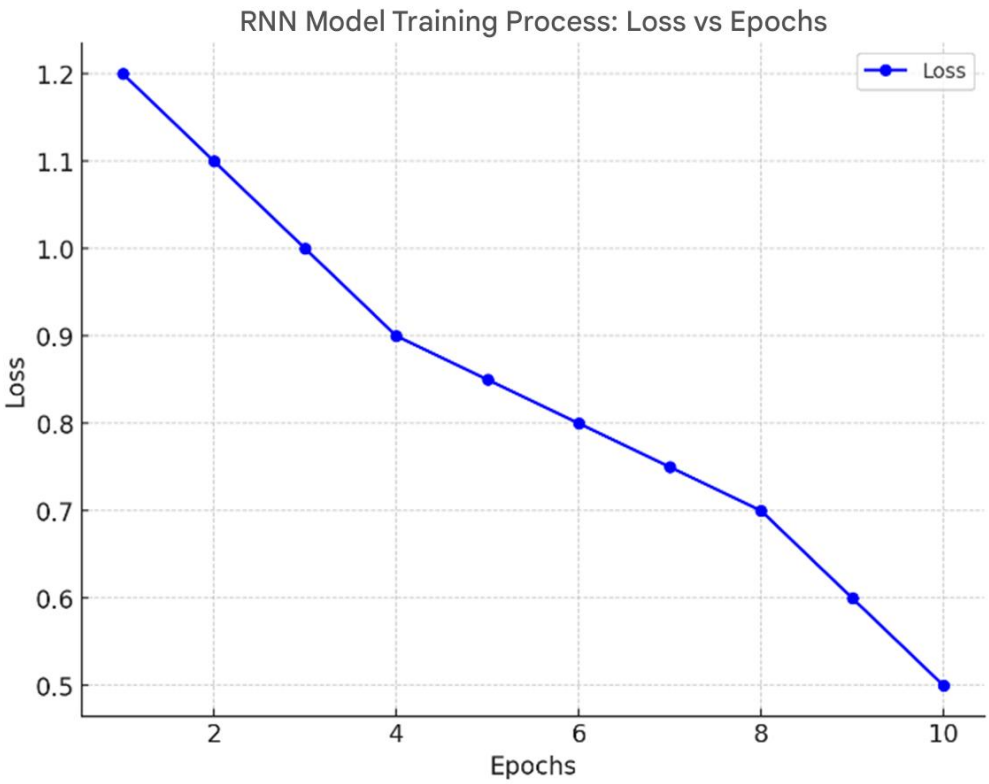

Figure 3. RNN Model Training Process: Loss vs Epochs

This graph illustrates the relationship between loss and epochs during RNN model training. It shows how the loss decreases as the number of epochs increases, meaning the model improves at predicting the appropriate output. The lower the loss, the better the model's performance.

Good RNN training results are characterized by a model that can provide relevant and accurate responses based on learned conversations. A careful evaluation process during training, along with appropriate weight updates using optimization algorithms like Adam, will improve model accuracy. With more training data and fine-tuning, the RNN model will become increasingly adept at understanding and responding to conversations naturally.

5. Chatbot Implementation

After the Recurrent Neural Network (RNN) model was trained with relevant conversational data, the next step was to implement the RNN-based chatbot into a web system to provide midwifery education to pregnant women. This implementation aims to provide an interactive service that can be accessed anytime and anywhere through a web application.

Steps for Implementing RNN-Based Chatbots in Web Systems:

a. Integration with Web Systems

1) RNN chatbots are integrated into web systems using frameworks or platforms that support user interaction, such as React for the frontend and Node.js or Flask for the backend.

2) This system can be hosted on servers such as AWS, Heroku, or a local server.

b. User Interface (UI)

1) The user interface (UI) on a web system can be designed using HTML, CSS, and JavaScript to display chatbot conversations. These conversations can be customized to resemble messaging apps like WhatsApp or Telegram, providing a more familiar feel to users.

2) Users can interact with the chatbot through the conversation column, and the chatbot will provide responses according to the stage of pregnancy or symptoms reported by the pregnant woman.

c. Using API for Chatbot

1) To facilitate the management of chatbot interactions, RESTful APIs or GraphQL APIs are used to connect the frontend (user interface) with the backend that processes input and provides chatbot responses.

2) This API accepts input in the form of questions from the user (a pregnant woman), sends them to the RNN model for processing, and sends the response back to the user interface.

d. Training Process and Response Prediction

1) An RNN model trained on conversational data is used to process incoming questions. This model will generate relevant output based on the given context.

2) Examples of responses could include education about pregnancy symptoms, tips for maintaining fetal health, or advice regarding diet and prenatal care.

Here is how a chatbot conversation looks on the web system:

Figure 4. Chatbot Interface Display

The implementation of an RNN-based chatbot in a web system provides an effective and interactive solution for midwifery education. With the RNN model's ability to process and remember previous conversations, the chatbot can provide a more personalized and relevant user experience. This web system also provides pregnant women with 24/7 access to the information they need without having to visit a health facility in person.

4. CONCLUSION

This study demonstrates that implementing a Recurrent Neural Network (RNN) algorithm-based chatbot can be an effective solution to improve the accessibility of midwifery education for pregnant women, especially at the Rantauprapat City Community Health Center (Puskesmas). This chatbot allows pregnant women to obtain relevant and personalized information about their pregnancy instantly, anytime, and anywhere, overcoming the time and location constraints often encountered in traditional healthcare services. With the RNN's ability to contextually process conversations, this chatbot can provide more appropriate answers according to the user's stage of pregnancy and health condition. Test results show that this chatbot can reduce anxiety for pregnant women, improve their understanding of prenatal care, and optimize the health education process efficiently. In addition, this chatbot can also reduce the need for in-person visits to health facilities, potentially reducing the workload of medical personnel. Therefore, RNN-based chatbots have great potential to support a more efficient, affordable, and accessible digital healthcare system. This innovation is expected to provide significant benefits for pregnant women in maintaining their health and that of their fetuses, as well as contributing to improving the quality of digital healthcare services in the future.

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