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Second Language Tutoring using Social Robots

# Project No. 688014

# L2TOR

## Second Language Tutoring using Social Robots

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| **Dissemination Level** | | |
| **PU** | Public | **PU** |
| **PP** | Restricted to other programme participants (including the Commission Service) | |
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# Executive Summary

This deliverable reports on the meeting and advice received from L2TOR's external ethics advisor, Matthijs Smakman. This report is based on Smakman's research as described in his paper *Moral Considerations Regarding Robots in Education: A Systematic Literature Review* [1]. Smakman is a lecturer at the ICT Institute of the HU University of Applied Sciences Utrecht. In addition, he is a researcher at the VU Amsterdam, where his research focuses on ethical issues concerning robots in education.

On the 12th and 13th of December 2018, the Symposium on Robots for Language Learning took place at Koç University in Istanbul, Turkey. This symposium was also the closing event of the L2TOR project. Matthijs Smakman was invited to speak and lead a discussion for the consortium and participants of the symposium on the ethical implications of robots in education, specifically robot tutors.

# Principal Contributors


| | |
|---|---|
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# Revision History

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# 1 Introduction

New technology provides important tools for modern education and can provide unique learning experiences to students, thereby improving their achievements. One such technology is the educational robot. Three roles are identified for educational robots: 1) as a programming project; 2) as a learning focus; 3) as a learning collaborator [2]. In this review, the focus is mainly on this last role, where the robot serves as “an all-season companion, aide, and even intellectual foil” [2]. In this role, students are not building or programming robots but interacting with the robot as a social entity, for example, children having a conversation with the robot. The robot appears to be perceived by children as a peer rather than a tool and – according to the children – the humanoid robots even seem to establish a kind of friendship relation learning collaborator is what this paper defines as a “robot tutor”, which is a common understanding of the definition in robotic literature [4].

Although the robot tutor provides great opportunities [4], it also introduces moral challenges. In this document, we present a systematic literature review aimed at identifying the (moral) values impacted by the implementation of tutor robots. We outlay our methodological approach to identify moral values, following the Value Sensitive Design methodology, which is often used to integrate moral values into technology [10]. Then, we detail the selection procedure of the literature search and categorise the moral values based on the harms and benefits identified in applying robots in education.


Figure 1: Matthijs Smakman, external ethics advisor to L2TOR, at the Symposium on Robots for Language Learning, Istanbul, Turkey (13 December 2018).

Moral conceptions are “the basic notions of the right, the good, and moral worth” [11]. They define the relative (moral) values of activities and experiences, and they specify an appropriate ordering [11]. This paper will use a common definition of a value, being: “a value refers to what a person or group of people consider important in life” [12].

Until now, researchers have focused on the moral conceptions of single stakeholders, such as teachers [8, 9, 13–16], students [17], the general public [18], and children [19]. However, an overview of the prevailing moral conceptions from a multi-stakeholder perspective is lacking.

A multi-stakeholder perspective includes not only the direct stakeholders (those who are in direct contact with the robot tutor), but also indirect stakeholders. Indirect stakeholders are those individuals who are impacted by the robot tutor, though they never interact directly with it, for example the managers at schools. Because different perspectives lead to different values.

An overview of the moral values from a multi stakeholder perspective could 1) help schools to make calculated, well-informed decisions when implementing robot tutors in a morally justified way, 2) provide researchers with a single knowledge base for further research on moral values and robot tutors, and 3) help the robotic industry to integrate moral values in their tutor robot design. Therefore, the aim of this study is to identify the moral values related to the implementation of tutor robots in education, from a multi-stakeholder perspective.

Given the nature of education and children being a vulnerable group it is important to critically examine technology used in education. Risks related to applying robot tutors are still unknown and earlier studies on moral conceptions regarding this topic stress the need for more systematic moral considerations and guidelines [4–9].

Value Sensitive Design is a theoretically grounded methodology that accounts for values, from a multi stakeholder perspective, when designing and integrating technology [12]. It provides a methodology to discover and conceptualise values related to technology by identifying the harms and benefits related to the system from a stakeholder perspective [10]. The first step is to identify the stakeholders who will be affected by the technology. Second, for each stakeholder the potential harms and benefits caused by implementing a robot tutor are described. These harms and benefits are then linked to moral values, thereby identifying the moral values related to the implementation of robot tutors in education. To identify the specific harms and benefits related to the moral conceptions, we conducted a systematic literature review.

# 2 Research method

The first step of our systematic literature review was to identify relevant databases. Eventually *IEEE Digital Library, SpringerLink, JSTOR, Science direct, ACM, NARCIS, EBSCO, Web of Science* and *Scopus* were used.

Second, an initial search string was formed to identify synonyms for tutor robots. To determine the initial search string, the keywords identifying robot tutors from an earlier, initial review concerning robot tutors were used first [20]. This resulted in multiple search terms for tutor robots (e.g., "tutor robot", "robot tutor", "educational robot", and "robot teacher") and various synonyms for harms and benefits (e.g., positive effect, negative effect, impact). After several refining search rounds, the final search string was formed as follows: ("robot tutor" OR "tutor robot" OR "robotic tutor" OR "teacher robot" OR "robot teacher" OR "robotic teacher" OR "education* robot") AND ("harm" OR "benefit" OR "positive effect" OR "negative effect").

The selection procedure is shown in figure 1. A final list of 254 studies was included in the synthesis of the results.

This review covers various scientific fields such as Communication science, Philosophy, Human-Computer Interaction, Robotics, Psychology, and Pedagogy.

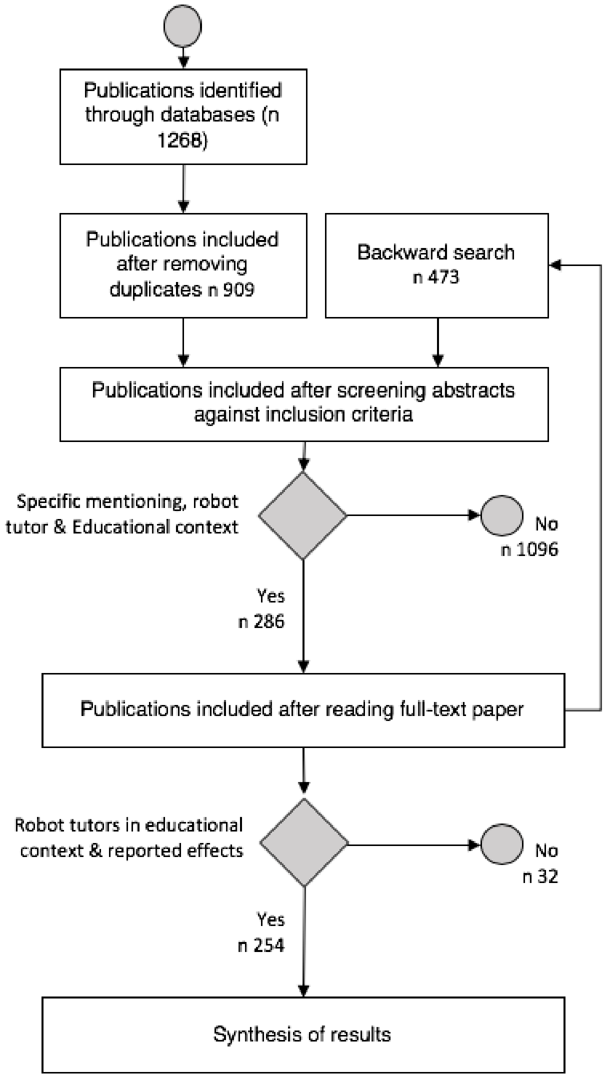

*Figure 2: Selection Procedure*

Therefore, the 254 publications selected for full-paper coding were diverse in their goal and methodology. Consequently, we segmented the publications based on their main goal, for comparison reasons. We identified five categories: 1) Conceptual studies, 2) Design studies, 3) Effect studies, 4) Exploratory cases, and 5) Perception studies, illustrated below in Table 1. This categorisation does not only provide a framework for comparison reasons but also provides a systematic overview of the available studies up until 2018 related to tutor robots.

| **Category (Total publications, *n* = 254)** | **Description** |
|---|---|
| Conceptual, *n* = 39 | The focus of the conceptual studies is primarily theoretical and visionary. They include short reviews, philosophical arguments, discussion papers, and publicised descriptions of research projects and their progress. No empirical work or applied cases are included in this category. |
| Exploratory cases, *n* = 87 | The focus of the exploratory studies is the discovery of the broad effects of robots by applying them in an educational setting. These also include comparison studies between teachers and robot tutors, often single case studies. |
| Perception studies, *n* = 24 | The focus of the perception studies is the identification of expectations, judgements ad opinions of stakeholders, such as teachers, children and the general public |
| Design studies, *n* = 31 | The focus of the design studies is to inform the design of tutor robots, frameworks, approaches, principles, classifications and technical aspects. |
| Effect studies, *n* = 73 | The focus of the effect studies is to establish the effect of the capabilities of the robot, such as: gestures, emotions, embodiment and personalisation. |

*Table 1: Categorisation of studies based on their main focus.*

# 3 Results

**Conceptual studies**
The benefits for children (including children with special needs) are increased motivation and enjoyment [21, 25, 27, 28-38], a learning environment which is tailored to individual learning styles [21, 22, 24, 34, 36, 39-47], new opportunities [25, 32, 36, 42, 44, 48-54], and a new social interaction [23, 26, 27, 50, 55]. However, this social interaction is considered a potential harm, possibly resulting in: the loss of human contact, compromised social skills, feeling of anxiety and a negative effect on concepts regarding trust, respect, friendship and relationships [3, 19, 22, 26, 29, 37, 44, 45, 51, 52, 54, 56]. Furthermore, the privacy and security of children could be compromised because of the physical presence of the robot and its ability to record sensitive data [37, 51].

Despite the recording of sensitive data being potentially harmful it is considered an opportunity for teachers, because it could give new insights in the learning progress of children [32, 51]. Additional benefits for teachers are reducing workload and improve job satisfaction, by taking over dull repetitive tasks [42, 44, 49, 57, 58]. Although robot tutors seem only able to assist in limited tasks, teachers are reported to fear being replaced by the robot. However, the state of current technology, could lead to extra workload, because of issues maintaining children's motivation [14, 32, 37, 44, 51, 58-62]. Other potential harms for teachers are the high cost of the robot and accountability concerns regarding the robot [26, 36, 44, 51, 60, 63].

**Exploratory cases**
The benefits for children (including special needs children and pre-school children) are: motivation and enjoyment [5, 25, 64-70, 71, 72-107], increased responsibility [74, 76, 77], reduced anxiety [66, 68-70, 77, 87, 88, 115], personalised learning [79, 80, 90, 103, 116-118], and new opportunities and social interactions [64, 72, 76, 82, 90, 92, 94-96, 99, 101, 103, 107-114]. Just as in the conceptual studies the effect of the new social interaction is considered as possibly deceiving [82], with could have to negative consequences. Additional harms for children are fear of the robot and feelings of discomfort [81, 82, 86, 90, 119].

The main benefits for teachers are reduced administrative work [66, 81, 94, 95, 102, 116, 120], the robot supporting teachers with topics they find difficult [69], and gaining new insights into the learning process of a child [79, 80]. Despite these benefits the following (potential) harms are reported: the robot being ineffective in general [64-66, 68, 71, 75, 86, 94, 95, 99, 121-125] or in maintaining students' motivation and engagement [121], costly [66, 91, 95], disruptive for the educational process [95], or too technically complicated [66, 92, 95, 119].

**Perception studies**
The benefits for children (including special needs children and pre-school children) are increased motivation and enjoyment [17, 127-129, 133, 135, 138], and new opportunities such as new social interaction [45, 136] and connecting schools to homes [138]. These new opportunities could lead to individual learning [8, 13, 16, 127], extra help when doing homework, emotional well-being [130, 131], and a comforting experience when children are feeling worried. The potential harms reported in these studies are a violation of privacy [9,

137], negative social implications [5, 9, 13, 17, 134, 137], distraction [127], fear [17, 128] and compromised safety [9].

Reduced workload [8, 132], new insights into the state of children [9, 13], and support with difficult subjects [126] are expressed as potential benefits by teacher. However, teachers fear that the robot tutor will be too complicated or inflexible, thereby increasing their workload or being disruptive for the educational process [8, 13, 14, 15, 131, 134, 135].

The perception studies also report on a new stakeholder affected by the robot tutor, the child's parents. When robot tutors enter children's homes the parents will be affected by the technology, making them potentially more involved in the educational process [138].

**Effect studies**

The benefits for children are motivation and enjoyment [106, 107, 139-165], new opportunities for education [108, 149, 150, 155, 161, 166-168], personalised learning [143, 169-173], and reduced anxiety [151]. Potential harms for children as expressed in these studies are: attachment issues caused by the relationship between robot and child [174], feelings of discomfort [142, 151, 154, 156, 175], and the robot tutor not being capable to keep children motivated [176, 177].

Interestingly no specific benefits, other than providing new educational tools [143, 165] are reported for teachers. There are, however, potential harms reported, being the technology not being efficient [108, 151, 156, 161, 177, 178], too costly [161] and disruptive [151, 168, 179].

**Design studies**

The reported benefits for children are: personalised learning [180, 181-185, 186], new social relationships [180, 187, 188], increased motivation [183, 187] and reduced anxiety [187]. Just as in the previous categories, three potential harms dominate, being: the potential negative effect of the social bond [182], the risk of compromising children's safety [184, 189, 190], and privacy concerns [184]. Furthermore, it is questioned who should be responsible for the potential negative effects [182].

Just as with the effect studies, there are no direct benefits for teachers reported, other than being a new tool for education. However, numerous potential harms were reported. These harms include: the high cost of the robot [190], the robot not being an effective tool due to technical issues [181, 187, 191], and being potentially disruptive for the educational process [185, 187].

# 4 Conclusion

Following the steps of the Value Sensitive Design methodology, the harms and benefits identified through our systematic literature review are mapped onto moral values related to tutor robots.

*Positive values attributed to robot tutors.* Based on the benefits reported, five values are positively influenced: psychological welfare, happiness, efficiency, freedom from bias, and usability. Psychological welfare is positively affected by the robot's ability to comfort children, for example making children with autism spectrum disorder feel more at ease. Furthermore, the robot can take over dull tasks of teachers resulting in increased job satisfaction. The ability to create an enjoyable educational context is linked to the value of happiness. The robot can be a more effective tool compared to a computer-based tutoring system, and is linked to the value of efficiency, for both children and teachers. Its ability to support teachers in multiple activities, such as building e-portfolios and record data during assessments further enhances the efficiency. Personalisation could lead to the removal of possible pre-existing social biases of teachers, thereby supporting the value freedom from bias. Finally, the value of usability is created, because the robot provides access to resources which were not available before.

*Values undermined by tutor robots.* Based on the harms reported for both children and teachers, 12 values are negatively influenced: psychological welfare, attachment, human contact, deception, friendship, trust, privacy, safety, security, accountability, efficiency and freedom from bias. Children are sometimes reported to fear robot tutors because of their appearance or sudden movements. Furthermore, the robot could lead to feelings of anxiety when children become too emotionally attached. The social bond could also lead to children preferring the companionship of a robot over that of their human peers, leading to the loss of human contact. Children might by deceived by the robot tutor, imagining that the robot really cares about them. When children perceive a robot tutor as their friend, as is reported, this might have a negative impact on the concept of friendship and trust.

The physical presence of the robot and its ability to record data has an impact on values such as privacy, security and safety of children. Who should be accountable for the impact of tutor robots and where the responsibility should lie is also an issue, especially since the technology is still costly and hardly able to meet the requirements posed by professionals. The required technology for a robot tutor is still nascent, which could lead to a robot tutor having a technical bias, favouring certain children over others.

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