Humour in Educational Robots: Investigating the Effects of Humour in a Robot-Led Scrumban Simulation in Business Education

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Abstract: Educational robots have been used as technologies to support social interactions with learners and enhance both cognitive and affective learning outcomes. While studies have shown positive impact of humour both in education and human-robot interaction, little is known about the impact of humour enacted by educational robots. This paper presents a between-subjects, randomized study, that explored the effects of humour on the perception of the robot competence and facilitation, as well as learning experience, and outcomes of 30 undergraduate students during a Scrumban simulation with the robot NAO in business education settings. The humorous version was programmed using positive humour with selected jokes and witty remarks generated by ChatGPT. The results of statistical analysis showed a range of differences in the perception of the robotic facilitator, the learning experience, and the learning outcomes in the humorous compared to the neutral condition. The results of the study provide preliminary evidence on the effects of humour in educational robots. While this study demonstrates the potential of "humoroids" and the participants favoured robot-enacted humour as a means to create a more enjoyable and relaxed learning environment, the generalisability of the results is limited by the absence of statistically significant findings.

1 INTRODUCTION

Educational robotics and robots have been used in computer-supported education since the early 1980s. Traditionally, educational robotics (ER), including programmable toys such as Bee-bots and platforms such as LEGO® Mindstorms®, have been applied in STEM education to foster mathematical, computational, and engineering skills, problem-solving and teamwork (Gubenko et al., 2021). A systematic review of studies on ER is provided by Anwar et al. (2019). Recently, there has been a shift in the application of ER, moving beyond their traditional use in STEM to actively support learning through meaningful social interactions with learners (Belpaeme, et al. 2018). Social robots like NAO can perceive, listen, and communicate in a manner reminiscent of human interactions. Social robots' educational potential lies in their physical presence, friendly appearance, and multimodal interface design, enabling human-like communication via speech, gestures, eye gaze, and touch (Belpaeme, et al. 2018; OECD, 2021; Buchem & Baecker, 2022). Social robots have been applied to support educators as instructors, tutors, or assistants who are able to engage learners in more human-like ways compared to other educational technologies (OECD, 2021). Numerous studies have indicated that social robots can effectively enhance the overall educational experience as well as cognitive and affective learning outcomes, often comparable to human instructors (Belpaeme, et al. 2018). Despite a surge in research in ER in recent years, studies examining the impact of humour in social robots on the learning experience and the achievement of learning outcomes, remain scarce.

Our study investigates how robot-enacted humour influences students' perceptions of robotic facilitation, learning experience, and outcomes. Our

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research extends our prior studies, where we employed NAO as a facilitator to support students in acquiring skills related to agile practices through playful, hands-on learning experiences (Buchem & Baecker, 2022; Buchem, Christiansen & Glißmann-Hochstein, 2023). The study presented in this paper applied NAO as a facilitator of a Scrumban session.

The research question was: *How will the use of humour by an educational robot affect students' perceptions of the robotic facilitator and robot-led facilitation, as well as students' learning experience, and learning outcomes?*

Our primary hypothesis was that the use of robot-enacted humour would result in higher ratings of the robotic facilitator's competence, the quality of the robotic facilitation and the learning experience compared to the neutral condition. Our secondary hypothesis was that the use of robot-enacted humour would result in lower ratings of learning outcomes compared to the neutral condition, which may be perceived as more serious and/or less distracting, and thus more appropriate for educational settings.

This paper is structured as follows. After this introduction, we delve into related work focusing on humour in education and human-robot interaction (HRI). Then we detail our study design and scales employed in the study. After that we present study results and end with a discussion and conclusions.

2 RELATED WORK

Humour is a human communication tool, which is often used to evoke positive reactions (Lynch, 2002). Conversational humour is a complex multifaceted construct, which includes jokes (statements with a punch-line), puns (wordplay with multiple meanings), sarcasm (sharp statements with a humorous undertone), anecdotes (humorous stories), and witticisms (clever, amusing remarks) (Dynel, 2009). Humour is related to non-verbal behaviours such as laughter (Bechade et al., 2016), and includes cognitive processes, while laughter is triggered by humorous stimuli (Mirnig et al., 2016). Research in cognitive psychology shows that comprehension and appreciation of humour require cognitive effort (Suls, 1983), and are linked to higher cognitive and emotional intelligence (Johanson et al., 2020).

Studies have shown that different types of humour may influence outcomes. Samson & Gross (2012) showed that positive (but not negative) humour is an effective form of emotion regulation. Mirnig et al. (2016) compared the use of self-irony and Schadenfreude (as an experience of satisfaction derived from the misfortune of others), as two types of robot-enacted humour and found out that participants significantly preferred robot-enacted self-irony over Schadenfreude. Gorham & Christophel (1990) showed that the amount and type of humour influence learning, such that personal and general anecdotes are related to positive attitudes towards a teacher, while tendentious (sarcastic) humour tends to diminish affect. Stoll, Jung & Fussell (2018) compared a human and a robot conflict mediators and showed that while affiliative humour (which implies equality), and aggressive humour (which implies superiority), was perceived as more appropriate for a human, self-defeating or self-deprecating humour (which implies inferiority) was rated as more appropriate for a robot, implying a favourable human-robot hierarchy. Our study applied positive type of humour (see Section 3.1).

2.1 Humour in Education

Humour is an important tool for conveying information and an excellent entry point in the classroom (Mora, Weaver & Lindo, 2015). Applying humour in education has both cognitive-affective and pedagogical effects (Musiichuk, Gnevek & Musiichuk, 2018). Humour can be used as a tool to encourage attention, creativity, and critical thinking, create a relaxed learning environment, and support social interactions among students (Mora, Weaver & Lindo, 2015). Teacher humour is associated with being amusing and making students laugh, e.g. by using funny words, actions, or reactions, while interacting with students, managing a classroom, and setting a tone for learning activities (Lovorn & Holaway, 2015). Although humour tends to improve students' perceptions of teacher's competence, intelligence, and friendliness, empirical evidence of its impact on learning remains inconclusive (Gorham & Christophel, 1990). Lovorn & Holaway (2015) showed that while teachers associate humour with educational benefits, they do not deliberately include humour, but rather rely on impromptu strategies in the classroom. The appreciation of humour combined with reluctance and discomfort in using it (Morrison, 2008), was called a "humour paradox in education" (Lovorn & Holaway, 2015).

2.2 Humour in HRI

Conversational agents equipped with humour have been called "humouroids" (Dybala et al., 2009). Research exploring the impact of humour in robots as conversational agents is still scarce (Johanson et al.,

2020). A social robot can use humour to engage or interact with students by using jokes and witty comments to evoke positive reactions and make itself more likeable and approachable (Lovorn & Holaway, 2015). Niculescu et al. (2013) explored how humour influenced the quality of interaction with a social robot receptionist and found that it improved the perception of task enjoyment and robot personality. Stoll, Jung & Fussell (2018) showed that self-defeating humour in robots in simulated conflict situations created a favourable human-robot hierarchy with the robot in an inferior position.

Research shows that making humanoid robots act emotionally, helps to make humans feel more comfortable. For example, when a robot expresses human-like emotions, such as surprise, agreement, sympathy, and approval, humans tend to nod and smile (Li et al., 2017). Omokawa et al. (2019) found that phatic dialogues of social robots, intended to support social relationships, elicit laughter and smiles from participants, compared to query dialogues aimed at conveying specific information. The study by Johanson et al. (2020) on the use of humour by a healthcare robot found that the use of humour resulted in significantly higher perceptions of the robot's likeability, safety, empathy, and sociability, and that significantly more participants laughed during an interaction with a "humouroid". Research also indicates that humour may be more effective for non-task-oriented agents, e.g. with focus on entertainment (Dybala et al., 2009).

Our study applied a social robot as a task-oriented agent, who facilitated a Scrumban session, thus leaving some uncertainty about how the use of humour may impact the learning experience.

3 STUDY DESIGN

The study design draws on our past studies with NAO applied as a facilitator of agile practices such as Daily Scrum (Buchem & Baecker, 2022) and Planning Poker (Buchem, Christiansen, & Glißmann-Hochstein, 2023). This study was designed as a Scrumban session, and was part of the agile project management course in the undergraduate program in Digital Business (BSc.). In this course, students learn agile practices, such as Scrum, Kanban, and Scrumban. The Scrumban session aimed to provide students with a hands-on experience of a daily stand-up meeting combined with the use of a Kanban board to visualise a workflow (Petricioli & Fertalj, 2022). Scrumban is a versatile and hybrid agile methodology, which allows for larger team sizes compared to Scrum (Alqudah & Razali, 2018). The Scrumban session included two roles played by students: (a) team member, and (b) agile coach. Students in the role of team members (10 students per condition) directly engaged in the daily standup meeting with a Kanban board. Students in the role of agile coaches (5 students per condition) observed the session and provided feedback to team members after the session. The team size of 10 with 5 agile coaches allowed us to create a hands-on experience for the cohort of 30 students (15 students per condition).

The study design included the preparation of didactic materials for a semi-scripted role-pay in the Scrumban session: (a) a script for team members with three daily scrum questions and answers, and (b) an observation template for agile coaches with points related to workflow improvements. These materials aimed to alleviate cognitive workload (Gittens, 2021) associated with a novel situation of a Scrumban simulation with a robot and in English (foreign language), allowing students to focus on methods and procedures of Scrumban.

3.1 Design of Robot-Enacted Humour

Drawing from research on humour in education and HRI, we designed a humorous version of the Scrumban session with NAO, incorporating two types of conversational humour: short jokes and witty remarks, following Dynel's (2009) classification. The study was conducted with business students in Germany. Considering that English was not their native language, we opted to exclude three other types of humour from Dynel's (2009) classification: puns, sarcasm, and anecdotes, as too challenging for non-native speakers.

We used ChatGPT 3.5 to generate short jokes and witty remarks for the humorous version. From the pool of 20 ChatGPT-generated responses we selected six jokes (e.g. "Ok team, let me ask you a question: Why do Scrum teams love the beach? Because they can always count on a good stand-up!") and six witty remarks (e.g. "So, team, let's channel our inner Usain Bolt and sprint through these updates. Keep your energy and remember we are running a quick sprint!"). Additionally, we used funny motivational prompts (e.g. "You go rockstar!"), which place students in a superior position, possibly creating a favourable hierarchy (Stoll, Jung & Fussell, 2018).

3.2 Application Design

The Scrumban application for NAO Power V6 Educator Pack was written in Python and designed

using Choregraphe software Version 2.8.6. The general flow used both in the neutral and the humorous versions is shown in Figure 1.

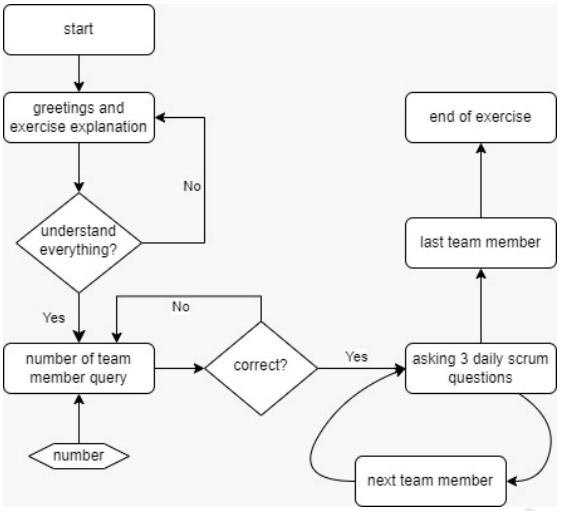

Figure 1: Flow diagram of the Scrumban application.

The interaction with the robot included verbal communication through speech and non-verbal interaction through tactile sensors positioned at the tip of each foot and on the head of the robot. We used the "Switch Case" box in Choregraphe to record the number of team members. This box is a programming module used to control the flow of the robot's behavior based on different conditions. In our application, Switch Case receives a number between 1 and 10 as a signal captured via speech recognition. The loop of the three questions of the daily scrum was implemented by combining the Counter box and the Switch Case box. The Counter box counts up a variable according to the team members and the Switch Case box controls the individual loops.

3.3 Experimental Setup

Our study aimed to investigate whether the use of humour by an education robot NAO would affect the perception of the robotic facilitator and facilitation, the learning experience, and the learning outcomes. A between-subjects, randomized design was chosen to compare possible effects. All participants signed a written consent before the study. The study was conducted at Berlin University of Applied Sciences in Germany. The study participants were 30 undergraduate students, 56.67% female (17) and 43.33% male (13). The age distribution was 10% under 20 (3), 69% 20 to 24 (20), 20.7% 25 to 29 (6), and 3.4% 30 to 34 (1) years old. 93.33% of the participants (28) had prioe experience in with NAO.

The participants were divided into two groups: (N) Neutral and (H) Humorous. Each group comprised of 10 students playing the role of team members and 5 students playing the role of agile coaches, resulting in a total of 30 study participants. Students convened with the teacher and the project team (authors of the paper) in a seminar room. The lead researcher (teacher), elucidated the purpose of the Scrumban simulation, outlined the 90-minute procedure of the session, obtained written informed consent, addressed inquiries, randomly assigned students to either the N or H condition, distributed a script to each team member, provided an observation template to each agile coach, and tasked students with preparing their Kanban cards using post-its.

After this preparation phase, the groups split into two different rooms, in which two parallel Scrumban sessions took place, each with a different NAO. Both groups were supported by two project members: (a) one operator (ensuring technical implementation on NAO), and (b) one assistant (helping participants with any issues).

In each condition, the Scrumban session was conduced following the same pattern with students assembling around the Kanban board and NAO facilitating the session. Both rooms were equipped with a Kanban board (whiteboard) with three columns: (1) To-do, (2) In Progress, and (3) Done, representing a workflow. Each student in the role of a team member answered the three daily scum questions and visualised tasks on the Kanban board using post-its. Students in the role of agile coaches observed the session. At the end, one person photographed the Kanban board and students participated in the online survey. After both sessions, all participants gathered in one room for the final part, in which mixed teams (students from the H and N groups) compared their Kanban boards and agile coaches provided guidance on improvements.

3.4 Measures

Our primary hypothesis was that the use of humour the robotic facilitator of Scrumban would result in higher ratings of the robot's competence, the quality of the robotic facilitation and the learning experience compared to the neutral condition. Our secondary hypothesis was that the use of humour by NAO would result in lower ratings of learning outcomes compared to the neutral condition, as a session without humour may be perceived as more serious and less distracting. Our hypotheses were informed by previous studies, e.g. Belpaeme, et al. (2018) who indicated that social robots can effectively enhance an educational

experience, Johanson et al. (2020) and Christoforakos et al. (2021) which showed that humor can increase perceptions of robot's competence and likeability, and Niculescu et al. (2013) who found that humor can improve task enjoyment and the perception of a robot. The effects of humour were nevertheless uncertain, considering findings from Dybala et al., (2009) and Gorham & Christophel (1990). The post survey included five scales used to measure participants' perceptions of robot-enacted humour, learning experience, learning outcomes, facilitator's competence and facilitation quality. All items were rated on a 5-point scale from 1=disagree strongly to 5=agree strongly:

- *Robot-enacted humour* was measured by two items ("NAO was humorous"; "The amount of humour was appropriate"). These items were used as a manipulation check, following the approach proposed by Johanson et al. (2020).
- *Learning experience* was measured by 22 items from the scale by Fokides et al. (2021) with 76 items. We applied the shortened version adapted to HRI by Buchem (2023) and added two new items on to peer interaction ("I enjoyed the interaction with my peers") and the atmosphere ("I enjoyed the atmosphere of the session"). Reliability was high, $\alpha = .872$.
- *Learning outcomes* were measured by two self-designed items: one about the general outcome ("The goal of the session was to provide a hands-on experience of Scrumban. How well did this session fulfil its goal?), and one about the robot ("NAO's facilitation was helpful to understand a daily meeting.").
- *Facilitator's competence* was measured by six items (competent, confident, capable, efficient, intelligent, skillful) using the scale was by Fiske et al. (1999), which was applied by Christoforakos et al. (2021) to measure perceived competence of robotic facilitators. The internal consistency was high, $\alpha = .844$.
- *Facilitation quality* was measured by three self-designed items about facilitation (interesting, motivating, entertaining). The internal consistency was good, $\alpha = .787$.

4 RESULTS

Statistical analyses were conducted with IBM SPSS v29 using the five scales described above.

Robot-enacted Humour (HU): A chi-square test showed that more participants in the H condition rated the robot as highly humorous with a 4-5 points (7/15) compared to the N condition (0/15), chi-square = 13.059, $p < 0.05$. More participants in the H condition rated the amount of humour as appropriate with a 4-5 points (8/15) compared to the N condition (0/15), chi-square = 12.952, $p < 0.05$. 17/30 students in both conditions rated the robot as fairly humorous with 3 points.

Learning Outcomes (LO): A chi-square test showed that an equal number of participants in both conditions rated the general outcome with a 4-5 points (12/15), chi-square = 1.950, $p > 0.05$. 16/30 students in both conditions rated the first outcomes with 4 points. There were no ratings of 1 (lowest). There was a slight, but not significant, difference in ratings of the second outcome. Contrary to expectations, the 4-5 point rating in the H condition (9/15) was more frequent compared to the N condition (7/15), chi-square = 2.726, $p > 0.05$. 13/30 students (N and H) rated this outcome with 4 points.

Learning Experience (LX): The comparison of mean values for 22 items of the LX scale showed that in both conditions students could equally *forget about time* (M=3.60). The H group got higher ratings for 14 out of 22 items, which were related to positive aspects such as having *fun* (M=3.13 vs. M=3.00), *atmosphere* (M=3.73 vs. M=3.53), *focus* (M=3.40 vs. M=3.33), *curiosity* (M=3.40 vs. M=2.60), *knowledge* (M=2.87 vs. M=2.80), sense of *control* (M=3.60 vs. M=3.40), *motivation* (M=3.40 vs. M=3.13), feeling *successful* (M=3.73 vs. M=3.27), *readiness to apply* what was learned (M=4.33 vs. M=3.87), *ease to learn* (M=3.67 vs. M=3.47), and negative aspects such as *complexity* (M=4.33 vs. M=3.80) and *frustration* (M=1.67 vs. M=1.53). The N group got higher ratings for 8 out of 22 items, which were related to negative aspects such as feeling *bored* (M=2.33 vs. M=2.27), and positive aspects such as *enjoyment* (M=2.40 vs. M=2.33), feeling *competent* (M=2.07 vs. M=1.60), and *peer interaction* (M=2.73 vs. M=2.53).

Facilitator's Competence (FC): The robotic facilitator was rated as more *confident* (M=4.00 vs. M=3.37), *capable* (M=3.13 vs. M=3.00), *efficient* (M=2.80 vs. M=2.40), *intelligent* (M=3.33 vs. M=3.00), *skillful* (M=3.13 vs. M=2.93) but less *competent (M=3.07 vs. M=3.40)* in the H condition.

Facilitation Quality (FQ): Facilitation in both conditions was perceived as *motivating* (M=2.87), but more *entertaining* (M=4.07 vs. M=4.00) and less *interesting* (M=3.33 vs. M=3.40) in the H condition.

Scale Scores: The comparison of mean values for scale scores revealed slightly lower ratings in the N condition for the FC scale (M = 3.07 vs. M = 3.24), and the LX scale (M = 3.03 vs. M = 3.20). The FQ

scale was slightly higher in the N condition (M = 2.73 vs. M = 2.59) (Figure 2). Independent samples T-tests yielded *no significant differences,* neither for single items nor for scale scores).

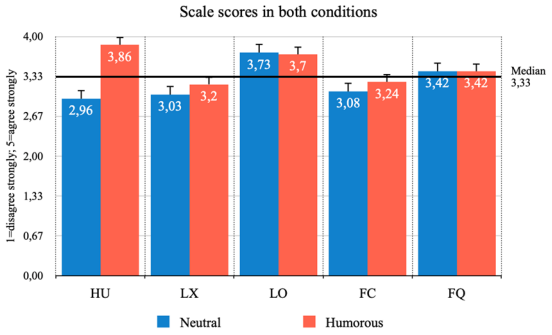

Figure 2: Ratings in the N and H conditions for aggregated scale scores. (Error bars represent the standard error).

Independent samples T-tests related to *gender differences* revealed one statistically significant result for the LX6 item "I felt frustrated" (p = 0.016). Female students rated this item significantly lower (M = 1.35, SD = .606) compared to male students (M = 1.92, SD = 1.256). Frustration was higher in the H condition (M=1.67 vs. M=1.53). The H group had more males (n=9) compared to the N group (n=4). In the H condition, 3 out of 9 males indicated high levels of frustration with a 3-5 point rating, while females chose only low ratings of 1-2. These differences were not significant. Correlation between LX6 and HU was not significant.

Qualitative results: Responses to an open-ended question seeking students' recommendations regarding the integration of robot-enacted humour, revealed that the majority of students advocated for the inclusion of robot-enacted humour, emphasising the capacity of humour to create a more enjoyable and relaxed learning atmosphere. Participants suggestions exemplify the spectrum of preferences of robot-enacted humour. Students' recommendations fall into five main categories: (1) *Balance*: create a balance between humorous and serious, learning setting. A robot should be relaxed and funny, but at the same time focused; (2) *Speed*: design quick interactions, robot's jokes should strive for brevity; (3) *Variety*: use a mix of varied conversational humour; (4) *Authenticity*: robot's humour should feel authentic; (5) *Customisation*: tailor robot's humour to educational objectives, e.g. lighthearted remarks for a relaxed atmosphere, and more extravagant remarks for grabbing the attention.

5 DISCUSSION

The research question was: *How will the use of humour by an educational robot affect students' perceptions of the robotic facilitator and robot-led facilitation, as well as students' learning experience, and learning outcomes?* Our results, specifically the absence of statistically significant differences between both conditions, indicate that the use of humour by NAO did not significantly affect students' perceptions of the learning experience (LX), learning outcomes (LO), facilitator's competence (FC) nor facilitation quality (FQ). The ratings of robot-enacted humor in both conditions indicate that more participants found the robot highly humorous in the humorous condition compared to the neutral one, highlighting the effectiveness of our humor manipulation in influencing participants' perceptions.

Results related to the Learning Experience (LX) showed that while students in the humorous condition had more fun, liked the atmosphere of the session more, felt more motivated, more curious, more focused, more successful, more in control, learned more and were more ready to apply what they learned, they also perceived the humorous sessions as more complex and they felt more frustrated. Participants in the neutral condition felt more bored but also more competent, and they enjoyed the session and the peer interaction more. High ratings of learning outcomes in both conditions indicate that students gained a good hands-on experience and a good understanding of Scrumban.

High ratings of facilitator's competence in the humorous condition for 5 out of 6 items of the FC scale indicate that the addition of humour enhanced the perception of NAO as a confident, capable, efficient, intelligent and skillful facilitator of the session. As shown by Christoforakos et al. (2021), perceived competence of a robot facilitator may be moderated by perceived anthropomorphism. Future studies could explore this moderating effects.

Our study uncovered a significant *gender difference*, with male students reporting higher levels of frustration compared to females, with slightly higher levels of frustration in the humorous condition. This discrepancy could indicate potential gender-specific implications of the humor style employed in our study. Building upon findings from Wu et al. (2016), who showed that males tend to prefer aggressive, negative humor, and females empathetic, positive humour, it is possible that positive humor applied in our study in some way moderated gender-specific frustration. However, gender differences in frustration may stem from a range of other factors,

such as technical issues in speech recognition by NAO or other factors not captured by the study. Nevertheless, it is advisable to consider gender-related humour preferences when designing robot-enacted humour in future studies.

Finally, iconic examples from the entertainment industry (including films, TV shows, and games) such as Star Wars, The Jetsons, and The Hitchhiker's Guide to the Galaxy demonstrate how humour can be incorporated in robotic characters. By drawing insights from these cultural references, researchers can explore which types of humour applied in educational robots resonate with learners.

6 CONCLUSIONS

Robot-enacted humour has been studied mainly independent of context and in isolation of social meaning (Stoll, Jung & Fussell, 2018). This study contributes to this field of research by embedding robot-enacted humour in a specific educational context. Our investigation into the impact of humour in a robot-led facilitation of a Scrumban session with undergraduate business students led us to the conclusion that even though the incorporation of humour did not yield statistically significant differences, the results suggest that humour may affect some aspects of the learning experience.

It is important to acknowledge limitations of our study, namely a small sample size, one vs. multiple sessions, the absence of baseline measurements and pre-study ratings of humour. Our results cannot be generalised, as the type and quality of the humour affects the results of the study. Further calibration and improvement of humorous elements is needed to elicit valid data on the effects of humor on learning from an external and ecological point of view. Future research would benefit from collecting ratings from learners before the study and choosing humorous elements that appeal to specific learners.

While our study provides valuable insights into a specific application of robot-enacted humour and demonstrates the feasibility and acceptability of "humoroids" in business education, further research is needed to tailor the choice of humor to different audiences and contexts. Another contribution of our study is the collection of qualitative data with recommendations for designing robot-enacted humour, which can be inform future studies.

Future studies could possibly apply mixed methods approaches with in-depth interviews to explore nuanced perceptions of robot-enacted humour, include larger samples and longitudinal designs to provide more robust insights into the potential impact of robot-enacted humour on learning, also addressing novelty effects. Research should also explore contextual factors, possible cultural and gender differences, and social dynamics in the classroom, e.g. group cohesion. Future studies could compare effects of different types of humour, and manipulate the number of humorous elements to explore how the quantity of humour may affect the difference facets of the learning experience.

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