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INTEGRATING SOCIAL ROBOT IN A JIGSAW COOPERATIVE ACTIVITY: INSIGHTS FROM AN INTERNATIONAL WORKSHOP WITH STUDENTS FROM UNIVERSITIES IN GERMANY AND ISRAEL

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Abstract

A Jigsaw activity represents an educational approach providing students opportunities to exercise collaborative learning targeting topics from across domains and levels including those addressing innovative technologies. This paper presents our efforts targeting a Jigsaw workshop addressing educational activities enhanced by Social Robots (SR). SR includes AI-enabled features becoming accessible through software affording to develop motivating and engaging cooperative learning processes. In light of these trends, we present a Jigsaw learning activity we conducted and supported by a Social Robot (SR). We conducted the activity as part of a mutual effort exercised by the authors of this paper in the framework of an Erasmus+ project in Social Robotics involving German and Israeli higher education Institutions. We examined this activity while focusing on various aspects corresponding to its interrelated phases and the educational interactions exercised by students. Results reveal a high potential for applying Jigsaw learning activities in groups of international students. The positive effects seem to be enhanced by choosing to focus the collaboration on an innovative learning environment such as social robots, designing the activity to maximize creativity, autonomy, and ownership, and addressing authentic application contexts to enhance the quality of the educational experience.

Keywords:

Active learning, cooperative learning, collaborative learning, Jigsaw activity, group of specialists, social robot

Introduction

In recent decades, researchers and practitioners seek to implement effective, innovative, engaging, and appealing education that addresses the realistic context and settings required by students in the world of the 21st century (Dominguez et al., 2019; Papert, 1980). Nowadays, practitioners constantly aim to implement approaches combining inclusiveness and cooperation exercised by students taking responsibility for their educational process (Papert, 1980). In many cases, practitioners aspire to implement educational approaches that foster students' activeness along a process exercised by students individually as well as in groupwork (Jeng, 2019).

In this sense, cooperative learning reflects a pedagogical approach in which students actively work together in small groups toward completing a task or a problem (Aronson, 1972). Such an educational approach is well known and exercised by practitioners seeking to exploit its various advantages including its potential to foster critical thinking toward problem-solving among students (Edrogan, 2019; Johnson & Johnson, 1987). In our efforts, we combine aspects of cooperative learning with collaborative learning. Collaborative learning relies on the concept of knowledge constructed through social interactions among team members working together (Johnson & Johnson, 1987). As implied, both learning approaches have mutual aspects including the nature of the activity in a workgroup, in which students share responsibility and accountability for achieving common goals in an ongoing process in which they receive feedback and refine artifacts they are working on (Aronson, 1972; Johnson & Johnson, 2005; Slavin,2005).

The activity approach known as Jigsaw is considered to involve aspects from both mentioned approaches. There, students work in groups to develop an educational outcome. Each of them is assigned the role of specialist addressing the aspired outcome. Each student is responsible to master and contribute to the development of their unique role as a specialist (Aronson, 1972; Johnson & Johnson, 1987, Johnson & Johnson, 2005). During this activity, students may be required to consult with their peer specialists assigned to other groups. As implied, Jigsaw activities require educators to enroll students in groups as well as to assign them to the roles of specialists. Occasionally, a Jigsaw activity may require task groups to deal with challenges concerning the design of innovative ideas later developed into modern forms of technological implementations reflecting the spirit of the 21st century (Gorlewicz & Jayaram, 2020). Kohn & Chia (2018) exercised their research as they focused on the exploration enactment of a Jigsaw activity supported by innovative technologies in the forms of Social Robotics (SR) exploited for educational purposes.

The applicability of SRs in a Jigsaw activity offers students the potential to exercise learning about an emerging field that is striving to deploy technological devices that resemble and mimic human movements, gestures, and behaviors (Kurtz & Kohen-Vacs, 2022). Occasionally in these activities, the design and development of scenarios for social robots aim at enhancing the learning or training experience (Kurtz & Kohen-Vacs, 2022). There, students may benefit from all advantages of a Jigsaw activity as they practice various skills associated with SR such as design thinking as well as computational thinking. Furthermore, students exercise tasks related to technological development that are also exploitable to benefit educational strategies (Koh & Chia, 2018; Kurtz & Kohen-Vacs, 2022; Voon et al., 2022).

In this paper, we present an enactment of a Jigsaw activity conducted as part of a mutual research effort among the authors of this paper conducted in the framework of an Erasmus+ project focused on Social Robotics involving a German and an Israeli Institution. We conducted this activity as part of our mutual efforts to explore techno-pedagogical aspects concerning the affordances of social robots for enhancing learning and training scenarios. As part of our aims, we examined this activity while focusing on its various aspects including the series of steps needed for deploying the outcomes of such efforts as part of a Jigsaw activity. Hence, we emphasize an activity requiring students to coordinate their efforts and work with their peers in task groups while designing, developing, and deploying the outcomes of their efforts. Specifically, we aim to examine the design and development of SR scenarios usable for enhancing learning and training. Additionally, we include in our exploration aims other educational aspects potentially beneficial to the learning process including students' ability to take responsibility for their tasks as individuals as well as members in groups working together in a group. We also examine the socio-educational dynamics occurring during this process. Last but not least, we do so as we believe that the aspects of the activity we design reflect the realistic settings students are expected to encounter following their study period.

Workshop Planning

The activity we present in this paper was conducted as part of an Erasmus+ visit made by the Israeli delegation to the German University that took place in May 2022. The Israeli team included two instructors and six students while the German team included one instructor and six students. There were altogether three lecturers and twelve students. The Israeli students were attending a master's program on Instructional technologies while the German students studied in a bachelor program on Humanoid Robotics. We conducted our planning efforts for the mentioned activity including a design of a workshop targeting the topic of social robots for enhancing learning and training. The activity was conducted in a form of a workshop that took place at a University in Germany. There, we used the research and development facilities available on the campus. During the workshop, German and Israeli students were required to participate in practical sessions enabling them to develop a scenario enhanced by social robots.

The Jigsaw activity including its planning addressed 7 main phases conducted chronologically according to its enumeration and description presented in Table 1.

Table 1: Overview of the activity phases and their goals conducted along the workshop

Number of Phases	Name	Day Number in Workshop	Aim
1	Introduction	1	Students are divided into heterogenous groups consisting of participants from both institutions capacitated with different skills: team leaders, designers, and developers. Teams are briefed about the phases they are about to experience during the workshop
2	Discussions of ideas for the selection of the theme	1	Each group brainstorms and selects an educational theme used for designing and developing an educational scenario enhanced by SR
4	Initial design	1	Team members work together on their concepts later designed as educational scenarios enhanced by SRs
4	Brain Storm in the group of specialists	2	Team members roam to new groups of specialists for brainstorming purposes in a manner creating homogeneous groups of specialists
5	Maturing the initial design	2	Specialists roam back to their original groups and share the insight they brought from the groups of specialists as they aim to mature their designs from phase 4
6	Development	3	Groups exercise actual development of educational scenarios enhanced by SRs according to
7	Presentations and summary of activity	4	Groups present their design and development outcomes to er groups and peers

Activity Proceeding and Outcomes

The students participating in this workshop were divided into 4 groups, each group selected a different theme for the educational scenario it would pursue along its conceptualization, design, and development efforts. The teams were briefed that their efforts should aspire to achieve the level of a Proof of Concept (PoC). All groups needed to submit a detailed report to the teachers at the end of each phase of the Jigsaw activity. As groups concluded their initial briefing of the activity they selected various themes for each group and reported them to the team of lecturers for their approval.

Participants in the 1st team choose to design and develop an experience enabling students to acquire new vocabulary in the English language through singing. There, the robot was designed and programmed to lead the signing encompassed with sub-titles shown on the display attached to the chest of a Pepper[1] robot manufactured by SoftBank robotics. To encourage students, singing was designed and developed to be encompassed by the body gestures of the robot. Participants in the second team choose to design and develop an educational scenario focused on improving students' cognitive skills aimed at the population of seniors while using a Nao[2] robot that is also manufactured by Softbank robotics. There, they exploited the robot’s capability to patiently teach while repeating messages as necessary. Participants in the third group aimed on designing concepts for a

[1] https://www.softbankrobotics.com/emea/en/pepper

[2] https://www.softbankrobotics.com/emea/en/nao

robotic scenario capable to facilitate meditation. This group used various abilities of the robot including its capability to play relaxing music while providing instructions for meditation encompassed by appropriate body gestures. In this case, participants completed a concept and matured design applicable across different types of humanoid robots. Lastly, participants in the fourth group addressed a learning scenario focused on teaching students to play chess. They aimed their design and development to be enacted on a Nao robot capable to walk and imitate steps on a chess board during a game of chess. Figure 1 illustrates the work of all four groups during the workshop.

Figure 1. Illustration of work in all four groups working on scenarios with social robots (from upper-left in a clockwise direction): (1) teaching new vocabulary through singing, (2) improvement of cognitive skills, (3) meditation, (4) playing chess.

The outcomes achieved in groups 1, 2, and 4 resulted in a working Proof of Concepts (PoC) while the outcome of group 3 demonstrated a plausible design applicable across various types of humanoid robots.

Figure 2 is a picture taken during the final phase in which all group members were provided with the opportunity to present their outcomes and receive feedback on their work during the activity.

Figure 2. Captured moment from activity presenting teachers, some of the students, and the Pepper robot.

In the final phase of the activity, students shared their insights and reported that they were concerned about conducting their efforts in groups consisting of participants from another university from a foreign culture. They mentioned their appreciation for the opportunity to learn from their peers as they work on a role or task they were unfamiliar with. Additionally, students valued the opportunity to work with peers from different institutions.

Students who participated in the workshop included six members from Israel and six from Germany, 50% female, and 50% male. All of them answered a questionnaire at the end of the activity. The results revealed that 75% of respondents rated the learning experience in international groups with the highest value on the scale from "1 = not at all" to "5 = very much", and 25% gave a rating of 3 to 4. The next item in the questionnaire required students to rate the skills and attitudes they learned through participation in joint sessions in international groups on a scale from "1 = I have not been learning this at all" to "5 = I have been learning this very intensely". The skills and attitudes with the highest rank were the ones in the area of creativity and innovation, life and career skills, openness towards people from other cultures, as well as social, emotional, and communication skills in ethnically, culturally, and linguistically diverse contexts. Finally, the majority of participants expressed the opinion that the joint workshops provided them with valuable experience of collaborating in international teams and that the diversity of students contributed to creative and innovative solutions which emerged during joint sessions.

Discussion and Future Work

International students assessed the Jigsaw-based activity related to designing human-robot interaction (HRI) as a valuable learning experience, which allowed them to create and innovate together, express and experience openness towards students from different cultures, and use their communication skills in an ethnically, culturally, and linguistically diverse context. Moreover, the students felt that the experience of the Jigsaw activity in international teams was helpful for their life and career skills. As noted by Costouros (2020), cooperative learning during a Jigsaw activity allows students to take ownership of their learning as well as responsibility for teaching one another in groups of experts. This feeling of ownership is very likely to enhance the experience of autonomy, empowerment, and control. This is in line with emancipatory approaches, such as Personal Learning Environments (PLE), which emphasize the shift of control and ownership from the educator or the designer to the learner (Buchem, Tur & Hölterhof, 2013). This shift is characterized by allowing learners to take a decision and make choices concerning the content of learning, the sequence of the learning steps, and the selection of the tools (Buchem, Tur & Hölterhof, 2013). These characteristics are found in the Jigsaw activity as shown in the example presented in this paper, in which students could choose the topic for their cooperation in teams, co-define the steps of collaboration and select the tools for collaboration such as the software to design and present prototypes. The Jigsaw activity affords learner control at different levels including those related to the task and its progress. Additionally, it enables control addressing the social interaction, its included level of cooperation, and exploitation of tools based on own competencies and preferences (Buchem, Attwell & Torres, 2011). As opposed to deterministic approaches, this empowering pedagogical approach resulted in a high level of engagement and motivation of participants as observed by the teachers taking place in the activity and reported by their students. One of the key observations of the teachers during the activity was the high energy in the classroom, demonstrated by lively discussions and at the same time by a strong focus on the task at hand. As indicated by Buchem, Tur & Hölterhof (2013), control and ownership of learning may be looked at from a cross-cultural perspective and specific elements of control may be valued differently by learners from different national and academic cultures. The study presented in this paper did not explore such possible differences in detail, hence our recommendation for future research is to explore possible cross-cultural differences in assigning value to different elements of control, ownership, and autonomy in cooperative learning in intercultural student teams, using the Jigsaw activity as an example. Furthermore, our results show that the implementation of the focus of the Jigsaw activity on applying social robots for learning additionally ignited students' engagement. This may be contributed to the perception of both social robots and an activity targeted toward designing a novel solution with social robots as a possible innovation field. At the same time, the Jigsaw activity brought together students with different knowledge and backgrounds to work together on designing prototypes with social robots. These combined factors, i.e. the pedagogical approach of the Jigsaw activity, the topic of the cooperation with a focus on the application of social robots, and the diversity of students in terms of their cultural and academic backgrounds may be increased engagement and motivation for innovation. As pointed out by Osterloh & Frey (2000) intrinsic motivation for innovation may be affected by tasks that afford creativity and the transfer of tacit knowledge. These two aspects (call for creativity and knowledge transfer in teams) were applied in the example of the Jigsaw activity presented in this paper. Further studies could explore these aspects in more detail focusing on factors that may impact motivation for innovation in international student teams. Future studies could also explore other aspects affecting learning during a Jigsaw activity in more detail, such as social relatedness and connectedness among students, quality of experience of confidence, autonomy, and competency. Finally, the limitations of the study presented in this paper must be mentioned. The key limitation is the small sample size and the limited number of research instruments used in the follow-up evaluation. Future studies could include larger sample sizes and apply a more diversified set of research instruments, going beyond self-reported evaluations by study participants. Also, following the argument by Costouros (2020), another limitation is the comparability of topics, tools, and materials used in the Jigsaw activity presented in this paper. Future studies could explore how variations in topics, tools, and materials may impact the perceptions of participants in Jigsaw activities. In summary, the results of this study reveal a high potential for applying Jigsaw collaborative learning activities in groups of international students. The positive effects seem to be enhanced by choosing to focus the collaboration on innovative topics such as social robots, designing the activity to maximize creativity, autonomy, and ownership addressing authentic application contexts to enhance the quality of the educational experience.

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