Effects of Virtual-Teacher Appearance and Student Gender on Lesson Effectiveness in Teaching About Social Issues

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Abstract: Virtual teachers (VTs) are an area of focus for the practical application of virtual agents. We focused on a VT design method for teaching adults about social issues. On the basis of prior research, we hypothesized that a robot-like VT would be perceived by students as more neutral. To verify this hypothesis, we conducted a two-factor two-level experiment. One factor was the participants' gender, and the other was the VTs' appearance. We used two types of VTs: human-like and robot-like. In the experiment, these VTs gave a lesson about a quota system for females. The participants answered a questionnaire on how much they would favor introducing a quota system after watching a lesson movie presented by a VT. We conducted a two-way ANOVA for the result of the questionnaire. As a result, female participants were more strongly affected by the robot-like VT than the human-like VT. We suggest that this needs to be considered when designing VTs that teach about social issues.

1 INTRODUCTION

In this paper, we examined virtual teachers who teach about social issues. Virtual teachers (VTs) are virtual agents that play the role of a teacher. Currently, there is a worldwide shortage of teachers (Sutcher et al., 2019). Therefore, the use of robot teachers or VTs is being considered. Robot teachers are real robots that are used for education in schools. Experiments using robot teachers are being conducted with students of all ages, from elementary school to university (Brink and Wellman, 2020)(Newton and Newton, 2019)(Huang, 2021). In this study, we focused on "adult education." Education for adults is important in promoting lifelong learning and raising awareness of social issues (Bin Mubayrik, 2020)(Loeng, 2020). It is important to educate adults as well as minors with the correct knowledge, especially regarding social issues.

We focused on "neutrality" among the characteristics that robot teachers possess. Edwards et al. showed that college students felt that robot teachers were neutral in the class (Edwards et al., 2018). The fact that a robot teacher is perceived as neutral by students is a great advantage, especially for robot teachers teaching social issues. Some social issues involve stakes among multiple groups in society. For example, consider the quota system. The quota system allocates seats in Congress and other offices on the basis of gender, human race, and religion (Schwindt-Bayer, 2009). Several European countries have introduced a quota system in parliament for females, but this is not yet the case in Japan (Gaunder, 2015). Some males believe it is not fair to adopt a quota system for females. When teaching about the quota system, it is preferable for students to feel that the teacher is neutral. We thought this was where we could use robot teachers.

VTs are virtual anthropomorphic agents who play the role of teachers. Many VTs that have been used in studies have had human-like appearances (Scassellati et al., 2018)(Matsui and Yamada, 2019). VTs are also called pedagogical agents. In this paper, we use the term "VTs" to emphasize the role played by teachers. The appearance of VTs can be configured in various ways. Prior research has shown that the appearance of a virtual agent has a significant impact

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on the user's internal state. Virtual agents can indicate their gender by their appearance. Several studies have shown that users have different impressions of virtual agents depending on the combination of the virtual agent's gender and the user's gender (Payne et al., 2013)(Guadagno et al., 2007)(Kim et al., 2007). This indicates that the gender indicated by the virtual agent's appearance affects the user's internal state. A virtual agent's appearance can also be human-like. Banakou et al. showed that embodying a white person in the virtual body (virtual agent avatar) of a black person can reduce implicit racial prejudice against blacks (Banakou et al., 2016). Virtual agent attire also affects users (Fox and Bailenson, 2009). The results of these previous studies show that the appearance of a virtual agent has a significant impact on the user. In this study, we focused on the appearance of VTs. Matsui and Yamada showed that the combination of the appearance of VTs and the subjects they teach changed the effectiveness of the classes taught by the VTs (Matsui and Yamada, 2019). Matsui showed that VTs teaching about environmental issues were more effective in the classroom if they looked more like animals (Matsui, 2021).

In this study, we used two types of VTs: human-like and robot-like. We expected the robot-like VT to have the same effect as a real robot. The reason for this effect is that "students feel that they are neutral" (Edwards et al., 2018). Robot-like virtual agents are often used instead of real robots (Bainbridge et al., 2008)(Kiesler et al., 2008)(Li, 2015). Thus, we hypothesized that a robot-like VT would feel more neutral than a human VT. We envision robot-like VTs teaching about social issues. Among social issues, we focused on the quota system. Ultimately, we hypothesized the following.

- **H1**: Robot-like VTs teaching about the quota system are more effective in spreading the adoption of the quota system than human-like VTs teaching about the quota system because they feel more fair to students.

We conducted an experiment to verify this hypothesis. We focused not only on the appearance of the VTs but also on the gender of the participants. The reason for this is that there may be differences in attitudes toward the quota system between males and females, especially the quota system for females. Thus, we hypothesized the following.

- **H2**: Female participants are more strongly affected by VTs teaching about the quota system than male participants.

We conducted the experiment with two factors: the participants' gender and VTs' appearance.

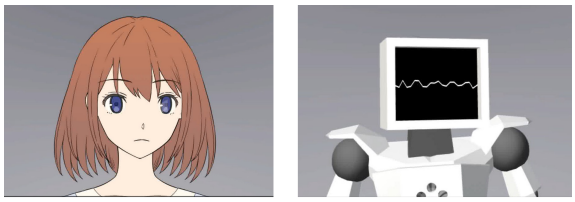

Figure 1: VTs used in experiment.

Table 1: Conditions in experiment.

Condition	Participants' gender	VT's appearance
Condition 1	female	human-like
Condition 2	female	robot-like
Condition 3	male	human-like
Condition 4	male	robot-like

2 EXPERIMENT

The experiment was conducted with two factors and two levels. The factors were the participants' gender and the VTs' appearance. The participants' gender had a female level and male level. The VTs' appearance had a human-like VT level and robot-like VT level. In the human-like VT level, the VT had a female human-like appearance. This VT was our original Live2D model. In the robot-like VT level, the VT had a mechanical robot-like appearance. This VT was a Live2D model that was released by VroidHub[1]. We chose these VTs to verify our hypotheses formulated in the introduction section. The human-like VT was a female VT because many studies have used female virtual agents. Figure 1 shows the VTs used in the experiment. Table 1 shows all conditions in the experiment.

The lesson theme in this experiment was "quota system." The quota system is a political issue that divides people according to their political beliefs. This problem has a lot to do with neutrality. Thus, this is an appropriate theme for this experiment, which seeks to test the neutrality of robot-like VTs. In this experiment, we will address a quota system for females. Table 2 shows the utterance text spoken in the lesson.

Next, we will explain the experimental flow. The experiment was conducted on the web. First, the participants watched a movie in which the VT gave a lesson. In the movie, the VT spoke the lesson text (shown in Table 2). The movie was about 2 minutes in length. Figure 2 shows a snapshot of the movie. After watching the movie, the participants answered

[1]https://hub.vroid.com/characters/7291239036418050595/models/7006001194448814569

Table 2: Speech text in invasive acid rain problem level.

Hello.
Today, I would like to explain the history
and current status of the quota system, which allocates a certain number of people to Congress
and public institutions to ensure the rights of minorities in terms of race, gender, religion, etc.
A “quota system” is a system in which a certain number of seats in Congress,
for example, are always allocated to social minorities.
It is introduced to reflect the opinions of residents with diverse attributes for the sake of a healthy democracy
and to improve the status of those considered to be of low social standing.
The first country in history to introduce a quota system was Norway.
The Norwegian Gender Equality Act of 1978 stipulates that
“when a public committee is established consisting of four or more members,
the members must be selected so that no more than 40 percent of the members are of any one gender.”
This was a revolutionary law at the time,
and it spread first to Scandinavian countries such as Denmark and Sweden and then to the rest of the world.
This is due, in particular, to the increased global awareness of the need to improve the status of females,
especially after World War II and the adoption of the Declaration
on the Elimination of Discrimination against Women by the United Nations.
A measure of the success of this effort is that
the percentage of females in the National Assembly is over 30.
Nordic countries such as Sweden, Denmark, and Norway as well as the Netherlands and Germany
exceed this standard.
In Japan, the percentage of female Diet members is about 10 percent in the House of Representatives
and 20 percent in the House of Councillors, but Japan has not yet adopted a quota system.
However, efforts to increase the percentage of females
in the Diet, as well as in corporate executive positions and university faculties, have been promoted by successive cabinets.
In April 2023, Prime Minister Kishida announced his intention
to increase the percentage of female executives at TSE prime companies to 30 percent by 2030.
On the other hand, some have expressed the opinion that the quota system discriminates against males
and that “true rights cannot be obtained while being legally singled out for special treatment.”
Another difficult issue being debated is whether this system should be expanded
in the future to include racial and religious minorities other than women.

Figure 2: Snapshot of movie used in experiment.

questionnaires. The questionnaires were constructed with three questions as follows.

- Q1: Do you favor the introduction of a quota system for female legislators?
- Q2: Would you support the introduction of a quota system for females on the boards of large corporations and in university faculties?
- Q3: Do you favor the introduction of a quota system for religious and racial minorities?

These were questions to examine the effectiveness of the lesson. The participants answered these three questions on a 7-point Likert scale (0: not at all, 7: very much). We analyzed the results of the questions with a two-way analysis of variance.

All participants were recruited via Yahoo! Crowdsourcing[2] and received 50 yen (about 46 cents) as a reward. The reliability of experiments on the web was

[2]https://crowdsourcing.yahoo.co.jp/

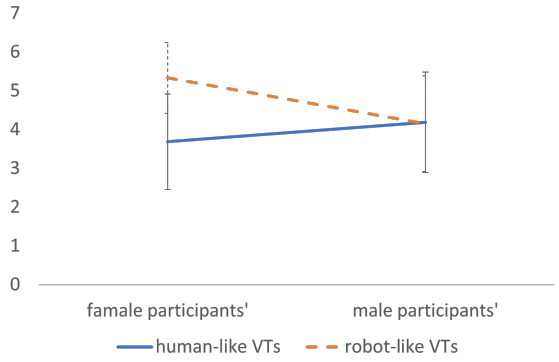

Figure 3: Averages for Q1 in each condition. Error bars mean SDs.

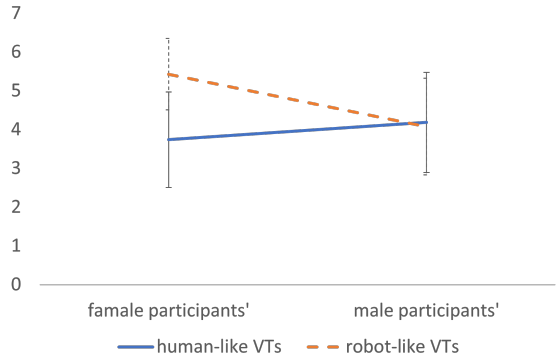

Figure 4: Averages for Q2 in each condition. Error bars mean SDs.

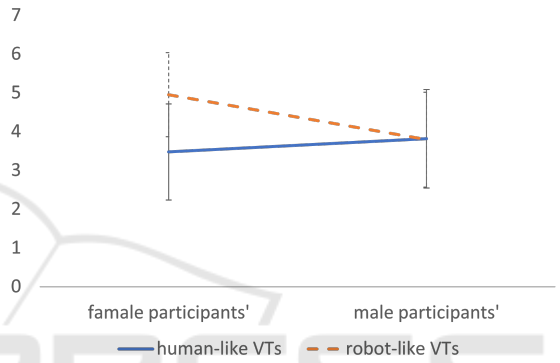

Figure 5: Averages for Q3 in each condition. Error bars mean SDs.

shown by Crump et al. (Crump et al., 2013). This experiment was conducted with the approval of the Ethics Committee at the Osaka Institute of Technology.

In condition 1 (female participants, human-like VT), there were 19 participants, ranging in age from 25 to 50 years for an average of 37.7 (SD = 7.4). In condition 2 (male participants, human-like VT), there were 54 participants, ranging in age from 19 to 50 years for an average of 42.5 (SD = 6.4). In condition 3 (female participants, robot-like VT), there were 20 participants, ranging in age from 20 to 78 years for an average of 48.7 (SD = 14.6). In condition 4 (male participants, robot-like VT), there were 81 participants, ranging in age from 28 to 66 years for an average of 46.7 (SD = 9.4).

3 RESULTS

Table 3 shows the averages and SDs for each question.

We conducted a two-way ANOVA for each question.

The top of Table 4 shows the results of the two-way ANOVA for Q1. There was a statistically significant interaction between the participants' gender $\times$ the VTs' appearance ($p < 0.01$). The bottom shows the results of a simple interaction test for the interactions between the participants' gender $\times$ the VTs' appearance. There was a significant difference for the simple main effect for the VTs' appearance when the participants' gender was the female level ($p < 0.01$). Also, there was a significant difference for the simple main effect for the participants' gender when the VTs' appearance was the robot-like VT level ($p < 0.01$). Figure 3 shows the interaction of Q1.

The top of Table 5 shows the results of the two-way ANOVA for Q2. There was a statistically significant interaction between the participants' gender $\times$ the VTs' appearance ($p < 0.01$). The bottom shows the results of a simple interaction test for the interactions between the participants' gender $\times$ the VTs' appearance. There was a significant difference for the simple main effect for the VTs' appearance when the participants' gender was the female level ($p < 0.01$). Also, there was a significant difference for the simple main effect for the participants' gender when the VTs' appearance was the robot-like VT level ($p < 0.01$). Figure 4 shows the interaction of Q2.

The top of Table 6 shows the results of the two-way ANOVA for Q3. There was a statistically significant interaction between the participants' gender $\times$ the VTs' appearance ($p < 0.01$). The bottom shows the results of a simple interaction test for the interactions between the participants' gender $\times$ the VTs' appearance. There was a significant difference for the simple main effect for the VTs' appearance when the participants' gender was the female level ($p < 0.01$). Also, there was a significant difference for the simple main effect for the participants' gender when the VTs' appearance was the robot-like VT level ($p < 0.01$). Figure 5 shows the interaction of Q3.

Table 3: Averages and SDs of scores for each question.

Condition	Q1	Q2	Q3
Condition 1	3.68 (1.52)	3.74 (1.52)	3.47 (1.53)
Condition 2	4.19 (1.68)	4.19 (1.67)	3.81 (1.61)
Condition 3	5.33 (0.84)	5.43 (0.85)	4.95 (1.17)
Condition 4	4.15 (1.53)	4.07 (1.55)	3.79 (1.50)

Table 4: Result of ANOVA for scores of Q1. There was significant main effect of interaction.

source	F	p	
participants' gender	1.43	0.23	
VTs' appearance	8.02	0.00	**
interaction	9.66	0.00	**
sub-effect test (simple main effect)			
effect	F	p	
participants' gender (human-like VT)	1.74	0.19	
participants' gender (robot-like VT)	9.72	0.00	**
VTs' appearance (female participants)	11.43	0.00	**
VTs' appearance (male participants)	0.08	0.77	

4 DISCUSSION

4.1 Hypothesis Survey

Table 4 and Figure 3 indicate that female participants were more strongly affected by the VT when the VT had a robot-like appearance than when it had a human-like appearance. For male participants, there was no significant difference between the human-like VT level and robot-like VT level. To interpret this result, we must consider the appearance of the VTs. In the human-like VT level, the VT had a female human-like appearance. This appearance seemed to make the participants feel that the VT thinks from a human female's perspective. Thus, participants may have felt the VT had biased opinions when it talked about the quota system for females. They may have thought "the VT is acting in her own best interest." This may have led to the diminishing influence of the VT. However, this effect was not observed in the male participants. This result suggests that the participants felt a bias when the VT's gender was the same as themselves. Table 4 and Figure 3 show that the robot-like VT felt fairer than the human-like VT. This result is consistent with prior research (Edwards et al., 2018).

Table 5 and Figure 4 also indicate that female participants were more strongly affected by the VT when the VT had a robot-like appearance than when it had a human-like appearance. This result was the same as Q1. The result of Q2 shows that the participants had a tendency to agree with introducing a quota system to areas other than legislators.

Table 6 and Figure 5 also indicate that female participants were more strongly affected by the VT when the VT had a robot-like appearance than when it had a human-like appearance. This result was the same as Q1. This is a remarkable result. Q3 was not directly related to "female." Thus, the bias derived from the VTs' appearance may not have affected this question. We have to wonder why there was a significant difference for this question. One possible explanation is the effect of the previous question. Participants who answered Q1 and Q2 with higher scores may have also given higher scores to Q3. In any case, the results suggest that the robot-like VT was effective in persuading the participants to adopt a quota system for minorities other than females.

4.2 Design Policy from Experimental Results

These results support our hypothesis. The results of the three questions show that the robot-like VT was effective in persuading the female participants to accept the quota system. This suggested that the female participants may have felt that the robot-like VT was neutral. The female participants seemed to think that the robot-like VT spoke without regard to its own interests. Otherwise, the female human-like VT seemed to be perceived as speaking for her own benefit. This may have led to differences in the results between conditions. However, this difference was not observed for the male participants, who seemed to think that the human-like VT was as fair as the robot-

Table 5: Result of ANOVA for scores of Q2. There was significant main effect of interaction.

source	F	p	
participants' gender	2.02	0.16	
VTs' appearance	6.79	0.01	$*$
interaction	8.66	0.00	$**$
sub-effect test (simple main effect)			
effect	F	p	
participants' gender (human-like VT)	1.10	0.30	
participants' gender (robot-like VT)	9.99	0.00	$**$
VTs' appearance (female participants)	9.97	0.00	$**$
VTs' appearance (male participants)	0.12	0.73	

Table 6: Result of ANOVA for scores of Q3. There was significant main effect of interaction.

source	F	p	
participants' gender	2.23	0.14	
VTs' appearance	6.95	0.00	$**$
interaction	7.36	0.00	$**$
sub-effect test (simple main effect)			
effect	F	p	
participants' gender (human-like VT)	0.69	0.41	
participants' gender (robot-like VT)	9.69	0.00	$**$
VTs' appearance (female participants)	9.38	0.00	$**$
VTs' appearance (male participants)	0.00	0.94	

like VT.

4.3 Limitation

The greatest weakness of this study is that it did not examine male human-like VTs. Male human-like VTs may affect only male participants. Alternatively, male human-like VTs may be perceived just like robot-like VTs because males do not benefit directly from the quota system. This is our future work.

5 CONCLUSION

In this paper, we discussed the design of VTs for teaching adults about social issues. On the basis of prior research, we hypothesized that robot-like VTs would be perceived by students as more neutral. To verify this hypothesis, we conducted a two-factor two-level experiment. One factor was the participants' gender, and the other was the VTs' appearance. We used two types of VTs: human-like and robot-like. In the experiment, these VTs gave a lesson about the quota system for females. The participants answered a questionnaire about how much they favored introducing a quota system after watching the lesson movie. We conducted a two-way ANOVA for the result of the questionnaire. As a result, female participants were more strongly affected by the VT when the VT had a robot-like appearance than when it had a human-like appearance. This result seemed to occur from a bias brought about by the VT's appearance. The female participants probably felt that the female human-like VT spoke in its own best interest and the robot-like VT spoke neutrally. This result shows that VTs' appearance has a huge impact on students when they teach about social issues. We suggest that this needs to be considered when designing VTs that teach about social issues.

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