Mobile Gramabot: Development of a Chatbot App for Interactive German Grammar Learning

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Abstract—This study aims to develop the Gramabot application as a means of online learning during the pandemic and to examine its effectiveness as a medium for German grammar learning. The design-based research uses learning experience design methodology. Beside an introduction of the state of the art of chatbots for language learning, the paper describes the concept of the chatbot application and its evaluation. Prior experiences with chatbots, implementation experiences and evaluations insights were obtained from 36 Indonesian students with beginner level German language skills. The data were described using qualitative and simple descriptive statistical analysis. The results of the analysis show that most of the respondents are familiar with several chatbot applications, the use of chatbots is not as a learning medium, but as a means of asking questions about products. In addition, String Matching is a suitable method used to develop Gramabot. Based on the results of the evaluation, it can be concluded that Gramabot can help students understand basic level grammatical material.

Keywords—chatbot, Gramabot, string matching

1 Introduction

The COVID-19 pandemic has succeeded in shaping a society to the digital world. Many educational institutions are adopting online learning to continue educational activities during this COVID-19 pandemic [1]. The use of online mobile learning media is very important in teaching and learning activities in Indonesia [2], for example for language learning [3], [4]. Chatbot, (some authors call Chabot or Lingobot) is one of the latest media that can be used for online mobile learning today.

Chatbots are computer-generated systems capable of interacting in certain ways with human users in natural language through input and output lines or speech recognition systems [5]. Chatbot is a computer application that can carry out conversations through written media [6]. Literally the word 'chatbot' comes from two words: chat and bot. In the field of computing, the term 'chat' refers to communication activities that use written means. Meanwhile 'bot' is a snippet of the word 'robot'. Thus, chatbot is an application that is used as a communication tool between users and robots.

So, a chatbot is a question-and-answer system application between humans and robots or automatic answering machines. Usually, chatbots are used to help provide information to users. In its development, chatbot can also function as *Question & Answering*, chatbot *monitoring*, and chatbot *searching* [7]. Currently, the use of chatbots has been applied in various fields and is very helpful for human work, including in the field of education [8]. In education, chatbot is used as an answering machine for questions related to lecture material, because chatbots play the role of assistant and guide for the learners and for the tutors [9]. In addition, chatbots can be used as learning media, presenting interactive and interesting material [10]. Research on the use of chatbots in learning, for example, research by Afrianto who developed an android application chatbot as a medium for practicing English conversation [11].

Research on the use of the chatbot application for Artificial Intelligence Markup Language (AIML)-based tourism objects in East Java has developed an information system that helps tourists to find out all information and tourist facilities in East Java [12]. Not only for the tourism sector, currently there have been many chatbot developments in various fields. But, still there is vacuum regarding usage of chatbots in education for effective learning [13]. In the fact, chatbot application as an e-learning application for students that can assist teachers in providing distance learning to students efficiently and easily [8]. This also sounded interesting to the German teachers at Universitas Negeri Malang, Indonesia: Learning German grammar material at the German Language Education Department, Universitas Negeri Malang is contained in a certain part of the study (called *Struktur und Wortschatz,* lectures level 1 to level 3). For most students, these courses are difficult subjects, because their focus on the study of German grammar, which is known as the high complexity degree level [14]. This current research aims to develop and to evaluate a chatbot application for Indonesian students learning German language. This mobile chatbot application with the name Gramabot can be accessed via a smartphone or desktop PC. The name 'Gramabot' is an acronym for *grammar* and *robot*, which means a robot that can answer questions about German grammar.

2　　Research questions and research design

To assist students in understanding German grammar, chatbot media is used as a means of self-study during the pandemic. Based on the advantages of chatbots, the researchers developed Gramabot as independent learning media and test their effectiveness in grammar learning. This study focuses on the research questions, if a chatbot application for learning German grammar is a helpful tool for Indonesian students. Our chapter therefore addresses the issues, how chatbots are used as a learning medium, how we developed our first version of a chatbot for German grammar learners, and the results of user tests and their evaluation. We then look more closely at what prior knowledge the students have in this and whether this influences the results of their evaluation.

This paper describes the initial development process of a chatbot for Indonesian students learning German, i.e. the literature research on the topic, the development of a

chatbot prototype and the first experiences and feedback of the target group on the chatbot and its use. The development and research process is presented in Figure 1. So, this research follows the design-based research approach [15]–[17] and therefore in more details the learning experience design [18]–[20]. The approach of design-based research is based on concrete didactic concerns, as they are also generally addressed in instructional design [21]. Design-based research, however, has a higher interest in acting based on current research and in systematic documentation and evaluation. A typical feature of learning experience design is that it focuses on learners and their needs, and the development of measures takes place in several cycles and iteratively.
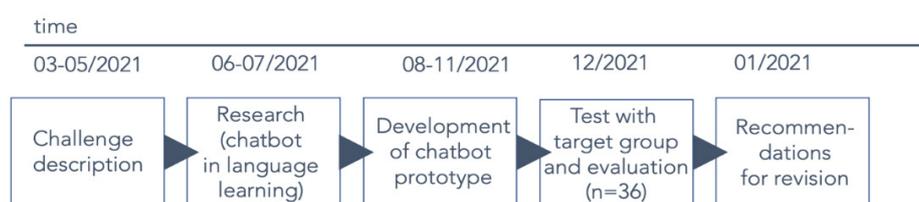
Fig. 1. Research and development flowchart

To describe the state of research on the use of chatbots in language learning, we used the ERIC database and Google scholar and searched for relevant articles using the terms "language learning" and "chatbot", e.g. those that give an overview of the state of research and in particular those that operate with the language German or in the Indonesian context. The development of the chatbot bases on current software development procedures as described later. For the test, students from the target group were involved and completed an online survey after using the chatbot. The test and survey involved 36 students with A1-A2 Common European Framework of Reference for Languages (CEFR) standard level of German proficiency.

3 Results

3.1 Current use of chatbots in general language learning and the challenge of German Grammar

Research about chatbot usage for language learning is mainly found for learning English. Most of the current literature are case studies and descriptions. A current review of chatbot-supported language learning found 24 empirical studies with control groups [22]. The current study gives a good overview about pedagogical usages of chatbots for language learning (see Table 1).

Table 1. Pedagogical usages of chatbots for language learning. Source: Shortened version of Table 4 in [22]

Affordance	Learning activity
Interlocutor	• Language knowledge practice (students interacted with chatbots to discuss a certain topic, e. g. hotel room booking) • Learning skills activity (students read stories being asked questions by chatbots) • Group discussion coordination (the chatbot distinguishes between weak and strong students with individual promptings)
Simulation	• Role-playing (The chatbot played the role of a waiter in an authentic language learning environment) • Learning scenario representation (chatbots were used in a part of a simulation (in a virtual estate company office)
Transmissive	• Delivering well-targeted interventions (a chatbot functions as a co-teacher delivering instructional materials)
Helpline	• Responding to requests for assistance (learners assessed chatbots for help when they encountered language problems regarding the learning content)
Recommendation	• Providing level-appropriate learning contents (the chatbot recommends a book based on students' language level)

Even though most of the scientific contributions deal with the use of chatbots in English learning, chatbots are also used for other languages learning. For example, chatbots have the potential to be used as a means of learning Chinese: Chen got positive results for Chinese vocabulary learning with a chatbot [23]. We found as well examples for Javanese [24], Acehnese [25], and Arabic [26], Malaysian [27].

In the case of German language, [28] probably published the first article on language learning with chatbots [29]. Interestingly, current publications on learning German with chatbots also include a pedagogical variant that cannot be found in Table 1 by Huang, Hew & Fryer [22]: Subhasri & Sathiaraj co-developed chatbots and other e-learning applications with engineering students who learn German as a foreign language [30]. Mazilli describes how an existing, non-language learning chatbot system is used for learning German which is described as "action-oriented language learning" and which was able to enhance conflict-solving skills as well [31]. So far, we did not find an example for the usage of a chatbot for learning German Grammar or learning German in Bahasa Indonesian.

German grammar is complicated and not easy to understand, especially for beginners. Notes and explanations are therefore important in the native language - Bahasa Indonesian. Since there are only a few textbooks and the teachers at Universitas Negeri Malang cannot always be available to their students, the idea arose to develop a chatbot that can support the learning of German grammar by providing answers to common questions. The expectation here is that students will also contact the chatbot more easily and directly than is the case with teachers.

3.2 Technical basics of chatbots and development Gramabot for learning German grammar

There are different methods how chatbots work and are developed. Generally, the way a chatbot works starts from the user inputting a word or sentence, then the system on the chatbot selects the data in the dataset and then presents it to the user as an answer output [24].

Haristiani distinguishes three structures how chatbots works technically [29] (see Table 2): a tree-based chatbot has fixed answers from experts, whereas artificially intelligent chatbots "learn" from previous communications and "hybrids" combines both approaches.

Table 2. Structures of chatbots. Source: excerpt of Haristiani (2019). Table 1, p. 2. (slightly adjusted)

| Structure	Description
Flow chatbot	A tree-based chatbot. This chatbot has fixed responds set by the developer, and only responds to questions that are already in the database. Flow chatbots include buttons, keywords, and catchphrases instead of free writing to drive the client down the predefined path.
Artificially intelligent	Chatbot with artificial intelligence has the ability update their knowledge and perception from previous conversations and users' experience, letting the users engage more freely.
Hybrid	This type of chatbot combines the concepts of Flow and AI chatbots. This chatbot can understand and communicate with users but remains in the pattern determined by the developer.

Chatbots can be built with many basic models, including AIML [12], php programming and the four pillars of the object oriented programming concept [24], sequence-to-sequence [32], [33], waterfall [11], dialogue flow [34], natural language processing method and black box testing method [35]. Natural Language Processing (NLP) and Digital Signal Processing (DSP) technology are used to convert the processed text into speech audio representations synthesized from text, for example in the use of the Google Speech Recognition API [11]. Chatbots can be used by utilizing social media applications, such as the LINE Messaging API [36], Telegram, and other social media.

In the case of Gramabot, we have chosen to develop the traditional expert-based model, also because it is easier to implement. Therefore, the string-matching method is used, which is a method of matching the given keywords with the keywords contained in the database. Step by step it works like follows: (a) break the sentence into word by word, (b) eliminate unnecessary words and characters, (c) match the words contained in the database, (d) get the result of the matching process and (e) show results. Of course, additional processes and programming languages must be used to develop the backend and frontend of the web-based application.

Keywords and the contents of the grammatical explanation in Gramabot were prepared based on the predetermined semester plan. The researchers make a list of keywords that are expected asked by students. To get an idea of the questions that students will ask, the compiled list of words is discussed with B1 level students. Based on their

experience, students provide suggestions on questions that potentially to be asked by A1 to A2 level students.

The German Grammar experts and teachers collect the keywords and explanations according to keywords for several topics. All explanations are written in Indonesian, because we aim to make it easier for students who are beginners in German to understand the learning material. Gramabot answer the questions by asking students in keyword questions. The answers and explanations are written in Indonesian. For example, the students type in a question or just keywords, e.g. on *conjugation, articles*, or modal *verbs*. The chatbot then gives the correspondingly prepared explanations for the answer. After going through a series of trials, the developers managed to create a stable application as shown in the Figure 2.
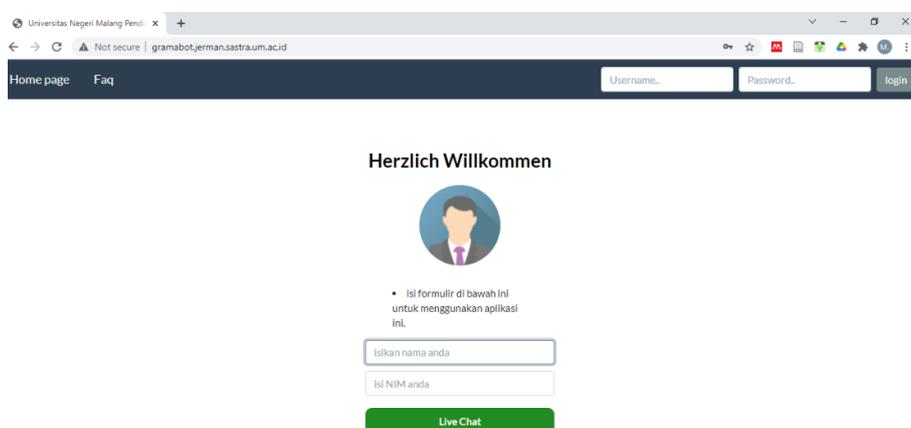
Fig. 2. The desktop version of Gramabot. Source: Screenshot of the Web-based application, see http://gramabot.jerman.sastra.um.ac.id/

Students open Gramabot via smartphones or PC/laptops via the Webpage and then log-in without registration. When the menu is ready, students write down the theme keywords they want to ask. Questions that can be answered by Gramabot are limited to German grammar for beginner (CEFR standard level A1).

3.3 Use of the application and evaluation by test users

Students of German were asked to try Gramabot on a trial basis. This means that it has not yet been integrated into regular classroom use. Over a period of 7 days, 36 students complied with our request and subsequently filled out an online questionnaire. In addition to the questions on prior knowledge already presented, open questions were asked. This made it possible to obtain many answers, some of which were concrete, about the technical and didactic possibilities or challenges.

A closed question referred to which grammatical topics the students can learn well with Gramabot. Here, different grammatical topics were given, all of which received high agreement ratings: On average, almost 40 to 70 per cent agreed that they can learn

on these topics with Gramabot. The topics tenses (68%) and separable and non-separable verbs (64%) received particularly high approval ratings. The grammar field pronouns scored rather poorly here (42 % agreement). In our view, this assessment roughly corresponds to how difficult the learners generally experience the grammatical topics.

To obtain concrete indications of possible improvements, four open question was asked about the things that the test persons liked or not liked, suggestions for improvements and other possibilities to use a Chatbot for learning German. They reported positively, for example, "The explanations are detailed and understandable" and "The explanation is very complete and easy to learn, besides that the response is also fast, there is no buffering or lag". The test persons found it negative, for example, that there was no Android version in the test phase or no additional information about the functionality: "there are no additional features that can help ordinary people understand how it works and what can be learned. The question concerning possible enhancements, such as "no pictures yet, can be equipped with more interesting pictures or designs". Concerning the last open question for other possible topics for learning German, the test users name practically the full range of German language learning issues.

Finally, a general assessment was also asked for in a standardized way, to which there was a very positive response: 19 (53%) strongly agreed, the other 17 (47%) agreed that in general, Gramabot helps better understand the grammar taught in SW1 courses. Agreement on the question of whether test users want to learn other subjects through the chatbot app besides grammar is - with one exception - even higher: 23 (64) strongly agree, 12 (33%) agree and one person (3%) disagrees.

3.4 Prior experiences of students testing Gramabot concerning chatbot usage and possible effects on assessment

To get an impression of the previous experience of the test participants, some questions were asked about it. Based on the questionnaire distributed, half of the 36 respondents admitted that they were not familiar with Chatbot technology, while the others had already used it, as shown in Figure 3.
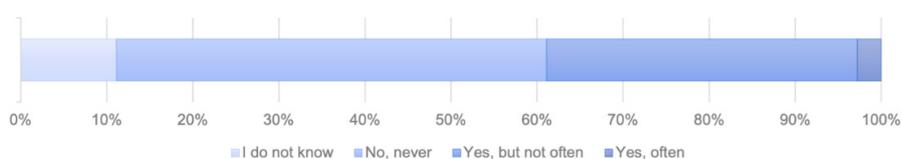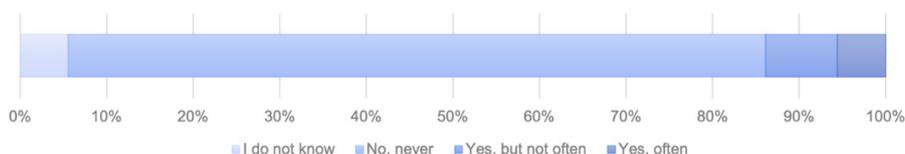

Fig. 3. Experience using Chatbot technology (N=36)

Based on the diagram above, only a small number are familiar with several chatbot applications, for example *Ica-Ica, Bot-Telegram, Simsimi, Google Assistant, Inner-Hour*, chatbots in online shops, customer services E-Commerce and applications for health monitoring. It appears that the chatbot used by students is not a medium for learning German but is used as a means of asking questions about the product.

Meanwhile, data that shows the experience of students using the Chatbot application as a learning medium is also obtained as shown in Figure 4.

Fig. 4. Student experiences using Chatbot technology in learning (N=36)

Based on this data, it is known that most of them have never used Chatbot technology as a learning medium, and only a small proportion of respondents have used it. To gain an insight into the role that prior knowledge plays in the evaluation of Gramabot, we have created two cross-tabulations that illustrate the correlations. Table 1 thus shows the proportions who experience Gramabot as helpful depending on previous general experience with chatbots. The cross table shows no clear sign that more intense prior knowledge of chatbots might be connected to better assessment of Gramabot. We therefore carried out a correlation analysis, using the values in brackets in the table for the high approval ratings. This results in a negative correlation of $r= -0.32$, i. e. only a very low negative correlation.

Table 3 presents the proportions of test users who experience Gramabot as helpful depending on previous general experience with chatbots for learning: Again, the cross table does not reveal clear dependency of positive experiences with Gramabot with prior knowledge of using chatbots in learning. We therefore made again a correlation analysis, resulting again in a slightly negative small statistical correlation ($r=-0.21$).

Table 3. Users who experienced Gramabot as helpful depending on previous general experience with chatbots (N=36)

Prior Knowledge concerning chat-bots	very helpful (2)	helpful (1)	not helpful (0)	sum
I do not know (-)	1	3	0	4
No, never (0)	12	7	0	18
Yes, but not often (1)	6	7	0	13
Yes, often (2)	0	1	0	1
Sum	19	*18*	*0*	36

Table 4. Users who experienced Gramabot as helpful depending on previous experience with chatbots for learning (N=36)

Previous experience	very helpful (2)	helpful (1)	not helpful (0)	n.a. (-)	sum
I do not know (-)	1	1	0	0	2
No, never (0)	17	11	0	1	29
Yes, but not often (1)	0	3	0	0	3
Yes, often (2)	2	0	0	0	2
Sum	20	*15*	*0*		36

4   Discussion

The described development has succeeded in developing a stable chatbot application for learning German grammar. Additionally, our user tests and evaluation showed that Gramabot is an application that can be used for learning basic German grammar. Beside learning itself, some of the advantages of this chatbot are that it uses Indonesian as the language of instruction, it is free, and users do not have to register.

We additionally used our evaluation data of 36 users if we can detect a clear hint about potential relations of prior knowledge with chatbot and user experiences. This might be a useful hint if, and how much additional introduction and materials we might need to implement Gramabot in the regular German studies. Nevertheless, at least our data shows no clear relation. So, a tutorial on how to learn with Gramabot might be helpful – for learners with and without prior knowledge.

5   Outlook and recommendations for others

So far, Gramabot has not yet been used in class. After the revision and adaptation of the application, this use will take place. For this purpose, it is planned to work with an experimental group and a group that does not use Gramabot. We can also imagine working with chatbots for other levels and themes of German grammar or other applications.

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