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## Chatbots as Cognitive, Educational, Advisory & Coaching Systems

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**Abstract.** Chatbots are software applications assimilating human communication with the aim to raise adherence and engagement between human-systems interaction. Text messaging-based conversational agents (CAs) make an interesting use of natural language processing and improve by learning, allowing coherent two-way communication with humans, either oral or written as well as real-time decision-making. Chatbots serve as means of learning and teaching, as virtual assistants and social companions. Machine learning algorithms embedded into Chatbots simulate human cognition, including cognitive learning, decision making and adaptation to the environment. Thus, the future of artificial intelligence in Chatbots lies in the development of a global, reliable and sustainable ecosystem of knowledge, skills and values by bringing together all interested stakeholders, such as scientists, consumers, businesses and the state. Such effective customized/personalized learning frameworks depend on sophisticated conversational flows based on user models, which cluster user preferences and attributes in combination with learning analytics to induce end users' personal skills, knowledge mastery, learning ability as well as professional development.

**Keywords.** Chatbots, Intelligent tutoring systems

### 1. Introduction

In general, the use of Chatbots focuses on marketing tasks or disseminating information about a product. Conversational bots are based on decision trees or driven by artificial intelligence (AI). When their algorithm is implemented in AI systems, they are trained to be able to interpret user input within the conversation, understand the questions and decide what to answer. Their training capability is possible thanks to the processing, comprehension and natural language generation technologies. There are two types of Chatbots according to complexity: a first type of structured or first generation Chatbot, which bases its operation on a set of rules and a second type of generative or second generation Chatbot that uses machine learning, artificial intelligence or other machine learning mechanisms to interact with the user.

User experience (UX) is responsible for making the conversation between the Chatbot and the user as natural as possible. User interface (UI) is the component through which the user interacts with the Chatbot, that is, what the user can physically see and hear to follow the conversation. Conversational design is a design language, which is based on human conversations and it is responsible for providing common sense to artificial intelligence.

Chatbots can be configured as a new UI/UX by enabling, facilitating and expediting access to information.

The interface used by Chatbots is based on the structure of human conversation that is obtained through natural language processing (NLP). The NLP allows algorithms to understand, interpret and manipulate human language. In addition, more advanced Chatbots are able to learn from conversations by implementing Machine or Deep Learning. Chatbots have conversational artificial intelligence to be able to manage and process natural language. Through conversational AI, Chatbots have the ability to analyze user entries, learn from them and generate a response as appropriate as possible in relation to the input entered [1].

Chatbots are in the very beginning of entering education on account of their capacity to offer individual learning support with limited financial and organizational resources. In addition to their educational benefits, Chatbots can be used as cognitive trainers as their development and use demands analytical and creative thinking as well as technological awareness. Moreover, they demand a student, who has critical thinking and is able to pose crystal-clear questions in order to receive the right answers [2].

AI tools in higher education aim to enhance students' internal incentives and boost students' academic performance through instant interaction, at any time without natural limitations on a person. In addition, the layered architecture of intelligent systems maximizes the final outcome of any data management system, which is to find the most appropriate answers and most adequate solutions. Intelligent educational systems can be integrated into face-to-face, semi-presence or online education models. The inclusion of a comprehensive system that includes data analysis, decision-making through AI and the recommendation of activities in a Learning Management System environment allows for a comprehensive improvement in learning.

In addition, the deployment of a data analysis platform that is responsible for the processing of academic data allows students to learn more about trends, strengths and weaknesses. However, the scope of such models is fully scalable, which means that the system allows adding other factors in the field of education, for example, the system can become the ideal teacher assistant and even more, it can have a complementary role in the administration services of a university [1].

Chatbots can initiate and assimilate human communication according to the user's specific context, such as location or clickstreams [3]. In [4] speech-base and linguistic classification were combined in order to successfully detect emotions and integrate them into a mobile conversational agent. In general, machine intelligence can perform tasks such as perception, reasoning and inference [5].

## **2. Technical Architecture**

### **2.1 Machine learning technology in Chatbots**

The technical architecture of a Chatbot consists of four mandatory and few optional modules. The input can be either voice or text. If a voice is chosen, it has to be processed by automatic speech recognition to get machine-readable text. Afterwards, the natural language understanding analyses the input, dismantles it as well as examines it for patterns. Then the dialog manager processes the outcome against the backend and enquires the data or knowledge bases, executes application systems or calls an API. After processing the user input, the results will be transformed into a natural language. Finally, the generated text can be outputted as audio by the text-to-speech component [6].

Machine Learning improves the Chatbots' performance by finding patterns from large amounts of data. The lexical feature is also called the "word form" feature because it focuses on each word rather than the structure of a sentence or grammar use. This is the bag of n-grams method to group words together. Stemming reduces words to their grammatical roots by removing suffixes. Lemmatization is a more accurate approach, which can identify the correct roots by referring to a lexical database of English. The Retrieval-Based Method collects data from many social media sources, such as Q&A forums and finds the differences between user inputs and questions online with the cosine similarities method. The Generation-Based Methods use an encoder-decoder framework. The sequence-to-sequence (seq2seq) model predicts the next sentence in a conversation given previous sentences using two recurrent neural networks (RNN), one being an encoder and the other being the decoder. The encoder output provides necessary information to the decoder to generate a sequence, element by element. The decoder takes a sequence as the input and generates a sequence output. However, Long Short-Term Memory (LSTM) networks are an extension of RNN as they maximize the probability of generating a response given the previous conversations. LSTM networks can learn the mapping from sequence to sequence. In case of using two LSTM neural networks, the first is used as an encoder that maps variable-length inputs to a fixed-length vector, whereas the second LSTM neural network is a decoder that maps this vector to a variable-length output. This explains the two RNN networks in the seq2seq model [7].

Personalized e-learning systems should be tailored to student needs, mainly through taking into consideration their preferences over different types of information, usability preferences as well as their level of performance in the educational process [8]. Adaptive and intelligent systems for collaborative learning (AICLS) introduce Artificial Intelligence and Web 2.0 techniques to support pre-task interventions, in-task peer interactions and learning domain-specific activities [9].

Chatbots can make general or more task-oriented conversations with restricted vocabulary. Current Deep Reinforcement Learning (DRL) Chatbots use clustered actions and rewards derived from human to human dialogues. These agents learn reasonable policies via a deep neural network, which models a representation of all sentences raised in the conversation together with a set of candidate responses or agent actions, they select a word-based action to send to the environment and they receive an updated dialogue history and a numerical reward [10].

A transactional Chatbot consists of a logical flow description that defines the flow of the Chatbot and an Information Extraction (IE) engine that extracts entities from the user input at each step. Moreover, the extracted entity values can also be used as branching conditions. Amazon Mechanical Turk (MTurk) was used to collect chat logs and similarity labeling data to evaluate response distance and session similarity functions [11].

Madan and Joshi proposed an approach to compute groups of utterances by clustering the frequent user utterances and their corresponding system responses through the SimCluster algorithm [12].

In case of a flight information system, a spoken dialog system (FLIGHTS) integrates user modeling with automated clustering such that information is structured in a way that enables users to effectively and efficiently browse their options. The system provides in detail only the options that are relevant to the user, which is determined by the user model. If there are multiple relevant options, a cluster-based tree structure orders these options to allow for stepwise refinement, taking into account the user's preference. In order to give the user a good overview of the option space, trade-offs between alternative options are presented explicitly. In

addition, the algorithm also briefly accounts for the remaining (irrelevant) options. It is hypothesized that this approach will enable users to make choices that are more informed since the information presentation is the main contributor to dialog duration [13].

In [14], personalized service regarding the user experience of the Chatbot is shaped first by the user's profile and second by the user's posts and responses, via a two-branch neural network and a deep neural network architecture, respectively. This way, the Chatbot could understand conversations thoroughly from the users' perspective and thus, give responses that are more appropriate for a specified person. The learning strategy utilized for measuring a user's compatibility for an explicit task through creating his personal profile is an assorted neural structure [15].

In [16] a cross-language, context-aware Chatbot was implemented for any domain without making custom rules for each use case scenario. This framework is dependent on dataset training and a dictionary of a language. The data are structured according to the following classes: Tag, Sample Patterns, Possible Responses, Current Context, Related Context. If new data occurs, it can be easily entered in one of the classes or in a new class without worrying about confusing new data with other classes. The Convolutional Neural Network is the clear choice for designing the prediction model for the Chatbot via the Lowest Common Ancestor (LCS). If we take two nodes of a tree and run an in-depth search on their parents, the Lowest Common Ancestor is the node, which is the first common parent shared among them.

In [17] an Intelligent Social Application was developed comprising six modules, three online and three offline. The modules encompass several machine learning technologies, such as binary classification and feature extraction to identify potential food safety information as well as Latent Semantic Indexing (LSI) and Singular Value Decomposition (SVD) to determine the similarities among Open Government Data (OGD), Facebook posts and online news. Moreover, the Chatbot included primarily keyword extraction and natural language processing to interact with users.

In [18] a sequential matching network (SMN) was proposed for context-response matching, where a matching vector is constructed for each utterance–response pair through convolution and pooling on their similarity matrices. Then the sequence of matching vectors is aggregated as a matching score of the context and the response.

In [19] focus is given to how media-rich Chatbots can be made more intelligent when given access to a continuous influx of voluminous, streaming and dynamic real-time sensor and multimodal IoT data. It is insinuated that intelligent Chatbots can contextualize and personalize abstract data into information in combination with incorporating more human-like behavior such as feelings, emotions and empathy. Chatbots can interpret data in a personal context with respect to domain-specific knowledge as well as they can ask the right questions at the right time to support decision making and actions originating from new data. In the healthcare domain, personalization refers to taking into account various factors with respect to a particular patient such as health history, physical characteristics, environment, activity and lifestyle. An intelligent Chatbot has the ability to leverage various IoT devices and online cognitive services such as a camera for visual recognition, the microphone for analyzing the speech tonality and sentiment, personality insights for discovering the personality of the patient in combination with patient's consented profiles in various social media platforms, language understanding and translator services as well as a QnA maker to formulate intelligent questions.

In [20] recent findings in the field of Enterprise Crowd Computing were presented in addition to introducing ECrowd, a platform for enterprise crowd computing designed to gather training data for cognitive systems. Likewise, Michiels suggests optimizing Chatbots as

Cognitive Systems, designed to solve problems through understanding, learning, reasoning and interacting with humans. In advance, Chatbots should be able to track their performance via in-depth metrics on their way of invocation, their tone of voice, their conversation flow and their self-serving options [21].

In [22] a research was conducted regarding the business integration of Chatbots and conversational interfaces in comparison to websites. The chronological structure of the communication between a user and the Chatbot starts from sending the user's input to the backend. The backend then sends the request to a NLU service, which extracts an intent and a possible parameter to get to know what the user wants. If necessary, additional APIs are visited. For example, the latest blog posts are retrieved from the website using the Wordpress REST API. Subsequently, a proper response is created. After all this processing, the response is sent back to the client and presented to the user. The Chatbot has to access different APIs in order to provide all required features. Wordpress's REST API is used to retrieve blog posts as well as open positions from the website. Mailchimp's REST API is used to subscribe users to the newsletter, if they want to. The advantages in the use of the Chatbot were instantaneous answers to specific questions without the hassle of clicking through menus and searching through pages as well as its interactive nature, which resulted in more fun for some of the participants.

In sum, a Chatbot user's utterance is analyzed to detect their intent, while a response is selected from a database and formed by a response generator. The database may entail tables and attributes, values and conditions that should be taken into consideration by the application. The Chatbot can perform several tasks in a dynamic environment, for example, in an environment with sensor data and/or in an interactive environment with many users at the same time. In addition, the Chatbot can be connected to a static data source or a dynamic data source like disease cases or weather forecast. For example, machine learning systems assisted in analyzing protein and patient data in order to aid the Covid-19 detection, treatment (molecular scale) and patient care (clinical scale), while the social media were used to predict disease severity, understand misinformation and communicate effectively to the benefit of society. Collaborative assistants (CA), also known as Conversational Interfaces (CI), Chatbots or Dialog Systems can serve as decision support systems so as to convey policy information for maximal societal protection. However, more research is needed to build systems, which are collaborative problem solvers [23]. Chatbots are developed either by using any programming language like Java, Clojure, Python, C++, PHP, Ruby and Lisp, or by using state-of-the-art platforms. At this time, there are six leading, machine learning supported, NLU cloud platforms that developers can use to create applications able to understand natural languages: Google's DialogFlow, Facebook's wit.ai, Microsoft LUIS, IBM Watson Conversation, Amazon Lex and SAP Conversation AI [24], [25].

## 2.2 Chatbots in intelligent educational systems

In [26] an intelligent campus includes a layered architecture of technologies based on data retrieved by the Internet of Things (IoT) in order to construct new knowledge and improve decision-making to serve the needs of students and teachers. A platform for data management integrates variable identification and evaluation through the analysis of data generated by students in several academic systems. The results of the data analysis through Hadoop pass to an AI tool for decision-making. This AI module is integrated in a Chatbot to offer a reliable and tailor-made experience through recommending activities to students according to their qualifications and records of performance. More specifically, the Chatbot notifies the user of any pending activities and already made achievements as well as it poses questions about

students' academic performance and detects the truthfulness of responses based on the Hadoop data. The Chatbot recommends the activity that suits the best students' characteristics and needs. If the results of the activities are not found adequate according to the criteria of a predetermined rubric, the Chatbot starts a new round of attempts on account of the students. In the interaction with the user, the Chatbot is forced to carry a personalized service for which it uses the first name of each person. However, names are stored in temporary variables and are deleted at the end of the session. When there is a need to carry out an analysis of information that involves the personal data of the members of the campus, a process is carried out in which the relevant authorization of different areas is requested as well as that of those involved.

In [27], an intelligent Chatbot was developed to assist high school students in learning general knowledge subjects using natural language processing and machine learning algorithms for recognizing the correct intent. Even without adding an AI layer, bots can be effectively used in an e-learning context, helping both teachers and students in their teaching and learning efforts. In this case, a simple Telegram bot, @dawebot, for training university students of Computer Science with multiple choice question quizzes, transforms the answers to the quizzes of each unit into a MindMap representation output. Students have adopted the bot easily and suggested that they would like to have these bot tools integrated also in multiple university subjects [28].

MOOCBuddy seems to be the first educational Chatbot related to MOOCs targeting individual learners interested in personal and professional development, but also teachers who intend to integrate MOOCs in their courses. The dialogues with the users are modeled as structured messages with multiple bubbles rendered as a horizontal list. Bubbles contain information, images and buttons that open an URL or receive a choice provided to users. MOOCBuddy learns continuously together with its users through improving its scenarios and assessing users' needs and satisfaction: it rates user experience, displaying values to be clicked. It also registers proposals for new features, which are stored in the developer panel or as comments in the associated Facebook page. Future artificial intelligence features will include an algorithm based on a larger category of users' characteristics; their background including the previously followed MOOCs and their participation rates, learning expectation and style, profiles on different social networks in addition to the history and interaction with the application [29].

The MathBot used fuzzy matching and basic string equivalence to parse responses and route users, appropriately. In this randomized-control trial, a contextual bandit was able to efficiently learn a personalized pedagogical policy as it could show extra practice problems and skip explanations to appropriately alter the pace of the MathBot conversation [30].

Seventy-five undergraduate students completed a formal ILS questionnaire and a tutorial in SQL using the OSCAR-CITS as part of their revision studies. OSCAR-CITS incorporated several intelligent techniques, including presenting learning material in a style and sequence adapted to the user's learning style (curriculum sequencing), providing analysis and detailed feedback of errors and omissions in solutions (intelligent solution analysis) as well as modeling the approach used by human tutors to discuss questions and give hints (problem solving support) to encourage learners to construct their own knowledge. The system architecture deployed fuzzy decision trees to build a series of fuzzy learning style predictive (FLSP) models as well as behavior variables captured from natural language within a CITS tutorial for the four dimensions of the Felder and Silverman Learning Styles model. During the tutorial, the student's behavior was logged in 41 different behavior variables that were used to build the Learner data set. Experiments were carried out for all four learning style dimensions:

perception (sensory-intuitive), understanding (sequential-global), input (visual-verbal) and processing (active, reflective) to build a set of four fuzzy decision trees, each with the ability to predict a dimension with a degree of possibility [31].

### 2.3 Chatbots in intelligent health coaching systems

CoachAI is a human-virtual Chatbot mediated system that delivers health recommendations in a sound approach and provides tailored and social support to individuals. Based on the replies to the conversational agent questions, users are categorized into three distinct groups; namely, vigorous, mild and sedentary users. More specifically, the platform assigns the activity definition and assignment to a human agent, while leaving the activity notification and feedback collection to the Chatbot agent. This tailor-made function is important so as to ensure that activities are adapted to individuals' lifestyle and hence overcome the limitation of repetitive activity. In addition, core features include presenting the Fitbit tracker data on the CoachAI platform as well as defining the behavior of the system when the coach assigns steps or distance related activity. Then the system aggregates the data from the wearable and checks if the condition to achieve the goal has been fulfilled [32].

In [33], an intelligent Chatbot system was used to provide an intervention in telemedicine for healthy lifestyle promotion. This AI-Chatbot supports nutrition education that could promote public health. It is a rule-based Chatbot that handles various user requests and calls API services for providing the response to such requests. The Chatbot is scaffolded on the Microsoft Bot Framework in order to host message-handling and integration with various bot client endpoints. This framework simplifies the task of setting up a server process. Since the rule-based frameworks provide no AI capabilities to parse or classify incoming messages, the developers used API services, such as MonkeyLearn to perform more advanced analysis (e.g. Sentiment Analysis and Intent Detection).

In [34], a review in Chatbots is focused on embodied and non-embodied Chatbots used for any mental disorder. In this review, Chatbots focused mainly on depression and autism due to the fact that depression and anxiety are the most common mental disorders around the world and Chatbots are reported to be effective in improving social skills for patients with autism. Also, it is recommended for Chatbots' designers to use a web-based platform and machine and deep learning in order to enhance performance and accessibility of the Chatbot.

EMMA, the first emotionally-intelligent and expressive mHealth agent, provided wellness suggestions in the form of micro-interventions by using automatically predicted emotional states to drive emotional dialog and the choice of interventions. The system continuously captured geolocation and five times a day the application took emotion-experience sampling by using a visual grid label, while it provided a textual prompt and a link to an online tool for executing the activity [35].

The conversational agent presented in [36] is a sophisticated artificial intelligence (AI) system for the purpose of diagnostic evaluation, recommendation and preventive actions against the Novel Coronavirus epidemic. The engine allows the Chatbot to identify patient preferences, problem areas and patient conditions in order to find the severity percentage that the user experiences. It can also either make contact with health specialists or provide information regarding immediate preventive measures. More specifically, the Chatbot engine is a principal backend logic that validates input using the method from the Web API and each symptom is defined with an integer variable to assess the seriousness score. Once all the symptomatic information is collected, the bot triggers a specialist consultation. The engine prepares a solution in the XML format for this action.

iHelpr has been developed as a digital intervention tool in the combat against stress, anxiety & depression, trauma, sleep and alcohol abuse by using the Microsoft Bot Framework and NodeJS with a MySQL database. The system administers several self-assessment tools and calculates the scores automatically. Users' scores are saved in a database, to allow them to look back and identify if their scores have improved over a period of time and track their progress. Adopting a stepped care approach, advice and evidence-based treatment recommendations are guided by which band the user's score falls into. In addition, domain experts can automatically insert, through a web-based form, coping mechanisms into the database, to allow for knowledge engineering and tailored intervention guidance, thus improving the user experience and engagement [37].

#### 2.4 Gamification of Chatbots

The educational Chatbot game called “CiboPoli” specializes in teaching children about healthy lifestyle through an interactive social game environment. The new version of the game shall encompass a dialog management module, a user-specific knowledge module or machine learning module that can offer the automatic identification of learners’ emotions as well as their demographics and provide personalized suggestions [38].

#### 2.5 Chatbots as intelligent Vocational Guidance Agents & Coaches

The Chatbot in [39] includes about 301 questions in French language, concerning students' educational and professional orientation following the John Holland model and the RIASEC typology. The end goal of the Chatbot is to determine the dominant type of the user’s personality in order to support undergraduate and graduate student's decision on the choice of the academic and career path.

Gengobot was successfully developed as a language learning medium to support students’ learning in Japanese grammar with descriptions available in English and Indonesian. Gengobot is a Chatbot-based dictionary application about multi-language grammar, using CodeIgniter (CI) framework. The database system used in Gengobot is MySQLGengobot and it was considered user-friendly since it could be accessed through the social media LINE [40].

Chatbots can also serve as personalized, digital travel advisors providing real-time and context-relevant information about trips, while they enable attractive and profitable sales channels via one-to-one marketing, new data collections and deep learning. In advance, the Chatbot stores individual user preferences based on the users’ requests, purchase history and other activities. These new data collections give companies the opportunity to address their customers in a relevant manner and customized offers can be targeted directly to users, thus avoiding usage of additional apps and websites [41].

#### 2.6 Chatbots as intelligent Communication Systems between Citizens and the Government

AI technology, the Chatbots, in combination with natural language processing, machine learning and data mining technologies develop an instant, immediate and more sophisticated digital channel of communication between citizens and the government. The current system in [42] has a knowledge base to provide responses to users as well as a dialogue management module in order to control the conversation process.

### 3. Discussion

Chatbots can have several roles while assisting human beings since their discursive and interactive features can augment human intelligence. In addition, Chatbots can be made available to billions of users of messaging platforms in an instant, which suggests a democratizing potential. Moreover, the simple natural language dialogue used in Chatbots evokes information literacy as humans have an innate need for communication and cooperation. Their intriguing conversational character as well as their ability to adapt to their users' needs can counterbalance digital divides. Some of the Chatbots already on the market exemplify applications that may have beneficial social impact. In the health domain, there are Chatbots supporting low cost, easy access medical triage, mental health support and health-promoting behavior change. In the domain of civic participation, Chatbots are used to strengthen voting behavior. Chatbots are also used to support education and training [43].

More specifically, conversational agent applications for the health care sector are rather scarce and focus on mental health e.g. neurodegeneration, metabolic medicine and sexual health. Future applications could expand towards alternative health care fields, such as dermatology, primary care, geriatrics and oncology [44]. Chatbots can also be used to teach themes such as mindfulness and consciousness in order to improve human consciousness [45-47]. Chatbots are the edge method that can be used in parallel with other AI apps and mobile apps to improve informational and educational applications both in education as well as in corporate environments [48-51, 61, 75, 76, 87, 88, 89, 91, 92, 93].

Machine learning is a technique currently used in extracting information from text and it depends on the use of specific algorithms and processes that attempt to model human learning. Machine learning involves applying pattern recognition and classification techniques through different algorithms and processes. The choice of which algorithm to use is situation based. Machine learning and NLP offer many potential areas of innovation in an academic environment [52, 71].

In the field of education, robots will not replace teachers soon because they lack the dynamic, creative ability to inspire students. The teaching profession is irreplaceable as humans acquire a combination of higher cognitive skills, such as critical and creative thinking as well as empathy and communication skills.

As an intermediate stage, AI technology can support human teachers to boost their teaching effectiveness by enabling them to obtain greater insights into student needs and requirements, according to individual circumstances, with minimal human effort overhead. Still, there are known risks associated with moving forward at a pace that is too high in implementing AI solutions for teaching, including the loss of the human traits of creativity, diversity, compassion, fun and out-of-the-box thinking. However, developed countries could be substantially benefited from the aforementioned implementations in an attempt to improve the quality of the teaching staff [53].

Such technologies can also alter the delivery of healthcare systems, increasing uptake, equity and cost-effectiveness of health services while narrowing the health and well-being gap. In the research made in [54], participants were more willing to use Chatbot services for general health information over finding out the results of medical tests or specialist advice.

In addition, the aim of the study made in [55] was to verify whether an artificial conversational agent was able to provide answers to patients with breast cancer with a level of satisfaction similar to the answers given by a group of physicians. As it turned out, artificial conversational agents may serve patients with minor health concerns.

Chatbots are already being deployed in the fight against COVID-19, although transforming medical information into advice for the public, requires expertise and evaluation by patients, healthcare workers, academics, technology companies, NGOs and governments [56].

#### 4. Conclusions

The format of machine-generated data and the purpose of machine learning algorithms should be carefully designed. A theoretical model is needed to guide the development, interpretation and validation of algorithms. It is desirable that academic researchers and industry practitioners increase their engagements via mutual presentations and even government initiatives. Stakeholders, such as academia, industry, consumers and the states should play more active roles [57].

COVID-19 triggered the launching of disease-specific, new Chatbots as well as accelerated the adoption of existing ones in customer care and mental health. However, most of them worked in simple scenarios and raised questions about usability, effectiveness and handling of user privacy. A Chatbot should be used in a scenario when it will add value to the user [23].

Overall, AI cognitive services equipped with semantic, cognitive and perceptual computing techniques, along with ML, deep learning and NLP that encompasses natural language understanding and natural language generation provide a human-centric approach to computing with richer and more natural interactions between Chatbots and humans [19].

Chatbots can be combined with [59, 60, 62, 63, 64, 65, 66, 67, 68] [94-106] STEM, ICTs, Games Mobiles and AI [69, 70, 72, 73, 74] and improve each other's procedures. The combined use of chatbots with other advanced technologies in general and special education [77, 78, 79, 80, 81, 82] can improve the assessment procedures and educational outcomes, as well as executive functions, problem solving, multisensory perception and consciousness of the students [83, 84, 85, 86, 90].

However, the efficient design of Chatbots still needs further research especially in regard to their capabilities, their conversational context and flow as well as the reasons for dialog failures and the finish of the conversations [58]. Also, future research should focus on semantic social web technologies in AICLS settings, extension of collaborative learning support systems to permit decoupled communication with external components/services and defining the peer interaction indicators that can assess and model the "learning to collaborate" and "collaborate to learn" features of the system [9].

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