LONG-TERM INTERACTION WITH A VIRTUAL ROBOT FACILITATOR OF SMALL GROUP DISCUSSIONS

Elinor Mizrahi, Noa Danzig and Goren Gordon[1]
Curiosity Lab, Department of Industrial Engineering, Tel-Aviv University, Israel

ABSTRACT

In this contribution, we present a follow-up work-in-progress on an innovative system for facilitating small-group online discussions using an avatar during a video conference. A previous study has shown that the system had an effective, understandable, and more participatory interaction. Here, we examine long-term usage and its effects on subjective perceptions as well as objective engagement measures. Five groups of fifth and sixth grade students had six interactions with the avatar's facilitation. The results of the study show that all measures remained stable throughout the entire interaction, suggesting that the previous results were not due to the novelty effect and that the system is capable of maintaining long-term engagement and learning.

KEYWORDS

Virtual Agent, Group Activity, Video Conference, Facilitation

1. INTRODUCTION

Prior to the COVID-19 pandemic, online learning environments for K-12 have not been a mainstream methodology. However, the pandemic has revealed the importance, as well as the advantages and drawbacks of video conferencing technologies, as well as other social educational technologies.

We report the continued evaluation of our system, that aims to facilitate small online group discussions during video conferencing (Mizrahi et al., 2021). Students interacted with the system, which consists of: (i) an avatar, a virtual agent, who manages the educational group activity as well as facilitates the online discussion; (ii) Zoom, and (iii) a screen for the educational content, which is produced on an activity site designed for that purpose.

Previously, during a single-session interaction, the system was found to be effective for discussions and engagement in group activities (Mizrahi et al., 2021). In this new report, we evaluated the long-term use of the system, along multiple dimensions, such as learning, perceptions and engagement.

In the study, five groups (two in fifth and three in sixth grade) interacted with the system, performing six different activities on socio-emotional learning. All the activities performed were with the avatar facilitation. Questionnaires regarding the perception of activity, as well as their learning of the content was administered after each activity. The system also recorded and analyzed who spoke and their facial expressions.

Our results show that the long-term use of the system does not suffer from the novelty effect, in all dimension, i.e. learning, engagement and perception of the activity remain high throughout all six activities.

This pilot study continues to support the concept of a virtual robot facilitator for long-term use in small group online discussions.

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[1] Corr. Author: goren@gorengordon.com

2. RELATED WORK

Small group learning activities have been considered as a promising education format (Johnson & Johnson, 2009). Small-group activities can enhance student thinking and learning of both formal and informal content and skills, (Elias & Schwab, 2006; Hadwin et al. 2018; Webb, 1995).

Studies have shown that personal face-to-face interactions and discussions in small groups have their advantages (Chen & Chen, 2015; Thomas & Thorpe, 2019). The question of scaling-up group facilitation is, thus, of prominent importance. In group activities, the role of group facilitator is important in teaching (Franco & Nielsen, 2018). This is because when students have a supportive environment it will foster both the understanding of the content learned, the task value, and positive beliefs about the students' abilities and thus their motivation to learn (Pietarinen et al., 2021).

The appearance of virtual visual agents, avatars, has also initiated a wider usage of conversational and social aspects of interaction. While a face of a conversational agent has been shown to increase rapport and other participant-agent-related measures (Shamekhi et al., 2018), it remains an open question of what *educational benefits* such an avatar presents. Although guiding virtual agents may have disadvantages, they have been found to have the ability to manage time better, to be more objective and efficient than a human facilitator (Rosenberg-Kima et al., 2020).

In order to have real education value, a long-term evaluation must be performed, to rule out the novelty effect. The novelty effect may cause an increase in achievements at first and then is characterized by a decrease of up to about eight weeks (Clark, 1988). In human-robot interaction, it has been found that over time there is a decrease in engagement (de Wit, 2020), but at the same time, there is no complete abandonment of the system due to the use of a system that elicits diverse interaction (Coninx et al., 2015; Davison et al., 2020)

Similarly, distance learning systems have been tested in the long term. During Covid-19, research found that there are no differences in the distance learning experience and system benefits, but the quality of learning has decreased over time (Tulaskar & Turunen, 2022). However, a study of MOOCs (massive online open courses) found that student involvement increased over time (Hsu, 2021).

This study will address the question of whether the benefits of an online learning system with video conference guided by a social virtual agent will remain effective even in long-term use.

3. METHODS

THE SYSTEM: The system is composed of a student-centered site, with which the students interact. The site includes: (a) a robotic avatar from SitePal.com (b) a frame with the Zoom web API, that enables gallery view to see all the group members and; (c) an interaction part, which shows the content and enables answering questions Mizrahi et al. (2021).

During the interaction, the students are presented with the content and after answering on their own, the avatar asks them to start a discussion. When the students are done with either question or discussion, a "done" button is presented to enable the continuation of the activity.

The system is also equipped with perceptual sensors. Using face-api.js, an on-client facial expression recognition system was activated, that enabled real-time and continuous analysis of facial expression such as happy and angry. Moreover, a volume-meter was activated client-side to detect speech of the students in real-time.

The avatar was programmed with best-practices of group facilitation behaviors. An expert group facilitator aided in formalizing the appropriate behaviors, e.g. how to give feedback and how to handle objections, which were then programmed into the avatar.

PARTICIPANTS: The study was conducted on fifth and sixth grade students, in a single elementary school. The content was taken from a curricular program on socio-emotional learning, and adapted to our system.

From fifth grade, 10 participants (3 males, 7 females) were recruited. The participants were divided into 2 groups: 1) 5 participants with 5 females, 2) 5 participants with 3 males and 2 females. From sixth grade, 11 participants (7 males and 4 females) were recruited. The participants were divided into 3 groups: 1) 4 participants with 2 males and 2 females, 2) 4 participants with 3 males and 1 female, 3) 3 participants with 2 males and 1 female.

Due to technical issues with the system, mainly due to low internet connectivity, not all participants had performed all activities. The results below, Fig.1, present the number of participants in each analysis.

All participants' parents signed a consent form. The study was approved by the IRB and the ministry of education.

MEASURES: The study was designed to have two types of measures: subjective, self-report, and objective, perceptual. After each activity, each student filled out two types of online questionnaires: the first was composed of eight 5-point Likert scale questions regarding the activity, and the second was composed of four true/false questions regarding the educational content of the activity. Furthermore, the perceptual part of the system supplied information regarding when each student spoke and a continuous stream of facial expressions (see Mizrahi et al. (2021) for more details).

4. RESULTS

Engagement: Student engagement remained high throughout the entire long-term use of the system, Fig.1(top). Both the duration of speech, as well as the amount of time participants were detected to be happy, fluctuated over the activities, but did not exhibit a monotonic decrease, as predicted by the novelty effect. A linear regression of the engagement as a function of time did not detect any significant trend (happy: $r=0.063$, $p=0.905$, speech: $r=-0.062$, $p=0.907$, Wald test with t-distribution).

Perceptions: Students' perception of the group activity, which is of paramount important in our system, remained constant throughout the long-term use of the system. We present the most relevant questions, regarding the student's perception of the group efficiency (q3) and interaction (q4), as well their perception of their own involvement in the activity (q5, q6). As presented in Fig.1(middle), there was little change in their perceptions from the first, second, fourth and last activity. A linear regression of the perception as a function of time did not detect any significant trend (q3: $r=-0.219$, $p=0.78$, q4: $r=0.866$, $p=0.134$, q5: $r=-0.682$, $p=0.318$, q6: $r=-0.283$, $p=0.717$, Wald test with t-distribution).

Learning: Student's achievements on the content assessment after each activity, also remained high throughout the long-term use of the system, Fig.1(bottom). While this depends mostly on the content of the activity, it signals that the students were attentive and learned something during the activity. A linear regression of their achievements as a function of time did not detect any significant trend ($r=-0.378$, $p=0.459$, Wald test with t-distribution).

5. DISCUSSION AND CONCLUSION

This short paper introduces a work-in-progress on the evaluation of a novel system that facilitates small group on-line discussion using video conferencing and best practices. While previous work has demonstrated the viability of the platform, for an educational system to be of any value, its long-term use must be evaluated. While distance learning during the COVID-19 pandemic has shown a decrease in effectiveness (Tulaskar & Turunen, 2022), we have shown that the use of our system has resulted in sustained engagement, positive perception and learning for a relatively long duration.

Moreover, previously the system has been used to teach curricular content, such as literature and science. We have shown in this work-in-progress that even socio-emotional learning content can be effectively delivered through our system.

The pilot study had several major limitations, most notably are the continued technical difficulties due to low internet connection of the participants, as well as the small number of participants.

Nevertheless, the pilot study results show the promise of the novel system as a long-term facilitator of more discussions and more learning in an environment that is becoming more prevalent in the formal educational system.

Future work aims to use the system as a tool to assess group dynamics, by analyzing the multi-modal data of the facilitated activities. Moreover, future developments include introducing speech recognition that will greatly enhance the effectiveness of the discussions. Finally, we aim to develop a more robust, stable and commercially viable system for the use of the formal education system.
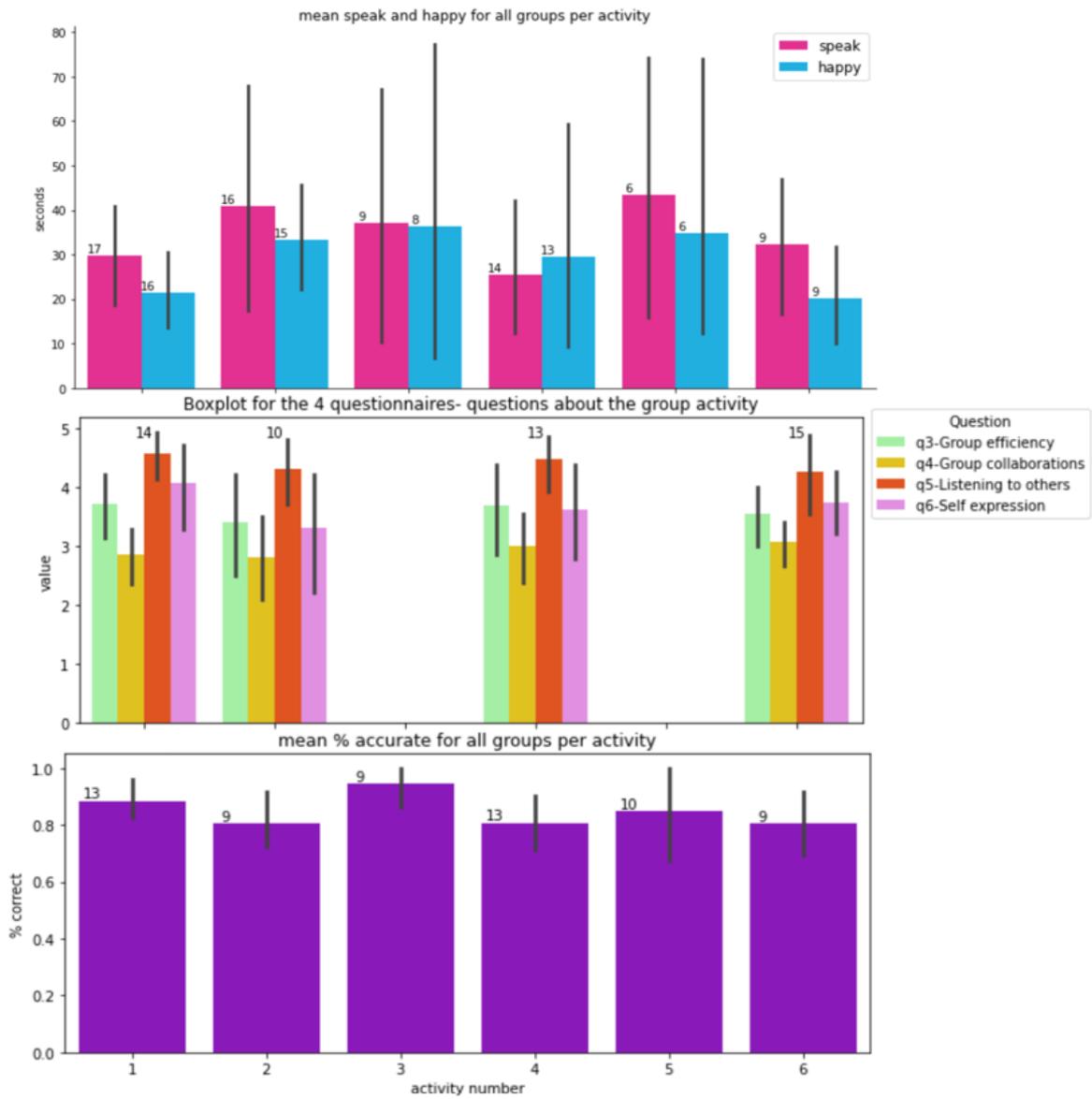
Figure 1. Average engagement (top), perceptions of group activity (middle) and learning (bottom) as a function of activity number (bars represent standard deviation). Top panel: Average duration in seconds of speech and perception of happy facial expressions. Middle panel: Average score on a 5-point Likert scale on the perception of the group activity. Bottom panel: Average score on the 4 true/false exam on the content after each activity

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REFERENCES

Chen, Y.-H., & Chen, P.-J. (2015, August). MOOC study group: Facilitation strategies, influential factors, and student perceived gains. Computers & Education, 86 , 55–70.

Clark, S. (1988). Research on instructional media, 1978-1988 *. Educational media and technology yearbook 1988.

Coninx, A., Baxter, P., Oleari, E., Bellini, S., Bierman, B., Blanson Henkemans, O., Belpaeme, T. (2015, August). Towards Long-Term Social Child-Robot Interaction: Using Multi-Activity Switching to Engage Young Users. Journal of Human-Robot Interaction, 5 (1), 32.

Davison, D. P., Wijnen, F. M., Charisi, V., van der Meij, J., Evers, V., & Reidsma, D. (2020, March). Working with a Social Robot in School: A Long-Term Real-World Unsupervised Deployment. In Proceedings of the 2020 ACM/IEEE International Conference on Human-Robot Interaction (pp. 63–72). Cambridge United Kingdom: ACM.

de Wit, J., Brandse, A., Krahmer, E., & Vogt, P. (2020, March). Varied HumanLike Gestures for Social Robots: Investigating the Effects on Children's Engagement and Language Learning. In Proceedings of the 2020 ACM/IEEE International Conference on Human-Robot Interaction (pp. 359–367). Cambridge United Kingdom: ACM.

Elias, M. J., & Schwab, Y. (2006). From compliance to responsibility: Social and emotional learning and classroom management. Handbook of classroom management: Research, practice, and contemporary issues, 309–341. (Publisher: Lawrence Erlbaum Associates Mahwah, NJ)

Franco, L. A., & Nielsen, M. F. (2018, October). Examining Group Facilitation In Situ: The Use of Formulations in Facilitation Practice. Group Decision and Negotiation, 27 (5), 735–756.

Hadwin, A., Jˇarvelˇa, S., & Miller, M. (2018). Self-regulation, co-regulation, and shared regulation in collaborative learning environments. In Handbook of selfregulation of learning and performance, 2nd ed (pp. 83–106). New York, NY, US: Routledge/Taylor & Francis Group.

Hsu, L. (2021, November). Learning tourism and hospitality subjects with massive open online courses (MOOCs): A cross-sectional and longitudinal study. Journal of Hospitality, Leisure, Sport & Tourism Education, 29, 100276.

Johnson, D. W., & Johnson, R. T. (2009, June). An Educational Psychology Success Story: Social Interdependence Theory and Cooperative Learning: Educational Researcher. (Publisher: SAGE Publications)

Mizrahi, E., Danzig, N., & Gordon, G. (2021, October). vRobotator: a Virutal Robot Facilitator of Small Group Discussions for K-12. Virutal.

Pietarinen, T., Palonen, T., & Vauras, M. (2021, June). Guidance in computersupported collaborative inquiry learning: Capturing aspects of affect and teacher support in science classrooms. International Journal of Computer-Supported Collaborative Learning, 16 (2), 261–287. (Number: 2)

Rosenberg-Kima, R. B., Koren, Y., & Gordon, G. (2020, January). Robot-Supported Collaborative Learning (RSCL): Social Robots as Teaching Assistants for Higher Education Small Group Facilitation. Frontiers in Robotics and AI, 6, 148.

Shamekhi, A., Liao, Q. V., Wang, D., Bellamy, R. K. E., & Erickson, T. (2018, April). Face Value? Exploring the Effects of Embodiment for a Group Facilitation Agent. In Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems (pp. 1–13). New York, NY, USA: Association for Computing Machinery.

Thomas, G., & Thorpe, S. (2019, January). Enhancing the facilitation of online groups in higher education: a review of the literature on face-to-face and online group-facilitation. Interactive Learning Environments, 27 (1), 62–71.

Tulaskar, R., & Turunen, M. (2022, January). What students want? Experiences, challenges, and engagement during Emergency Remote Learning amidst COVID19 crisis. Education and Information Technologies, 27 (1), 551–587.

Webb, N. M. (1995). Learning in small groups. Interaction in Cooperative Groups: The Theoretical Anatomy of Group Learning, 102. (ISBN: 052148376X Publisher: Cambridge University Press).