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# Work-in-Progress Paper: Virtual Agents in Teaching: A Study of Human Aspects

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**Abstract**—Students require human intelligence and social interaction in the form of academic assistance at different times of their study period. Their desire to get and find academic assistance varies and is dependent on many factors such as attendance mode, personal situation, semester timetables, and assessment due dates. Providing students with access to this expertise when it is needed and to large numbers of students is problematic. Virtual Agents (VAs) seek to provide a technology-enabled social element to encourage and provide timely support to aid students' learning. We have implemented 4 unit-specific VIRTUAL Teaching Assistants (VIRTAs) across 2 universities to provide support to answer student's questions about various aspects of the unit. In this paper, we present the usage patterns of students to show how many questions were asked by students and at what point of time in the semester the questions were asked addressing the desire to find assistance when required from VIRTAs.

**Index Terms**—virtual agent, unit helper guide, learning components, educational institutions.

## I. INTRODUCTION

Indeed, there are many benefits of using AI in education [1, 2]. The applications of AI in education include intelligent tutoring systems, automated evaluation system, educational robots, and educational games [3]. Current educational theories also advocate for more personalisation [4]. Learning characteristics, as informed by research [5], vary for each individual learner. Every learner exhibits distinct personality characteristics engagement levels and emotional responses that can affect their academic performance and behaviour in various educational settings.

Research [6] suggests that knowledge is processed and represented in different ways and that students prefer to use different types of resources in distinct ways. Most of the information delivered ahead of time about assessments and exams in the classroom are not retained by all students. There is a requirement to generate interactive delivery of these informations. Students require to have these pieces of information when they need it or when they have the desire to have it.

AI has provided an advantage of accessing and participating in an interactive learning environment

anytime, anywhere mode [3]. It can provide individualised learning for students, promote and enhance students' literacy and abilities in all aspects, and reduce teachers' repetitive work [7]. Pedagogical agents, a subclass of Virtual Agent (VAs), have been found to provide a mentoring role to aid student's learning [8]. Learner relationships (teacher and peer) involving computer based learning are similar to the equivalent human-human learning relationships in the classroom [9].

We have created and provided Virtual Reality (VR) innovative learning platforms to our students. In this research, we have designed, developed and implemented VIRTAs, a VA. This research seeks to understand if a VA is helpful and assists students in understanding what is required in the unit<sup>1</sup> and where they can get help. To provide human-like behaviours, we utilise game and virtual reality technology to design and deliver VA that are available 24/7 to play a role like what students would expect from teachers. Many students require help while doing their assignments, or understanding weekly teaching resources, or finding out the impact of not referencing others' work correctly.

Australasian context where VAs are used in education in a university. Our research focuses on the use of VAs in university systems. More specifically, the contributions of this paper are as following:

- How many times students use VA's during their study?
- What kind of information is asked from VAs?

The remainder of the paper is organised as follows. In section 2, we review the literature on VAs and outline some of their benefits. Section 3 presents the study. In section 4, we present the design, development, and implementation of our VA-VIRTAs. Section 5 presents the empirical results from the use of VIRTAs. Finally, in section 6 we present our findings and the possible directions for continued research in the field of virtual assisted human aspects to enhance human-computer interactions in educational settings.

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<sup>1</sup> In this paper, we used the term 'unit' to refer to an individual subject. In the context of our institutions, a unit is a single semester subject worth a fixed number of credit points.

## II. LITERATURE REVIEW

The use of virtual agents has been popular in the last decade as they allow for a more immersive conversational experience [10, 11]. Dialogue systems are multimodal interactions based on voice and text [12]. Many studies have been conducted on the applications and effectiveness of virtual reality in education and training since the 1980s. There are many arguments to support that use of VA will increase students' motivation to persist in a learning environment and engage in the learning activities [13, 14, 15]. Pantelidis et al., [16] identify reasons to use virtual reality in education and training courses and form a model to determine when to use virtual reality. The authors suggest the use of VR is essential to make learning more interesting and fun and when simulation could be used.

Roussou [17] asserts that one of the main motivations for VR use is that it is time-independent and gives learners' the opportunity to access it anytime. It is possible that self-perceptions, such as self-efficacy [18], could prove to significantly influence learning or performance outcomes when learning from virtual agents as they have in other learning situations [19]. Chee [20] argues for the need to root learning in experience, using physics as an example. He stated that physics students require more help and support with learning and teaching resources. Chee believes that VR can be used to achieve this goal. Lester et al., [21] believe that the addition of virtual agents makes the computer more lifelike and this increases motivational impact. The authors also believe that the presence of lifelike characters in interactive learning environments can have a strong positive effect on students' perception of their learning experience. Putting students in control of their avatar, not the teacher, meant they could explore and interact independently. Unlike student teaching tools such as lecture slides and/or tutorial worksheets, where everybody sees the same information in the same way at the same time, a virtual world allows students to create their own understanding.

Because of the ease of manipulation, virtual agents have become a popular tool in learning environments, functioning as learning companions, tutors, and teachers [22, 23, 24, 25]. Computer Science education has its own challenges and is considered as one of the difficult courses at universities. We thus propose that virtual agents can step in to simulate teachers and help students in understanding complex tasks. In this first study, we focus on a more general problem faced by students; how to understand what is required of them in a unit. It is common for students to struggle to comprehend the unit content and assessment tasks. VIRTAs aim to help these students with understanding the unit requirements and seeks to provide evidence for the value of implementing VIRTAs in computer science units at universities.

## III. SYSTEM DESIGN AND IMPLEMENTATION PLATFORM

This section describes the creation of the VIRTAs prototype. The VIRTAs prototype was built in Unity 3D. We wanted to build a character that students at Universities would find engaging. For this, we had to pay special attention to many aspects such as appearance, behaviour, and content all working together. Thus, we had to consider carefully how our VA would look, how it would interact, and what content it would deliver. For the VA's appearance, we wanted to design a look that would appeal to the broad

demographics of the students. The basis of this decision is embedded in the international student's market in Australia. In 2017, 799,371 international students were enrolled in education programs in Australia. Of these, there were 350,472 international students enrolled in the higher education sector [26]. We used the Unity 3D game-building developer environment to customise a character for our purposes. Because designing and building a character from scratch is both time and labour-intensive, we used Adobe's character creation software, Fuse, and its character animation repository website, mixamo.com, to design and animate our character. Figure 1 shows VIRTAs with which students interact. As most commonly found in virtual assistants and chatbots, we created a female character. We chose to create a character to look more like a teacher or tutor in their thirties to provide a level of authority and knowledge, rather than a peer learner who also would not know much about the unit. This age was chosen to appeal to the mostly young adult (18-25) participant population.



FIGURE 1. VIRTAs, our Virtual Agent

VIRTAs is designed to be a virtual pedagogical agent, employed in educational settings for instructional purposes, interact with learners using text-based and audio-based communication. We used WebGL for lip synchronisation software and text-to-speech software for spoken dialogue. With regards to audio-based communication, agents are often employed with text-to-speech software where they are able to respond to learners dynamically, translating text-based information into its equivalent audio form [19]. In terms of VIRTAs's non-verbal behaviours, gaze was predetermined, eye and eyebrow movement were coordinated. The same pedagogical agent was used for three different units taught at two different universities. In each case, the pedagogical agent was identical in body, image, clothing, animation, dimensions, voice, and facial expressions. We had the ability to customise it using the colours and logos for both universities. In order to interact with VIRTAs, students click a Web page link to start a conversation with VIRTAs and then proceed to ask questions and seek help from VIRTAs. Using speech bubbles, audio and text-to-speech synthesised spoken voice, VIRTAs was able to help students about their inquiry with unit requirements, assessments, referencing, submission dates and textbook.

## IV. THE STUDY

An initial case study was conducted at two universities in Semester 2, 2019. The VA-VIRTAs described in the previous section (System Design and Implementation Platform) was hosted on Moodle Learning Management

Systems at two different Universities in Australia. We are naming these universities as the University A and the University B.

The units selected are from the computer science and engineering disciplines. At University A, a postgraduate Business Intelligence unit with an enrolment of 131 was selected. At University B, an undergraduate first-year programming unit with around 500 students and third-year team-based industry project with 190 students were selected. This research was ethically cleared by the Human Research Ethics Committees at both Universities. Students enrolled in the above-stated units could access VIRTAs. We collected log-file data of their interactions with VIRTAs. This enabled us to identify usage and what questions they were asking most frequently. Students could access VIRTAs anytime from anywhere with internet access. There were 821 total students as a sample size for this research project. The excerpts from an interaction between a student and VIRTAs is shown in Table 1.

TABLE 1. Students' suggested dialogue for VIRTAs

Sample student dialogue options	Responses from VIRTAs
Start	This virtual character is in development and we are conducting research to test its utility
Unit Overview	What do you want to know about this unit?
What I am going to learn in this unit?	On successful completion of this unit, you will be able to: 1. Apply concepts and principles of....
Assessment Tasks	In this unit you are required to complete 3 assessment tasks. The first assessment is a written assessment worth 35%.....
Referencing Style	At this University we follow Harvard style referencing.
What mantra must I remember in this unit?	The unit mantra is "Something of Value". Each time you need to make a decision, ask yourself, "Is this something of value for the client?"
Attendance and Time Requirements.	Four classes are required attendance and two are optional.

## V. RESULTS FROM THE USE OF VIRTAs

This research used a combination of qualitative and quantitative methods to answer our research questions. This involved analysis of the dialogue options chosen (which is text) and the frequency the options were chosen. The server log files were imported as Excel CSV files. We applied Excel capabilities for statistical analysis and used Rapid Miner for clustering the data for responses and predict the most likely dialogue. Data collected from three different units at two different universities were analysed to find out empirical evidence to support the arguments for the implementation of VIRTAs. Firstly, we wanted to measure how students have used VIRTAs as virtual support and how many of the users returned back to use VIRTAs again. This will justify the usability of VIRTAs, virtual support in the educational environment to our cohorts of participants.

Secondly, we wanted to find overall students' reactions to the virtual support, VIRTAs by collecting the responses from the survey. This will give us a better understanding of how many times the students have used VIRTAs and what they perceive about VIRTAs in an educational setting.

### A. Students' Demographic

We wanted to capture how well this VA-VIRTAs was useful in providing support to our students and how students would like to use it in the future, if provided. We also captured the age and gender of the participants to understand and find out if there are any biases of gender and age while asking for support from VIRTAs. Table 2 shows the demographic of students involved in the study. Looking at the demographics of students we can conclude that all participating students are more than 21 years of age and a good mix of male and female students with 100% face-to-face cohort.

TABLE 2. Students' Demographic

Age	100% >21 years
Gender	46% Female; 54% Male
Face-to-face	100% of students are from face-to-face learning environment

### B. Count of Responses

For University A, 289 log-file responses from students using VIRTAs were recorded from June 2019 to September 2019. Responses (i.e. dialogue options chosen by students) are labelled as re\_dialogXXX. Most of the recorded responses are re\_dialog2, seeking help in assessment tasks; followed by re\_dialog100, moving onto another query. This provides empirical evidence that students are willing to use VIRTAs to gain support to understand their assessment tasks. The least recorded is re\_dialog4a3 and re\_dialog10c. Re\_dialog4a3 is about help in assessment 3, which was due in week 12. The data was collected in week 10 and students did not look at assessment 3 when data was collected. This supports that students do not want to receive information if it is not of immediate use to them. Re\_dialog10c, Not Really, is about how helpful was VIRTAs to them. Only 1 out of 289 responses had a query where VIRTAs could not help the student with his/her query. This is a very insignificant number where VIRTAs could not help the student. The average number of uses of VIRTAs per student is almost  $289/131 = 2.20$  at University A.

For University B, a total of 1608 responses were recorded from 23 July 2019 to 20 September 2019. For the first-year programming unit, 433 responses were recorded and for the third year team-based industry project, 1,174 responses were recorded. For the first-year programming unit, most of the recorded responses are re\_dialog1, looking for the unit overview followed by re\_dialog9, "Do you have another question?". The next most recorded response was for "What is the hurdle assessment?". A hurdle assessment is an assessment that must be passed in order to pass the unit. In this case, students were looking for a unit overview and then hurdle assessment tasks. The least recorded responses are for re\_dialog4a "I want to know more about assessment 1". The average number of uses of VIRTAs per student is  $433/500 = 0.866$  at University B. It seems the first-year students in this unit are most concerned with gaining an overview of the unit and how to pass it rather than gaining any deeper understanding of the unit requirements.

### C. Number of Times Students' used VIRTAs

The numbers in Table 3 shows that 73% of the participants did use VIRTAs 1-5 times. 15% used it more than 6 times and 12% never used it. This provides us with

a strong case of implementing VIRTAs in other units of university studies.

TABLE 3. Number of times students' used VIRTAs

Students' use of VIRTAs	Times
More than 10 times	12%
6-10 times	3%
1-5 times	73%
Never	12%

#### D. Using and re-using VIRTAs

Table 4 shows how many number of users used VIRTAs and how frequently. The numbers in Table 7 suggest that 38% of the users have returned back to use VIRTAs for different queries. The rest of the users did not return back. This suggest us that the information provided by our virtual support VIRTAs is most of the time only required once and once the information has been understood by the users they do not need to know the same information again and again in contrast to teachers repeating the same information about assessments and other unit related information in the class multiple times.

TABLE 4. Users who have returned back to use VIRTAs

Users	Percentage of users
Used VIRTAs only once	62%
Returned back to use VIRTAs	38%

## VI. CONCLUSION AND LIMITATION

The results of our study show the benefits of using a VA in educational institutions and emphasis the concept of human aspects of virtual agents in teaching. The identified limitation of our study is, as the collected log file and other data are de identifiable we could not analyse students' success rate in the unit after using VIRTAs. In the future VIRTAs can evolve to be more intelligent and engage the user in conversation. The work can also be enhanced by adding facial expressions, gestures, and movements. Complex Scenarios in units can be developed for students using virtual assistants.

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