Robots are Good for Profit: A Business Perspective on Robots in Education

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Robots are Good for Profit: A Business Perspective on Robots in Education

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***Abstract*—This paper aims to chart the (moral) values from a robotic industry's perspective regarding the introduction of robots in education. To our knowledge, no studies thus far have addressed this perspective in considering the moral values within this robotic domain. However, their values could conflict with the values upheld by other relevant stakeholders, such as the values of teachers, parents or children. Hence, it is crucial to take the various perspectives of relevant stakeholder's moral values into account. For this study, multiple focus group sessions (*n* = 3) were conducted in The Netherlands with representatives (*n = 13)* of robotic companies on their views of robots in primary education. Their perceptions in terms of opportunities and concerns, were then linked to business values reported in the extant literature. Results show that out of 26 business values, mainly six business values appeared relevant for robot tutors: 1) profitability, 2) productivity, 3 & 4) innovation and creativity, 5) competitiveness, and 6) risk orientation organization.**

Keywords—educational robots, robot tutors, ethical considerations, moral values

I. Introduction

Innovations and technology advancements have skyrocketed in the area of robotics and as a result, it is becoming a vastly growing domain [1]. With the development of robotics, researchers are examining how robots could play a supporting role in education [2], among others. For example, robots have been shown to attract attention and motivate children to perform learning tasks [3]–[5]. Furthermore, robots could potentially create a new learning environment for both children and teachers [6], [7] and could contribute to reducing administrative tasks [8].

A recent study identified three types of educational robots: build, use and social (ro)bots [9]. Build and use (ro)bots focus on developing children's Science, Technology, Engineering and Mathematics (STEM) skills by letting children build and use robots. Children then use these robots as a tool. Social robots on the other hand, are not merely considered a tool. Children experience these robots as a social entity, in roles such as a) a tutor or teacher, b) a peer or c) a novice [10]. In the first role (a), the robot can contribute to the learning process of children by giving them hints, tutorials, rehearsing exercises, and even supervision in some cases. In the second role (b) a robot acts more as a peer or learning companion and when interacting with children – either autonomously or controlled by a human – it has the potential to be perceived as less intimidating than learning from a tutor or a teacher [10]. In the third role (c) the robot is seen as a novice. In this scenario, a child takes on the role of an instructor to teach different subjects to the robot, thereby learning themselves. In this paper, we refer to robot tutors in the first two roles (a and b). In these roles, a robot is considered a social entity and takes on the role of a teacher, tutor, or peer.

Although robot tutors could provide a valuable contribution to the educational process [10], several studies report on new moral challenges when robot tutors would be introduced into classrooms [11]–[13]. Robot tutors have the potential to undermine or promote (moral) values of different stakeholders more than traditional types of educational robots, such as build and use (ro)bots. Furthermore, the values of different stakeholders could conflict with each other, thereby making it important to study the values affected by the introduction of robot tutors from a multiple stakeholder perspective. A recent systematic literature review [11] reports that moral considerations reported in the extant scientific literature thus far, is limited to the perspectives of children and teachers. Evidently, these two stakeholders are directly affected if robots are implemented in education, yet, they are not the only stakeholders in this domain. Other relevant stakeholders are, for example, schools, parents, organizations offering educational robotics (non-profit companies), universities, industry (business, robotic industry), and educational policy makers [14]. In the current study, we consider the moral values from the business' perspective (to be followed by the others). We define a value as: "what a person or group of people consider important in life" [15]. In our study, moral considerations refer to how the appearance and social interaction of a robot can impact a value upheld by a stakeholder.

This paper aims to identify the values regarding robot tutors that are at stake from a robotic industry's perspective. The robotic industry in this study refers to robotic companies that manufacture, design, or sell educational robots. It is important to look at the robotic industry as they have a direct interest in the introduction of robots in education. For one, they are responsible for building and selling the robot tutors and they decide how the robots operate, behave, store information, and interact with the children. What values are relevant for the

robotics industry have not yet been studied. This is important because their moral values might conflict with values from other stakeholders. The results presented in this paper contribute to completing the picture of moral values from the variety of stakeholders involved. Eventually, it can be used to formulate guidelines for ethical considerations when designing and building robots for education. In this paper, we will first describe the method used for data collection and present how the research is conducted. Second, we will present the results and in the last section, we will discuss which conclusions can be drawn based on our findings as well as the limitations.

II. Method

In the following section, the method used to identify what values are undermined or promoted from a robotics industry perspective are elaborated.

A. Value Sensitive Design

For this study, we used the Value Sensitive Design (VSD) approach to identify the moral values relevant from a robotic industry's perspective. VSD is a theoretically grounded approach that takes human values into account when designing a technology [15]. It is used to design and implement socially acceptable technology in different fields, such as robotics [16], wind parks [17] and smart metering [18]. It provides an approach to discover and conceptualize which values are related to the new technology by first identifying the (potential) harms and benefits related to the system from a multiple stakeholder perspective [19]. Following this approach, we identify the harms and benefits regarding robot tutors from a robotic industry's perspective, in terms of opportunities and concerns. We later link these opportunities and concerns to relevant business values reported in the extant literature.

B. Focus Group Sessions

In total three focus group sessions were conducted in The Netherlands, in three different cities (spread through the country: Utrecht, Eindhoven, and Enschede). Focus group sessions are group discussions organized to explore a specific set of issues, such as people's views and experiences on a certain subject [20]. These sessions consist of a small group of homogenous people – with similar demographic variables –, usually between four to six people each [21]. We considered focus group sessions an appropriate method for answering our research question because focus group sessions do not just look at people's opinions, but also look at why or how an opinion is formed and may address controversial points of view.

During a focus group session, opinions and attitudes can be socially formed and it can give a deeper understanding of the opinions given regarding the subject discussed [21]. This deeper understanding could then later be used to identify what values were relevant for the robotics industry. Another advantage of using focus group sessions is that the researcher can guide the session to stay on-topic and ensure that various viewpoints are addressed [22].

For this study, we approached employees of companies that currently build/ sell robots or robotic software platforms. A total of 13 participants from 8 different companies across The Netherlands took part in this study (M-age = 40; SD = 17.49; age range 22-75) (see Table I – Overview of the focus group sessions). The reason that the mean age of one of the focus groups (FGS 3) is considerably higher than the other two, is because the representative of one of the companies involved was 75 years old.

The participating companies were mostly focused on selling humanoid robots (e.g., NAO). Some of these robots didn't carry a commercially known name yet, but most of them had social features that compared to the NAO. One company also developed a sports (football) robot. Furthermore, three of the companies involved had their own platform to manage and operate (social) robots.

The mean length of experience of the participating companies with social robots was approximately 4 years, ranging from 2 years to 10 years. Most participants stated that the company they work for had only recently started working with robots or had just recently started their own industry in robotics. One focus group session (FGS 2) consisted of future business stakeholders, candidate employees for robotic companies because they were still university students, studying courses such as BioRobotics, Creative Technology, Computer Science and Interaction Technology. One participant in this group was a university teacher in these topics.

The focus group sessions were organized in regular meeting rooms and each session lasted approximately two hours. Two of the focus group sessions were conducted in the participants' native language (Dutch) and one session was conducted in English because of an international participant involved. The focus group sessions were conducted by the first two authors of this paper, one acting as a discussion moderator and the other as an observer. Minor discrepancies in coding the results were discussed and resolved.

TABLE I. OVERVIEW OF THE FOCUS GROUP SESSIONS

Focus group	Participants (*n*)	M-age	SD	Gender	Date	Location
FGS 1	3	37	15.95	M1, F2	18-12-2018	Utrecht
FGS 2	5	26	7.70	M2, F3	20-12-2018	Enschede
FGS 3	5	55	14.25	M3, F2	10-01-2019	Eindhoven

At the start of each session, participants were asked for their consent to record the session both on audio and video. All participants provided active, verbal consent. Then, participants were given a short presentation on the purpose and relevance of this study. Following this presentation, the participants were shown a video of approximately 5 minutes about the use and functions of robot tutors (online available at https://osf.io/xc5vt/).

The video was included to level participants with similar basic knowledge of educational robots. The video included a general introduction to different kinds of robots, their current capabilities, and footage of a NAO robot used in a classroom setting. The video ended with the following question; "Robots in education, what do you think?". The images in the video were presented in a neutral way as to not influence the participants, but merely as a starting point for the discussion.

After the introduction video, there was a live demonstration of a NAO robot to get the participants even more familiar with the topic and engaged for discussion. The NAO introduced itself, performed a dance and interacted with the participants

through a short calculation exercise. During the demonstration, the NAO robot was teleoperated by an assistant-facilitator in each session, which the participants were made aware of.

Following the introduction of NAO, the discussion started. The facilitator emphasized to keep the robotic industry's perspective in mind and asked to write down all the opportunities related to educational robots they could think of on different post-its.

These opportunities were then discussed and further elaborated on by the participants. Thereafter, the facilitator asked the participant to do the same exercise but then for the robotic industry's concerns and potential harms. After both exercises were completed, the discussion moved on to the last part of the session. This part consisted of a free debate among the participants regarding anything that was not yet discussed and possibly bring a new opportunity or concern to the fore. This routine was applied for each of the conducted focus group sessions.

After finalizing the last focus group session, all audio recordings were transcribed and combined with the notes and post-it's taken from the sessions. Two additional researchers reviewed this process to reduce the chance of any possible biases and a coding scheme was constructed for further analysis, based on the Grounded Theory Approach [23].

III. Results

The concerns and opportunities related to the possible implementation of robots in educations that were reported by the stakeholders from a business perspective are presented in the following sub-sections. Each section consists of a description of the concerns and opportunities as mentioned. Thereafter, we interpret these in terms of the moral values that are at stake.

A. Opportunities

In this section, we present the opportunities as expressed by the participants from a robotics industry's perspective. The following five opportunities were identified when analyzing the data; A) appeal, B) creativity, C) new relationship with education, D) motivation & future preparations and E) new skills within a company.

1) Appeal

One of the main opportunities mentioned by participants in all of the three sessions is that a robot draws attention: "[...] it is an appealing product". Participants stated that the robot appeals to people in many ways and this could lead to the robot selling the hardware by itself, as well as the software needed for it to work. They mentioned that this attractiveness can increase their profit by making it easier to sell their products. One participant further mentioned that the robot could also assist a company by "advertising, the robot tells about my products". It was discussed that a robot could help a company to promote other robotic related products. Furthermore, two participants mentioned that the use of robots could create the opportunity to sell other software programs more easily, for instance, educational lessons to schools, because of the way they are presented and integrated within the robot.

2) Creativity

The focus group sessions expressed a strong indication that companies see robots as a way to boost their innovations. During one of the sessions, the following statement was made: "In my case, we learn a lot as a company, in a playful, fun way we are working on the technology and you get very creative with your ideas, and the big advantage is the feedback from the customers, from the people who are working with it, that actually accelerates, because they often come up with good ideas". Two participants also mentioned that the way children interact with a robot could be used to further improve their products and services.

3) Closer relationship with education

The possibility to create a closer relationship between robotic companies and schools was discussed as a positive potential of robot tutors. This closer relationship could lead to: "Creative ideas from education to companies" that can inspire companies in their approach to design and create robots. Furthermore, it was mentioned that having a closer relationship with schools could create the possibility to "[…] enter into a closer connection with the educational practice". This would give companies the opportunity to tailor their products much more to the current needs of the educational institutes who are using the robots.

Related, another participant mentioned that an opportunity for the robotics industry is that robots could be made "very smart" – beyond their current capabilities – because companies can get a constant feedback feed from this technology. Two participants mentioned that they could tailor their product based on the feedback and data received by the users and create a robot that would be useful for different types of children, with different learning needs.

4) Motivation and Preparing for the Future

Four participants in two of the sessions reported that robot tutors could potentially increase children's' interest in the robotic domain. Having better-educated people within this robotic domain was also mentioned by two participants as an opportunity. During the sessions, four participants mentioned a gap in what is currently taught in schools and how fast the robotic companies are currently evolving. To keep up with fast-developing robotic innovations, companies are looking for employees with adequate knowledge regarding (upcoming) technologies, which is posed to be arduous. They mentioned that the robot is: "[…] inspiring and motivating for the technology […]", and that it "[…] can also stimulate education at a young age in a certain direction". These statements referred to the expectancy that tutor robots would spark children's interest in working with this technology and that it would stimulate the technical skills needed for future employees.

Furthermore, one of the participants mentioned that in the near future, robots will take over basic and repetitive tasks within a company and there will be a necessity for employees who can program and control them. With programming and controlling a robot, the participant did not refer to "[…] hardcore programming" because "[…] that is going to shift much more to the background", but that the work of future employees will become much more "about learning how to model processes rather than real programming." This participant stated that schools should already start preparing for this change by teaching these skills in classes, this would benefit robotic companies in the long run.

B. Concerns

In the following section, we present the concerns discussed by the participants in relation to robot tutors from a robotic industry's perspective. The categories discussed below are classified according to the concerns that were mentioned most frequently throughout the groups. Expected reluctance of the schools to use a robot in education (1) was a main concern that multiple participants (n = 8) mentioned. Whether robot tutors would be accepted by the children (2) and the responsibility of the companies (3) were mentioned as the next two concerns. Finally, dealing with users' expectations and the need for continuous improvement (4) was discussed as well as the level of relevant expertise in the companies (5).

1) Reluctance of Schools

The reluctance of schools to implement robot tutors was the concern most often raised in the discussion in each of the three groups. Participants argued that especially among the teachers, there is a resistance to use robots in a classroom setting. One participant asked whether such resistance had anything to do with the fear that a teacher might have of being: "completely replaced by such a robot". Another participant said that this is currently indeed the case. The participant explained that this was one of the first concerns expressed when talking to teachers about the possibility of robot tutors. This idea contributed to the reluctance of schools towards the robots.

Besides the potential fear of being replaced by robots, two participants in two of the sessions also mentioned the limited applicability as a factor which contributes to the reluctance of schools. For example, "[…] many teachers, even after being trained how to use it, still have to take that step to … how am I actually going to use it? That takes time and nobody has that time". This statement refers to the bewilderment of the teachers, the lack of time and high work pressure they currently experience, which limits the possibility to explore and perhaps implement this technology.

2) Acceptability by Children

The children's acceptance of the robot tutors was also mentioned as a concern of the robotics industry. Five participants coined that there is a risk that pupils or even the teachers would not like or accept robot tutors when introduced in the classroom. This differs from the reluctance as discussed before (1), because at this stage a robot would already be present in a classroom setting. One participant illustrated this with a personal experience in which she introduced a new robot to children, and after two lessons the children said: "Those [the robots] are stupid, they can't do anything". This indicated that the expectations of the children might be higher than some companies currently foresee and that this is something to investigate before designing and introducing a (new) robot into the classroom.

3) Responsibility of Companies

Four participants agreed about mentioning copyright issues as a concern: "Uncertainty about copyright of application development". This argument relates to the ownership of a robot and its functions/programs. The participants wondered if they can still be held responsible when something goes wrong – either physically or in the way the robot teaches different subjects – when a robot is used within a classroom. Furthermore, they discussed that it was unclear if they would still have ownership of the educational software they might sell to schools. One participant mentioned that at this moment there are no clear responsibility guidelines for issues such as failures in the lesson materials of the robot. It was argued that without clear guidelines, the issue of being responsible in some way still poses a risk. The participants mentioned that they hope clear guidelines will soon be developed to create some transparency in this matter.

4) Expectations and Improvement

Three participants mentioned that robotic technology currently does not always work properly, which is a serious concern. One of the participants gave an example in which she went to a school to give a demonstration and that the robot did not do what was planned due to technological issues. As confirmed by other participants, this creates a situation in which the often-high expectations of the users drop significantly. This problem indicates that this technology is still very nascent and that, when implementing a robot too soon, these problems could contribute to a negative bias towards robots.

Besides the concerns regarding the technology not working properly, two participants mentioned that "[…] investments that you have to make continually [...], come up with something innovative", and the fact that "[…] companies also have to adjust their strategy to the changing situation" are disadvantages of this technique. With these arguments, the participants referred to a company's need to come up with innovative products and services at an accelerated rate to stay ahead of their competition, and the costs associated with this. When robots become more familiar in a classroom setting, some schools might look at companies with the newest developments within this domain. If a company would fall behind, this could damage their status towards their customers.

Companies run the risk of putting their product too quickly on the market, because of the vastly changing robotics domain. One participant mentioned that "[…] the company can have too high expectations and therefore put products too early on the market". When a company feels the pressure to deliver a new version of their product, they could run the risk of having more software and/or hardware related difficulties. These issues could make it harder to find a balance between innovation and quality.

5) Expertise Needed

A last concern discussed in the focus groups, is related to the expertise needed when working with this technology. Two participants expressed the concern that "[…] you have to have skilled staff […]". This indicates that some companies apparently have a hard time finding qualified employees for the tasks required to design and develop robot tutors. When the demand for social robots will rise, participants argued, society will need more employees who know how to program these robots.

C. Business Values

Following the VSD methodology, we mapped the concerns and opportunities derived from the focus group sessions onto business values prevailing in the literature. Cameron and Quinn (2011) [24] identified 26 business values derived from different organizational cultures From these 26 business values, we could relate six to the concerns and opportunities raised in our focus group sessions, which is discussed next.

1) Profitability

According to our findings, the main business value that would positively be affected by the introduction of robot tutors from a robotic industry perspective, is the profitability of a company. Profitability in our study is defined as "All the tools surrounding a given investment to earn a return from its use" [25]. A main reason for robotic companies to build a robot tutor might be to increase the turnover of a company. In part, this might be driven by the current intriguing nature of robots (robots are 'hot'). This would make promoting and selling robots, and its corresponding software, easier to achieve.

One participant mentioned as an example that the robot even has the capability to sell itself. With this example, he referred to the possibility of a robot to talk to and interact with potential customers. Furthermore, the possibility to sell other related software products, such as educational lessons or the core software for a robot to function, increases the chances of generating higher profitability for a company.

In addition to the positive effects for profit, there were also concerns mentioned that could undermine this value. Participants perceived that robots are sometimes harder to sell within a certain target group, such as teachers, because of their reluctance towards tutor robots. Furthermore, the participants argued from their experience that teachers are very hesitant when deciding to purchase robot tutors. The current inadequacies of robot tutors downplay live demonstrations, which in turn could disinterest already hesitant potential buyers even further. It is perceivable that if a robot breaks down in front of a potential buyer who is still in doubt, this could negatively impact their decision to purchase a robot.

2) Productivity

Productivity in our study is defined as how efficiently the production inputs, such as labor and capital, are being used in an economy to produce a given level of output [26]. The participants mentioned that the use of robots can have a positive effect on their productivity. However, continued research and development seem to be required to keep the production process on a desired level, because of the constantly changing nature in the robotics domain. If these developments are halted, a risk is present of undermining the productivity of a company.

Employees are therefore required to constantly learn new skills to keep up with this change and stay capable of doing their jobs. The participants mentioned that pupils should already start learning the newest skills. This would potentially reduce training time for new employees, and thereby not undermine the productivity of a robotics company. To ensure that the adequate skills are taught to young professionals, the participants considered a robot tutor as a suitable tool to promote these technical skills and mindsets to pupils who are currently still in school. When implementing robots within schools, the participants mentioned that they hope it will stimulate an interest in children regarding this technology and possibly steer children towards a more technical profile. This could potentially lead to more skilled future employees and a mindset needed for future development of the robotics industry.

3) Innovation and Creativity

Innovation in this study is defined as "[…] a constant search for more value, entrepreneurship, and opportunities to use knowledge for growth" [27]. The participants discussed that the use of robots increases their creativity because of the playful way that they can work with this technology. The personal feedback they receive from the children and teachers working with the robots could boost the innovation of this product at an accelerated rate. Furthermore, because a robot can register different kinds of data, such as audio and video, the participants mentioned that their companies could gather considerable amounts of information from their users. This could help companies to also be creative in other ways and potentially lead to new products and services.

4) Competitiveness

Competitiveness in our study refers to a company's ability to provide products and services that are more effectively and efficiently than the relevant competitors [28]. Multiple participants (n = 3) mentioned that this business value might mostly be negatively affected regarding robots in education. The quickly changing domain of robotics requires companies to adapt their strategies on a large scale. This might run the risk of their product to be less efficient because there is less time to optimize them. The participants mentioned that this puts greater pressure on their companies because they all want to stay on top. Furthermore, the high expectations of the users were also mentioned as putting more stress on a company, because this makes it harder to anticipate and achieve their users' needs. All these concerns could lead a robotic company to introduce its product too soon, which could have negative effects on a company's brand.

5) Risk Orientation Organization

The business value 'risk orientation organization' refers in this study to the uncertainty or potentially disappointing outcomes of certain decisions that a company can encounter [29]. Multiple participants (n = 2) in two of the sessions mentioned that it is currently unclear whether a company could and should be held responsible for an issue derived from the use of a robot within an educational context. This uncertainty reinforces the risk of a company to be overly cautious regarding the implementation of robot tutors within schools. Furthermore, it may also undermine other business values in creating more restraints to the development of their products within this domain. Because it is unclear how this will play out in the future, the participants mentioned that this is something to keep in mind when working in the robotics industry.

IV. Discussion

In this paper, we described the business values that are at stake when robot tutors would be implemented in schools, according to stakeholders from the robotic industry. The business values under consideration were derived from a review of business values as described by Cameron and Quinn [24]. Out of 26 business values, mainly six business values appeared relevant for robot tutors: 1) profitability, 2) productivity, 3 & 4) innovation and creativity, 5) competitiveness, and 6) risk orientation organization. The results of the focus group sessions indicate that the possibility to increase a company's profit was mentioned as the main motivation of a robotics company to build, sell or work with robots.

One way to increase a company's profit and create new products mentioned by the participants was to utilize the robot's ability to gather (personal) data of children. However, none of the participants mentioned privacy issues related to this opportunity. This is surprising since privacy is one of the key (moral) values related to robot tutors from a child and teacher perspective [11]. This shows that the business values of robotic

companies can conflict with the (moral) values of other main stakeholders, such as children and teachers. Therefore, more research on conflicting values of different stakeholders should be examined in future research.

Besides the aforementioned conflicting values, it is also interesting that the participants mentioned future preparations and a broader awareness of programming as a benefit of using these robots. This indicates that not only do the robotic company's look for ways to make a profit but also look at this technology from a more corporate social responsibility perspective. This study solely focused on social robots as a potential tool in education, as described in the introduction. A future study might compare the potential concerns and opportunities that other types of robots, such as built and use bots, from various stakeholder perspectives.

V. Conclusion

For this study, we examined how stakeholders from a robotic industry's perspective discussed potential concerns and opportunities when using robots in education. We then mapped these concerns and opportunities onto business values prevailing in the organization literature. The results indicate that a generally positive effect on the business values are expected. Robotic companies see this technology as a new way to generate a profit for their company in the long run. According to the participants, the data gathered from robots could create a far more tailored product over time and could create new functions within a company by requiring new creative skills to be developed in a way that is enticing by its users. Furthermore, the possibility to connect the robotic industry and education give companies a better understanding of the needs that schools have and in turn, also gives them the possibility to steer education in a certain direction. Almost all participants agreed that the use of robots at an early stage in education, as a form of introducing modern techniques to younger people, is necessary to make sure that in the future enough people will have the knowledge and skill-set needed to work with this technology.

The concerns of the robotics industry are mostly focused on the fear of losing a profit. Almost all the concerns and opportunities related to tutor robots from a robotic industry's perspective can be originated to the business value of profitability. Besides the profitability, the robotic industry often mentioned the fear that schools are reluctant and children might be limited in their acceptability due to technical failures. These fears can be overcome but require, according to the participants, a different approach and a change in the current way that the educational setting is organized. Furthermore, the ambiguity about copyright and responsibility issues are still open. It was mentioned that the issue of responsibility could even halt the development of introducing new software within an educational context. Participants mentioned that this would be a huge miss for robotic companies.

The business values identified from a robotic industry perspective have the potential to conflict with other stakeholders, such as the value of privacy upheld by teachers and children. It is therefore worthwhile to compare the values, concerns and opportunities from various relevant stakeholders in further research. Currently, it is unclear which values of different stakeholders correspond or may conflict, and how possible conflicts could be resolved.

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