FUNDAMENTAL AND BASIC COGNITIVE SKILLS REQUIRED FOR TEACHERS TO EFFECTIVELY USE CHATBOTS IN EDUCATION

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Abstract

With the rapid advancement of technology, education is undergoing a transformational change. Chatbots have become increasingly popular in recent years and are being utilized as teaching assistants to support teachers and students in various ways. However, little research has been done on the skills required by teachers to prepare curriculum content using chatbots. The research aims to identify the skills teachers need to prepare curriculum content with chatbots. It examines the fundamental and cognitive skills individuals need to interpret content generated by chatbots and explores the difference between self-assessment and evaluator-based assessment. Fifty-eight third-year students, pre-service teachers, in the Elementary education program attempted to write a lesson plan using ChatGPT and completed a questionnaire to assess the skills required. Their communication with the chatbot as well as their prepared lesson plans were reviewed by an evaluator who rated the skills of the participating pre-service teachers. Results indicate that pre-service teachers tend to overestimate their skills required to interpret chatbot-generated content compared to the evaluator's ratings. Such discrepancies could lead to inaccurate or incomplete assessments of their skills, which could hinder their potential for growth and development.
Keywords: *artificial intelligence, chatbots in education, cognitive skills, fundamental skills, lessons plan*

Introduction

In December 2022, the field of artificial intelligence, particularly the area of chatbot development and utilization, experienced a surge in growth with the launch of the ChatGPT chatbot. However, chatbots are not a new concept, as they have been in existence for almost six decades. The first chatbot, called ELIZA, developed by Weizenbaum in 1966, utilized pattern matching to simulate psychotherapist conversation with human patients. While ELIZA may be unfamiliar to the general public, many individuals are familiar with more modern virtual chatbot assistants, such as Amazon's Alexa and Apple's Siri, which operate on logical and virtual chatbot systems. The fundamental goal and premise of so-called chat-bots is that a computer converses with human clients in natural language in a manner that is as human-like as feasible (Bradeško & Mladenić, 2012). They are computer programs that mimic and process human communication, allowing people to interact with digital devices as if they were speaking with another person (Ciechanowski

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et al., 2019). The dialogues thereafter typically serve some specific purpose, such as conducting web searches, organizing computer files, scheduling appointments, etc., depending on the work the bot was designed for (Bradeško & Mladenić, 2012).

Chatbots are increasingly being used in education. Clarizia et al. (2018) introduced it as a useful technology for supporting education, as they enable one of the most important ways to promote and enable personalized learning, not only increasing support and inclusion of students but also significantly reducing the administrative workload of teachers and enabling them to focus more on curriculum development and research (Cunningham-Nelson et al., 2019). Their advantage is that they are an interactive mechanism compared to traditional e-learning systems (Kowalski et at., 2011), and their users are only limited by the creativity and imagination of the user (Roos, 2018). In 2021, Okonkwo and Ade-Ibijola presented a study in which they analyzed 53 articles from reputable digital databases, with the aim of understanding the use of chatbots in education, including basic information, benefits, challenges, and suggestions for future research on the use of chatbots in education. Their study found that chatbot technology is used in various areas of education, including teaching and learning (66 %), administration (5 %), assessment (6 %), advisory (4 %), and research and development (19 %). They highlight that the introduction of chatbot systems in education can bring personalized online learning and greater accessibility to learning materials, which students can access from anywhere and at any time. Lin and Chang (2020) and Murad et al. (2019) added that chatbots are good technological innovations that improve students' interest in learning, cognitive skills acquisition, and academic achievements. They also have a successful impact on students' motivation (Bii et al., 2018), improve their learning experience (Sandu & Gide, 2018) and much more. Georgescu (2018) stated that the effects that chatbots can have on education are changing humanity forever with new methods and principles. As a complement to existing methods and learning approaches, chatbots can play an important role in presenting pedagogical content and assessment. They can create new ways of evaluating and providing real-time feedback, among other things. In addition to the benefits of using chatbots in education, it is important to mention the teacher's skills in their use. Teachers must be skilled in the use of chatbots, which means they must have basic skills for working with technology, such as knowledge of computer use and internet applications, as well as basic knowledge of programming and artificial intelligence. Additionally, it is important for teachers to develop their cognitive skills, such as the ability to think critically, adapt their teaching to different learners and their needs, and the ability to lead interactions using chatbots, which can become key in personalized learning. Teachers must be prepared for changes and adjustments in the use of chatbot technology in education and be ready for learning and developing new skills that will be required for the effective use of this technology in the classroom.

Although there are some studies that deal with the area of teacher's use of chatbots in teaching (e.g., Bii et al., 2018; Chocarro, 2023), there is a lack of research that examines the fundamental and basic cognitive skills that teacher needs for successful and productive communication with a chatbot, with the aim of curriculum content planning and lesson planning.

Research Problem

The use of chatbots in educational environments requires special skills from teachers. Most existing research on the use of chatbots focuses on the opportunities they offer teachers and other educators to assess curriculum goals. However, it is difficult to find research that explores the skills that teachers need for preparing curriculum content with the use of chatbots. They need to understand the concept they want to present to their students, they need to be able to design instructional material suitable for use with a chatbot, they need to use the correct technologies, and be able to analyze data collected from chatbot usage to improve their teaching. To create an effective and interactive learning environment with the help of chatbots, teachers need to have certain skills that must be defined and monitored to ensure a quality curriculum preparation process with the use of chatbots. According to Atlas (2023), chatbots for teachers provide a unique opportunity to improve the educational process and connect with students in new ways by providing individual feedback and assistance, allowing teachers to focus on other tasks.

Research Focus

The aim of this study was to explore the fundamental and basic cognitive skills that teachers require for preparing curriculum content with the use of chatbots. The research focus was based on fundamental research questions:

RQ1: What are *fundamental skills* that teachers require for interpreting content generated by chatbots?
RQ2: What are *basic cognitive skills* that teachers require for interpreting content generated by chatbots?
RQ3: How do pre-service teachers assess their *fundamental skills* required for interpreting content generated by chatbots?
RQ4: How do pre-service teachers assess their own *basic cognitive skills* required for interpreting content generated by chatbots?
RQ5: What is the difference between self-assessment and evaluator-based assessment regarding the *fundamental* and *basic cognitive skills* that teachers require for interpreting content generated by chatbots?

Research Methodology

General Background

In the academic year 2022/2023, the use of chatbots in the work of students of the academic undergraduate program Elementary education, has expanded with the launch of the ChatGPT chatbot. They use it as an aid in learning, as a tool for writing essays and assignments, and as a means of planning lessons and other curriculum content. However, it often becomes apparent that students are not fully proficient in the use of chatbots, frequently merely copying generated content without critically evaluating it, neither linguistically nor substantively. Additionally, during discussions about their use of chatbots, students often overestimate their skills.

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In order to study the abilities that teachers need to plan the curricular content in their teaching, third-year students of the Elementary education undergraduate program attempted to write a high-quality and didactically justified lessons plan for teaching literature, and engineering and technology in March 2023, using the chatbot ChatGPT (5 students who were unable to log into ChatGPT worked with ChatJBT instead). The topics varied, but in all cases, they were related to the exact topic that the students had recently written a lesson plan, delivered a presentation on, and tested it in the classroom. They then led the communication with the chatbot themselves until they were satisfied with the plan. Because they had already prepared the plan for the presentation in the "traditional way", they were familiar with the theoretical background of the prepared curricular content, while also being informed about the appropriate didactic approaches to teaching the prepared content. Then they shared the plan with the researcher through the 1ka web application, which allows for anonymous submission, and also compared a two-part questionnaire to assess the fundamental skills and cognitive abilities necessary for the successful use of chatbots for preparing educational content.

The uniqueness of this study lies in its focus on the skills required by teachers to prepare curriculum content using chatbots, a topic that has received little attention in previous research. The study explores both fundamental and cognitive skills required for interpreting chatbot-generated content, which helps teachers develop the necessary competencies to effectively utilize chatbots as teaching aids in their classrooms.

Sample

The present study utilized a purposive non-random sampling method consisting of 58 third-year students enrolled in the Elementary Education program at the Faculty of Education in Slovenia, during the academic year 2022/2023. Of the participants, 12.06 % were male and 87.94 % were female, and all were aged between 20–22 years. The selected participants had previous experience in using the chatbot ChatGPT for academic purposes, including writing lesson plans for educational work as part of practical training. The sampling procedure aimed to include individuals who were similar to the population with respect to the research questions posed. The formation of the sample adhered to ethical guidelines, ensuring that participants' rights were not violated, and the treatment of results was anonymous.

Instrument and Procedures

Prior to conducting the proposed study, a pilot study was carried out. Nine individuals (3 students, 3 teachers, 3 university professors) attempted to write a lesson plan for teaching literature, and science and technology, using the ChatGPT chatbot. Based on their work, the skills required for working with the chatbot were evaluated, and fundamental and basic cognitive abilities needed for interpreting the chatbot's outputs were identified. Fundamental skills are specific to communicating with a chatbot, while basic cognitive skills are more general skills that are useful in interpreting any type of text. These abilities were also monitored in the main study.

The curriculum preparations generated with the chatbots were reviewed by a researcher who identified *fundamental skills* that teachers need to successfully

communicate with a chatbot, based on the communication between pre-service teachers and the chatbot. The main nine identified skills include:

1. Ability to recognize and troubleshoot issues: Awareness that the chatbot sometimes does not understand the posed question, resulting in an incorrect answer. In this case, the individual must identify this problem and find appropriate solutions.
2. Abstract thinking: The ability to think abstractly, recognize different concepts related to content, connect ideas, identify patterns, and perform the analytical process of thinking.
3. Awareness that chatbots are capable of learning: Understanding that chatbots are programmed to learn and improve their abilities over time, which means that the chatbot also learns from its queries, behaviors, and actions, contributing to the improvement (or not) of the chatbot's performance.
4. Creativity: Awareness that chatbots do not necessarily provide appropriate solutions or answers to users' questions. In this case, the individual must be able to find new ways of communicating with the chatbot.
5. Incorporating knowledge from diverse fields: The ability to discern and recognize the content generated by the chatbot, as it may deal with content from different thematic areas, which may result in inadequate answers for the particular field.
6. Language skills of the individual: The ability to express questions and requests in a language format that the chatbot understands, usually in the form of clear and understandable thoughts. Additionally, the individual must be able to understand the chatbot output.
7. Recognition and understanding of language limitations of the chatbot: The ability to recognize and understand the language limitations of chatbots, which are programmed to understand only a limited range of linguistic structures and expressions.
8. Understanding concepts: awareness of the context of the generated content, understanding it, and understanding the content that the chatbot conveys, while also recognizing the purpose of the chatbot and distinguishing between different response options.
9. Understanding the logic and programming of chatbots: Knowledge that chatbots are based on certain logic and programming and understanding this logic to better understand how the chatbot works and what is expected of it.

The main seven identified *basic cognitive skills* for interpreting the text generated by a chatbot are:

1. Attention to detail: An individual must carefully monitor the chatbot's responses to ensure that important information is not overlooked.
2. Comprehension: An individual must be able to understand the language used by the chatbot and explain its meaning.
3. Critical thinking: An individual must be able to evaluate the chatbot's responses based on accuracy, relevance, and completeness.
4. Cultural competence: An individual must be attentive and sensitive to cultural differences that may affect or arise in conversations with a chatbot.

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5. Emotional intelligence: An individual must be able to recognize and understand the emotions conveyed by some chatbots (e.g., Replika, Woebot, Mitsuku, Xiaoixe, Cleverbot), and respond appropriately to them. Additionally, individuals need emotional intelligence when using a chatbot if questions or situations arise that trigger emotional responses.
6. Logical reasoning: An individual must be able to use logical reasoning skills to understand the chatbot's responses and draw conclusions from them.
7. Memory: An individual must remember the information provided by the chatbot in previous conversations.
8. Problem-solving: At times, an individual must use their problem-solving skills to determine how to formulate questions to obtain the necessary information from the chatbot.

Based on the identified fundamental (9) and cognitive (7) skills necessary for successful communication with a chatbot, two assessment scales were designed. Within the first scale, which focused on *fundamental skills*, students rated their abilities in abstract thinking, language skills, creativity, recognition and understanding of language limitations of the chatbot, understanding concepts, understanding the logic and programming of chatbots, ability to recognize and troubleshoot issues, incorporating knowledge from diverse fields, and awareness that chatbots are capable of learning. The reliability of the questionnaire was checked with Cronbach's Alpha coefficient, which is .901 and shows excellent internal consistency. Within the second scale, which focused on *basic cognitive skills*, students rated their basic cognitive skills when communicating with a chatbot: comprehension, memory, attention to detail, critical thinking, problem-solving, logical-reasoning, emotional intelligence, and cultural competence. They assessed the abilities on both scales on the basis of a 5-point Likert scale (1 – not capable at all, 2 – not capable, 3 – neither capable nor incapable, 4 – capable, 5 – very capable). The reliability of the questionnaire was again checked with Cronbach's Alpha coefficient, which is .922 and also shows excellent internal consistency. Similarly, the researcher reviewed and assessed the fundamental and basic cognitive skills of participating students based on their submitted reports, re-evaluating the students on a 5-point Likert scale (1 – not capable at all, 2 – not capable, 3 – neither capable nor incapable, 4 – capable, 5 – very capable).

Data Analysis

The internal reliability of the questionnaire was assessed using Cronbach's alpha, which confirmed the appropriateness of the questionnaire design. Data from online questionnaires were analyzed in terms of descriptive statistics, including the number of participants, minimum and maximum response values, mean, and standard deviation. The same procedure was used to calculate data related to evaluator ratings. Self-evaluation and evaluator-evaluation data were compared to determine the characteristics of the relationship between the data.

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Research Results

The results were systematically presented according to the addressed skills, which were divided into fundamental skills and basic cognitive skills. Table 1 displays the outcomes and comparison between self-evaluation and evaluator-evaluation of fundamental skills for successful communication with a chatbot that pre-service teachers had.

Table 1

Self-Evaluation and Evaluator-Evaluation of Fundamental Skills for Successful Communication with a Chatbot That Pre-Service Teachers Have

Grade	*N*	Min.	Max.	*M*	*SD*	Min.	Max.	*M*	*SD*	χ^2	*df*	*p*
		Student self-evaluation				Evaluator-evaluation						
Troubleshoot	57	2	5	3.82	.759	1	5	3.37	.919	88.985	12	.001
Abstract thinking	58	2	5	3.78	.773	1	5	3.48	1.112	91.814	12	.001
Chatbot learning	58	2	5	3.53	.922	1	5	3.19	.963	90.160	12	.001
Creativity	58	3	5	3.93	.697	2	5	3.53	.799	53.650	6	.001
Diverse fields	57	2	5	3.91	.714	1	5	3.40	.904	60.488	12	.001
Language skills	58	2	5	4.05	.711	2	5	3.50	.884	56.801	9	.001
Chatbot language	57	2	5	3.77	.708	1	5	3.51	1.020	95.951	12	.001
Understanding concepts	57	2	5	3.88	.781	1	5	3.44	.945	108.284	12	.001
Understanding logic	57	1	5	3.55	1.018	1	5	3.09	1.074	95.453	16	.001

Note. Troubleshoot = Ability to recognize and troubleshoot issues; Abstract thinking = Abstract thinking; Chatbot learning = Awareness that chatbots are capable of learning; Creativity = Creativity; Diverse fields = Incorporating knowledge from diverse fields; Language skills = Language skills of the individual; Chatbot language = Recognition and understanding of language limitations of the chatbot; Understanding concepts = Understanding concepts; Understanding logic = Understanding the logic and programming of chatbots.

As shown in Table 1, it is evident that pre-service teachers received the highest ratings for language skills ($M = 4.05$), creativity ($M = 3.92$) and incorporating knowledge from diverse fields ($M = 3.91$), while they identified the weakest fundamental skills as the ability to recognize and troubleshoot issues, awareness that chatbots are capable of learning and understanding the logic and programming of chatbots, recognition and understanding of language limitations of the chatbot ($M = 3.77$), understanding the logic and programming of chatbots ($M = 3.55$), awareness that chatbots are capable of learning ($M = 3.53$). The evaluator rated the students highest in creativity ($M = 3.53$), language skills ($M = 3.50$) and abstract thinking, and lowest in the ability to recognize and troubleshoot issues ($M = 3.37$), awareness that chatbots are capable of learning ($M = 3.19$) in understanding the logic and programming of chatbots ($M = 3.09$). In all cases, a statistically significant difference between the ratings of participating pre-service

teachers and evaluators was also evident, indicating a statistically significant difference in the assessment of students' fundamental skills. The results indicate that students rated their fundamental skills for working with a chatbot higher than the evaluator who reviewed their products, and the evaluator's response dispersion is higher as well. This may suggest that the evaluator had different expectations or criteria for evaluating the students' work, or that the students may have overestimated their own abilities.

In addition, the self-evaluation and evaluator-evaluation of basic cognitive skills necessary for successful communication with a chatbot, which are possessed by pre-service teachers, were also examined.

Table 2

Self-Evaluation and Evaluator-Evaluation of Basic Cognitive Skills for Successful Communication with a Chatbot that Pre-Service Teachers Have

Grade	*N*	Min.	Max.	*M*	*SD*	Min.	Max.	*M*	*SD*	χ^2	*df*	*p*
	Student self-evaluation					Evaluator-evaluation						
Attention to details	58	1	5	3.74	.890	1	5	3.34	.928	132.288	16	.001
Comprehension	58	1	5	3.91	.844	1	5	3.57	.920	141.546	16	.001
Critical thinking	58	2	5	3.84	.834	1	5	3.41	.992	74.105	12	.001
Cultural competence	57	1	5	3.49	1.002	1	5	3.09	1.128	-89.617	16	.001
Emotional intelligence	58	1	5	3.43	1.126	1	5	3.28	1.089	86.795	16	.001
Logical reasoning	58	2	5	3.76	.802	1	5	3.12	1.010	69.727	12	.001
Memory	58	1	5	3.74	.785	1	5	3.33	.962	102.889	16	.001
Problem-solving	58	1	5	3.74	.874	1	5	3.31	1.030	89.452	16	.001

The results presented in Table 2 indicate that pre-service teachers rated their basic cognitive skills for communicating with chatbots fairly high. They considered their strong areas to be comprehension ($M = 3.91$), critical thinking ($M = 3.84$) and logical reasoning ($M = 3.76$), while they evaluated their cultural competence ($M = 3.49$) and emotional intelligence ($M = 3.43$) slightly lower. Similarly, the evaluator identified comprehension ($M = 3.57$) and critical thinking ($M = 3.41$) as strong areas of the participants, while the abilities of logical reasoning ($M = 3.12$) and cultural competence ($M = 3.09$) were rated lower. As with fundamental skills, there was also a greater dispersion of evaluator responses for basic cognitive skills, but the emotional intelligence of the participants was identified as more consistent. Similar to fundamental skills, there was also a statistically significant difference between self-evaluation and evaluator rating in basic cognitive skills, where again, evaluator ratings were significantly lower than student self-ratings.

Discussion

The number of studies exploring the use of chatbots in education is increasing (e.g., Kuhail et al., 2023; Yildiz Durak, 2023; Hew et al., 2023). Within the presented study, fundamental and basic cognitive skills required by teachers for interpreting content

generated by chatbots were identified. The study investigated and presented how pre-service teachers assess those skills for interpreting content generated by chatbots. The results provide an answer to the question of what the difference is between self-assessment and evaluator-based assessment regarding the fundamental and basic cognitive skills that teachers require for interpreting content generated by chatbots. When interpreting the results, it is necessary to be aware of the challenges, controversies, and opportunities that the introduction of chatbots into education brings (Hwang & Chang, 2021; Kooli, 2023).

The study's results are considered in the context of the research questions. The response to the first two research questions defines the fundamental and basic cognitive skills that teachers require to interpret content generated by chatbots. The most basic fundamental skills that an individual needs for successful communication with chatbots include the ability to recognize and troubleshoot issues, abstract thinking, awareness that chatbots are capable of learning, creativity, incorporating knowledge from diverse fields, language skills of the individual, recognition and understanding of language limitations of the chatbot, understanding concepts, and understanding the logic and programming of chatbots. On the other hand, basic cognitive skills are more general skills that individuals also require for communication with chatbots, including: Attention to detail, comprehension, critical thinking, cultural competence, emotional intelligence, logical reasoning, memory, and problem solving.

The main finding of the study is that pre-service teachers assess their fundamental skills required for interpreting content generated by chatbots at a higher level than the evaluator of their communication skills with the chatbot. Differences emerge that are important for the work of pre-service and in-service teachers with chatbots, while also considering other factors and variables related to self-evaluation (Mabe & West, 1982). Such discrepancies could lead to inaccurate or incomplete assessments of their skills, which could have negative consequences in terms of their learning and development. Moreover, the statistically significant difference between self-evaluation and evaluator rating suggests that the students may not be fully aware of their strengths and weaknesses, which could hinder their ability to improve and develop their skills in a meaningful way. This is particularly relevant in the context of education, where self-assessment and reflection are critical components of the learning process. Inaccurate or inflated self-evaluations could prevent students from identifying areas of improvement and taking appropriate action to address them, which could limit their potential for growth and development. Taking into account all that has been mentioned, we can draw parallels with Wollny et al. (2021) – chatbots have the potential to develop into powerful teaching tools that can provide insightful feedback to students, but we are not there yet. There is still more work to be done in the area of chatbots in education.

Other aspects and challenges in the research on chatbots in education are also significant, as they can greatly influence users' distorted perceptions of chatbots and limit their use in education. For instance, Okonkwo in Ade-Ibijola (2021) highlighted ethical issues, user relationships, control and maintenance, and recommended well-defined rules for chatbot usage that are consistent with user ethics. They also advised conducting more research on the functionality of chatbot systems, as it would significantly contribute to a positive impact on education.

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Conclusions and Implications

The use of chatbots in education is on the rise, with the majority of applications focused on teaching and learning, administration, assessment, advisory, and research and development. This study discusses the potential of chatbots to revolutionize education by making it more accessible, engaging, and personalized. The advantages of using chatbots in education include integration of content, quick access, motivation, engagement, personalization, and immediate feedback. Nonetheless, there are also challenges to be addressed, such as ethical considerations, security issues, and the need for training and support for pre-service (and in-service) teachers. Overall, chatbots have great potential for improving education and should be further explored and developed in the future. This study has implications for the design of educational programs aimed at preparing pre-service teachers to work with chatbots. There is a need for more focused training on the fundamental skills that pre-service and in-service teachers struggle with. While pre-service teachers may have strengths in communicating with chatbots, there are areas for improvement, particularly in cultural and emotional intelligence. Overall, the study's findings and implications have relevance for teacher training and development programs in various countries around the world, as they navigate the potential of chatbots to revolutionize education and the challenges that come with their use.

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