

Designing Conversational Agents for Education: A Preliminary Study of User Personality's Impact on Design

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-----ABSTRACT-----

An educational conversational agent (CA) is a dialog system that can interact with students automatically. Educational CAs are inevitably becoming popular considering their purpose of serving students. Groups of designers are developing different conversational interfaces to help students and educators retrieve information and make decisions. Our preliminary work aims to demonstrate that students' personalities impact the design of educational CAs. We put the participants into different groups according to their personality dimensions. We designed a prototype of educational CA and investigated the task accuracies of different personalities. The results showed differences in the task accuracies of four personalities and two pairs of personality dimensions: intuition VS Sensing and introverts VS Extroverts. Therefore, we confirm that personalities impact users' interaction with educational CAs. Hence, we call on designers to design accordingly for users with diverse personalities. The results of our study may shed a light on the future design of educational CAs when the current CA design methods in the industry are still rapidly developing.

KEYWORDS: Artificial intelligence, Conversational agent, chatbot, education, personality, user-centered design, prototype

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I. INTRODUCTION

With the rapid advancement in science and technology, people rely on quick, convenient, and reliable applications/technological devices. Artificial Intelligence is the new reality of modern science, and the computer-based applications that use AI are highly popular in the current digitized market[1]. These highly advanced applications use AI to connect with users on a deeper level. These applications and their databases have been highly advanced over the years as these applications are upgraded and updated from time to time.

Users always seek the most convenient, easy-to-use, and quick method for receiving information. A conversational agent is a step up in this technologically dependent era. Conversational Agents are computer-based programs that are designed to interpret and stimulate the statements made by the human in ordinary natural language[2]. Every learner has different techniques of learning, and educational Conversational agents focus on connecting the learners with the educational environment by making the resources available and by quickly solving the queries.

In traditional settings, students/ learners had to spend a long hour finding/searching/learning a small fraction of information. Over the years, the scenario is slightly changing, but it varies from developed and developing to undeveloped nations. Not all countries have the infrastructure to support the schools and colleges to change the traditional educational setting to smoothen the learning/teaching methods and techniques. Conversational agents play a vital role in education sectors as it reduces stress and, over time, overconsumption in finding information. And the available CA software has profound information in a single place and tends to deliver the information quicker, whereas there aren't enough CAs that focus on educational settings. Conversational agents brought hope and efficiency in every sector of life, from business and school to home. Many people are comfortable connecting with these chatbots that have changed the meaning of using technology.

There are various educational chatbot apps on the market, such as Juji, Mia, Powschool, and Ocelot. However, few educational CAs have been designed according to students' diverse personalities. This study examines student personality's impact on educational CA design. It aims to design for college students' diverse personalities so that CAs can provide equal service to all students.

II. Related Work

Conversational agents are dialogue systems that use artificial intelligence agents to respond to queries posed by users of the system and conduct natural language processing. Conversational agents have also been referred to as chatbots. They have evolved into automated components that have embraced diversity to accommodate various users[3]. It is found in all systems, as users will always have queries that need answers. Real estate(28%), travel(16%), education(14%), healthcare(10%), and finance (5%) are the top 5 industries that rely upon and benefit from conversational agent technology [4].

Needs, Resources, and Platforms

The conversational agents have been applied to the education system with the rise in distance and online learning. Students get to study and ask questions through a user interface, possibly created by the IT department of the school, where the tutor does not need to be available 24/7. Educational CAs can be used to access the course material for a better learning experience for the student. Learning materials such as learning videos would be helpful to learners in improving their understanding and reducing their search time[5].

Conversational agents can be designed and applied to different educational platforms to harness the technological advancement evolving in the last decade. Educational initiatives have come to solve the distance problem that was a barrier to acquiring knowledge among students across the globe[6]. Conversational agents have solved the interaction problem in distant learning by providing a connection for the student.

Conversational agents can therefore be improved to meet the specific needs of the students despite already forming an essential part of their connection. Online learning platforms can use evolving technology to create a conversational agent that would interact with different personalities to understand the student's behavioral patterns.

Lack of Personality Design

Students who interact with CAs possess different personalities and traits. Since a CA does not have a human brain to know how to respond, it has to be configured to respond appropriately to different user behavioral patterns. A little research has been done exploring the possibility of designing educational CAs according to users' personalities.

Conversational agents stimulate a social presence in students such that they feel psychologically supported despite the physical absence of their teachers. The agents interact with the students, know their state of mind, and understand how to interact with their different behavioral patterns[7]. However, conversational agents cannot better understand student behaviors, which may be caused by their unique personalities. Conversational agents should be better designed to bridge this gap and improve their interactions with students.

Conventional pedagogical practices are geared towards students cramming and memorizing content rather than mastering the content. Evolving pedagogical tools have been modified to improve students' understanding of their studies but have not fully achieved this objective. Conversational agents have been developed to improve the students' social interactions, which are core to improving their understanding and learning experience[8]. The natural lines of communication created by conversational learning have been established to support learning and the different students' personalities. Topic dialogues with humans would be essential in enhancing and improving the interaction of conversational agents with different personalities.

With increased online learning, meaningful interactions between the student and the online educational platform would be essential in ensuring the student stays on course in pursuing their online course. Conversational agents are essential components that a student can use for meaningful interactions; however, it would be essential to affirm the system's feasibility in making these meaningful interactions before implementing them[9]. In addition, quality interactions between students and conversational agents will help designers better understand users' behavioral patterns directed by their personalities. Our study aims to bridge the gap and explore different student behaviors based on their diverse personalities when interacting with CAs. We aim to investigate how design should be improved to coordinate with students' diverse personalities.

III. METHODS

We conducted two studies to investigate different students' behaviors when they interact with educational CAs and their impact on design. The two studies were logically designed. The first study asked the participants to present their favorite or preferred educational CAs. Based on their responses, we built a prototype using one of the top-ranked platforms the participant presented. Then we assigned tasks to the participants who participated in our second study and collected data on their personality dimensions and task accuracies.

Study 1 Educational CAs

We invited 14 college student participants to explore, interact with, and list one to three of their favorite educational CAs and submit them to us online. Because the concept of educational CA is still new to the general population, we invited college students whose majors were information technology related. Five of

them were male, and nine of them were female. They had a basic understanding of how to interact with CAs. The educational CAs are listed in Table 1. Juji, Mia, Powerschool, and Ocelot are the top ones that the participants presented.

Name	Vote
Juji	3
Mia	3
Powerschool	3
Ocelot	3
GeckoBot	1
Zendesk	1
Instructure Bot	1
Preply	1
KajeetChat	1
edubirdie	1
SnatchBot	1
Aibot	1
Hawk	1

Table 1: Educational CAs with Preferences

Study 2 Prototype Design

1. Participants and Personalities

Beginning with the sample size, we believed the most pertinent group of people to test this technology would resemble those who would use these technologies in an educational environment. College or other secondary education students between the ages of 18-30 were the populations determined[10,11,12].

This population was then be broken up into personality categories based on two of the four pairs of the Personal Style Inventory by R. Craig Hogan and David W. Champagne[13](Table 2). Our previous studies used Hogan and Champagne’s personality concepts to analyze users’ experiences[14,15]. In this study, the two pairs chosen were Introversion vs Extroversion and Intuition vs Sensing (Table 3). This system provided the best middle ground as we have four personality groups and some pairs that can overlap and be analyzed between multiple groups without adding the unnecessary complexity of 16 groups.

		SENSING TYPES		INTUITIVE TYPES	
		ISTJ	ISFJ	INFJ	INTJ
INTROVERTS		Serious, quiet, earn success by concentration and thoroughness. Practical, orderly, matter-of-fact, logical, realistic and dependable. See to it that everything is well organized. Take responsibility. Make up their own minds as to what should be accomplished and work toward it steadily, regardless of protests or distractions.	Quiet, friendly, responsible and conscientious. Work devotedly to meet their obligations and serve their friends and school. Thorough, painstaking, accurate. May need time to master technical subjects, as their interests are usually not technical. Patient with detail and routine. Loyal, considerate, concerned with how other people feel.	Succeed by perseverance, originality and desire to do whatever is needed or wanted. Put their best efforts into their work. Quietly forceful, conscientious, concerned for others. Respected for their firm principles. Likely to be honored and followed for their clear convictions as to how best to serve the common good.	Usually have original minds and great drive for their own ideas and purposes. In fields that appeal to them, they have a fine power to organize a job and carry it through with or without help. Skeptical, critical, independent, determined, often snobbish. Must learn to yield less important points in order to win the most important.
		Cool onlookers-quiet, reserved, observing and analyzing life with detached curiosity and unexpected flashes of original humor. Usually interested in impersonal principles, cause and effect, how and why mechanical things work. Exert themselves no more than they think necessary, because any waste of energy would be inefficient.	Retiring, quietly friendly, sensitive, kind, modest about their abilities. Shun disagreements; do not force their opinions or values on others. Usually do not care to lead but are often loyal followers. Often relaxed about getting things done, because they enjoy the present moment and do not want to spoil it by undue haste or exertion.	Full of enthusiasms and loyalties, but seldom talk of these until they know you well. Care about learning, ideas, language, and independent projects of their own. Tend to undertake too much, then somehow get it done. Friendly, but often too absorbed in what they are doing to be sociable. Little concerned with possessions or physical surroundings.	Quiet, reserved, brilliant in exams, especially in theoretical or scientific subjects. Logical to the point of hair-splitting. Usually interested mainly in ideas, with little liking for parties or small talk. Tend to have sharply defined interests. Need to choose careers where some strong interest can be used and useful.
EXTRAVERTS		Matter-of-fact, do not worry or hurry; enjoy whatever comes along. Tend to like mechanical things and sports, with friends on the side. May be a bit blunt or insensitive. Can do math or science when they see the need. Dislike long explanations. Are best with real things that can be worked, handled, taken apart or put together.	Outgoing, easygoing, accepting, friendly, enjoy everything and make things more fun for others by their enjoyment. Like sports and making things. Know what’s going on and join in eagerly. Find remembering facts easier than mastering theories. Are best in situations that need sound common sense and practical ability with people as well as with things.	Warmly enthusiastic, high-spirited, ingenious, imaginative. Able to do almost anything that interests them. Quick with a solution for any difficulty and ready to help anyone with a problem. Often rely on their ability to improvise instead of preparing in advance. Can usually find compelling reasons for whatever they want.	Quick, ingenious, good at many things. Stimulating company, alert and outspoken. May argue for fun on either side of a question. Resourceful in solving new and challenging problems, but may neglect routine assignments. Apt to turn to one new interest after another. Skillful in finding logical reasons for what they want.
		Practical, realistic, matter-of-fact, with a natural head for business or mechanics. Not interested in subjects they see no use for, but can apply themselves when necessary. Like to organize and run activities. May make good administrators, especially if they remember to consider others’ feelings and points of view.	Warm-hearted, talkative, popular, conscientious, born cooperators, active committee members. Need harmony and may be good at creating it. Always doing something nice for someone. Work best with encouragement and praise. Little interest in abstract thinking or technical subjects. Main interest is in things that directly and visibly	Responsive and responsible. Generally feel real concern for what others think or want, and try to handle things with due regard for other people’s feelings. Can present a proposal or lead a group discussion with ease and tact. Sociable, popular, active in school affairs, but put time enough on their studies to do good work.	Hearty, frank, able in studies, leaders in activities. Usually good in anything that requires reasoning and intelligent talk, such as public speaking. Are usually well informed and enjoy adding to their fund of knowledge. May sometimes be more positive and confident than their experience in an area warrants.

Table 2: R. Craig Hogan and David W. Champagne

	Sensing type	Intuition type
Introversion	IS (Seven participants)	IN (Seven participants)
Extroversion	ES (10 participants)	EN (Six participants)

Table 3: Personality dimensions

These two pairs were chosen because they have the highest estimated effect on a subject’s conversational ability and tendencies. Extroversion/Introversion judges how outwardly one communicates with others affecting the amount someone communicates and the way they do it. Intuition vs Sensing can also have an effect as people who are sensing gain and act on feedback from their environment, while intuitive people gain more of that information and action from within. These differences are likely to affect how people react and interact with a virtual chat environment.

Then the 30 participants were required to perform three tasks using a prototype conversational assistant we designed using Juji. Juji is a platform that provides chatbot templates for users to build AI chatbots[16]. These tasks were accurately measured to determine the impact of personality types on our design.

2. Tasks

According to the results of Study 1, we designed one educational CA prototype using Juji. Juji is among one of the highest rates listed by the participants in Study 1. Plus, this quick and dirty prototype design can maintain integrity in measuring effectiveness between personality types and users’ task responses, as currently, in the industrial market, users with different personalities can only use the software universally designed for all.

Three tasks are as follows:

The first task asked the CA where to register for classes, with the CA responding with a university link. This question was programmed to trigger based on an 85% similarity to a list of predetermined answers (Figure 1).

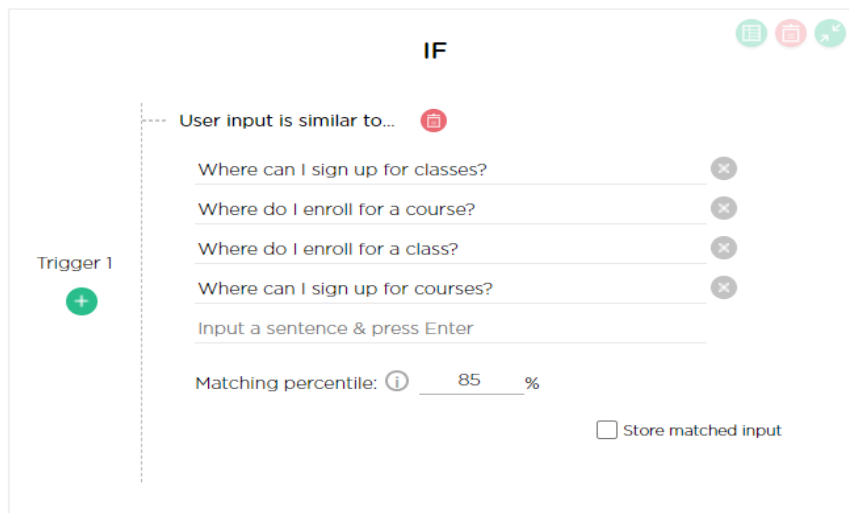


Figure 1: Task 1

The second task involved asking the CA where to find homework help or a tutor. This question was programmed to trigger based on a list of keywords.(Figure 2)

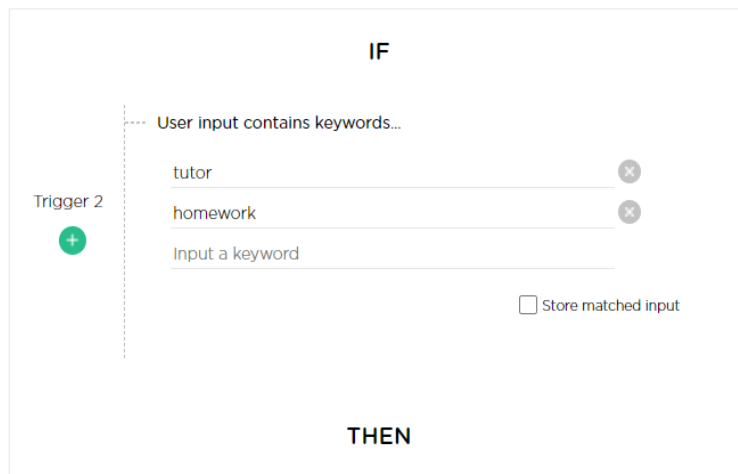


Figure 2: Task 2

The third task required the participants to ask the CA where to make a payment to the university. It directed them to the eServices site based on a trigger that combines the methods of the first two tasks (Figure 3).

We believe these three tasks represent an accurate spread of the sorts of things these technologies will be used for within educational institutions. We programmed each differently also to determine the effectiveness of the method of designing conversational assistant responses.

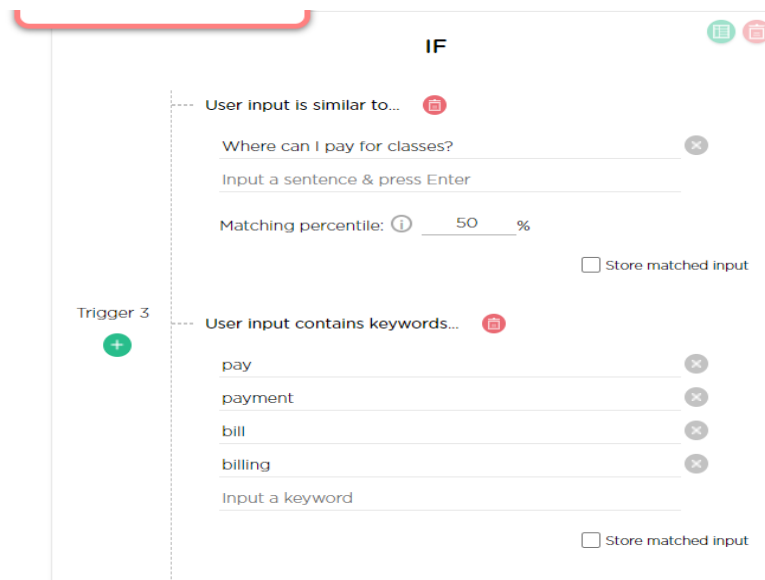


Figure 3: Task 3

IV. RESULTS

Table 4 shows the full person-by-person results and total accuracy calculations. The overall results showed that the CA we designed was 86.67% accurate for all responses. It showed that combining keywords and string similarity % together when designing responses was by far the most effective, as observed by the 100% rate for Question 3, which used the dual approach. Question 2, designed to only look for keywords, had the lowest effectiveness. No task took more than two tries for any participant.

The responses were then broken up into the four isolated personality dimensions to determine if there would be any differences.

Personality Type	Question 1(Enroll) Errors	Question 2(Tutor) Errors	Question 3(Payment) Errors	Total Errors
IS	0	1	0	1
ES	0	0	0	0
IN	0	1	0	1
ES	0	0	0	0
IS	0	1	0	1
EN	0	0	0	0
ES	1	0	0	1
EN	0	0	0	0
IN	0	0	0	0
IS	0	0	0	0
EN	0	1	0	1
ES	0	0	0	0
ES	0	0	0	0
EN	0	0	0	0
IN	0	0	0	0
IN	0	0	0	0
IN	0	0	0	0
ES	0	1	0	1
ES	0	1	0	1
IS	1	0	0	1
IN	0	0	0	0
ES	1	0	0	1
ES	0	0	0	0
IS	0	0	0	0
IS	0	1	0	1
EN	0	0	0	0
IN	0	1	0	1
ES	0	0	0	0
EN	0	0	0	0
IS	1	0	0	1
TOTAL	4	8	0	12
%	86.67%	73.33%	100.00%	86.67%

Table 4: Task accuracy of different personality dimensions

As shown in Table 5 below some key patterns have been discovered. The extroverted participants had a success rate of 4% higher than introverted participants. People who fell into the sensing category had 10% more wrong answers than those categorized into intuition. This difference was significantly higher than that between introverts and extroverts. Moreover, the percentages between questions in different groups stayed consistent. Question 2 was always the least accurate and Question 3 the most. This showed that the triggers behind the questions did affect overall performance regardless of personality.

Introverted Accuracy Results			
Question 1	Question 2	Question 3	Total
85.71%	64.29%	100.00%	83.33%

Extraverted Accuracy Results			
Question 1	Question 2	Question 3	Total
87.50%	81.25%	100.00%	87.50%

Sensing Accuracy Results			
Question 1	Question 2	Question 3	Total
76.47%	70.59%	100.00%	82.35%

Intuition Accuracy Results			
Question 1	Question 2	Question 3	Total
100.00%	76.92%	100.00%	92.31%

Table 5: Personalities: Introverted, Extraverted, Sensing, & Intuition

We then combined the attributes into four personality pairs to cross-reference the two spectrums mentioned previously and determine if the patterns remained within subgroups. The results of these pairings are shown below (Table 6).

Introverted/Sensing Accuracy Results			
Question 1	Question 2	Question 3	Total
71.43%	57.14%	100.00%	76.19%

Introverted/Intuition Accuracy Results			
Question 1	Question 2	Question 3	Total
100.00%	71.43%	100.00%	90.48%

Extraverted/Sensing Accuracy Results			
Question 1	Question 2	Question 3	Total
80.00%	80.00%	100.00%	86.67%

Extraverted/Intuition Accuracy Results			
Question 1	Question 2	Question 3	Total
100.00%	83.33%	100.00%	94.44%

Table 6: Dimensions: Introverted VS Extraverted & Sensing VS Intuition

As shown in Table 6, between the introverted and extroverted pairs, this conversational assistant was more effective for extroverts (Introverted: 76.19% VS 90.48 compared to Extraverted: 86.67% VS 94.44%). When comparing the two pairs with sensing and the two pairs with intuition, the responses of the intuition pair were more effective than those in the sensing category (Sensing: 76.19% VS 86.67% compared to Intuition: 90.48% VS 94.44%). This shows that the pattern from the previous statement is profound when broken down further. The intuition/sensing spectrum still holds the larger influence over extraversion/introversion. The most accurate pair of Extraverted/Intuition was nearly 20% more effective than the least accurate pair of Introverted/Sensing (94.4% vs 76.2%), reinforcing a statistical difference between personality types.

V. DISCUSSION AND LIMITATIONS

As little research has been done to explore user personality impact on design, our study aimed to bridge the gap by comparing the task accuracies of different personality characteristics. The data shows a clear difference in the accuracy of this conversational assistant between Intuition and Sensing categorized individuals. It also shows a slight decrease in accuracy in introverts compared to extroverts. Therefore, we confirm that personalities impact users' interaction with educational CAs, which also leads to possible new ways of effective design. The results also show that using multiple programming techniques to solve questions increases accuracy dramatically, as seen by the 100% accuracy rate for the one question programmed to detect multiple different triggers.

Even though our work showed that user personalities impact their interaction with educational CAs, there are limitations in this preliminary study. For instance, because educational CAs are still new to the whole population our participants are all technology majors related, unlike our previous participants with multicultural and discipline backgrounds in other studies [17,18,19]. The results of our study can be generalized to other user groups with different personalities in the future when CAs are more dominantly used.

Since this is a preliminary study, a future and larger study will soon be done with a much larger sample size to determine if these patterns maintain within larger populations and an in-depth analysis of the reasons behind these differences. We will build a mature version of the educational CA according to user personalities, and hopefully, it may serve all students equally. In future studies, a wider array of tasks will be used. This will also shed light on the nuance the task itself has on accuracy and outcomes.

VI. CONCLUSION

Conversational agents are becoming increasingly utilized within the education space to automate simple Q&A tasks and other processes to save human resources. This study investigated the effectiveness of these conversational assistants in the different personality types of the students they are supposed to serve. Our results demonstrated that different personalities performed different task accuracies by interacting with our prototype. Through two studies, we believe that user personalities impact their interaction with CAs. This finding provokes new ways of thinking concerning design CAs. Our next step is to design a CA with different personality design logic to meet diverse users' personality needs so that the human-CA interaction can reach high-standard usability goals.

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