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Simulating the Influence of Social Robotics Technology on the Student's Academic Performance

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Abstract

Teaching robotics in the classroom is a fantastic method to engage and inspire kids, and it may offer opportunities for hands-on learning that can aid in the development of crucial abilities like cooperation, critical thinking, and problem-solving. Furhat is one type of robot that has many potential uses, including research and education. This study aims to investigate Furhat's influence on teaching students in the classroom and the level to which students engage with its explanations Four of the characters are used to explain various factors. This study was conducted on 300 students with Diploma and Bachelor's degrees at Sohar University in Oman. Data was collected through surveys that were based on the UTAS model including 12 factors. Where this study showed the extent of positive interaction between the students and the four personalities presented by the Furhat robot through the exciting results of the ANOVA test and t-test. The students preferred Omar's character among the other characters, which has a higher figure of probability values reaching 8 factors.

Keywords: *Furhat Robots, Classifications, hands-on learning, UTAS model.*

1 Introduction

There has been a noticeable acceleration in the development of artificial intelligence sciences in recent times. One of these sciences is robotics. A group of scientists and researchers put

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forward a group of robots in various fields of various shapes and sizes (Liu et al., 2018; Interaction et al., n.d.). It can be programmed to perform a variety of tasks automatically. They can range from simple, single-function devices to complex, multifunctional systems that can perform a wide range of tasks. Robots can be used in manufacturing, assembly, inspection, transportation, and many other industries. They canwork alongside humans or operate independently. Some robots are designed to mimic human or animal behaviours (Batiha et al., 2022), while others are designed for more specialized tasks (Al Moubayed et al., 2012). The use of robots can help improve efficiency, reduce costs, and increase productivity in many industries. Three decades ago, a humanoid robot was first used by William Richards in London in 1928 (Moran 2014).

The robot was powered by electricity and was controlled by voice. In 1939, an electro-human robot that was moved by the translation of voice commands was demonstrated, in addition to its ability to speak approximately 700 words. Then, in 1995, the first programmable robot called Unimate was created by George Devol. After that, we note the focus of experts specialized in developing Technologies for robots, expanding their capabilities, and intensively increasing practical experiences. One of these areas is educational bots such as Lego Mindstorms EV3, the Sphero SPRK+, and the Dash and Dot robots (Maslin 2016). Where these robots have important advantages, such as embracing physical sensors and effectors capable of receiving instructions and processing them to perform the required functions easily and simply.

Robots are employed in education as assistant coaches for subjects such as science, technology, and mathematics (Murphy et al., 2010), for educating kids with autism and intellectual disabilities, and for teaching foreign languages (*Book-Talks with Furhat How Can Interaction with Conversational Robots Be Used to Motivate Swedish Middle Schoolers To*, 2022). Robots that can display emotions and gestures are evolving into engaging and dynamic devices owing to ongoing research, which improves educational communication. The average market value of these robots today is expected to be US$640.594 million, increasing at an annual rate of 27% (Ed, n.d.).

One such device includes Furhat Robotics, a humanoid social robot that was developed in 2011 to interact with humans, naturally and intuitively (Bengtsson et al., 2018; Perugia & Lisy 2022; Perde n.d.). Furhat includes several sensors and actuators, along with a high-

resolution camera, many microphones, and an expressive face that moves and alters its expressions in response to its environment. Furhat Robotics is used as a Quantum leap in the field of education for its highly interactive ability in the teaching process and to increase the effectiveness of its educational outputs. Furhat Robotics employs strategies centred around self-learning, problem-solving, the use of educational games, discussion, and discovery.

These strategies enhance thinking innovatively and more creatively which is commensurate with the nature of the content of the students, such as creative thinking, information analysis and the skill of solving mathematical operations, which motivates them (Skantze et al., 2015). The level of intelligence of these robots reached in perceiving the students' words and actions and making them more attentive, responsive, and creative (Abualkishik et al., 2023). Furthermore, these robots can interact with the students in a manner that is used by the teachers to interact with students having differing linguistic, cognitive, and mental processes. In addition to other criteria in the field of low- and high-frequency sound, facial expressions, their effect on the speed of information delivery, And physical sensitivities, such as the age and gender of the teacher (Ågren & Thunberg 2022; Thunberg et al., 2022). This study has determined the effectiveness of using Furhat Robotics as a teacher substitute in transmitting essential data to the students. In addition to define the strategies that Robotics Furhat will use to display the content. This study revolves several factors:

- The impact of gender on information delivery.
- The effect of facial gestures and tone of voice on receiving information and attracting students' attention.
- Does the age of the teacher have an impact on the delivery of information?

2 Related Work

Many studies have examined the effectiveness of using robots in different sectors like education, health, entertainment, etc. In (Belpaeme et al., 2018) Belpaeme described the effectiveness of robots in children's cognition such as understanding, analysis, and synthesis. In addition to the positive results in terms of affective learning outcomes, such as attention and response. When evaluating a person for the first time in a meeting, the main factor is the first impressions such as confidence, physical movements, verbal expressions, etc. Therefore, some studies revolve around this line, in how to convey information through expressions

(AlAmri & Almaiah, 2021). Sometimes, in the first meeting, happy faces affect us more than sad and angry faces (Feng et al., 2022).

In a research paper, Calvo-Barajas et al. (2020) focused on Furhat Robotics' facial expressions and studied children's perceptions such as anger and happiness. The study used 129 children to assess Furhat Robotics' ability to communicate these perceptions to children. The results showed that children respond to these expressions after a few seconds, due to the ability and efficiency of the robot that can reach children's emotions easily.

While the paper (Calvo et al., 2020) conducted an exploratory study on 42 children to receive the directions and instructions of Furhat Robotics in telling fairy tales. These instructions were delivered using the measurements of facial and head movements. The study was based on many factors, including the frequency with which youngsters obey the robot's orders, how much they are likely to like the activity, and how much faith they have in Furhat Robotics.

In a training environment, where the psychotherapist John used Furhat Robotics to study his skills in psychotherapy by observing the patient's behaviour and understanding his verbal and nonverbal movements and how to deal with him during the session (Beskow et al., 2017). And light was also shed on an ISTDP theory so that Furhat Robotics could deal with the patient.

In the educational activities, Furhat Robotics evaluates if he can teach a group of players the rules of the game by guiding them in one of the games. The rules are listed in various language skills and motor skills. It also shows the impact of the language skills of the robot on the performance of the participants in the game and the mastery of personality and language (Paetzel-Prüsmann et al., 2021).

3 Problem Formulations or Methodology

In this research, this research proposed a study that uses Furhat Robotics (a social robot) to deliver lectures capable of teaching students. This study focused on Sohar University students in the computer department. A group of parameters was studied and the extent of their impact on the interaction between Furhat as a lecturer and the students and the extent of their impact on the delivery performance by using the following primary parameters:

- Different facial gestures

- Furhat gender (male and female).
- Voice type (high and low frequencies).
- English language pronunciation type.
- The Furhat skin colour (tan and white).

Utilize Furhat Robotics as a lecturer to teach students at Sohar University, focusing on the computer department and evaluate the impact of various parameters on interaction and delivery performance, including facial gestures, Furhat's gender, voice type, pronunciation, and skin color.

3.1 Participants

This study was conducted on students who received a similar education in the same language as Furhat Robotics, specifically the university education category, such as college students and those with a computer science background. This study was conducted on 300 students from Sohar University, including 100 third-year (diploma) students. The students were categorized into 2 groups, where each group included 50 students. In addition to 200 students from the fourth year (Bachelor's), who were divided into 3 groups (each containing 70 students), 60 third-year students were included. These two levels of pupils are distinct from one another. A 15-minute lesson was given to each group. The interaction showed the student's response to the robot and their interaction with its explanation, through their interaction with the questions it poses and their ability to answer and discuss them. After the lecture, a questionnaire was distributed amongst the students for collecting the results.

During the implementation of this study, 4 personalities were presented for the students' groups. As showed in Fig.1, these characters differ in gender, age, skin colour, voice, and pronunciation. In addition, each character has a different level of showing happy and angry gestures on their face. A flow of stimuli (laughter, sadness, gestures...) is created and processed according to the dialogue.

Name: Omar Gender: Male Age: 31 years old Pronunciation: USA	Name: Yumi Gender: Female Age: 35 years old Pronunciation: UK	Name: Fernando Gender: Male Age: 45 years old Pronunciation: USA	Name: Gyeong Gender: Female Age: 51 years old Pronunciation: UK

Figure 1. Four Characters were used as a lecture to explain to the students.

Conduct this study on 300 students from Sohar University, including third-year diploma students (100) and fourth-year Bachelor's students (200). Categorize students into different groups to receive a 15-minute lecture from Furhat Robotics, assessing their responses, interactions, and distributing questionnaires post-lecture.

The implement four different personalities (Omar, Yumi, Fernando, Gyeong) as shown in Figure 1 for the students, varying in gender, age, skin color, voice, pronunciation, and facial expressions to create engaging interactions.

3.2 Measurement

Positive results were obtained by measuring the response of students' interaction with Furhat Robotics. The response to the student with the robot was adopted by studying several parameters such as the student's understanding and interaction with the robot, the gestures that appear on the face of the Furhat lecturer and the student, and the results of the questionnaires which were included under the UTAUT model. A paradigm called UTAUT (Unified Theory of Acceptance and Use of Technology) seeks to identify the elements that affect a person's acceptance and utilisation of technology (Han & Conti 2020). According to the model, a person's acceptance and usage of technology are influenced by four factors: performance expectations, effort expectations, social influence, and facilitating conditions. Performance expectancy is the extent to which a person thinks that implementing technology will enable them to accomplish their objectives. On the other hand, the degree to which a person expects that employing technology will not require any effort is known as effort expectancy. The

extent to which an individual perceives that other people must apply technology is referred to as social influence. The extent to which an administrative and technological framework is in place to enable the application of technology is referred to as facilitating conditions (Fridin & Belokopytov 2014).

In addition, the Verbs Unit (AVS) measures the extent to which information is communicated through facial movements. Action units were manipulated through programming, such as moving the head in several directions and moving some areas of the face such as the mouth, eyebrows, and cheeks, which resulted in dynamic changes such as joy and sadness (Engwall & Lopes 2022; Torre et al., 2022; Al Moubayed et al., 2013). The functioning of the robot would be explained by adding stimuli, which would be developed using a novel programming language proposed by Furhat Robotics, i.e., Kotlin programming language. These stimuli varied according to the student's reaction to the robot, for example: When the student does not answer, the Furhat Robotics interacts with some motivational phrases such as "don't worry", "don't be sad", and others. While his response to the student's answers were "great", "good because you know that", "wow" and "happy to hear that" and other motivational words (Saravanan et al., 2022; Rawal et al., 2022).

3.3 Proposed model

Fig. 2 includes the proposed model. The proposed model includes a lecture by the Furhat robot and the users which are the students. Firstly, Farhat greets the students and asks them how their day was, then the Farhat welcomes them as Omani students and then tells them how the system of explaining the lesson will be. Farhat introduces four lecturers to teach the lesson, Omar, Yumi, Fernando, and Gyeong respectively. Each of these characters begins with an introduction to himself, his name, and his age.

In stage one, Omar begins to introduce the outline of the topic and asks the students if they know about the topic which is about distributed databases, and from the answers of the students, he responds to them and encourages those who have the information and motivates those who said we do not know.When Omar finishes presenting the characteristics of the topic, asks them if they understood what he explained or not, or if they need to re-explain the characteristics once again. In the case of the students answering “yes” and everything is understood, here the character Yumi begins by explaining the following part. bIn the 2nd stage, Yumi begins to explain the Types of Distributed databases and asks them in the end if they

understood what she explained or not, or if they need to re-explain the Types of Distributed databases again. If students answer “yes” and everything is understood, here the character Fernando begins by explaining the following part. Thirdly, Fernando begins to explain Distributed database storage. After Fernando finishes explaining the Distributed database storage. Fernando asks the students if they understood what he explained or not, or if they need to re-explain the characteristics once again. If the students answered “yes” and everything is understood, here the character Gyeong begins by explaining the following part which is Distributed database advantages or if they need to re-explain the characteristics once again. After Gyeong finished, she asked students if they understood what she explained or not, or if they need to re-explain the characteristics once again. If yes, Then the questions and answers section begins. Here, the students ask the robot about general questions for the lesson and about the robot itself if they want to know something. Finally, when Furhat finishes the questions and answers paragraph, asks them if they enjoyed the lesson and explanation, asks them about their opinions, and then Furhat concludes by saying encouraging words to them.

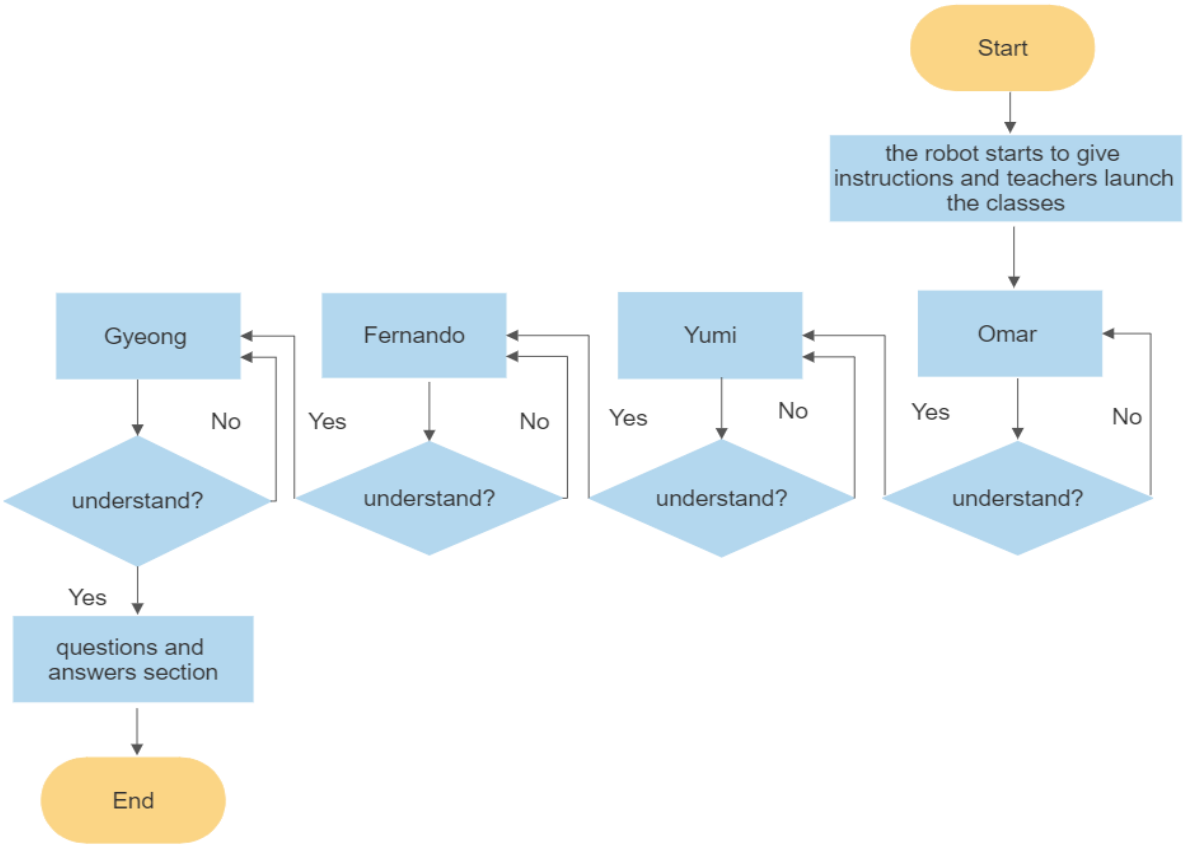

Figure 2: Proposed model overview

The Proposed Model Steps overview as illestrated in Figure 2 First step Introduce the lecture by greeting and welcoming students, presenting the system for the lesson explanation. Second step introduce four lecturers (Omar, Yumi, Fernando, Gyeong) to explain different parts of the lesson sequentially.Third step each lecturer evaluates understanding and re-explains topics if needed before passing the teaching to the next character.and final step after all lecturers complete their segments, a Q&A session between students and Furhat begins, followed by seeking feedback and concluding with encouraging words.

4 The Proposed Method

This section presents the tools used in our study to obtain the results as GraphPad Prism (One-way ANOVA and T-test) and 12 scales of the UTAUT model.

4.1 ANOVA evaluation

In this study, a one-way ANOVA statistical technique was used to compare the average values of three or more independent groups. It is used to assess if the group means differ significantly from one another. In this study, one-way ANOVA was carried out using a set of data containing at least three groups that were randomly assigned to the various treatment levels. The first step is to check whether the data meet the assumptions of the ANOVA test, which include normality and equal variances among the groups.

The Sum of squares (SS) for each group and the total sum of squares (SST=SSR + SSE) must be calculated to execute the one-way ANOVA technique, where SSR = regression sum of squares and SSE = error of SS. The F-statistic is then calculated using these values and the degrees of freedom for each group. The F-statistic is then computed using these values and the degrees of freedom for every group. Furthermore, for calculating the summarised statistical results, the mean and standard deviation are determined for each group. The number of groups minus 1 is used to calculate the degrees of freedom for a one-way ANOVA While the F-statistic measures the variation across the groups in comparison to the variation within the groups. It is determined by multiplying the variance within each group by the variance between the groups.

To calculate the F-statistic use the following formula:

F = (between-group variance) / (within-group variance) or F= MSB/MSW

The statistical significance of the variations between the group means is then determined by comparing the resulting F-value to a critical value from the F-distribution. Also, the p-value is determined. First, assuming that the null hypothesis is correct, the p-value refers to the likelihood of observing a result that is as extreme as the one that was achieved. The alternative hypothesis is accepted, and the null hypothesis gets rejected if the p-value is less than the pre-set significance level, which is often 0.05. The P-value corresponds to $F_{dfr,dfe}$, where df_r = regression degrees of freedom (df_r = k-1) and dfe = error degrees of freedom (df_e = n-k). where k = total no. of groups and n = total observation.

To interpret the findings, the mean value in the groups is significantly different when the null hypothesis gets rejected. The null hypothesis is not rejected when there is no significant difference between the group means.

4.2 T-test evaluation

A statistical test called a t-test is used to compare a sample's mean to a real or hypothetical population mean. It is frequently used to examine whether the sample means and population mean show statistical significance.

The t-test depends on the t-distribution, which is a probability distribution used to estimate the probability of acquiring a particular test statistic under specific conditions. The t-test is frequently used in hypothesis testing, where the alternative hypothesis refers to the difference; while the null hypothesis was that there was no difference between the sample and population means.

To carry out the t-test, the t-value is calculated, which refers to the difference between the population and sample means, divided by the standard error of the mean. By dividing the sample's standard deviation by the square root of the sample size, one may compute the standard error of the mean, which is a measure of the variability of the sample mean.

$$t = \frac{M_1 - M_2}{SE}$$

The t-value is then compared to a critical value, which is determined by the statistical significance level that is selected (often 0.05 or 0.01), while the degree of freedom, $df = n1 + n2 - 1$, which refers to the no. of observations determined for a sample minus 1. When the t-

value was higher compared to the critical value, the null hypothesis is rejected. Thus, it can be concluded that the sample and population mean values showed a statistically significant difference.

Table 1: UTAUT models of Proposed model overview

Code	Construct	Definition	Questionnaire
ANX	Anxiety	Inducing anxiety and emotions before using the new system	▪ I find robotic teaching intimidating ▪ I find the robot scary ▪ During the training, I would be afraid to break something ▪ During the training, I would be afraid to make a mistake
ATT	Attitude	Positive or negative feelings regarding the technological application	▪ During the training, I felt that I am learning something ▪ I do not think robots can teach like humans ▪ I think that robot teaching is a good idea
FC	Facilitating Conditions	Environmental factors which improve the system application	▪ I know enough to make use of robot teaching ▪ I have everything I need to use robotic teaching
ITU	Intention to Use	The user's intention to implement the system for a long time	▪ In future, I will use robots as teachers
PAD	Perceived Adaptability	Perceived system flexibility in responding to user needs	▪ I felt that the robot knew which words are easy or hard ▪ I felt that the robot knew in which words I am weak or strong ▪ I think the robots gain experience and teach better over time ▪ I think the robot better adapts to me over time ▪ I think the robot is adaptive to me
PENJ	Perceived Enjoyment	The apparent delight or pleasure felt because of using the system	▪ I enjoyed the adaptation of the robot ▪ I find robotic teaching fascinating ▪ I enjoy interacting with robots ▪ I enjoy robotic Teaching

PEOU	Perceived Ease of Use	The extent to which one thinks that utilizing the system would be effortless	▪ I know quickly how to use robotic teaching ▪ I find robotic teaching easy
PS	Perceived Sociability	The system's supposed capacity for friendly behaviour	▪ I find the robot a pleasant social partner ▪ I think the robot understands me
PU	Perceived Usefulness	The extent to which a person thinks the system would be helpful	▪ I think it would be convenient to use robots as teachers ▪ I find robotic teaching useful
SI	Social Influence	The individual's opinion of what relevant people to him believe about whether to use the system	▪ It would give a good time impression if I would use robotic teaching
SP	Social Presence	The perception of a social entity while interacting with the system	▪ Sometimes the robot seems to have real feelings ▪ I can imagine the robot to be a living creature ▪ When interacting with the robot I felt like it was a real person
TRUST	Trust	The belief that the system operates with honesty and reliability	▪ I would follow the advice the robot gives me ▪ I would trust robotic teaching

As showed in Fig.3, the proposed model was built based on the UTAUT model and several related studies. The participants were asked to complete a questionnaire survey that has 31 items, anonymously, and all answers were scored with the help of a Likert seven-point scale: The following replies are possible while accounting for variables that might change during employment of the Furhat robots: (1) Strongly Disagree, (2) Disagree, (3) Slightly Disagree, (4) Neither Agree nor Disagree, (5) Slightly Agreed, (6) Agreed, and (7) Strongly Agreed.

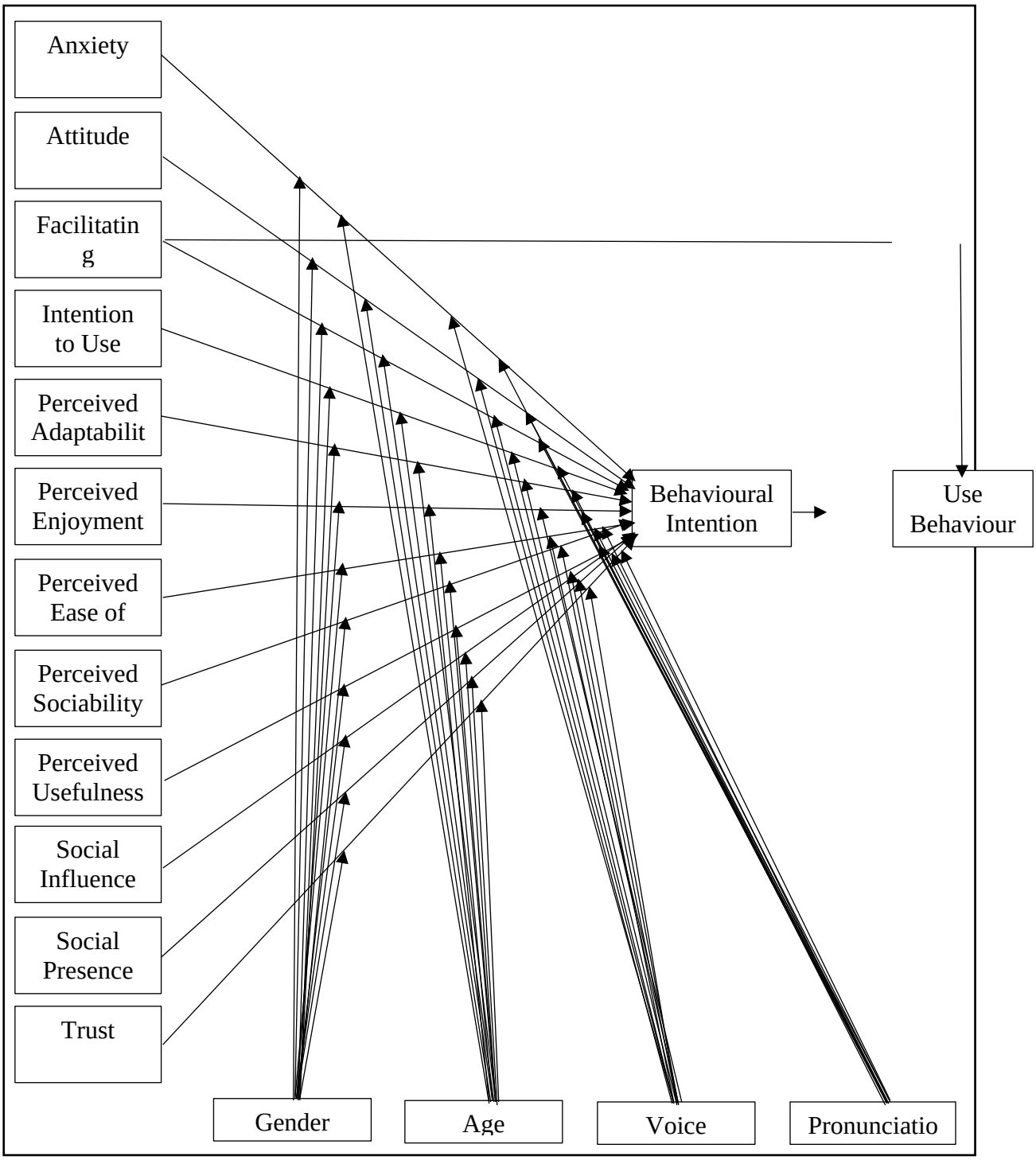

Figure 3. Hypothetical construct interrelations for the UTAUT model

The methodology has been entails analyzing various parameters impacting student interaction and Furhat's delivery performance. These parameters include facial gestures, Furhat's gender, voice type, pronunciation, and skin color. The study involves students from Sohar University, assessing their interaction with Furhat during a 15-minute lecture and collecting their

responses via questionnaires.Moreover the nalysis methods encompass the use of GraphPad Prism for One-way ANOVA and T-test analyses, aiming to compare group means and assess statistical significance. Additionally, the study incorporates the UTAUT model with 12 constructs (e.g., anxiety, attitude, perceived enjoyment, perceived usefulness) measured via a 31-item questionnaire utilizing a Likert seven-point scale.

The construct interrelations for the UTAUT model, illustrated in Figure 3, It related studies, encouraging participants to anonymously complete a questionnaire to gauge their perceptions of Furhat Robotics usage in teaching, allowing for comprehensive feedback.

5 Results, Analysis and Discussions

This section presents the findings of the proposed system using the Furhat social robot. According to the analysis of the survey used in this study, several undergraduate students generally agree that the social robot Furhat can be used as a university lecturer. Software namely GraphPad Prism was used to get the results. Here, the researchers used a Furhat social robot that can improve learning as a proof-of-concept. However, literature has shown that robot learning produces better results. Additionally, it demonstrated the robot's word recognition abilities during exercises in vocabulary, understanding, teaching, and learning. Some instructors or students, who are pursuing careers in the field of education, find robot-assisted learning to be controversial. This topic is now being investigated in many fields. Robotics and robot-assisted learning must advance because of the soon-to-be-discovered technical acceptability. The literature currently in circulation illustrates the results of the UTAUT paradigm using robot humanoids. A Furhat social robot and UTAUT model were used in this work. The statistical findings for each of the questionnaire items are summarized separately.

This session showed an overview of the statistical findings for the survey items. Items in (Table 1) differ significantly (i.e., have p-values of 0.05 or less). As can be observed, there are significant variances in 12 parameters. This is most likely caused by many participants, which indicates greater statistical validity. The subsections that follow provide more information on these items. We have experimented on four different personalities (lecturers), namely Omar, Yumi, Fernando, and Gyeong, to study whether age, gender, pronunciation, and voice affect the teaching process and the extent of their impact. When we use Furhat social

robot in teaching, we can see that the items display a substantial difference by comparing the parameters in (Table 1). The findings revealed that all four lecturers shared a very statistically significant preference for robotic teaching, with a p-value of 0.0001. This demonstrates favourable responses to the use of robots in the classroom, as well as satisfaction with regards to their high integrity and reliability, simplicity of use, and adaptability. We have done four experiments, each character (lecturer) has his experiment, and the character (lecturer) explained the content of a subject in front of a group of students from Level 3 and Level 4. In the first experiment, which was with lecturer Omar (Male), 31 years old speaking with an American accent. The results and analyses indicated that this experiment was preferred by the participants among the other experiments through what is indicated by the probability value in Tables 2 and 3. Where the items ANX, ATT, FC, PAD, PENJ, PEOU, PS, and TRUST obtained the most statically significant values among the students with a p-value of <0.01. while, In the second experiment, which was with lecturer Yumi (Female), 35 years old speaking with a British accent. The results of this experiment indicated that this experiment was the least preferred by the students among the other experiments, as indicated by the probability value in Table 5. Where only the ANX, PAD, and SP items obtained statistically significant values with a value of $p < 0.01$. In the third experiment, which was with lecturer Fernando (Male), 45 years old speaking with an American accent. The results indicate that this personality (lecturer) had a good level of acceptance, and this experiment occupied the third level among the experiments in terms of the p-value of FC, PAD, PEOU, and TRUST with less than 0.01. In the fourth experiment, which was with lecturer Gyeong (Female), 51 years old speaking with a British accent. The analyses indicate that the occurrence of this experiment was very positive, and it ranked second after the first experiment in terms of the probabilistic value of the items ANX, PAD, PENJ, PEOU, PS, and TRUST with <0.01.

5.1 First Experiment [Omar]

In this experiment, which was with lecturer Omar, 31 years old speaking with an American accent, the results and evaluation on Fig.4 indicated the highest indicators of acceptability, significance, and response among all other experiments. One of the factors demonstrating the significance of research on user education is the users' anxiety (ANX). The results outcomes indicate that the probability value is less than 0.01, which indicates the students' comfort in using robots and their systems in the classroom without worrying about them making a mistake

that would harm something. Also, participants showed that Facilitating Conditions (FC) questionnaire item that this study considers to be the most significant with a p-value of <0.01 smaller than 1% and Attitude (ATT) with a p-value of <0.01 and a Cohen's d effect size of 0.94. Through what appears in the P-value, participants demonstrated that they possess the factors that aid them and make it simpler for them to operate the robotic system and handle it. The participants demonstrated a strong considerably more favourable Perceived Adaptability (PAD) value towards robotic education, as shown by the data in Table 2, with a p value<0.01. This shows that the robot Furhat was able to communicate its feelings more successfully. With a Cohen's d-effect size of 0.94 and a p-value less than 1%, this exhibits the same trend as the PEOU item. Additionally, it is important to note that the Social Influence (SI) item is statistically significant (with a p-value of 0.04 and a Cohen's d effect size of 0.65), demonstrating that participants generally showed a more favourable impression of the effect exhibited by robotic teaching on their lives in the future. This demonstrates that the adaptive behaviour of Furhat's robot teaching could be successfully seen by users or students and that the methods put forward in this work were successful in making the robot teaching program adaptive. The other bigger items are Perceived Enjoyment (PENJ) with a p-value of less than 0.01 and a Cohen's d effect size of 0.94 and Perceived Sociability (PS) with a p-value of <0.01 and a Cohen's d effect size of 0.32.

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Table 2: A Summary of the Statistical Analysis of the Items included in the Questionnaire for Experiment 1

Item	L3 students mean	L 4 students mean	P Value two-tails	Cohen's d effect size	Number of observations
ANX	4.68	10.92	< 0.01	0.32	40
ATT	4.68	10.89	< 0.01	0.94	39
FC	4.68	10.94	< 0.01	0.84	41
ITU	3.66	8.54	0.04	0.28	32
PAD	4.68	10.94	<0.01	0.84	41
PENJ	4.67	10.89	< 0.01	0.94	39
PEOU	4.61	10.77	<0.01	0.94	39
PS	4.68	10.92	< 0.01	0.32	40
PU	3.66	8.56	0.04	0.10	33
SI	3.65	8.53	0.04	0.65	31
SP	2.92	6.83	0.03	0.12	26
TRUST	4.67	10.89	< 0.01	0.94	39

Table 3. T-test analysis of Omar

Table Analysed	Omar
Column B	Level 4 students mean (var)
vs.	vs.
Column A	Level 3 students mean (var)
Paired t-test	
P value	<0.0001
P value summary	****
Significantly different (P < 0.05)?	Yes
One- or two-tailed P value?	Two-tailed
t, df	t=24.05, df=11
Number of pairs	12
How big is the difference?	
Mean of differences (B - A)	5.698
SD of differences	0.8209
SEM of differences	0.2370
95% confidence interval	5.177 to 6.220
R squared (partial eta squared)	0.9813
How effective was the pairing?	
Correlation coefficient (r)	1.000
P value (one tailed)	<0.0001
P value summary	****
Was the pairing significantly effective?	Yes

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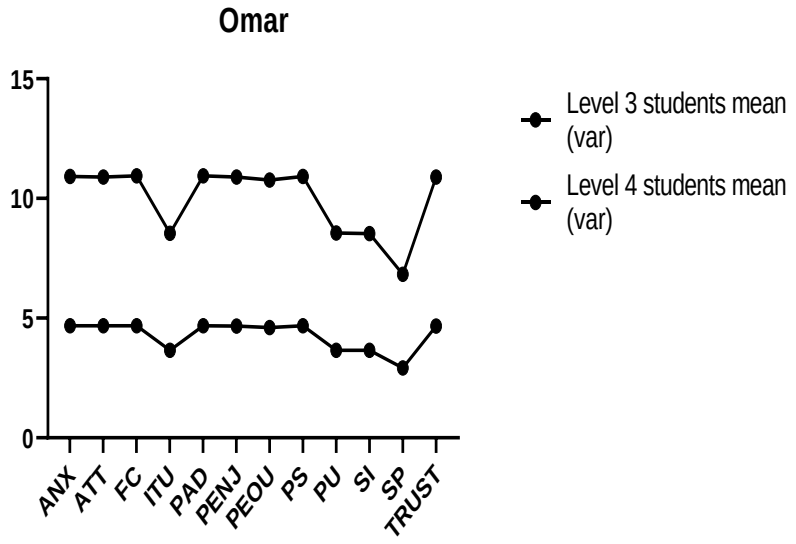

Figure 4: Items Analysis Graph of Omar

Table 4. One-way ANOVA analysis

Table Analysed	Omar				
Repeated measures ANOVA summary					
Assume sphericity?	No				
F	694.9				
P value	<0.0001				
P value summary	****				
Statistically significant (P < 0.05)?	Yes				
Geisser-Greenhouse's epsilon	0.5011				
R squared	0.9844				
Was the matching effective?					
F	3.099				
P value	0.0115				
P value summary	*				
Is there significant matching (P < 0.05)?	Yes				
R squared	0.02358				
ANOVA table	SS	DF	MS	F (DFn, DFd)	P value
Treatment (between columns)	7179	2	3590	F (1.002, 11.02) = 694.9	P<0.0001
Individual (between rows)	176.1	11	16.01	F (11, 22) = 3.099	P=0.0115
Residual (random)	113.6	22	5.165		
Total	7469	35			
Data summary					
Number of treatments (columns)	3				
Number of subjects (rows)	12				

Number of missing values	0

As a result, all the indicators and results of this experiment achieved statistically very strong significant values, as indicated in Table 3 for the t-test analysis and Table 4 for the one-way ANOVA analysis.

5.2 Second Experiment [Yumi]

Through this experiment, which was with lecturer Yumi, 35 years old speaking with a British accent, the results shown in Table 5 & Fig.4 indicate that there are only three very strong significant values that achieved a probability value <0.01 with items (ANX), (PAD), and (SP). The participants showed a significantly more positive Perceived Adaptability (PAD) and Anxiety (ANX) toward robotic teaching, with a p-value of <0.01 (Table 5).

This indicates that the robot was able to express its emotions more effectively because it was more aware of the next series of events, including which words were more difficult and which were simpler, how quickly and frequently each task should be completed, and how best to express each user's emotional response. In addition, the participants had favourable attitudes about operating and managing the robot (ATT), as indicated by a p-value of 0.05 and a Cohen's d effect size of 0.32. This suggests that making a robot learning program more user-friendly results in students having a more positive attitude toward robots used in teaching and learning. where employing robots for instruction was praised and largely accepted. Evidence shows that the participants enjoyed and considered robot teaching very interesting, which increased their effectiveness and enthusiasm during the lesson. In addition, it shows that students may benefit psychologically from robot teaching. Moreover, within (SP) result with p-value < 0.01, the participants felt that the Furhat robot is a real person because of its motions, actions, and sentiments because it has numerous personalities with real dimensions, various voices, and human-like facial expressions. Whereas (ITU) and (SI) probability value is 0.03, and (FC), (PEOU), (PS), (PU), and (TRUST) probability value is 0.04 which concluded that robotic teaching is beneficial and that it is feasible to employ robots as instructors because it lends a useful character and develops a new, developed learning environment considering innovative technology, and will therefore be a useful and effective factor in educational development.

The participants accepted the instructional robotic system to a large extent. The student participants, on the other hand, said they fully believed in robotic teaching and its

competence and capacities in the field of education, and that they would take the lessons, information, and advice given to them by the machine seriously. Due to his extensive qualifications and compliance with the standards, he enjoys strong confidence among the participants.

Table 5: A Summary of the Statistical Analysis of the Items included in the Questionnaire for Experiment 2

Item	L3 students Mean	L 4 students mean	P Value two-tails	Cohen's d effect size	Number of observations
ANX	4.86	11.34	<0.01	0.79	42
ATT	4.13	9.65	0.05	0.32	34
FC	3.37	7.84	0.04	0.25	21
ITU	2.13	4.98	0.03	0.28	12
PAD	4.68	10.92	<0.01	0.69	40
PENJ	4.05	9.45	0.05	0.29	32
PEOU	3.36	7.84	0.04	0.25	21
PS	3.36	7.84	0.04	0.25	21
PU	3.36	7.84	0.04	0.25	21
SI	2.00	4.66	0.03	0.71	11
SP	3.60	8.38	<0.01	0.42	24
TRUST	3.36	7.84	0.04	0.25	21

Table 6. T-test analysis of Yumi

Table Analysed	Yumi
Column B	Level 4 students mean (var)
vs.	vs.
Column A	Level 3 students mean (var)
Paired t-test	
P value	<0.0001
P value summary	****
Significantly different (P < 0.05)?	Yes
One- or two-tailed P value?	Two-tailed
t, df	t=14.14, df=11
Number of pairs	12
How big is the difference?	
Mean of differences (B - A)	4.693
SD of differences	1.150
SEM of differences	0.3319

95% confidence interval	3.963 to 5.424
R squared (partial eta squared)	0.9479
How effective was the pairing?	
Correlation coefficient (r)	1.000
P value (one tailed)	<0.0001
P value summary	****
Was the pairing significantly effective?	Yes

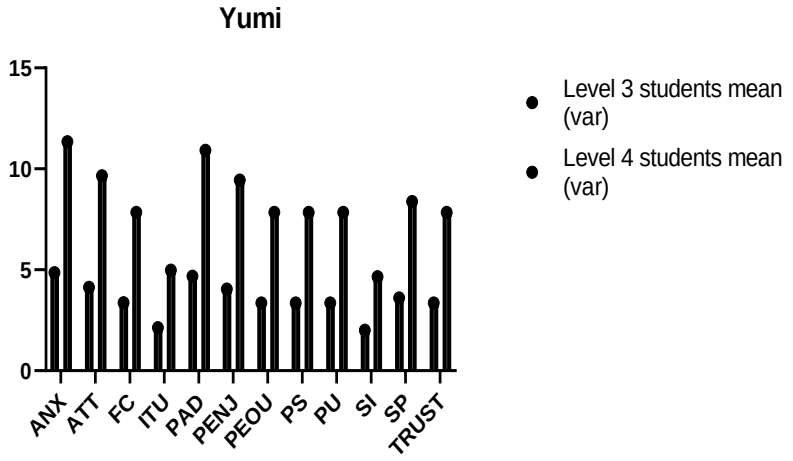

Figure 5: Items Analysis Graph of Yumi

Table 7. One-way ANOVA analysis of Yumi

Table Analysed	Yumi
Repeated measures ANOVA summary	
Assume sphericity?	No
F	61.78
P value	<0.0001
P value summary	****
Statistically significant (P < 0.05)?	Yes
Geisser-Greenhouse's epsilon	0.5009
R squared	0.8489
Was the matching effective?	
F	2.194
P value	0.0562
P value summary	ns
Is there significant matching (P < 0.05)?	No

R squared	0.1422				
ANOVA table	SS	DF	MS	F (DFn, DFd)	P value
Treatment (between columns)	3060	2	1530	F (1.002, 11.02) = 61.78	P<0.0001
Individual (between rows)	597.8	11	54.34	F (11, 22) = 2.194	P=0.0562
Residual (random)	544.9	22	24.77		
Total	4203	35			
Data summary					
Number of treatments (columns)	3				
Number of subjects (rows)	12				
Number of missing values	0				

As a result, three indicators in this experiment achieved very strong statistically significant values, and therefore it can be considered that this experiment ranked last among the other experiments in terms of preference by the students.

5.3 Third Experiment [Fernando]

In the third experiment, which was with lecturer Fernando, 45 years old speaking with an American accent. Based on the probability values and results in Fig.6, it was concluded that his experiment had significant values (Table 8). Where the items (FC), (PAD), (PEOU), and (TRUST) obtained the strongest significant values among the students with a p-value of <0.01. The participants demonstrated that using robotic teaching (FC) would be simpler for them if the robot exhibited adaptive behaviour. With a p-value of less than 1%, participants demonstrated that they possess the factors that aid them and make it simpler for them to operate the robotic system and handle it. This shows that the participants have enough expertise in robot education, which qualifies them to work with the automated system without encountering any difficulties. (Table 8) shows that the Furhat robot learns from users and words to modify its output parameters and that the more people who experience this adaptation in practice, the better the robot gets at adapting itself over time (PAD). This was demonstrated by the interactions of the robot with the participants and vice versa, as the robot was a significant and useful adaptation for the students. Which shows the students' attitude towards the robot and their adaptation to it. Show flexibility in meeting each student’s needs and determining what was challenging and simple for them. With Cohen’s d-effect size of 0.94, and the p-value less than 1%, it was noted that it

displayed a similar trend as the PEOU item. The P-value of (TRUST) in the teaching robot system, which is displayed in Table 8, indicates that the system functions with high levels of personal integrity and dependability. In addition, (ANX), (ATT), and (PU) got a common probability value which is 0.02 and (PENJ), (PS), (SI), and (SP) got a common p-value with 0.04 as shown in (Table 8). The P-value shown is a pretty good predictor of such, in that case. And this was demonstrated by the participants' excitement, satisfaction, and enthusiasm after receiving instruction from a robotic instructor. I also demonstrated a dreadful and enjoyable engagement with robotic teaching. The P-value of (PS) in performing social behaviour with people, which is predicted because it was created to be sociable, demonstrates that it performs fantastic results as a social robot like Furhat. It interacts with users in the same way that humans do with one another by talking, seeing, listening, and displaying emotion. The participating pupils discovered that the instructor robot is extremely clever, socially nice, and responsive to them.

Table 8: A Summary of the Statistical Analysis of all Items Included in the Questionnaire for Experiment 3

Item	L3 students mean	L 4 students mean	P Value two-tails	Cohen’s d effect size	Number of observations
ANX	4.02	9.40	0.02	0.43	31
ATT	3.97	9.26	0.02	0.36	30
FC	3.56	8.32	< 0.01	0.96	20
ITU	4.79	11.18	0.06	0.28	42
PAD	3.56	8.32	<0.01	0.96	20
PENJ	2.31	5.41	0.04	0.99	16
PEOU	3.59	8.39	<0.01	0.94	23
PS	3.56	8.32	0.04	0.46	20
PU	4.02	9.40	0.02	0.43	31
SI	2.31	5.41	0.04	0.99	16
SP	2.31	5.41	0.04	0.99	16
TRUST	4.15	9.69	< 0.01	0.61	35

Table 9. t-test analysis of Fernando

	Fernando

Column B	Level 4 students mean (var)
vs.	vs.
Column A	Level 3 students mean (var)
Paired t-test	
P value	<0.0001
P value summary	****
Significantly different (P < 0.05)?	Yes
One- or two-tailed P value?	Two-tailed
t, df	t=15.24, df=11
Number of pairs	12
How big is the difference?	
Mean of differences (B - A)	4.697
SD of differences	1.068
SEM of differences	0.3082
95% confidence interval	4.018 to 5.375
R squared (partial eta squared)	0.9548
How effective was the pairing?	
Correlation coefficient (r)	1.000
P value (one tailed)	<0.0001
P value summary	****
Was the pairing significantly effective?	Yes

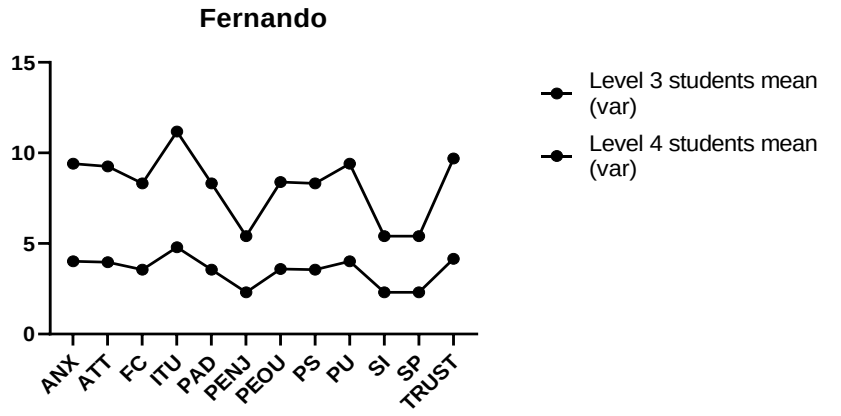

Figure 6. Items Analysis Graph of Fernando

Table 10. One-way ANOVA analysis of Fernando

Table Analysed	Fernando
Repeated measures ANOVA summary	
Assume sphericity?	No
F	82.76
P value	<0.0001

P value summary	****				
Statistically significant (P < 0.05)?	Yes				
Geisser-Greenhouse's epsilon	0.5040				
R squared	0.8827				
Was the matching effective?					
F	2.194				
P value	0.0562				
P value summary	ns				
Is there significant matching (P < 0.05)?	No				
R squared	0.1140				
ANOVA table	SS	DF	MS	F (DFn, DFd)	P value
Treatment (between columns)	3063	2	1531	F (1.008, 11.09) = 82.76	P<0.0001
Individual (between rows)	446.6	11	40.60	F (11, 22) = 2.194	P=0.0562
Residual (random)	407.1	22	18.50		
Total	3916	35			
Data summary					
Number of treatments (columns)	3				
Number of subjects (rows)	12				
Number of missing values	0				

5.4 Fourth Experiment [Gyeong]

In this fourth experiment, which was with lecturer Gyeong (Female), 51 years old speaking with a British accent. The analyses on Fig.7 indicate that the occurrence of this experiment was very positive, and it ranked second after the first experiment in terms of the probabilistic value of the items [ANX, PAD, PENJ, PEOU, PS, and TRUST] with <0.01 as shown by the data in (Table 11). So, we conclude that a social robotics education program might be modified using the technique used in this study. This is consistent with the findings, which show that an individual's sense of system understanding is improved by the robot's adaptive capability. Additionally, the robot's profound and quick adaptation to the participants may be shown in the P-value (PAD). Also, participants showed that the Social Presence (SP) questionnaire item that this study considers to be the most significant with a p-value of 0.05 smaller than 1%, that the student’s interactions with the teaching

robot felt quite natural and not at all like they were interacting with a machine manufactured by humans. This is what the statistics show and what is used to account for the (SP) item. With Cohen's d-effect size of 0.41 and the p-value <1%, it showed a similar trend as the ITU item.

Table 11: A Summary of the Statistical Analysis of all Items included in the Questionnaire for Experiment 4

Item	Level 3 students mean	Level 4 students mean	P Value two-tails	Cohen's d effect size	Number of observations
ANX	4.68	10.92	<0.01	0.24	40
ATT	4.16	9.71	0.03	0.35	36
FC	4.18	9.76	0.03	0.45	38
ITU	3.99	9.33	0.05	0.41	34
PAD	4.68	10.92	<0.01	0.24	40
PENJ	4.68	10.92	<0.01	0.24	40
PEOU	4.14	9.67	<0.01	0.40	35
PS	4.18	9.76	<0.01	0.45	38
PU	3.66	8.54	0.04	0.39	31
SI	4.14	9.67	0.03	0.40	35
SP	3.39	7.91	0.05	0.89	21
TRUST	4.68	10.92	<0.01	0.24	40

Table 12. t-test analysis of Gyeong

Table Analysed	Gyeong
Column B	Level 4 students mean (var)
vs.	vs.
Column A	Level 3 students mean (var)
Paired t-test	
P value	<0.0001
P value summary	****
Significantly different (P < 0.05)?	Yes
One- or two-tailed P value?	Two-tailed
t, df	t=35.04, df=11
Number of pairs	12
How big is the difference?	
Mean of differences (B - A)	5.623
SD of differences	0.5558
SEM of differences	0.1604
95% confidence interval	5.269 to 5.976
R squared (partial eta squared)	0.9911
How effective was the pairing?	
Correlation coefficient (r)	1.000
P value (one tailed)	<0.0001

P value summary	****
Was the pairing significantly effective?	Yes

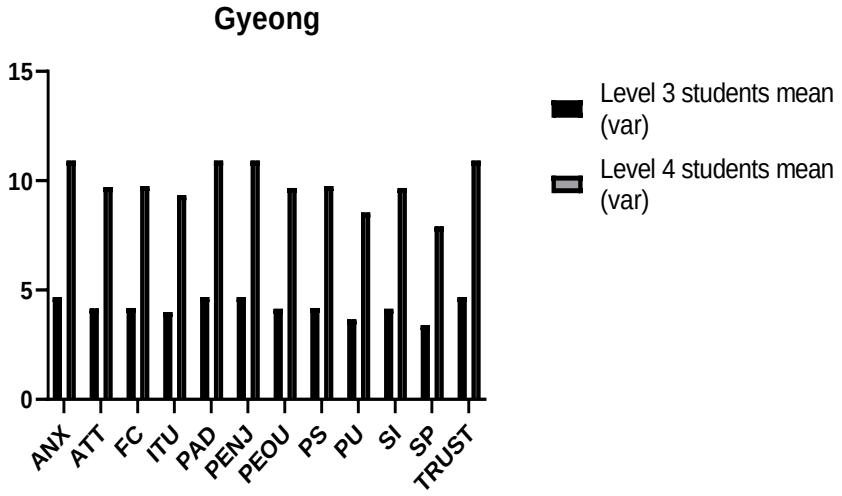

Figure 7: Items Analysis Graph of Gyeong

Table 13. One-way ANOVA analysis of Gyeong

Table Analysed	Gyeong				
Repeated measures ANOVA summary					
Assume sphericity?	No				
F	432.3				
P value	<0.0001				
P value summary	****				
Statistically significant (P < 0.05)?	Yes				
Geisser-Greenhouse's epsilon	0.5019				
R squared	0.9752				
Was the matching effective?					
F	1.946				
P value	0.0886				
P value summary	ns				
Is there significant matching (P < 0.05)?	No				
R squared	0.02358				
ANOVA table	SS	DF	MS	F (DFn, DFd)	P value
Treatment (between columns)	6753	2	3376	F (1.004, 11.04) = 432.3	P<0.0001
Individual (between rows)	167.2	11	15.20	F (11, 22) = 1.946	P=0.0886
Residual (random)	171.8	22	7.810		
Total	7092	35			
Data summary					
Number of treatments (columns)	3				
Number of subjects (rows)	12				
Number of missing values	0				

In summary, there is a significant effect of age, gender, voice, and pronunciation on students' responses to the content provided by robotic teaching using the Furhat robot.

Where the character known as Omar, a 31-year-old, male, speaking with an American accent, was given preference and utmost importance by the students, as indicated by the results of the analyses, and his attainment of 8 very strong probability values. This was followed by the character Gyeong, a 51-year-old, female, speaking with a British accent, as she obtained 6 very strong and extremely important probabilistic values, and this indicates her personal ability in teaching and the acceptance and satisfaction of students. Then, the character Fernando, a 45-year-old, male, speaking with an American accent, comes to have 4 highly significant probability values as shown in the pre-analysed data. Finally, in the last place in terms of importance is the character of Yumi, a 35-year-old, female, speaking with a British accent, who had only 3 values of high importance.

6 Conclusion

A robot that has been specially created or programmed for use in educational institutions like schools or universities is known as an educational robot. These robots can instruct students in a range of courses, which is an important step in improving student learning. Furhat robots were employed in this study. It refers to a humanoid robot that could communicate with people in a friendly and expressive manner. The robot was used to interact with 300 students from Sohar University, through interaction in a lecture explained by the robot by four characters which are Omar, Fernando, Gyeong, and Yumi. Based on how the students interacted with Omar's character and its probability value, P value, acceptability, and significance, the results of the ANOVA and T-test revealed that the personality of Omar was preferred by the students compared to the other characters. Here, the probability value was seen to be <0.01, while the p-value <0.01; and Cohen’s d-effect size was 0.94.

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