SUPPORT OF HYBRID TEACHING BY AN AVATAR: DEVELOPMENT AND EVALUATION OF THE "FERNSTUDENT" CONCEPT

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ABSTRACT

Hybrid teaching has become a standard format in many universities. Typically, synchronous live sessions are attended either in person or remotely, with interaction from remote students often limited to textual chat. While hybrid teaching offers advantages in terms of inclusivity and sustainability, it also presents challenges to wellbeing and educational quality, including increased cognitive demands on teachers, limited integration between on-site and remote learners, and reduced interaction opportunities for the latter. Using a user-centered design approach, we developed the Fernstudent—a physical avatar that represents remote students within the classroom and enables communication through the same modalities as on-site participants. A field test of the prototype, involving teachers, on-site students, and remote students, yielded promising results. In a longitudinal study conducted over the course of one semester, the Fernstudent was compared to a standard video conferencing tool (Jitsi). It showed that the social presence of remote students was perceived higher with the Fernstudent and the interaction between teacher and remote students more similar to that with on-site students. Also, remote students' intention for active participation became comparable to that of on-site students. A broader evaluation across multiple disciplines supported the general feasibility of the concept while highlighting the need for adaptation to specific disciplinary requirements (e.g., alternate camera angles for showcasing artefacts). Limitations of the current prototype, directions for further development, and broader implications for hybrid teaching are discussed.

KEYWORDS

Hybrid Teaching, Social Interaction, Cognitive Load, Teachers, Students, Fernstudent

1. INTRODUCTION

Hybrid teaching has become an established format in many universities, offering benefits such as increased inclusion and improved sustainability. Students who are unable to attend campus due to illness or personal constraints can still participate in lectures, and the need for unnecessary travel is reduced (e.g., Johannessen et al., 2023; Klunder, 2022). However, from the perspective of educational quality and user experience, the outcomes of hybrid teaching are mixed (Huizinga et al., 2022; Gamage, 2023; Lorenzo-Lledó et al., 2021). The research literature highlights a range of challenges, including increased cognitive demands for teachers, lower levels of motivation and participation among remote students, and a lack of social integration between remote and on-site learners.

While remote teaching became the norm during the COVID-19 pandemic, the current situation prompts a reconsideration of its role in post-pandemic education. As on-site teaching is possible again, the question emerges of whether hybrid teaching should continue, under what conditions it is most effective, and how the strengths of digital and in-person learning can be successfully integrated. As with all educational technologies—including blended learning—the mere availability of technical solutions does not guarantee pedagogical effectiveness (Henderson et al., 2017). Instead, meaningful design requires a nuanced understanding of how educators and students engage with digital tools in practice.

In order to address these issues, we developed the concept of the Fernstudent: a physical avatar placed in the classroom to represent remote students. This system aims to enhance presence and interaction for remote learners, reduce the cognitive load on teachers, and facilitate more natural communication between all participants. In the following sections, we describe the design and rationale behind the Fernstudent, report on pilot implementations across multiple university lectures, and reflect on feedback from teachers, on-site students, and remote students. We conclude with implications for future development and research.

2. RELATED WORK

2.1 Hybrid Teaching

Hybrid teaching typically refers to a synchronous teaching format in which students attend a live session either on-site or remotely via an online platform such as Zoom or Jitsi. While the terminology is not used consistently, most definitions emphasize the combination of face-to-face and digital instruction within the same session, allowing remote students to interact via textual or voice chat (e.g., Singh et al., 2021; Wu et al., 2021).

One of the most widely acknowledged benefits of hybrid teaching is its inclusive character: individuals unable to be physically present due to illness, travel, or caregiving obligations are still able to participate (e.g., Johannessen et al., 2023; Klunder et al., 2022; Newhart et al., 2016). Once such options are available, they may be used more broadly, potentially resulting in a 50:50 distribution of on-site and remote students—or even a predominance of remote attendance. Although initially introduced out of necessity during the pandemic, hybrid teaching has since become a valued element of higher education for its flexibility and adaptability. Similar trends are visible in other domains such as business, adult education, and recreational training. As hybrid formats increasingly signal an inclusive and modern digital society, it is crucial to

examine both their benefits and limitations to ensure that participation and engagement are truly equitable.

Nonetheless, the literature highlights numerous challenges, particularly on the part of remote students. These include decreased motivation, feelings of isolation, limited interaction with teachers and peers, and lower engagement in active learning, critical thinking, and discussion (Lorenzo-Lledó et al., 2021; Gamage et al., 2023). Remote students are more likely to multitask during class and participate passively, while teachers often focus their attention on the physically present group—especially when remote input is infrequent (Huizinga et al., 2022). Effective hybrid teaching requires teachers to develop new pedagogical and technical skills. These include managing technological tools and adapting teaching styles to overcome limited non-verbal communication with remote students. As a result, it becomes harder for teachers to assess comprehension, provide real-time feedback, or maintain attention across modalities (Huizinga et al., 2022; Gamage et al., 2023).

Another key challenge is the divided audience: two student groups with different contexts and affordances attending the same lecture. Even with equal intentions, teachers tend to prioritize the larger or more visible group (Huizinga et al., 2022), and the envisioned "blending" of physical and digital classrooms often fails. As known from other hybrid settings, remote participants frequently feel excluded from spontaneous in-room discussions and struggle to find the right timing or medium to contribute (Ma et al., 2023). This fragmentation not only impairs student well-being but also hinders cohesive learning communities. It contradicts theoretical frameworks of student engagement (Fredricks et al., 2004), exploratory learning (de Freitas & Neumann, 2009), and transactional distance (Moore, 1993; Gallon et al., 2019). A key task in designing educational technology for hybrid teaching is therefore to bridge this psychological divide and create remote learning experiences that are physically distant but socially and cognitively close (Boye & Ayet, 2021).

2.2 Technology for Remote Presence in Educational Settings

Drawing from the concept of telepresence robots (TPRs), one promising approach to enhancing the social presence of remote students is the use of a physical avatar within the classroom. Through its tangible presence, such an avatar may serve as a visible and persistent representation of remote participants. Equipped with a camera, microphone, and speaker, it allows remote students not only to observe and listen to classroom interactions but also to be seen and heard themselves.

Typically, TPRs serve as one-to-one representations of remote individuals, displaying their faces on a screen and enabling them to control the camera angle to direct their view of the physical environment (see e.g., https://telepresencerobots.com). TPRs have been applied in a variety of educational contexts—including higher education and medical training—with generally promising results (e.g., Kwon 2010; Velinov et al. 2021; Virkus et al. 2023). A systematic review of 28 studies supports the potential of TPRs to enhance socialization, integration, and collaboration between remote and on-site learners (Velinov et al., 2021). For example, TPRs have proven particularly valuable in supporting homebound students. For instance, they enabled children recovering from illness to maintain social ties with classmates and reduce feelings of isolation. The anthropomorphic appearance of the robots encouraged their peers to perceive them as classmates, fostering curiosity and conversation about their return (Newhart et al., 2016).

Despite these advantages, broad implementation of TPRs remains limited, often due to technical constraints such as poor audio quality (Velinov et al., 2021; Virkus et al., 2023). In response, more exploratory design concepts have emerged to address specific challenges of hybrid formats. For example, Grønbæk et al. (2021) and Ma et al. (2023) propose systems with memory functions or visual indicators that reflect the level of participation by remote users—highlighting disengagement through subtle cues like blinking lights.

Research in human–robot interaction further emphasizes that anthropomorphic design features lead to more natural, human-like interaction compared to non-anthropomorphic devices (Airenti, 2015; Araujo, 2018; Damiano & Dumouchel, 2018; Klopfenstein et al., 2017). Placing such a physical representation among the on-site students can thus promote a greater sense of shared space and group unity. Instead of a disembodied voice emanating from a loudspeaker, the voice of the remote student would originate from within the group—bridging the perceptual divide between remote and on-site participants. This immersive integration has the potential to normalize the presence of remote students, making them appear as equally involved participants and enhancing their visibility, audibility, and perceived legitimacy within the classroom.

3. THE EVOLUTION OF THE FERNSTUDENT: CONCEPT DEVELOPMENT AND DESIGN RATIONALES

The Fernstudent concept was developed following the principles of user-centered design, incorporating a detailed context analysis and interviews with key stakeholders, specifically students and teachers.

To gain insights into previous experiences with hybrid teaching, we conducted in-depth interviews with two university teachers: "Peggy" (P), a 31-year-old psychologist, and "Tom" (T), a 44-year-old media informatics lecturer (pseudonyms). To include student perspectives, we also analyzed interview data from 57 students collected during a practical seminar on Experience Design in the Media Informatics curriculum at our university. A comprehensive overview of the context analysis is presented in Ullrich et al. (2023).

Across these data sources, recurring challenges associated with hybrid teaching were identified:
- One-directional communication and lack of social interaction
- Cognitive overload for teachers and divided attention between groups
- Fragmentation of the audience, resulting in two socially disconnected student groups
- Difficulties in moderating discussions and diminished engagement from remote participants
- Hybrid formats perceived as suboptimal compromises that fail to leverage the potential of live sessions

In terms of desired improvements, the following needs were repeatedly emphasized:
- Equal representation of on-site and remote students (in terms of visibility, interaction, and presence in the room)
- Decoupling of remote student input from the teacher's screen to foster welcome, rather than disruptive, engagement
- Dedicated loudspeakers for remote student voices and cameras capturing the physical classroom audience

To address these requirements—and the broader issues identified in the literature—we conceptualized the Fernstudent: a physical avatar placed within the classroom that would represent remote students more prominently than conventional solutions such as a laptop on the teacher's desk. A schematic representation of this concept is shown in Figure 1.
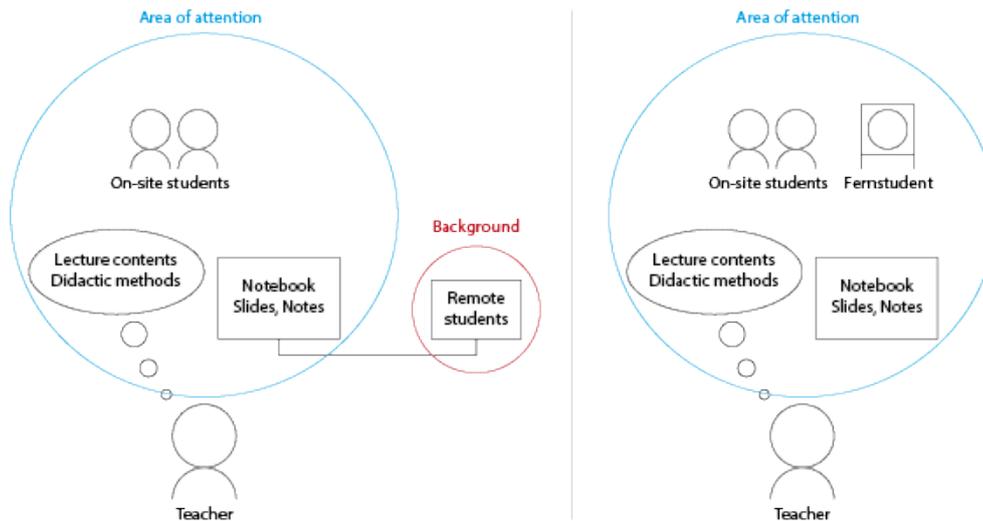

Figure 1. Situation in current hybrid teaching (left) and situation with an avatar sitting the classroom which represents the remote students at home in a more prominent way (right)

Picking up the German term for a student enrolled at a remote university (Fernstudent), we coined the term to describe our concept of a classroom-based avatar representing remote students. In contrast to conventional telepresence robots, the Fernstudent is specifically adapted to the context of university lectures. Rather than providing a one-to-one representation, all remote students are embodied by a single physical entity placed at a fixed location among the on-site audience. This design choice offers a more practical and cost-effective solution than deploying multiple mobile devices, particularly in standard academic environments.

The Fernstudent facilitates bidirectional communication: audio and video from the lecture hall are streamed to remote participants, while incoming signals from remote students are transmitted into the physical classroom. Remote participants can indicate their intent to speak using visual or mechanical signals (e.g., motorized gestures, light indicators), and the total number of remote attendees is displayed in real time via an LED matrix (with one light dot representing each student).

This configuration addresses key challenges identified in the literature and user research. By consolidating remote presence into a single physical and communicative focal point, the Fernstudent reduces cognitive load for teachers and simplifies attention management. Signals from remote students occur within the same physical and sensory space as those from the on-site audience, allowing the teacher to focus more effectively on content delivery and interaction quality. Furthermore, the Fernstudent enhances the social presence of remote students through anthropomorphic design features and aligns the two student groups more equitably in terms of visibility, modality, and opportunities for interaction.

To evaluate the concept under real-world conditions, several prototypes were constructed, exploring variations in form, size, and technical configuration. Figure 2 shows the basic set-up of hardware components and related functionalities, Figure 3 shows design variants developed by media informatics students in context of a seminar. For example, a basic feature is that the number of remote students joining the lecture is displayed in real time, as realized by an LED matrix where one dot represents one student.
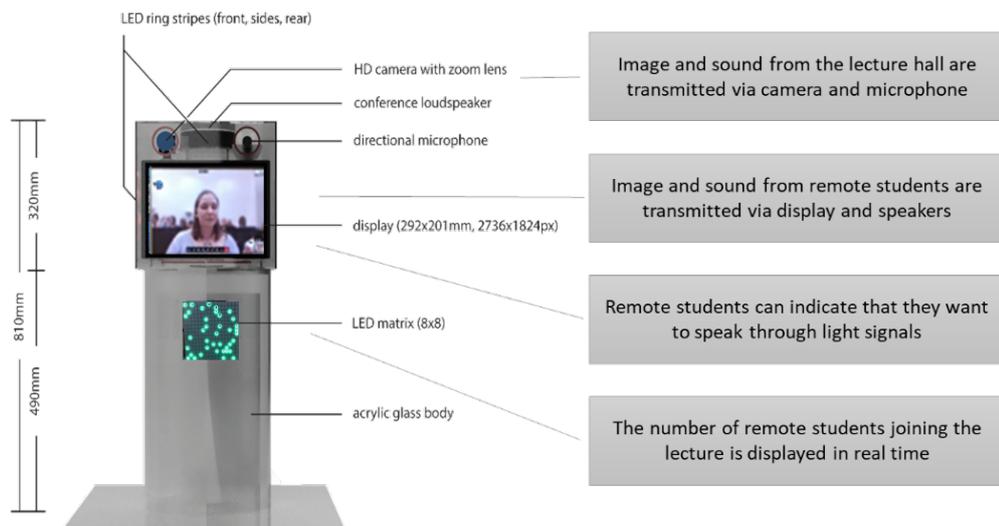

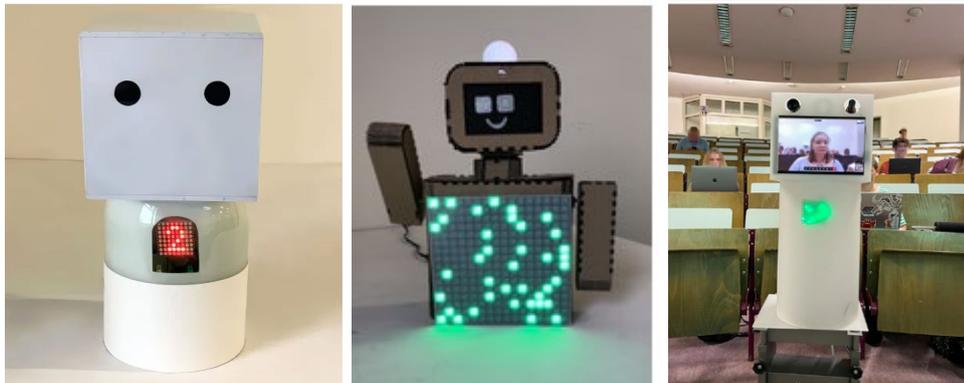Figure 2. Set-up of hardware components and related functionalities

Figure 3. Design variants (bottom) of the Fernstudent

4. EXPERIENCES IN PILOT APPLICATIONS

Following the development of the Fernstudent concept and the construction of initial prototypes, we conducted a series of pilot applications to evaluate its suitability in authentic teaching contexts. Figure 4 shows the functional prototypes used during field tests. Thereby, we combined different studies and perspectives. Specifically, we report (1) a longitudinal field study of the Fernstudent implemented across two university courses over the duration of one semester (Section 4.1), and (2) an interdisciplinary evaluation involving one-time Fernstudent sessions in four different academic disciplines (Section 4.2). The studies were approved by the institutional review board of the faculty for mathematics, computer science and statistics and performed in accordance with the APA (American Psychological Association) ethical guidelines for research with human subjects. Informed consent was collected from all participants. Statistical analyses were performed by IBM SPSS statistics version 29. Interview data and open questions were analyzed by qualitative content analysis.

4.1 Longitudinal Field Test

In the longitudinal field test, the Fernstudent prototype was implemented in multiple sessions of two university lectures over the course of one semester. A combination of quantitative and qualitative evaluation methods was used to assess its impact:
-   Post-session surveys completed by both on-site and remote students following each Fernstudent lecture (N = 94)
-   Post-session surveys completed by the two teachers after each Fernstudent lecture
-   A baseline survey capturing student experiences in conventional hybrid sessions using the standard videoconferencing tool Jitsi (N = 151)
-   Baseline surveys from the same two teachers after each Jitsi lecture
-   Retrospective in-depth interviews with the two teachers reflecting on both Jitsi and Fernstudent sessions, conducted at the end of the semester

Students were free to decide whether they wanted to join the lecture on-site or remote. In both types of sessions (Fernstudent, Jitsi), the ratio of remote students was about double the ratio of on-site students (Fernstudent: 36% on-site; Jitsi: 32% on-site). Detailed study procedures and single findings have already been published in Ullrich et al. (2023). In the following sections, we summarize insights from the different data sources from the perspectives of teachers, on-site students, and remote students, followed by an overarching discussion.

Figure 4. The Fernstudent during the field test

4.1.1 The Teachers' Perspective

Teachers who used the Fernstudent prototype reported two major benefits: (1) a reduced cognitive load due to simplified interaction management, and (2) a stronger sense of connection to remote students. Compared to regular hybrid sessions using Jitsi, teachers acknowledged that they often paid little attention to the remote interface and struggled to include remote participants effectively. In contrast, the physical presence of the Fernstudent created a shared point of attention that felt more natural and less cognitively demanding.

As one teacher summarized, "The remote students are just as present as the others and can attract attention independently. The signals are so salient that you notice them automatically. No more stress of toggling between chat windows and presentation views—it's a very relaxed situation" [T]. This reduction in technological distraction allowed teachers to refocus on content delivery and classroom interaction, enhancing their sense of teaching competence. "Finally, you can offer good hybrid teaching. Everyone expects it to work—and now it actually does" [P].

Overall, teachers perceived the two student groups as more integrated, and described interaction with remote students as more natural and satisfying. Nevertheless, they also noted that further refinements would be needed to achieve complete parity between remote and on-site participation.

4.1.2 The On-Site Students' Perspective

For on-site students, the primary impact of the Fernstudent was the increased awareness of remote participants. In contrast to standard Jitsi sessions, where no visible indication of remote attendance was present, the avatar served as a constant physical reminder of their participation. As a result, on-site students perceived the interaction between the teacher and remote students to be more comparable to that with on-site students in the Fernstudent setting than during Jitsi-based sessions.

However, when it came to their own participation, the presence of the avatar did not significantly alter behavior. Rates of active engagement (e.g., hand-raising) remained similar across both formats. Most students described the Fernstudent as a neutral addition to the classroom environment. Typical comments included, "Quite neutral" or "You get used to it quickly—it becomes part of the usual setting." Some students viewed its presence positively, referring to it as "an agreeable presence," or showed curiosity toward its features, such as the glowing signal indicating a remote student wished to speak. Others expressed a desire for more dynamic features: "A bit disappointing. It didn't do much. I would have liked more interaction with the prototype."

When asked to describe the Fernstudent using three adjectives, most students chose descriptive terms related to appearance (e.g., large, angular), materiality (e.g., rough, crafted, unfinished), or practicality (e.g., simple, easy). A smaller number of responses attributed character-like traits (e.g., cute, harmless). In summary, the avatar was primarily perceived as a neutral or pragmatic component of the classroom. Figure 5 visualizes students' descriptions in form of a word cloud (created with tagcrowd.com).
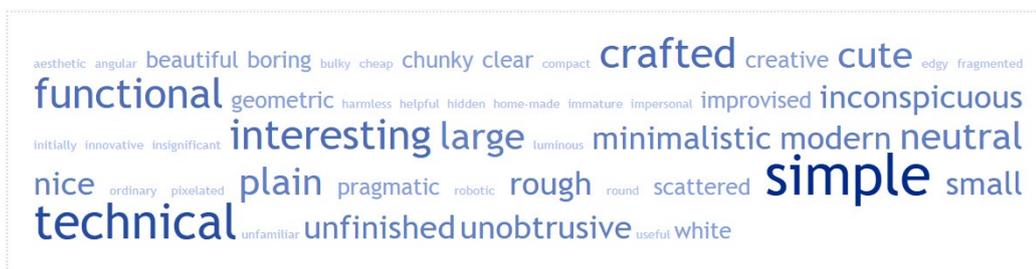

Figure 5. Student's characterization of Fernstudent by adjectives
Note: Text size visualizes frequency of mentions. Word cloud created with tagcrowd.com

4.1.3 The Remote Students' Perspective

From the perspective of remote students, the Fernstudent primarily enhanced three aspects: their perceived presence in the classroom, their opportunities for active participation, and the modalities of interaction. Compared to traditional hybrid sessions using Jitsi, the ability to contribute verbally—being heard by on-site peers, fellow remote participants, and teachers—was perceived as a key improvement. This alignment in communication modality made participation feel more natural and encouraged engagement in class discussions. Indeed, remote students in Fernstudent sessions felt a stronger intention to participate actively (e.g., hand-raising), reaching participation levels comparable to those of on-site students. While causal conclusions cannot be drawn, the combined evidence suggests the emergence of a

positive feedback loop. Enhanced visibility through the avatar increased students' perceived recognition and presence, which in turn encouraged greater attentiveness and engagement.

Specific features of the Fernstudent supported this dynamic. The LED panel, which displayed hand-raising signals at the teacher's eye level, reduced the risk of remote contributions being overlooked. Moreover, the video feed of remote students enabled teachers to receive real-time non-verbal feedback (e.g., head nodding, expressions of confusion), facilitating better adaptation of the lecture to students' needs.

Importantly, increased visibility also placed greater expectations on remote students. Interviews conducted during the context analysis phase revealed that camera-off participation often led to distraction: "If no one notices what I'm doing, I might as well do something else." In contrast, the visual presence afforded by the Fernstudent appeared to reduce such tendencies. As students paid more attention, they reported feeling more involved and more motivated to participate. However, although the Fernstudent made remote students more present in the physical classroom, this increased presence was not reciprocated in their own visual experience. On their screen, they only saw lecture slides and a small video feed of the teacher—lacking the sense of being situated within the classroom environment. Thus, their mental model remained one of "watching from home" rather than "being in the room." This asymmetry highlights a critical area for further development: enhancing the remote students' view to more fully reflect their own integration into the live classroom setting.

4.2 Interdisciplinary Evaluation

In addition to the longitudinal field study, the *Fernstudent* was evaluated in single-session applications across four academic disciplines: history and art studies, veterinary medicine, primary school pedagogy, and educational psychology (for detailed procedures and full results, see Eska, 2024). In all cases, both teachers and students had previous experience with conventional hybrid teaching, providing a relevant basis for comparison.

Participation in the *Fernstudent* sessions was voluntary, with students choosing whether to attend on-site or remotely. Across the four disciplines, the total sample included 81 on-site students and 43 remote students. Data collection involved two types of surveys:
- A Fernstudent survey completed by on-site students, remote students, and teachers, capturing their experience of the session. This included standardized rating scales and open-ended questions, as well as targeted items on perceived social interaction (e.g., remote students' ratings of their perceived social connectedness with on-site peers).
- A baseline survey, capturing corresponding experiences during conventional hybrid teaching sessions using standard videoconferencing software (e.g., Jitsi or Zoom).

In the following sections, we present the results of statistical analyses comparing students' evaluations of *Fernstudent* sessions and regular hybrid formats. Unless otherwise stated, all scales were measured on a seven-point Likert scale (1 = do not agree at all, 7 = fully agree). For teachers (n = 4), we report only descriptive data due to the limited sample size.

4.2.1 Remote Students' Perspective

A central aim of the Fernstudent concept was to promote a stronger sense of unity between remote and on-site students. To assess this, remote students rated their perceived social connectedness to on-site students using five items adapted from the established Social Connectedness Scale (Lee & Robbins, 1995). Example items include "I feel isolated from the

people in the lecture on-site" (reverse scored) and "I don't feel noticed during the lecture." Internal consistency was high (Cronbach's α = .89 for Fernstudent sessions, α = .94 for regular hybrid sessions). Evaluation results revealed significantly higher social connectedness in Fernstudent sessions (M = 4.15, SD = 1.66) compared to regular hybrid sessions (M = 3.55, SD = 1.77), $t(42)$ = –2.01, p = .03 (see Figure 6, left).

In addition, perceived usefulness of the Fernstudent was evaluated using four items based on the Technology Acceptance Model (Davis et al., 1989). Sample items included "I find the Fernstudent/the regular hybrid teaching software easy to use" and "I would like to use the Fernstudent/the regular hybrid teaching software more often." Reliability was again high (α = .91 for Fernstudent sessions, α = .84 for regular sessions). Results indicated that usefulness ratings for the Fernstudent were significantly higher (M = 5.56, SD = 1.35) than for the regular hybrid solution (M = 4.80, SD = 1.75), $t(42)$ = 2.40, p = .01.

In total, 30 out of 43 remote students (70%) reported that they would prefer to use the Fernstudent more frequently in future hybrid sessions. Among those who were less favorable, audio-related issues were the most commonly cited concern. Positive comments highlighted lowered communication barriers, improved responsiveness to remote contributions, and increased motivation to participate. For example:

- "Communication and interaction become easier. Questions from online participants are more likely to be noticed, and you also hear what is asked in the lecture hall." (P 32)
- "The Fernstudent makes it easier to pose questions." (P 33)
- "Compared to a regular hybrid session, remote students get a fair chance to raise their hands and be noticed." (P 79)

4.2.2 On-Site Students' Perspective

A key question in the evaluation of on-site students was how well the Fernstudent prototype was perceived to be integrated into the lecture, and whether it was seen as distracting or irritating. This was assessed using four items, including "The Fernstudent/online meeting was well integrated into the lecture" and "The Fernstudent/online meeting was irritating" (reverse scored). Internal consistency was high (Cronbach's α = .89 for Fernstudent sessions, α = .94 for regular hybrid sessions). Results showed that both types of technology were perceived as well integrated. However, ratings were significantly higher for Fernstudent sessions (M = 5.78, SD = 1.08) compared to conventional hybrid teaching formats (M = 5.07, SD = 1.43), $t(80)$ = –3.85, p < .001 (see Figure 6, right).

Overall, 59 out of 81 on-site students (73%) indicated that they would like to see the Fernstudent used more frequently. Among the remaining 22 students (27%) who did not express a preference for continued use, the most commonly reported reason was the perceived lack of added value compared to regular hybrid teaching tools.
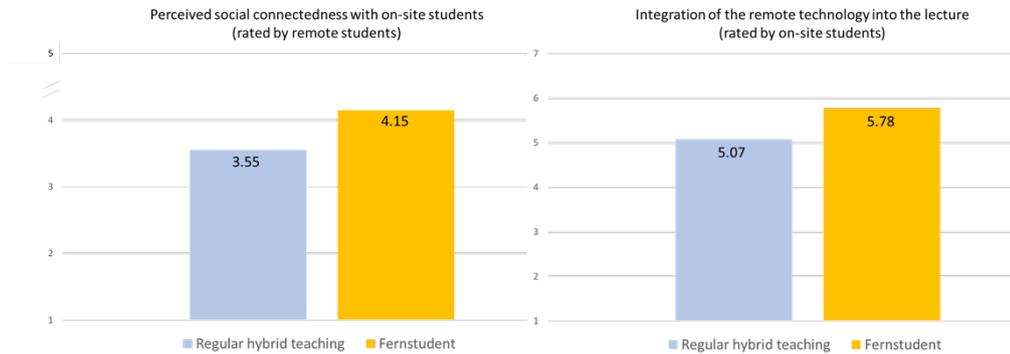
Figure 6. Remote student's ratings of the perceived social connectedness with on-site students (left) and on-site student's ratings of the integration of the remote technology into the lecture (right) in regular hybrid teaching and Fernstudent sessions

4.2.3 Teachers Perspective

Among the participating teachers, the Fernstudent was also perceived as better integrated into the lecture (M = 5.75, SD = 0.98) compared to regular hybrid teaching software (M = 4.69, SD = 0.77). Similarly, the perceived usefulness of the Fernstudent was higher (M = 5.25, SD = 0.98) than for conventional tools (M = 4.38, SD = 1.05).

All four teachers reported being able to concentrate well on delivering their lectures while using the Fernstudent, rating this item with the maximum scale value ("fully agree", M = 7.00, SD = 0). In contrast, the average rating for regular hybrid teaching sessions was lower (M = 4.75, SD = 2.63), indicating greater cognitive load under standard conditions.

Overall, two of the four teachers expressed a desire to continue using the Fernstudent, highlighting benefits such as improved integration of remote and on-site students and a more positive teaching experience. As one teacher noted: "It was very pleasant to look at the avatar and at faces, and not at black tiles on a separate screen" (T2). The remaining two teachers were more hesitant regarding future use, primarily due to existing technical limitations of the prototype rather than conceptual concerns.

5. CONCLUSION AND FUTURE DEVELOPMENT

In sum, the pilot applications of the Fernstudent demonstrated distinct benefits for all user groups—teachers, on-site students, and remote students—though with different focal points. Based on these insights, future development should address three primary goals: (1) increasing added value for on-site students, (2) enhancing remote students' awareness of their presence in the physical classroom, and (3) improving the information available to teachers about remote participants. Furthermore, technical improvements (e.g., audio quality) and enhanced handling and portability of the prototype remain essential.

(1) Regarding on-site students, no particular issues emerged during the pilot studies. However, the innovative classroom infrastructure can serve as an invitation to explore how interaction dynamics and engagement could be further improved. For instance, the LED matrix currently visualizing the number of remote students could be extended to display live poll results

or quiz responses, involving both student groups. On-site students could participate via tangible input devices (e.g., dice or tokens), while remote students could use digital interfaces. This dual-input setup could reinforce the sense of unity between the groups and foster collaborative learning experiences. Ultimately, the direction of future development will depend on the underlying pedagogical goals—whether to simulate a conventional classroom or embrace a blended-learning philosophy.

(2) To further strengthen remote students' sense of co-presence, several enhancements are being considered. A 360-degree camera or adjustable viewing angles could be implemented, though privacy concerns and practical limitations must be addressed. Another approach would be to alter students' mental model of participation—for example, by letting remote students select a "seat" in the lecture hall from a virtual seating plan, or through a short introductory animation that simulates "flying" into their avatar upon joining the session. Both concepts aim to increase psychological closeness to the physical classroom environment and support a more immersive learning experience. However, these ideas require empirical evaluation to confirm their effectiveness and acceptance.

(3) To meet teachers' demands for clearer feedback from remote students, additional features could be integrated. For example, "hand raise" signals could include student identification or queue indicators to help teachers manage questions more effectively—especially in larger groups. Rotating video thumbnails could ensure that even passive remote participants are visible over time, highlighting the collective identity represented by the Fernstudent and preventing individual students from becoming invisible.

The ideal configuration of the Fernstudent will vary depending on the teaching context, class size, familiarity between students and teachers, and the level of interactivity required. While the current prototype is optimized for lecture-style teaching, other disciplines may demand alternative features. For example, in veterinary medicine, showing live specimens or anatomical models would benefit from adjustable camera perspectives tailored to physical objects. Early feedback suggests that the Fernstudent offers a flexible framework that can be adapted to the specific needs of diverse teaching scenarios.

From a broader perspective, the continued development of the Fernstudent must align with fundamental questions about the role of hybrid teaching in higher education. As one conference attendee remarked during the ICEduTech conference in March 2025: "If the system becomes too good, everyone will stay at home—and the teacher will end up alone with the avatar." This provocative comment highlights a critical tension: Should hybrid teaching serve as an inclusive backup for students unable to attend on-site, or evolve into a fully equivalent alternative to physical attendance?

In its current iteration, the Fernstudent supports a vision where on-site learning is still pedagogically advantageous but hybrid options offer necessary flexibility. Within this framework, the Fernstudent helps reduce teachers' cognitive load, integrates remote participants more fully, and encourages their active involvement through increased visibility and participation opportunities. We look forward to exploring further use cases in other universities, cultural contexts, and disciplines—and invite collaboration from researchers and practitioners interested in shaping the future of inclusive hybrid learning.

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REFERENCES

Airenti, G. (2015). The cognitive bases of anthropomorphism: from relatedness to empathy. *International Journal of Social Robotics*, Vol. 7, No. 1, pp. 117-127.

Araujo, T. (2018). Living up to the chatbot hype: The influence of anthropomorphic design cues and communicative agency framing on conversational agent and company perceptions. *Computers in Human Behavior*, Vol. 85, pp. 183-189.

Boye, T. & Eyet, J. (2021). *Fostering inclusivity: bridging the gap between in-person and online student learning.* Available at: https://share.vidyard.com/watch/b9o8hHQrLc55DXGn12ssMW (Accessed: 17 December 2024).

Damiano, L. & Dumouchel, P. (2018). Anthropomorphism in human–robot co-evolution. *Frontiers in psychology,* Vol. 9, 468. https://doi.org/10.3389/fpsyg.2018.00468

Davis, F. D., Bagozzi, R. P. & Warshaw, P. R. (1989). User acceptance of computer technology: a comparison of two theoretical models. *Management Science*, Vol. 35, No. 8, pp. 982-1003.

De Freitas, S. & Neumann, T. (2009). The use of 'exploratory learning' for supporting immersive learning in virtual environments. *Computers & Education*, Vol. 52, No. 2, pp. 343-352.

Eska, M. (2024). Fernstudent 2.0 - Digital barrier reduction between lecturers and students in hybrid courses using an interactive robot avatar, Unpublished master's thesis, Munich, Germany, Ludwig-Maximilians-Universität München.

Fredricks, J. A., Blumenfeld, P. C. & Paris, A. H. (2004). School engagement: potential of the concept, state of the evidence. *Review of Educational Research,* Vol. 74, No. 1, pp. 59-109.

Gallon, L., Abénia, A., Dubergey, F. & Negui, M. (2019). Using a telepresence robot in an educational contex. In *15th Int'l Conf on Frontiers in Education: Computer Science and Computer Engineering* (FECS 2019).

Gamage, K. A., Jeyachandran, K., Dehideniya, S. C., Lambert, C. G., & Rennie, A. E. (2023). Online and hybrid teaching effects on graduate attributes: Opportunity or cause for concern?. *Education Sciences, 13*(2), 221.

Grønbæk, J. E., Saatçi, B., Griggio, C. F., & Klokmose, C. N. (2021). Mirrorblender: supporting hybrid meetings with a malleable video-conferencing system. *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems,* pp. 1-13.

Henderson, M., Selwyn, N. & Aston, R. (2017). What works and why? Student perceptions of 'useful'digital technology in university teaching and learning. *Studies in higher education,* Vol. 42, No. 8, pp. 1567-1579.

Huizinga, T., Lohuis, A., Zwerver-Bergman, J. & van der Meer, R. (2022). Student and teacher perceptions of community of inquiry in hybrid virtual classrooms. *Heliyon*, Vol. 8, No. 12.

Johannessen, L. E., Rasmussen, E. B. & Haldar, M. (2023). Student at a distance: exploring the potential and prerequisites of using telepresence robots in schools. *Oxford Review of Education*, Vol. 49, No. 2, pp. 153-170.

Klopfenstein, L. C., Delpriori, S., Malatini, S. & Bogliolo, A. (2017). The rise of bots: A survey of conversational interfaces, patterns, and paradigms. In *Proceedings of the 2017 Conference on Designing Interactive Systems,* pp. 555-565.

Klunder, S., Saab, N. & Admiraal, W. (2022). A teacher perspective on using a hybrid virtual classroom for students with a chronic illness in mainstream primary and secondary schools. *Technology, Pedagogy and Education*, Vol. 31, No. 4, pp. 493-508.

Kwon, O. H., Koo, S. Y., Kim, Y. G. & Kwon, D. S. (2010). Telepresence robot system for English tutoring. In *2010 IEEE workshop on advanced robotics and its social impacts*, pp. 152-155.

Lee, R. M. & Robbins, S. B. (1995). Measuring belongingness: The social connectedness and the social assurance scales. *Journal of Counseling Psychology,* Vol. 42, No. 2, pp. 232-241.

Lorenzo-Lledó, A., Lledó, A., Gilabert-Cerdá, A. & Lorenzo, G. (2021). The pedagogical model of hybrid teaching: Difficulties of university students in the context of COVID-19. *European Journal of Investigation in Health, Psychology and Education,* Vol. 11, No. 4, pp. 1320-1332.

Ma, S., Hu, Q., Chen, Y., Zhao, Z. & Li, H. (2023). Social Bots that Bring a Strong Presence to Remote Participants in Hybrid Meetings. In *Companion of the 2023 ACM/IEEE International Conference on Human-Robot Interaction*, pp. 853-856. https://doi.org/10.1145/3568294.3580200

Moore, M. G. (1993). Theory of transactional distance. *Theoretical principles of distance education*, Vol. 1, pp. 22-38.

Newhart, V. A., Warschauer, M. & Sender, L. (2016). Virtual inclusion via telepresence robots in the classroom: An exploratory case study. *The International Journal of Technologies in Learning,* Vol. 23, No. 4, pp. 9-25.

Singh, J., Steele, K. & Singh, L. (2021). Combining the best of online and face-to-face learning: Hybrid and blended learning approach for COVID-19, post vaccine, & post-pandemic world. *Journal of Educational Technology Systems*, Vol. 50, No. 2, pp. 140-171.

Ullrich, D., Butz, A. & Diefenbach, S. (2023). The "Fernstudent". Enhancing The Potential of Hybrid Teaching Based on User-Centered Design. In *Proceedings of the 20th International Conference on Cognition and Exploratory Learning in Digital Age (CELDA)* 2023. https://www.iadisportal.org/digital-library/the-fernstudent-enhancing-the-potential-of-hybrid-teaching-based-on-user-centered-design

Ullrich, D., Butz, A. & Diefenbach, S. (2024). The Fernstudent. A User-Centered Design Case Study on Improvements of Hybrid Teaching Through a Physical Avatar in the Classroom. Fernstudent Case Study. In *Proceedings of the 2024 CHI Conference on Human Factors in Computing Systems*, Article No. 534. https://doi: 10.1145/3613905.3637144

Velinov, A., Koceski, S. & Koceska, N. (2021). A review of the usage of telepresence robots in education. Balkan *Journal of Applied Mathematics and Informatics,* Vol. 4, No. 1, pp. 27-40.

Virkus, S. et al. (2023). Telepresence robots from the perspective of psychology and educational sciences. *Information and Learning Sciences,* Vol. 124, No. 1/2, pp. 48-69.

Wu, G., Zheng, J. & Zhai, J. (2021). Individualized learning evaluation model based on hybrid teaching. *The International Journal of Electrical Engineering & Education*, Vol. 60, No. 1, 0020720920983999.