The Wider Supportive Role of Social Robots in the Classroom for Teachers

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Abstract. Robots are being increasingly used in schools by researchers keen to assess how they may be used to facilitate learning and provide support. Based on 15 school experiment visits at 9 different schools in the U.K., we outline our observations, specifically focusing on the broader implications of robots in the classroom primarily from the perspective of the teacher. We then outline the basis for future research considerations in HRI, centred around the three themes of pedagogy, methodology, and ethics. For further application of robotics to education, we suggest that these three themes need to form a central part of continuing research.

Keywords: Education, Ethics, Methodology, Pedagogy, Social HRI, Teacher Support

1 Introduction

There are increasing numbers of applications of social robots to the domain of education, and in particular to deployment in classrooms. There are typically two main, and often overlapping, goals for these efforts. Firstly, they are intended to augment teaching structures and provide supplementary support to children by providing an alternative and/or personalised learning experience. Note that these applications, quite rightly, do not seek to replace any human teaching staff or reduce human contact time, but are rather intended as supplementary to existing pedagogical structures. Secondly, they seek to examine the attitudes of teachers and students regarding robots in the classroom, and solicit their views on how applications should be implemented and used.

Rather than fit into one of these two essential goals, we rather in this paper seek to take a step back and address some of the wider implications of robots in the classroom from the perspective of the teachers themselves. We further consider research methodology, beyond the application to the learning task that is typically the focus of the work conducted.

We report on the experiences gained from 15 separate school visits to nine different schools around Plymouth (in the south-west of the U.K.) to run a number of experiments over the past three years. Our observations are qualitative

and based on extensive interactions during and after the experiments with teachers. Despite this, a number of trends and facets have emerged that we believe have consequences for the conduct of HRI experiments with children in schools, but also more generally 'in the wild' – a difficult task with many pitfalls [9].

Three outcomes from these observations are derived. Pedagogically, the way the teachers use the robot in terms of its (social) presence needs to be properly characterised from the perspective of teaching practice. Methodologically (from the experimental point of view), the manner in which children anticipate their interactions with the robot are altered by the changed behaviour of the teacher (beyond the mere presence of the robot) needs to be accounted for. Ethically, the way the robot is treated by the teacher with respect to the children and the consequences of this needs to be considered.

2 Robots for Teachers

As noted above, much existing work is focused on having a robot support and supplement existing teaching structures, by, perhaps, engaging children in additional one-on-one tuition. While space constraints prevent a complete overview of the literature here, this is typically conducted from the perspective of the individual children and/or of the robot itself. For example, Kanda et al provided a seminal exploration of how robots interacted and formed relationships with children over time [5], considering both the social dimension from the point of view of the children, and the technical and behavioural facets of the robot used to encourage this. Similar to this, the focus on improving robot competencies to facilitate interaction with children has encompassed empathic behaviour [8], interactant-directed behavioural cues [7], etc.

The second strand of work is on teachers' and children's perceptions of robots and how they may be useful. This has for example highlighted practical concerns of robustness and equality of access, but also acknowledged the positive role of the robot in maintaining the engagement of children [11]. In the domain of children with health problems, a social robot has been highlighted as a means of integration at school (a novel experience to share that is not health-related) [1].

3 Teachers with Robots

Beyond the established goals described above, in this section we seek to expand our observations of other factors involved in running experiments in real schools that typically do not explicitly form part of the experimental considerations (or appear in the subsequent publications). We first provide some general observations, and then provide more specific observations from a recently conducted longer-term experiment.

3.1 General Observations

In the majority of our experiments (e.g. [7]), we set up the robot in a room in the school that is not the children's classroom, but one with which they are

familiar. In this way, we maintain the school environment while not disturbing the ongoing lessons in another room. Children from our subject group (typically a single class) are brought by the experimenter one by one to this experiment room, the experiment is conducted, and the children are subsequently returned to their classroom.

One consistent observation from our experiments in the schools was that the teacher adapted their behaviour both in the presence of the robot and also given just the prospect of the robot being present. This is not so surprising given that, at the present time at least, robots are not a typical feature in U.K. schools. A certain level of excitement at a novel experience in school time is thus to be expected.

However, it was apparent that the teachers, without exception in our experience, would use the occasion to aid in their management of the classroom. There were two general means of achieving this observed. Firstly, prior to the start of the experiments, the teachers would emphasise to the children the importance of getting the parents/guardians to complete the consent form - otherwise the children would miss out. Secondly, during the experiment, the teachers would explicitly refer to the robot when requesting that the children settle down to work - a common phrase used was "if you don't behave/be quiet, you won't get to *play* with the robot" (emphasis added[3]).

It must be acknowledged that the teachers would use similar tactics to encourage and remind the children to do various other normal school activities[4]. However, in the case of the robot, this has a number of methodological consequences. By emphasising that the children would miss out on the novel experience, the teachers are implicitly raising the expectation in the children that this is a desirable experience. The children are therefore primed, with consequences for subsequent interactions with the robot: it has indeed been shown that prior expectation strongly shapes human-robot interactions, e.g. [4].

3.2 Long-term Embedded Study Observations

In one of our more recent studies, we dispensed with the presence of experimenters, and placed robots directly into classrooms without technical supervision: the teacher (and perhaps a teacher's assistant) was the only supervising adult present. In this continuous two-week study (publication in preparation), the robot interacted with individual children during class time, in the classroom, where the teacher was responsible for designating which child would be allowed to interact with the robot next. Two classes were involved in the same school

[3] This use of the word 'play' seems to arise irrespective of the way in which the robot is presented by the researchers. This could indicate that despite the insistence that we are attempting to help the children learn, the robot does give rise to the expectations associated with toys. Alternatively, it could just be the manner the teachers choose to portray the robot in order to maximise the effect with the children: play is fun, work is not.

[4] Perhaps implicitly taking advantage of the children's desire not to be left out, and to remain included.

and in the same age-range, with separate teachers. In initial planning discussions with the teachers, they enquired whether it would be possible to use the robot to indicate to them when the classroom was too noisy to help them manage the children, however this interfered with the planned experimental protocol and so was subsequently not pursued. Based on observations from video recorded interactions, and subsequent discussion with the teachers, this long-term embedded situation provides additional insight into the altered dynamics in the classroom when a (social) robot is present.

Firstly regarding the general attitude of the children over the two week period. Both teachers involved said that while in the first week the behaviour of the robot caused distraction for the rest of the class (e.g. children turning to look when the robot spoke), in the second week, this distraction effect wore off. This meant that the classes continued uninterrupted by the robot despite the interactions taking place during normal lesson time. Conversely, both teachers reported that their ability to use the robot as a 'bribe' (i.e. a means of motivating the children) was maintained over the experimental period. In other words, while the distraction caused by the robot decreased, it still formed a sufficiently attractive lure to induce behaviour change.

Secondly, prior to this experiment, a great deal of effort was put into designing the content to be learned by the children. We chose to maintain a strong link to the curriculum that the children were following, and also chose a topic that would appear in the syllabus for the following year (thus a novel topic for the children at the time of the experiment). This was done for two reasons. Firstly, any positive learning outcomes would be directly useful for the children (and thus also increasing ecological validity). Secondly, it was a means of making the experiment relevant to the school, and reducing the potential (perceived) distraction from the curriculum if a completely unrelated topic were chosen.

4 Discussion

In all of the examples described above, it is clear that the novelty effect provides a significant influence. As a means of increasing interest in a topic to be learned, this effect can be bootstrapped to improve child learning, e.g. [10]. However, as robots become more pervasive in these environments, there will naturally come a point where this effect of novelty can no longer be relied upon to increase the interest levels sufficiently to enhance engagement and/or learning. While long-term studies have examined relationships between children and robots in classroom settings [6], the equivalent research for learning outcomes has yet to provide conclusive evidence that learning benefits will remain, although there are indications that at a least a moderate positive effect will persist. Based on these considerations, we can identify three themes around which our observations and their implications can be structured: pedagogy, methodology, and ethics.

Pedagogy: Assuming that the goal is to enhance the classroom as a learning environment with social robots, the wider question is how the robot would fit in terms of both the teaching style of the teacher and the content to be learned

by the children. Insight can be gained from research in the field of Computer Supported Cooperative Work/Learning, which has approached the problem from the more general perspective of technology in the classroom. For example, the concept of 'classroom orchestration' [3] investigates how device appearance and functionality affords improved teacher-directed workflow. Taking advantage of frameworks such as this will enable the role of the robot to be considered from a global educational, rather than robot-centred technological, perspective.

Methodology: Given our observations, it would appear that the methodological consequences need to be handled. If the children's expectations are inflated prior to the interaction with the robot by implicit suggestions from the teacher, then a practical consequence could be a reduction in measurable difference between conditions. Consider that in many studies, a single manipulation distinguishes between conditions, and it is clear that an initial increase of excitement or engagement in all subjects could be enough to reduce the significance of any differences between conditions – made already difficult due the child propensity to anthropomorphise [2]. This could be an effect that distinguishes research with children from research with adults for instance. The means of handling this potential confound could however be difficult. One means could be to extend the length of studies so as to get over this initial biasing effect. Although this may be practically difficult, another benefit of this solution is that begins to address the questions in a more ecologically valid manner.

Ethics: A further consideration is how the manner in which the teacher treats the robot impacts on the dynamics of the classroom, and the subsequent way the robot is viewed by the children. This goes beyond the existing concerns of the long-term effect of children interacting with robots (e.g. in the extreme case [12]). One example given above was of the teacher requesting that the robot be used to indicate if the classroom was too noisy. By using the robot in the capacity of an 'informant' in this way, the children in the classroom would begin to see it as an 'other' rather than as a peer (if the robot designers envisaged a peer role for the robot). Similar scenarios can be constructed that follow similar lines of argument: a mismatch between the roles apparently ascribed by the teacher to the robot, and the role the robot takes on when interacting with a child. To the extent that such discrepancies impact trust, for example, this becomes an ethical issue that requires consideration.

5 Conclusion

In this paper we have outlined the three themes of pedagogy, methodology and ethics as areas that are impacted by the presence of (social) robots in the classroom, but which are not typically considered in research efforts at the present time. The example from methodology demonstrates what we contend are real experimental issues that can be addressed if this perspective is taken. These observations are not intended to be read as criticisms of current practice (we have been subject to the same effects mentioned here), but rather as opportunities for further research endeavours. What we advocate though is a wider consider-

ation of the role of the robot within the classroom beyond the actual learning application that is typically the focus of the studies reported in the literature.

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