



HAL
open science

Chatbot design to help learners self-regulate their learning in online learning environments

Franck Poirier, Khalifa Mansouri, Wijdane Kaiss

► **To cite this version:**

Franck Poirier, Khalifa Mansouri, Wijdane Kaiss. Chatbot design to help learners self-regulate their learning in online learning environments. The 23rd IEEE International Conference on Advanced Learning Technologies (ICALT 2023), IEEE Computer Society and the IEEE Technical Committee on Learning Technology, Jul 2023, Orem (UT), United States. hal-04083828

HAL Id: hal-04083828

<https://hal.science/hal-04083828v1>

Submitted on 27 Apr 2023

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Chatbot design to help learners self-regulate their learning in online learning environments

Wijdane Kaiss^{1,2}, Khalifa Mansouri¹, Franck Poirier²

¹Laboratory Signals, Distributed Systems and Artificial Intelligence, ENSET
Mohammedia, University Hassan II of Casablanca, Casablanca, Morocco

²Lab-STICC, University Bretagne Sud, Vannes, France

wijdane.kaiss@univ-ubs.fr

khmansouri@hotmail.com

franck.poirier@univ-ubs.fr

Abstract—E-learning environments are part of the self-learning ecosystem of which self-regulation is one of the main pillars. One of the key factors contributing to dropping out in an e-learning environment is the lack of self-regulatory skills. This skill is often absent in many learners, leading them to abandon their training. In this paper we propose a methodology, chatbot architectural design, allowing to help the learner to self-regulate in his/her learning by supporting him/her through a chatbot within the Moodle platform, which constitutes a metacognitive virtual assistant, to provide metacognitive messages. The aim is to improve the quality of learning in the e-learning environment.

Keywords—self-regulated learning, e-learning, chatbot, moodle.

I. INTRODUCTION

E-learning environments require learners to be able to self-regulate their learning. The three pillars of self-learning are: *Self-Regulated Learning* (SRL), which involves the ability to set goals, plan and monitor progress, regulate emotions, and adapt strategies to optimize learning; *Metacognition*, which involves the ability to reflect on one's own thinking and learning processes, to evaluate one's own strengths and weaknesses, and to identify and address areas for improvement; and *Motivation*, which involves the drive and willingness to engage in learning activities, to persevere in the face of challenges, and to take ownership of one's own learning.

Self-Regulated Learning (SRL) is one of the three pillars of Self-Learning and it is demonstrated that, when mastering SRL skills, learners become more engaged in their learning and achieve stronger gains in learning [1]. These skills must therefore be developed and promoted during learning [2]. Its absence or weakness is seen as a factor that can lead to abandonment [3], [4].

The SRL skills refer to the learners' ability to define specific goals for their work, plan strategies to achieve those goals, and monitor and adapt those strategies as they progress.

Indeed, the teacher is not able to provide, in real time, help to learners to use self-regulation strategies, either because of the number of learners, as each demand requires an appropriate time for reflection and decision, or because of his availability. To solve this problem, we propose, in this paper, a design architecture of the chatbot that will be integrated in the Moodle

platform to support learners to self-regulate during their learning process, to improve their learning and to stay motivated.

A chatbot is a new form of automated contextual communication between users and machines or systems, which exploits a conversational approach based on natural language. It refers to a software system, also known as a conversational agent, as it takes turns interacting with the user, through written messages [5]. It is a technology that simulates human conversation by providing feedback and can interact intelligently through machine learning and artificial intelligence [6].

The rest of the paper is organized as follows. The section 2 reviews our related works. The section 3 presents in detail our proposed chatbot in terms of architecture design. The chatbot service processes are shown in the section 4 and the section 5 concludes this work.

II. RELATED WORKS

A. Self-Regulated Learning (SRL)

Self-regulation generally refers to “self-generated thoughts, feelings, and actions that are planned and cyclically adapted to the attainment of personal goals” [7]. Self-regulated learners “plan, set goals, organize, self-monitor, and self-evaluate at various points during the process of acquisition” [8]. In [9], reviewed a variety of definitions of self-regulated learning and identified three common components of self-regulated learning: (1) metacognitive strategies (e.g., planning, monitoring, and modifying cognition), (2) task management and control, and (3) actual cognitive strategies to learn the material.

SRL can be understood as a learner's ability to self-monitor and adjust their learning strategies or behaviors in response to the current learning context [10]. Numerous studies have investigated the models, frameworks and fundamental phases of SRL [11], [12]. On this basis, educators have made various attempts to help learners develop SRL skills and apply these strategies to their learning. However, studies have shown that students struggle with self-regulation in online learning [13]–[16].

It should also be noted that self-regulated learning support was more effective in the online learning condition than in the face-to-face setting. The researchers explained this with the

nature of online learning, which requires the learner to monitor their own learning and demands metacognitive strategies more than face-to-face environments [17]. Providing metacognitive support in the form of feedback improved students' self-regulation in an online learning environment. The feedback helped students reflect on their learning processes and set goals for improvement. Also, providing opportunities for self-assessment and reflection was effective in supporting SRL in an online learning environment. Students who engaged in self-assessment and reflection had better learning outcomes and higher levels of SRL compared to those who did not. These examples reveal the potential of self-regulated learning support to increase students' self-regulated learning skills and learning performance.

The model of [18] was the most frequently accepted and we will use it, who postulated that SRL occurs in three cyclical phases: forethought (such as goal setting, planning), performance (such as time management, help seeking), and self-reflection (such as self-evaluation) [7], [18]. Each phase of self-regulated learning consists of processes that self-regulated learners engage in, and each phase influences the processes of the next phase.

B. Supporting self-regulation through chatbots

Chatbots are machine agents that serve as natural language user interfaces to provide data and services [19]. In recent years this technology has been employed for multiple purposes mainly in messaging applications. Chatbots can also serve various purposes such as customer care, emotional or social support, information providers, entertainment, etc [20].

Chatbot promises to solve a variety of problems in education today. One of the biggest advantages of chatbot is that it can support students individually and intently [21]. Other research has confirmed that chatbots can be virtual companions for users intended to resolve availability issues, provide support and customer assistance [22], [23] powered by artificial intelligence.

In the higher-education, a chatbot can be trained from a wide variety of resources ranging from learning experiences to learning materials. According to [24], chatbots are trained to answer common questions about the study of a subject. This motivates learning supports more quickly and conveniently.

In [25], the use of a chatbot in an educational context for the automation of higher education student care is presented. The chatbot interacts with students through text messages on topics in a closed context answering doubts about the "Higher Institution Course".

However, to our knowledge, there are no chatbots that have been used in the educational context to support self-regulated learning strategies on the Moodle platform. In this subsection, we have discussed some scientific contributions on chatbots in the field of education.

III. PROPOSED CHATBOT ARCHITECTURAL DESIGN

Figure 1 shows the proposed design of our chatbot to support self-regulated learning strategies on the Moodle platform, including the two main components (Learner message analysis and Response generator).

A. Learner Message Analysis

The Learner message analysis component uses natural language processing techniques to comprehend what learners are talking about. Specifically, it consists of two main tasks:

1) *Intent matching*: the aim of this component is to determine the intent of learners through their messages. It can be considered as the goal of the messages. The learner intent identification is studied from the perspective of the text classification. Correspondingly, learner text messages are classified into those intents: Engage in learning (which will allow the learner to establish his/her goal to start learning), Make appointment (to plan and manage his/her time in order to reach his/her defined goal), the intentions Exercise (to do an exercise on a part of the course chosen by the learner), My tasks (to see the tasks he/she has defined), My progress, Evaluation, which allows the learner to self-evaluate and self-monitoring (allow the learner to control and track his/her progress towards his/her goal), and ask for help via FAQ intent.

2) *Entity Recognition*: once the intent of the learner is determined, a specific set of context information is extracted from the message. Chatbots use this information to capture the current situation of the learner and generate the response accordingly. In the field of natural language processing, the researchers performed this work *very* effectively, known as Named Entity Recognition (NER) system [26]. In essence, it is a model of classifying a word block in a message into a given entity (label). The main entities, the context information, that is usually extracted for most learner intents are the domain, specialty, course, concept, tasks.

For example, when a learner message is "please, I want to know my progress in the pointers part of the C programming course.", the chatbot will automatically categorize the message to the intent of My progress. For this intent, two context information about the concept (pointers) and the course (C programming) is automatically determined.

In this paper, all the natural language processing operations mentioned above are implemented by Dialogflow. Dialogflow is a Google technology that supports human-computer interaction based on conversations in natural language. Unfortunately, Google has not published which algorithms are used in the Dialogflow. However, according to the Dialogflow documentation, the selected algorithms are most effective with the user message to the training phase.

B. Response Generator

Based on the intent and context information returned from the Learner message analysis component, the Response generation component constructs responses for the Learner. Three models : the Pattern-based model [27], Retrieval-based model [28], and Generative model [29], are utilized to generate the appropriate responses. For the Pattern-based model, chatbots match learner messages with each underlying question-answer pattern to create a response. Compared to the Pattern-based model, the Retrieval-based model offers much flexibility. Specifically, this model queries and analyzes available resources using APIs and databases. The Generative model is the smartest

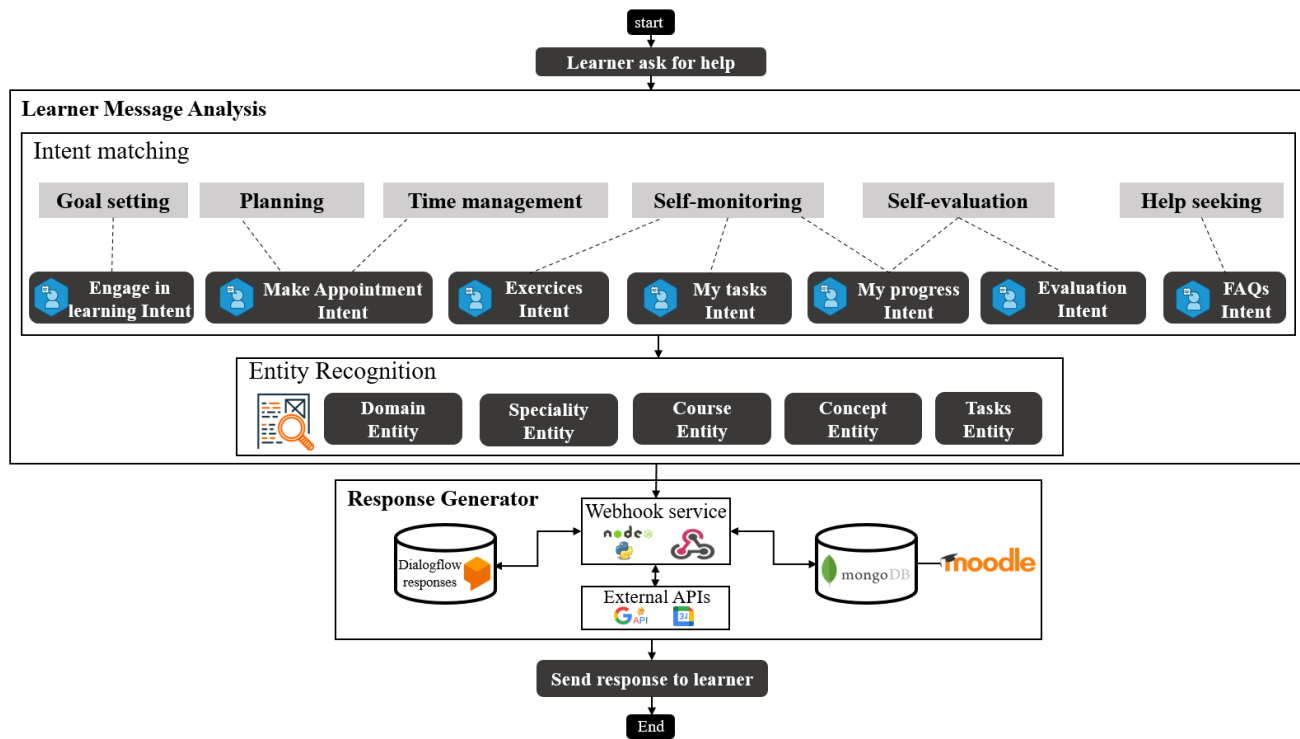


Fig. 1. The proposed chatbot design.

among the three models in terms of generating answers based on current user messages and previous messages. However, it encounters many difficulties in building and training. This means that it needs training with a very large set of data in order to achieve a good conversation. Because of this disadvantage, this model still has not been much used to build a chatbot in reality yet. In the proposed approach, the retrieval-based model will be used in our chatbot like most of the current chatbots in order to provide more flexibilities in our services.

Once the intent is detected by Dialogflow, an action to perform is chosen, the Webhook sends a formatted response corresponding to the intent. All actions will be coded in Node.js and hosted by the Webhook Fulfillment. The latter is a service that allows a dynamic response by searching for response elements in an external database. The database we will use is MongoDB which will contain data about the learner, to keep track of him/her, and about the moodle resources. And there is also the local database that will contain the answers recorded in Dialogflow. So, we will use external API google calendar to record the tasks (by date and time) that the learner has defined.

IV. CHATBOT SERVICE PROCESSES

In this section, we will present service processes for handling learner messages to help them self-regulate.

Fig. 2 shows the process of the 'Engage in Learning' service, which helps the learner to set a goal by asking a set of questions. It responds to the SRL "Goal setting" strategy of the Fourtough phase. After the learner chooses to engage in a learning activity, the chatbot determines the intent (in this case, it will be Engage in learning intent) and recognizes the entities (e.g. Domain entity, Course entity, ... those defined in the design of the chatbot Fig. 1), in order to generate the set of questions from Dialogflow

(will be questions, e.g. in which domain he/she wants to learn, which specialty, by which concept he/she wants to start, ...), so that the learner can clarify his/her goal and start learning.

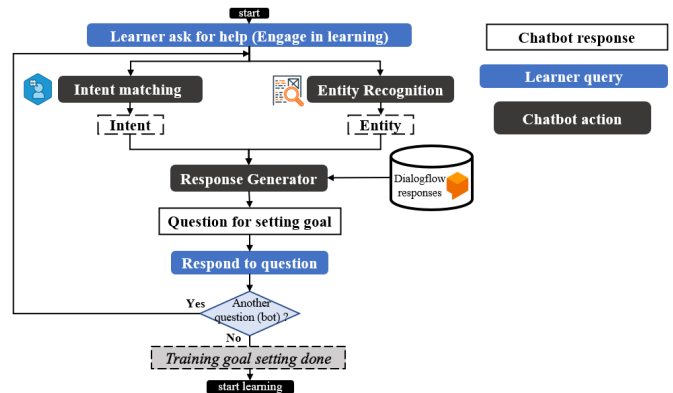


Fig. 2. The service process « Engage in Learning».

Fig. 3 shows the process of the 'make appointment' service, which helps the learner to plan the course parts in order to manage his/her time. It meets the SRL strategies "Planning" and "Time Management". After the learner chooses this service to organize his/her learning in order to reach his/her goal, the chatbot repeats the first phases (classification of the intention and recognition of the entities), to generate answers containing questions, for example, about the name of the task, the time to perform the task (date and time). After it confirms what it has defined, a check will be made to know if the chosen time or date is available, otherwise the chatbot will ask the learner to change. If it is available, the chatbot will record it in the learner's calendar, using the Calendar API, and keeps track of this in the MongoDB database.

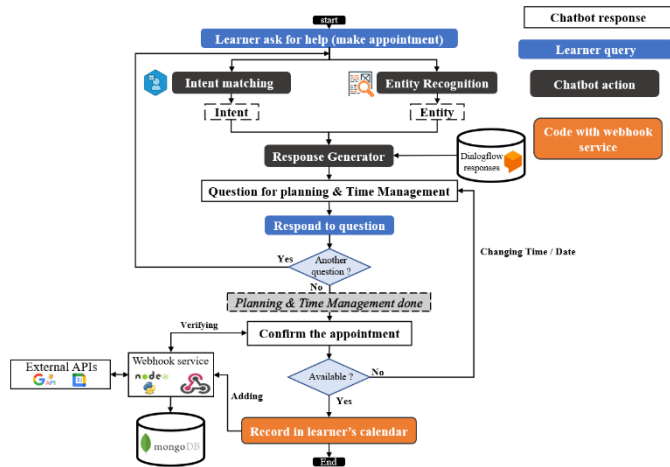


Fig. 3. The service process « make appointment ».

One of the self-regulation learning strategies is self-evaluation. The chatbot will help the learner to evaluate him or herself, by generating a test following a set of questions, generated from Dialogflow responses (see Fig. 4), which will determine the module on which he or she wants to pass the test. The latter will be generated from the moodle resource database using weebhook. At the end, the chatbot will generate a feedback, which will be personalized, on the parts that he/she has not answered correctly with corrections. This test and feedback will allow the learner to self-evaluate and self-monitor, since the learner will know the learning progress and its advancement to ensure the achievement of the objectives.

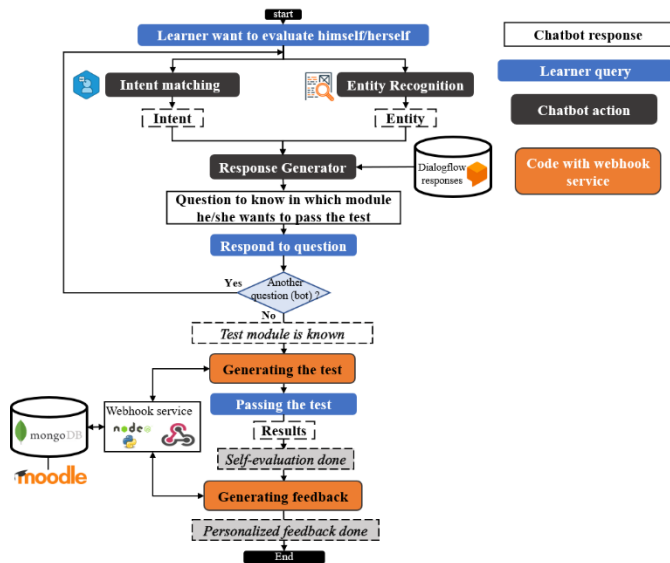


Fig. 4. The service process « self-evaluation ».

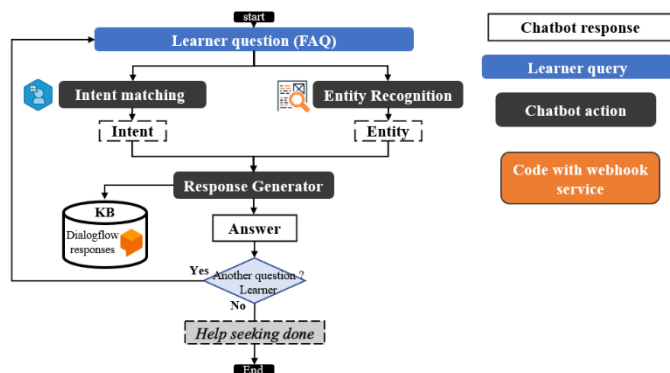


Fig. 5. The service process « FAQ ».

In Fig. 5 shows the process of the 'FAQ' service. Instead students going to the website and long faq to ask for help (help seeking), they can simply ask a question to the chatbot and they can get an answer, by integrating data faq into Knowledge Base (KB). A Knowledge Base was populated with pertinent information regarding the topic at hand, to satisfy the requests for definitions and examples. Afterward, the chatbot generate an answer to satisfy the learner request from KB. The answer is sent back to the learner.

V. CONCLUSION

Self-regulated learning has become a popular topic in the online learning research field. Self-regulation is not an inherent feature of human but the self-directive process. Despite the proliferation of participating in online courses and a large number of learning resources around the world, scant knowledge exists about how to support and scaffold self-regulated learners in online learning environments and how to guide instructors to lead to their successful online courses. The results of this study show the possibilities of using a conversational AI agent when scaffolding learners' self-regulated learning in online courses via our conceptual proposal. Future work will focus on the implementation and use of the chatbot, integrated into the Moodle platform, by learners who will participate in the experiment that we will do to validate our conceptual proposition.

ACKNOWLEDGMENT

The authors would like to express their gratitude to the editors and referees committee of the IEEE International Conference on Advanced Learning Technologies for their constructive comments and valuable feedback on this work.

REFERENCES

- [1] D. H. Schunk and B. J. Zimmerman, "Motivation and self-regulated learning : theory, research, and applications," 2008.
- [2] B. J. Zimmerman, S. Bonner, and R. Kovach, "Des apprenants autonomes: Autorégulation des apprentissages.," 2000.
- [3] H. Khalil and M. Ebner, "MOOCs Completion Rates and Possible Methods to Improve Retention - A Literature Review," in World Conference on Educational Multimedia, Hypermedia and Telecommunications, 2014, pp. 1305–1313.
- [4] I. Nawrot and A. Doucet, "Building engagement for MOOC students: Introducing support for time management on online learning platforms," in Proceedings of the 23rd International Conference on World Wide Web, WWW 2014 Companion, Republic and Canton of Geneva, Switzerland, Apr. 2014, p. 1077. doi: 10.1145/2567948.2580054.

- [5] S. Valtolina, B. R. Barricelli, S. di Gaetano, and P. Diliberto, "Chatbots and Conversational Interfaces: Three Domains of Use", 2018.
- [6] T. Parthornratt, D. Kitsawat, P. Putthapipat, and P. Koronjaruwat, "A Smart Home Automation Via Facebook Chatbot and Raspberry Pi," 2018 2nd International Conference on Engineering Innovation, ICEI 2018, pp. 52–56, Aug. 2018, doi: 10.1109/ICEI18.2018.8448761.
- [7] B. J. Zimmerman, "Attaining self-regulation: A social cognitive perspective.," pp. 13–39, 2000.
- [8] B. J. Zimmerman, "Self-Regulated Learning and Academic Achievement: An Overview," *Educational Psychologist*, vol. 25, no. 1, pp. 3–17, 1990.
- [9] P. Pintrich and E. D. Groot, "Motivational and self-regulated learning components of classroom academic performance.," *J Educ Psychol*, vol. 82, no. 1, pp. 33–40, 1990.
- [10] A. Littlejohn, N. Hood, C. Milligan, and P. Mustain, "Learning in MOOCs: Motivations and self-regulated learning in MOOCs," *Internet High Educ*, vol. 29, pp. 40–48, 2016.
- [11] U. Kirschenmann, M. Scheffel, M. Friedrich, K. Niemann, and M. Wolpers, "Demands of modern PLEs and the ROLE approach," vol. 6383, 2010.
- [12] D. Renzel, R. Klamma, M. Kravcik, and A. Nussbaumer, "Tracing self-regulated learning in responsive open learning environment," in *International Conference on Web-based Learning*, 2015.
- [13] N. Capuano, G. R. Mangione, A. Pierri, and S. Salerno, "Learning Goals Recommendation for Self-Regulated Learning," *International Journal of Engineering Education*, vol. 28, no. 6, pp. 1373–1379, 2012.
- [14] I. Hidayah, T. B. Adji, and N. A. Setiawan, "A framework for improving recommendation in adaptive metacognitive scaffolding," in *Proceedings of the fourth International Conference on Science and Technology (ICST)*, 2018, pp. 1–5.
- [15] R. F. Kizilcec, M. Perez-Sanagustin, and J. J. Maldonado, "Self-regulated learning strategies predict learner behavior and goal attainment in Massive Open Online Courses," *Computers & Education*, vol. 104, pp. 18–33, 2017.
- [16] M. Manso-Vazquez and M. Llamas-Nistal, "Proposal of a learning organization tool with support for metacognition," *IEEE Revista Iberoamericana de Tecnologías Del Aprendizaje*, vol. 10, no. 2, pp. 35–42, 2015.
- [17] B. Kramarski and T. Michalsky, "Investigating Preservice Teachers' Professional Growth in Self-Regulated Learning Environments," *J Educ Psychol*, vol. 101, no. 1, pp. 161–175, 2009.
- [18] B. J. Zimmerman, "Motivational Sources and Outcomes of Self-Regulated Learning and Performance," no. 11237, 2011, doi: 10.4324/9780203839010.ch4.
- [19] R. Dale, "The return of the chatbots," *Nat Lang Eng*, vol. 22, no. 5, pp. 811–817, 2016.
- [20] P. B. Brandtzaeg and A. Følstad, "Why People Use Chatbots," in *The 4th International Conference on Internet Science*, 2017.
- [21] R. Winkler and M. Söllner, "Unleashing the Potential of Chatbots in Education: A State-Of-The-Art Analysis," *Academy of Management Annual Meeting (AOM)*, 2018.
- [22] Eric Hsiao-Kuang Wu, Chun-Han Lin, Yu-Yen Ou, Chen-Zhong Liu, Wei-Kai Wang, and Chi-Yun Chao, "Advantages and constraints of a hybrid model k-12 e-learning assistant chatbot," *IEEE Access*, vol. 8, pp. 77788–77801, 2020.
- [23] S. Yang and C. Evans, "Opportunities and Challenges in Using AI Chatbots in Higher Education," pp. 79–83, Nov. 2019, doi: 10.1145/3371647.3371659.
- [24] Hubert, "6 Ways Artificial Intelligence and Chatbots Are Changing Education," 2017.
- [25] J. D. S. Oliveira, D. B. Espindola, R. Barwaldt, L. M. I. Ribeiro, and M. Pias, "IBM Watson Application as FAQ Assistant about Moodle," in *Proceedings - Frontiers in Education Conference*, 2019.
- [26] S. M. Weiss, N. Indurkha, T. Zhang, and F. J. Damerau, "Text mining: Predictive methods for analyzing unstructured information," *Text Mining: Predictive Methods for Analyzing Unstructured Information*, pp. 1–237, 2005, doi: 10.1007/978-0-387-34555-0.
- [27] A. Joshi, A. Kunchukuttan, P. Bhattacharyya, and M. Carman, "SarcasmBot: An open-source sarcasm-generation module for chatbots," in *WISDOM at SIGKDD*, 2015.
- [28] Y. Wu, W. Wu, C. Xing, M. Zhou, and Z. Li, "Sequential Matching Network: A New Architecture for Multi-turn Response Selection in Retrieval-Based Chatbots," in *55th Annual Meeting of the Association for Computational Linguistics*, 2016.
- [29] M. Patidar, "Correcting Linguistic Training Bias in an FAQ-bot using LSTM-VAE," in *ECML-PKDD, DMNLP Workshop on Interactions between Data Mining and Natural Language Processing*, 2017.