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“Robot Teachers in the classroom: An ethical evaluation.”

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Declaration of authenticity

I confirm to have conceived and written this paper in English all by myself.

Quotations from other authors and any ideas borrowed and/or paraphrased from works of other authors are all clearly marked within the text and acknowledged in the bibliographical references.

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1. Introduction

Nowadays robots take over more and more tasks for humans. While their use used to be restricted to industrial settings like for instance car factories, they are now increasingly used to support humans in all kinds of situations. By now, there is more demand to use them in interpersonal aspects of our lives. Take for example the use of robots in health care, sex-robots, military robots, robotic cars, and robots in education. As these robots are in closer interaction with humans, they have a much bigger impact on our lives which in turn raises a number of ethical implications.

The aim of this paper is to answer the question whether social robots can take over tasks, originally only performed by humans. More specifically, the author of this paper seeks to answer the question whether robots can replace teachers.

In order to answer this question, this paper is structured as follows: There will first (1) be an introductory part which focuses on the field of robot ethics in general. It will outline the necessity for ethical discussion of emerging social robots. There will be four different kinds of social robots presented, namely sexbots, care robots, military robots, and self-driving cars. Each one will be discussed regarding its advantages, disadvantages as well as its ethical implications.

The second part (2) of this thesis will focus on the three main ethical implications that arise with the introduction of social robots, i.e. responsibility, safety, and privacy. First, it will be argued that robots are increasingly autonomous and thus the question about agency and responsibility arises. Furthermore, it will be argued that such social robots can indeed interfere with humans' safety and privacy.

In the third part (3) the focus will first lie on (digital) technologies that are currently already used in the classroom. Examples will be given, namely YouTube, E-learning, and tablets. Then, I will focus on robot teachers and answer the question why there is the idea of replacing teacher by robots. I will give three examples of robots currently used as teachers in the classroom. These are Thymio II, SAYA, and RoboThespian. These robots differ not only in their appearance but also in their features and skills.

In the fourth part (4) the focus will switch from robot teachers to human teachers. More specifically, I aim to present the various functions and roles that a teacher has in a classroom. The goal is to show that a teacher does not merely recite knowledge but can be regarded as much more. I will show that teachers have a huge impact on students and thus also shape students' lives. Teachers not only function as mediator of learning but also fill a complex set of roles. Besides their role of imparting knowledge to students, teachers function as disciplinarian and controller of student behavior, parent substitute, confidant to students, and role model. Teaching involves much more than simply standing in front of a class and lecturing. It involves human contact, feelings and emotions and especially empathy. Teachers must be able to react and respond to their students' needs; for instance, to their strengths and weaknesses but also to worry, or conflicts in the classroom community. Nobody can deny that the role of teachers is demanding and requires much more than excellent knowledge in a subject but excellent social skills.

In the fifth part (5), I will outline the important nature of a positive and supportive teacher-student relationship. Various authors, including feminists, argue that a quality-relationship between teacher and student can be beneficial for both the students' academic as well as their social development. On the contrary, a negative and conflictual relationship may put the students at risk of school failure and behavioral problems.

The sixth part (6) of this paper focuses on the ethical issues raised by robotic teachers. It is concerned with the question if robots could replace human teachers and whether it would be possible that they take over all the functions a human teacher has. This section will be centered around the following ethical problems: (5.1) loss of human contact, attachments, and deception, (5.2) control and accountability, and (5.3) privacy issues. These issues need to be taken into account before placing robots in the classroom. As argued in the previous section, teachers have a huge impact on students' and are thus an import figure in their lives. The question is whether a robot can take over the role of a teacher or rather whether robots used as teachers can be harmful.

In the conclusion, I will argue that robots are not able to function as substitutes for human teachers, unless they will be able to eventually develop human social capabilities. Thus, robots in the classroom should be used with caution and only under limited circumstances, i.e. as tool that supports the teaching by humans.

1.1. Robot Ethics

The current technological development in robotics and “the exponential growth of robot technology in non-industrial settings” (Fosch-Villaronga and Roig 2017: 502) give reason to critically engage in ethical discussions. As robotics is a rapidly growing field, we must be prepared for the “social and ethical challenges [that] emerge from robotics” (Lin 2012: 3). There is a strong need for laws and regulations which tackle the problems that can arise from the use of robots. Nowadays, many robots “imply a close human-robot interaction (HRI)” (Fosch-Villaronga and Roig 2017: 502); take for instance robots used in elderly care or child care, self-driving cars or sexbots. Such close HRI give rise to various ethical challenges including concerns about insufficient programming, privacy issues, responsibility, social issues like deception as well as safety and errors. Human safety must be ensured in such environments.

The field called *Robot Ethics* is concerned with the ethical issues that arise with the use of robots. It argues that robots' design should be adjusted in such ways that it is programmed to act in an ethical manner and does not harm humans.

Isaac Asimov can be regarded as the first to directly address the ethics of robots. In 1942, he published his science fiction short story "Runaround", where Asimov explicitly mentions the *Three Laws of Robotics*. In providing these laws, Asimov lay the foundation for 'good robot behavior'. Asimov's Laws read as follows (Asimov 1950: 40):

> 1. A robot may not injure a human being or, through inaction, allow a human being to come to harm.
> 2. A robot must obey the orders given it by human beings except where such orders would conflict with the First Law.
> 3. A robot must protect its own existence as long as such protection does not conflict with the First or Second Laws.

As robots are becoming increasingly autonomous and thus need this kind of guidance it is up to us, more specifically to the engineers to think about how we want robots to treat us. Roboticists and ethicists are eager to install a set of principles into robots to work by. Often the laws by Asimov are used as foundation to install moral guidelines into robots. But how is it possible to equip robots with the right programming to act ethically and morally in a situation?

Especially social robots, which are very close to humans, need to be able to make right decisions. It needs to be able to choose between good or bad and in some cases, it must choose between two bad possibilities.

In the following sections, examples of social robots in our life will be given and discussed. These should not only raise awareness of how broad the field of robotics is but also show how close robots can nowadays be to humans.

1.2. Examples of social robots in our life

While robots where once only used to replace humans in manufacturing and industrial settings, they are nowadays increasingly incorporated into our society. Robots can be found almost everywhere, take for instance robots in healthcare and care for elderly people and children. There are also robots used in warfare as well as for research and education. By now, robots are even capable of replacing humans during difficult surgeries. They are used to explore places which would otherwise be inaccessible for humans like for example, the ocean, contaminated places or the Mars. They can fight at the battlefield or do such mundane things like vacuuming your house or mowing your lawn.

Given the difference between industrial and social robots, concerns about emotional bonds between human and robot must be emphasized. As robots are increasingly anthropomorphized the question arises whether people can “become over-invested in robots” (Lin et al. 2012: 203). Scheutz (2012: 205) even mentions the danger of affinity toward robots which can develop because of factors like for instance “appearance, environment, programming, mobility, autonomy, and perceived agency” (Lin et al. 2012: 203).

Social robots like therapy robots, robot pets or care robots are specifically designed for personal interaction, that is, they are part of our personal life and daily routine. As soon as robots enter the personal sphere, emotions and feelings inevitably arise. Breazeal (in Scheutz 2012) describes a social robot in the following way:

> a sociable robot is able to communicate and interact with us, understand, and even relate to us, in a personal way. It is a robot that is socially intelligent in a human-like way (205).

These characteristics clearly can have benefits for humans but a potential danger can also be identified. Scheutz (2012) for instance argues that it is possible that social robots could “inflict harm – emotional harm” (205).

In the following sections I will discuss sexbots, care robots, military robots and self-driving cars. These are examples that will show how beneficial social robots can be but there will also be discussion about their potential dangers.

1.2.1. Sexbots

Authors like for instance Levy (2012) and Whitby (2012) argue that "the arrival of sexbots seems imminent" (Levy 2012: 223) and that "there will almost certainly be increasing use of robots in intimate settings - and especially for sexual purposes" (Whitby 2012: 252).

Various advantageous reasons for the introduction of sexbots are identified in the literature on such technology (cf. Levy and Whitby 2012): firstly, it is argued that many people seek *variety*. A robot makes it not only possible to have sex with a wide range of different women, or more specifically differently designed robots, but also to experience and act out all kinds of sex practices. Ultimately, sexbots are able to "provide a variety in terms of conversation, its voice, its knowledge and virtual interests, its virtual personality, and just about every other aspect of its being, including appearance and size" (Levy 2012: 238). Furthermore, variety in sexual practices is made possible, to which clients would otherwise may not have access to because of their partners distinct sexual preferences.

Secondly, literature identifies *lack of complications and constraints* as another reason. Clients, willing to use sexbots, state that with robots there is this clear purpose as well as anonymity, brevity and impersonality. A robot will not talk back, start a fight, complain or request another meeting. If the client prefers, he can meet and immediately afterwards elope and never get in touch with the (artificial) woman again. When a human is involved, this behavior is not exhibited as easy but is linked to inhibitions, guilt and contrition.

Thirdly and probably one of the most obvious reason, is the *lack of success with the opposite sex.* Levy (2012) argues that men's inability to form relationships with women is often due to the man's "ugliness, physical deformity, or psychological inadequacy" (cf. 226). Men, lacking the social skills or abilities to attract a mate, fear rejection and therefore the only sex available is prostitution. Sexbots are "immune to any ugliness or physical deformity in their clients, and to their clients' psychological inadequacies" (Levy 2012: 226).

Additionally, it is argued that the introduction of sexbots could help prevent catching AIDS or other fatal sexually transmitted diseases. Parallelly, as it is the common assumption that prostitution is degrading, developments in sex robots could help women to stay away from this business and lifestyle for good. There would be no more need for women to sell their body to men. Most importantly, it could be possible to reduce or even prevent sexual crime. People unable to find lovers, for instance pedophiles, could be prevented from doing so. Thus, criminals would be the perfect target for sexbots (cf. Levy 2012).

The discussion above shows that numerous personal and emotional (discontent with own sex-life and lack of sexual contact) as well as societal problems (decrease in sexually transmitted diseases, reduction of prostitution and crime) could be eliminated by sexbots.

Still, however, there are indeed numerous negative aspects to sexbots. Scheutz (2012) mentions an underestimated and hidden danger: “the potential for humans’ emotional dependence on social robots” (205). This goes along with the argument that these robots are increasingly anthropomorphized and much more autonomous; and thus, are mistakenly perceived as agents[1]. This perceived agency has its roots in the robots’ ability to

> use […] its capabilities to pursue its goals, without intervention by any other agent in the decision-making processes used to determine how those goals should be pursued (Barber and Martin in Schutz 2012: 207).

Simply put, this mean that robots can be unmanned and still able to execute their duties; there is no need for human control. While this can be regarded as a brilliant development in technology, it presents a primary danger in the dealing with robots.

Scheutz (2012) argues that “humans anthropomorphize robots, project their own mentality onto them, and form what seem like emotional yet unidirectional relationships with them” (211). Humans becoming emotionally attached to robots is worrisome as the robot does not and indeed cannot (yet?) care about humans. Scheutz (2012) utters concerns about unidirectional emotional bonds to robots: they

[1] For more information on robot agency consult section 2.1

"create psychological dependencies that could have serious consequences for human societies because they can be exploited at a large scale" (216). Scheutz (2012) mentions the threat about people being manipulated by their beloved robot: the robot could get them to do things which they could not possibly have done before.

For illustration Scheutz (2012) gives the following example: a request of a futuristic *robo-dog*: "please get rid of this animal, he is scaring me, I don't want him around any longer" (216). Scheutz (2012) argues that robots could get people to perform such actions in order to maintain the relationship. In contrast to such unidirectional relationships, in (most) human relationships "social emotional mechanisms such as empathy and guilt would prevent the escalation of such scenarios" (Scheutz 2012: 2016) 2.

Levy (2012) mentions another argument which is held against the use of sexbots:

> prostitutes have careers based on giving pleasure, they can teach the sexually inexperienced how to become better lovers, they make people less lonely, they relieve millions on people of unwanted stress and tension, and they provide sex without commitment for those who want it (225).

Thus, prostitutes would be deprived from their jobs and their clients from the social benefits of prostitution if sex-robots would take over the prostitution market. While it is the common assumption that "prostitution harms women, exploits women,

[2] There will be more information on undirectional relationships between humans and robots in section 5.1

demeans women, spreads sexual diseases, fuels drug problems, leads to an increase in organized crime, breaks up relationships, and more” (Levy 2012: 225), there are, as Levy (2012) infers, women who enjoy this kind of business.

In conclusion, while a robotic prostitute can be very beneficial to people and the society, one must always consider the consequences that come into the picture when using robots. I have argued that a sex-robot does indeed pose some risks and ethical problems which must be considered but can also be advantageous for both clients and society.

1.2.2. Care Robots

Tools have already been used in health care for quite a long time, take for instance the MRI scanner or the computer at the GP’s practice (Coeckelbergh 2015a: 271). No one could deny that such inventions are of utmost importance and of course extremely beneficial to humans. Inventions like the MRI scanner cannot be assumed away as it depicts essential information and helps physicians in identifying and diagnosing a wide range of diseases and abnormalities. It is thus used for detecting tumors.

As a matter of fact, medical tools are constantly refined and new inventions are developed. Development in this field made it possible that medical and care technologies became increasingly autonomous, take for instance surgical robots or “mobile devices that function as interfaces through which doctors and nurses can communicate with their patients” (cf. Coeckelbergh 2015a: 266). Such devices can help patients as they offer a fast and easy way to get in touch with their doctor.

Coeckelbergh (2015a), for example, focuses on a rather innovative technology in medicine, namely care robots. These are robots which are developed to replace human nurses and caregivers and “carry out tasks usually assigned to humans” (Coeckelbergh 2015a: 266). At first sight, care robots appear to be highly advantageous as they can take over many tasks which caretakers would be happy to dismiss. One could imagine that robots take over the cleaning of patients, the night shifts, or make sure that pills are taken. Furthermore, a care-robot could be designed to communicate with patients, play cards with them or take them for a walk. All these aspects would be very profitable for not only the patients but also for the nurses.

There are, however, various ethical concerns that arise with the use of nursery-robots. Coeckelbergh (2015a) describes them as “artificial medical agents”: machines which are becoming increasingly autonomous (266). The crucial part is that they are not just built to support, help or assist medical caregivers but that they are designed to replace them. Given their autonomy, such robots appear as agents and are thus designed to (one day) take over the field of medical care takers and childcare.

The question clearly is whether such technology can and should take over tasks which are normally done by professionals. Is it ethically acceptable to put vulnerable people like young children or elderly people into the "hands" of a robot?

Sharkey and Sharkey (2010a) argue that "robots and robotic technology could improve the lives of the elderly, [in] reducing their dependence, and creating more opportunities for social interaction" (27). They list various promising developments in the field of assistive robotic technology:

- *My Spoon*, an automatic feeding robot
- *Sanyo,* an electric bathtub robot that automatically washes and rinses
- *Riba* (Robot for Interactive Body Assistance), a robot that can pick up and carry humans from a bed to a wheelchair
- Sophisticated wheelchairs which will take the user to a designated known location in an indoor environment on vocal command (cf. 29).

The examples above show that robots seem to be a beneficial innovation in the field of human health care and that care-robots could help to solve a great number of problems that elderly persons must face. Often, elderly people do not want to be a burden and feel guilty or even embarrassed that their family or nurses have to help them eat, use the bathroom or get from one room to another.

Yet, despite their promising nature and many advantages, such robots do indeed raise ethical concerns. These concerns mainly relate to an "increased social isolation, and […] involves deception and loss of dignity" (Sharkey and Sharkey 2010a: 27). After all, it appears as if the development of care-robots is more beneficial to the caregivers than focusing on improving the lives of the caretakers.

Objections must be uttered as the use of robots in care of people results in lack of human contact. Equally to sex-robots, care-robots could deprive senior citizens of "a valuable opportunity for social interaction" (Sharkey and Sharkey 2010a: 29). It must be stated that everyone, if not especially elderly people, "need contact with fellow human beings, and that their welfare would suffer in its absence" (Sharkey and Sharkey 2010a: 29). Concerning this argument, Sharkey and Sharkey (2010a) point out that lonely people are "more likely to develop Alzheimer's disease [and] dementia and that social contact can reduce the level of stress a person experiences" (29-30). This further reinforces the fact that deprivation of social contact is not ethical.

Additionally, one must mention the issue of deception[3]. Given the robots appearance and autonomy, we again must argue that people, for example the elderly or children, are tricked into thinking that the robot is capable of forming a proper relationship. Robots "can interact with people, and even show simulated emotions […]" (Sharkey and Sharkey 2010a: 35). Thus, elderly people could perceive them as real companions and consequently develop deep feelings which cannot be reciprocated in a satisfying way.

[3] For more information on *deception* consult section 5.1

In conclusion, when considering criteria for *good care,* one must agree with Coeckelbergh (2015a), namely that "machines in care are unacceptable, if and *insofar as* the machines *appear* as agents that take over care tasks" (273). Clearly, if machines and care robots are solely used as tools in order to assist human care takers, it would be acceptable to use robots in health care since the responsibility and agency "remains on the side of the human" (Coeckelbergh 2015a: 273). If, however, the patient is put into the responsibility of a robot which obviously cannot take over the role of a caregiver, it is unacceptable as they cannot meet the criteria proposed for good care. These include, besides others, *a significant amount of human contact* and *emotional and psychological support* (cf. Coeckelbergh 2015a).

1.2.3. Military Robots

Robotics does not spare the military. Or to be correct, one must argue the military does not spare robotics, more specifically engineers. Indeed, it is the military which "fund a significant amount of – and perhaps even most – robotics research today" (Sparrow 2012: 57). Also, Lin et al. (2012) argue that "the military services are a large driver of robotics research and development" (109). Currently, the military is "working to develop and perfect the technologies for the next generation of unmanned aerial vehicles, unmanned surface vehicles, and unmanned submersibles" (Sparrow 2012: 57).

Clearly, the ethical hazards of military robots are tremendous. This is because the use of such robots can often be lethal. Despite their deadly character, however, Lin et al. (2012) point out that

> Not all military robots are killing machines. Quite the contrary, many are concerned with saving lives by moving into potential danger zones ahead of or instead of human soldiers, as well as rescuing wounded personnel (109).

Still, ethical problems arise with their use and must be discussed here. Authors like Sharkey, Guarini & Bello, Coeckelbergh, and Lokhort & van den Hoven address issues concerning the ethical status of robots. For instance, they focus on how military robots change the nature of war (cf. Sharkey and Coeckelbergh) or the question of responsibility (cf. Lokhorst and van den Hoven).

Coeckelbergh (2013) and Sharkey (2012) emphasize how war has changed since the introduction of military robots, more specifically since the development of drones. Drones make distant fighting possible and are “designed to separate fighters from their foes” (Sharkey 2012: 111). A major argument adopted by many who highlight the benefits of drones is the distance created between the fighters. It is even inferred that “distance weapons led to a more effective killing technology” (Sharkey 2012: 111); mainly because it is possible to eliminate the number one reasons why warfighters are unable to fight effectively: “fear of being killed and resistance to killing” (Sharkey 2012: 111). With drones, it is possible to extinguish this fear as the killing takes place far away from the killer and machines do not know fear. Major Kenneth Rose, a trainer of the US Army's Training and Doctrine Command, depicts important advantages that come with the use of military robots:

> Machines don't get tired. They don't close their eyes. They don't hide under trees when it rains and they don't talk to their friends [...]. A human's attention to detail on guard duty drops dramatically in the first 30 minutes [...]. Machines know no fear (*BBC News*).

So, machines constitute many advantages concerning the effectiveness of soldiers. But it is also argued that military robots are beneficial for the soldiers themselves. Military robots help to save soldiers' lives. Soldiers are removed from the battlefield; they are safely positioned somewhere in a room, the cockpit, where they operate the machines. There is no more need for them to be on the battlefield themselves. In fact, there is a great physical distance between killer and target. While it has been argued that this distance is to the advantage of the soldier and the military, it will now be outlined what consequences this physical distance has.

Coeckelbergh and Sharkey argue that through this physical distance also moral distance is created. Confer for instance the following thesis made by Coeckelbergh (2013):

> *By means of new teletechnologies, (more) physical distance is bridged, but at the same time (more) moral distance is created* (88).

In explanation, killing is made easier. The operators of the drones are far away from their target and thus "feel no particular emotion about the moral consequences of their actions" (Coeckelbergh 2013: 88). It could even be claimed that "the killing is easier since the practice appears to the pilots as a videogame: promoting an entirely detached view of the of the battlefield" (Coeckelbergh 2013: 94). There is indeed a big difference to drone-fighting and face-to-face fighting:

> In body-to-body fighting, the fighter sees the eyes and body of his opponent, and has body contact with him. He smells him, feels him, hears him. The fighters see, smell and feel the skin, the bodily movements, the breathing, the sweat, and perhaps the blood of their opponent. During the fight, they are frequently and literally *in touch* (Coeckelbergh 2013: 90).

This enables the fighter to immediately see the consequences of his actions. There is no distance, indeed face-to-face fighting is very personal. One might even argue that there may be some degree of empathy (at least in most fighters). The personal matter and empathy make killing more difficult. Looking someone in the eyes while pulling the trigger of a gun includes more moral inhibitions than operating a drone from far away and pushing a button. According to Coeckelbergh (2013), the soldier on the battlefield perceives his opponent as vulnerable person and thus rather refrains from cruelty and killing. An autonomous machine, on the other hand, will never refrain from killing. If it was programmed to kill, it does not care about the target and will perform its order no matter what.

Coeckelbergh (2013) mentions another negative aspect about remote killing concerning fairness. He argues that machine fighting is not only unfair but also cowardly. While one “team” is right at the battlefield fighting with their hands and guns, the other one is fighting from the cockpit. There is an unequal power relationship, an asymmetry, which “may be regarded as unfair, and in terms of virtue and vice the drone fighter could be called ‘cowardly’” (Coeckelbergh 2013: 92).

Furthermore, it must be stated that, given the huge impact of the bombs dropped by drone, it is inevitable to miss civilians. While on the battlefield the soldier knows exactly who he is aiming his gun at, the drone-pilot cannot make sure that the bomb will only hit the target he is aiming for.

Still, however, it is unfair to claim that operators of drones and pilots on the battlefield act free of emotion or moral reflection. Drone operators are still emotional human beings and know that they are killing people, despite the fact that they are removed from the real battlefield. Indeed, drone fighting is not just handling the stick and watching the screen; it is not a videogame.

In the end, one must argue that military robots entail numerous advantages, namely more safety for soldiers and more effective killing (if one wants to regard effective killing as advantage). On the other side, however, killing becomes colder as the physical distance also creates a moral distance. Still, it must be argued that morality is not completely extinguished. Operators keep their ability to reflect on their actions.

1.2.4. Self-Driving Cars

Self-driving cars or also referred to as autonomous cars or robotic cars are vehicles which can drive all by themselves. No humans are needed to control or navigate the car. Thanks to its built-in software, which scans and senses the environment, it can be unmanned. While they are at the moment not permitted at public roads (there must be a human behind the wheel who can take over at any time) it may be possible that they entirely replace normal cars in the future.

Many argue for the introduction of autonomous cars. One of these is Sebastian Thrun, the Director of the Stanford Artificial Intelligence Lab and the project leader of Google's Driverless Cars project. He claims that self-driving cars can “help to prevent traffic accidents, free up people’s time and reduce carbon emission” (Thrun 2010).

Concerning the argument that autonomous cars help to free up people’s time, Thrun (2010) points out that “almost all congestion has nothing to do [with] how many cars there are and how many miles you drive” (15:09-15:16min) but with the way we use our highways. He explains that about 92% of the roadway on highways is not utilized; this is the space between the cars. Only 8% of the surface area is actually occupied by cars. With autonomous cars, more space of the roads could be used as the safety gaps between cars could be reduced. Thus, making it possible to save time and decrease the time lost in congestion. With the space used more efficiently, speed limits could also be higher (Houston Chronicle 2012) which again leads to more time-efficiency. Additionally, the time spent in cars can be used for things like reading, making phone calls or other things that cannot be carried out while driving an ordinary car.

Furthermore, car sharing could be implemented more easily. Autonomous cars can, after you exit the car, pick up other people, instead of being parked at the parking lot the whole day while you are at work. This ultimately leads to less cars needed and thus means even more reduction in carbon emission (cf. Thrun 2010).

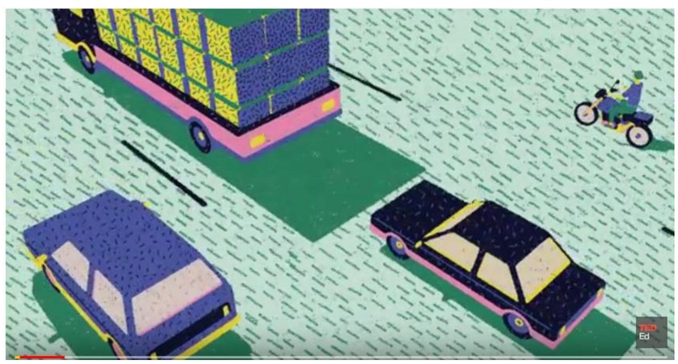
Additionally, driving could again be possible for those who would otherwise not be able to drive. Take for example, the people who are visually impaired or the elderly. Robotic cars could help them to get from A to B. Of course, nowadays they could just call a taxi which would do the same job. Taxis, however, are rather expensive and people who are unable to drive should not be dependent on a cab company.

Another major argument in favor of autonomous cars is the claim that car fatalities can be drastically reduced. Most car accidents happen due to lack of attention and lack of skill (Thrun 2010). Humans get easily distracted while driving. More and more people, despite the law, use their phones while behind the wheel or are just too tired to drive. Robots are always attentive. In fact, a robotic car performs multiple things at the same time. Thus, robotic cars, Thrun (2010) argues, make it possible to reduce traffic accidents by 90 percent.

While these arguments all seem very promising, one must take into account the risks and ethical problems that arise with autonomous cars. Most importantly, questions about their ethical status arise. What if something goes wrong, who is to blame and responsible? Will the car be blamed? The engineer or the manufacturer? When programming such cars, can engineers preconceive all contingencies?

Authors like Lin (2015) and Coeckelbergh (2016) explore and discuss these questions. When discussing the cars ethical responsibility, Lin (2015b) proposes the following dilemma:

> Imagine, you are driving down the highway in your self-driving car and you find yourself boxed in on all sides by other cars. Suddenly a large heavy object falls off the truck in front of you. Your car can't stop in time to avoid the collision, so it needs to make a decision: Go straight and hit the object? Swerve left into an SUV? Or swerve right into a motorcycle? Should it prioritize your safety by hitting the motorcycle? Minimize danger to others by not swerving even if it means hitting a larger object and sacrificing your life? Or take the middle ground by hitting



> the SUV which has a high passenger-safety rating? So, what should the self-driving car do? (TED-Ed: 0:5-0:57min).

This dilemma illustrates how difficult it is to program an autonomous car and how difficult it is to ascribe responsibility when it comes to robotic cars. If a human was driving in this particular situation, she or he would not think about what to do. The person will not weigh all the different options and then decide on the best one. The person driving reacts automatically. It is thus understood as a reaction and not a deliberate decision. Rather, it is an instinctual, panicked move with no forethought. In self-driving cars, however, the human "stops being a driver and becomes a passenger" (Coeckelbergh 2016: 754). Humans do not really have an influence anymore. The car decides, according to its programming, what to do.

And as robotic cars are designed and programmed to "avoid causing harm to its passengers and other human traffic participants" (Coeckelbergh 2016: 749), there must be some kind of ethical manual upon which the robot decides on an action. In these so-called 'trolley problems' where there is not right way to act, the decision can only concern *who* to kill and not *if* to kill. But who could be in the position to design such guidelines? Such scenarios can help to make these cars safer and need to be taken into account but still it is extremely difficult to preprogram the car for such situations.

It is again the case that the robot offers a lot of advantages. Still, however, there are a lot of ethical implications which need to be considered. While a robotic car promises to be safer, environmentally friendlier and more time saving, it can be ethically problematic. The ethical implications become apparent by considering trolley problems. It is hard to predict whether these issues can ever be solved; obviously, there is need for discussion.

In this section, I have highlighted and discussed four examples of social robots. Concerns and benefits associated with the incorporation of sex-robots, care-robots, military robots and self-driving cars have been articulated. All robots, which I focused on, constitute a lot of advantages. Every single one is designed to make our lives easier. At first, they do in fact appear to be extremely beneficial – who would not want robots which can care for us, our children or our grandmother? Or have your car drive you to the next mall while you can lean back and relax? On the contrary, the various discussions above show that society is still not entirely ready for the robotic support. I argue so because there are too many unresolved issues, especially ethical questions, which need to be sorted out. In particular, the issues concerning responsibility and moral agency, safety, and privacy need to be clarified. These issues will thus be the focus of the next section.

2. Ethical implications of social robots

While each social robot implies its own ethical concerns, there are indeed three implications which affect most, or rather, all social robots. The ethical implication which are to follow and discussed here are (1) responsibility and moral agency, (2) safety and errors, and (3) privacy.

2.1 Responsibility – robots as moral agents?

Neuhäuser (2015) argues that it could eventually be possible that robots "develop their own personality, love, hate other robots and humans, develop individual life plans, they would learn to respect themselves, and even suffer from low self-esteem" (131). In other words, robots would become very much human-like. As a matter of fact, robots are already becoming increasingly human-like and it has already been attempted to build such robots (cf. Neuhäuser 2015: 131). While it is not (yet) possible to design a completely human-like robot, it is indeed (as the previous section shows) possible that robots perform tasks that once were only carried out by humans. As Neuhäuser (2015) puts it:

> Robots perform transactions in financial markets and could perhaps even be (co-) blamed for the current financial crisis. Robots can defuse bombs during wars and can even shoot people or drop bombs on them. They can commit war crimes if they attack the

> wrong persons, innocent civilians for instance. Robots, like the German Care-O-Robot, now serve and assist older people who might otherwise be unable to cope with everyday life (132).

Most would agree that robots are very beneficial to us humans. They support and help us and are designed to make our lives easier. The crucial part, however, is that, in their position to help and replace humans, something could go wrong. For instance, robots could act in a completely wrong way and thereby cause damage; or even worse, it could be possible that they physically as well as psychologically harm people.

With the current trend to make robots more and more autonomous, this danger becomes even more apparent. While in many cases robots are still operated, and controlled directly by humans, like for instance combat drones, some are not operated directly but are designed to follow complex computer programs. Neuhäuser (2015) points out that “in simple cases, such as service robots, one can clearly see what type of programmes, they execute and how they operate following their commands” (132). Contrary to that in some cases however, the original programs cannot be perceived easily. This is due to the fact that robots, like the ones already operating at the financial market, “are capable of learning” and are able to “assimilate a large amount of information” (Neuhäuser 2015: 132). This has effects on the robot’s action and can trick people into thinking that it is “an independent machine pursuing its own goals” (Neuhäuser 2015: 132). As robots are capable of learning there is constant adjustment in their behavior; behavior which was not originally programed. Consequently, robots possess some degree of autonomy. If robots possess autonomy, the question concerning their moral status arises. The more autonomous robots get the more responsibilities they have. Think about the care-robot which lifts an elderly from the bed to his wheelchair or the self-driving car which is responsible to drive safely from point A to B. But can these robots really be responsible for these actions? What if the care-robot drops the patient? Who is to blame then?

More specifically, one might ask if robots are capable of acting in a moral and responsible way. Can they thus be regarded as moral agents? And furthermore, could they be considered moral agents who possess moral rights themselves? While the question about the moral status of robots themselves is not the focus of this paper, the question whether they can act responsible and thus can be made accountable is of interest.

First, one must clarify the question *what is a moral agent*? A moral agent can be described as an individual who is able to determine, according to the context and situation, what is good and bad. Thus, as a moral agent can deliberately decide what to do in a situation. The emphasis here lies on *deliberately*. A moral agent has the freedom to choose between different options. It is his own will to perform a particular action. Also, Misselhorn (2013) takes this view, as her argument illustrates: "agents are in some sense self-originating sources of their doing, i.e., that their actions are not determined by external factors, involve some sort of flexibility, or are under the control of the agent" (2). Furthermore, the actions by moral agents can be described to be performed with reason. According to this, an agent has "the capacity to act for reason" (Misselhorn 2013: 2). Thus, he or she can be held accountable for his or her behavior. But what exactly makes humans moral agents and what distinguishes them from other, not moral, agents?

Abney (2012) claims that (most) humans are uniquely moral beings because of the fact that they have "not one but two types of decision-making systems" (46). While humans share the ability to instinctively react to a situation with, for instance, animals, it is the humans' sole ability to reflect upon their initial and intuitive behavior which sets them apart from them. Humans alone can, in retrospect, decide whether his or her reaction was appropriate and, if necessary, try to alter its effects. Abney (2012) refers to these two systems as a) *the instinctual, emotionally laden system* and b) *the deliberative system* (cf. 46).

The former described as to "serve as the default for much of human activity, particularly when stressed or under pressure" (Abney 2012: 46). This is the system we share with animals. A deer, for example, can instinctively react to a danger by fleeing as soon as it hears an unusual noise. The later, described as "a 'veto' ability [enables us to] still alter our action" (Abney 2012: 46). Humans can reflect on their actions. After a human's reaction, he or she can determine whether the initial behavior needs alteration.

A robot on the contrary cannot reflect upon its actions; it does what it has been programmed to do. Even if a robot appears to be entirely autonomous, it cannot make up its mind whether its actions are morally good or bad. Also, Allan and Wallach (2012) argue that "there are miles to go before the full moral agency of (ro)bots can be realistically conceived" (62). They and many others argue that, at the moment, a robot cannot act in a moral way (on its own). Thus, cannot be regarded as moral agent.

If this is so, the question about accountability and responsibility remains. If a robot is not a moral agent but is increasingly "involved in situations that have moral character" (Sullins 2006: 24), who is responsible for its actions? According to Sullins (2006) the answer to this question is straightforward: "if a robot is simply a tool, then the morality of the situation resides fully with the users and/or the designer" (24). He, however, does not agree with the previously stated argumentation that robots cannot be regarded as moral agents.

In fact, Sullins (2006)[4] argues that autonomous robots are indeed moral agents. He does not consider all robots moral agents but claims that "in order to evaluate the

[4] See also Luciano Floridi and J.W. Sanders (2004)

moral status of any autonomous robotic technology, one need to ask three questions" (28). The questions he proposes are the following:

- Is the robot significantly autonomous?
- Is the robot's behavior intentional?
- Is the robot in a position of responsibility? (cf. Sullins 2006: 28).

Thus, in Sullins' (2006) words, a robot is a moral agent if it has autonomy, intentionality and responsibility. Concerning autonomy, he argues, that as soon as the robot is capable of making its own decisions and is not dependent on any users or operators, which they most certainly are (cf. vacuum robot navigates itself), "these machines are somewhat responsible" (Sullins 2006: 26).

Consequently, the designer is not the only one who can be blamed if the robot malfunctions. Furthermore, the robot must be able to act intentionally. For Sullins (2006) it is enough that the robot's "actions are seemingly deliberate and calculated" in order to ascribe moral agency to it. Meaning that, if a robot is acting morally harmful or beneficial it must be taken into account whether this action is performed intentionally or deliberately. Finally, Sullins (2006) assumes that if the robot "has a responsibility to some other moral agent(s)", it can be regarded as moral agent. Take again the example of the robotic caretake: here the robot must make sure to care for its patient in a responsible manner just as a human nurse would do.

Many, including me, would argue against this viewpoint. Because of the opinion that robots are never really autonomous, cannot act entirely intentional and thus cannot take responsibility for their actions or patients. Sullins (2006) counters by providing the following argument: these characteristics need to be seen “from a reasonable level of abstraction” (24). According to him (see also Floridi & Sanders 2004) robots do not need to have real autonomous intentions and responsibilities – it is sufficient that they appear to be so (cf. 29).

Whether robots should be regarded as agents and thus making them responsible difficult to answer. Still, it must be taken into account as human-robot interaction (HRI) increases and robots thus can have a huge impact on our lives. Additionally, to the question about agency and responsibility, the issues of safety in HRI arises. Safety concerning robots will be the focus of the next section.

2.2 Safety: Human-Robot Interaction

As robots’ scope of duties extends, the demand for safety and proper functioning increases. More specifically, as Murashow et al. (2017) point out, “the increasing use of robots in performing tasks alongside or together with human[s] [..] raises novel […] safety and health issues” (1). Robots’ software is extraordinarily complex, which makes it highly vulnerable to errors. Cleary, there is a lot of pressure on the part of the engineers as “even a tiny software flaw in machinery, such as a car or a robot, could lead to fatal results" (Lin 2012: 7). People need to be instructed about how to properly use a robot, especially "how to operate the robot, and how to operate around it safely" (cf. Robot Worx: a Scott Company) as many robots work "with enough force and speed to severely injure or kill a person" (cf. Robot Worx: a Scott Company).

There are already a lot of safety measures taken for industrial robots, for instance "new software-based safety systems can slow a robot to a safe speed […], allowing people to share the same workspace with far less risk" or "new wireless technology eliminates the cable, reducing the risk that operators could trip over the cord or becoming entangled with other equipment in the work cell" (Schuster and Winrich).

Non-industrial robots, namely social robots like for instance personal care robots must also fulfill safety requirements. As service robots perform actions which directly affect humans, they must guarantee safety and reliability. Thus, "any risk of injury to humans must be fully eliminated" (Fraunhofer IFF).

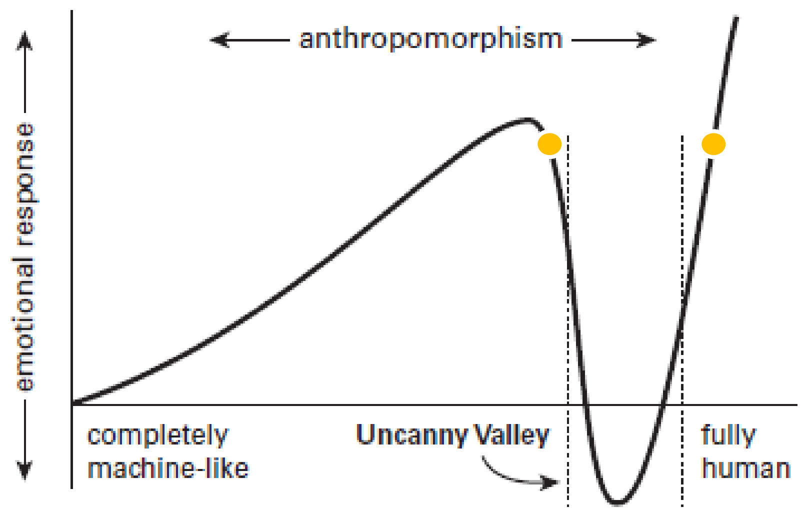
Lasota et al. (2014) investigated human-robot interaction (HRI) and identified two different kinds of risks "in which a robot could inflict harm on a human being" (263). They define the first one as *physical safety*. Thus, harming people through close physical contact. Imagine for example a care robot lifting an elderly person and dropping the patient or the self-driving car, not able to swerve, bumping into another car. There is always the possibility of errors in the software.

The second way in which robots could harm humans is of psychological source. Lasota et al. (2014) refer to it as *psychological safety*. It is argued by Lasota et al. (2014) that while the physical safety can be maintained through thorough and precise programming, psychological harm induced by robots often translates into stress and discomfort and must be handled with caution. For explanation, consider the following example:

> […] a hypothetical manufacturing scenario in which a robot uses a sharp cutting implement to perform a task in proximity to human workers, but is programmed to stop if a human gets too close (Lasota et al. 2014: 263).

Even though the robot is programmed to stop, the fear remains that there is a flaw which causes the robot to not stop but to continue handling the knife. In such a situation, the robot cannot be fully trusted like one would trust a human. It is thus inferred that such a human-robot interaction can be psychologically harmful for humans as they may be in constant fear that the robot does not stop.

Psychological harm and stress can also have its roots in "a robot's appearance, embodiment, gaze, speech, posture, and other attributes" (Lasota et al. 2014: 263). This is referred to as the "Uncanny Valley"; a term coined by Masahiro Mori in the 1970s. The term describes humans' feelings towards robots in relation to their humanoid characteristics. Mori found that "the ability of humans to relate to humanoids becomes worse as they approach human-like appearance" (Lin et al. 2012: 25). Consider the following figure[5]:



This graph depicts the theory of the *uncanny valley* and shows the relationship between how human the robot looks (x-axis) and our emotional response to it (y-axis). It shows that

> Our emotional response to robots increases as they resemble humans more and more, until they reach a point at which their resemblance is close to perfect but eerily dissimilar enough such that we no longer trust them (Lin et al. 2012: 25).

The more human-like characteristics a robot has, the more appealing it is to us. The idea is that as long as the object is clearly not human, the humanoid characteristics

[5] Graphic taken from: Lin et al. 2012: 26; slightly altered by me

appeal to us. There is, however, a point where we perceive the robot as disturbing and *uncanny.* At this point, there is this decrease in appeal; referred to as the *uncanny valley*[6]. The mind struggles to determine whether the object is real. This is when we regard it as threatening. People feel uncomfortable with robots which are very much but not fully humanoid. Eventually, when the robot reaches full human characteristics the feelings of uneasiness disappear. So, for engineers to avoid and fight the uncanny valley it is important to either hit the point before or after the drop (depicted by yellow dots).

It is thus important that "the human perceives interaction with the robot as safe" (Lasota et al. 2014: 314). Whether robots are perceived as safe, depends on the robot's behavior. It is argued by Lasota et al. (2014) that robots must adjust their behavior in order to be regarded as safe. This adjustment involves two categories: "those based on robot features and those based on social considerations" (314).

The former refers to the robot's degree of uncanniness. Features that come into play here are the robot's appearance, its movements (like speed or acceleration) and also its physical proximity to the human (cf. Lasota et al. 2014: 314). The latter concerns the robot's behavior in regard to social rules and norms. It is argued that robots are to follow social standards in order to be perceived as psychologically unharmful. Thus, it is not only the robots' appearance that needs to be taken into

[6] For visual examples consult Youtube: "Most Uncanny Valley Videos" (https://www.youtube.com/watch?v=IM82RzN0urI)

account but also its personality. Both factors contribute to perceived comfort and safety towards robots.

Safety, both physically and psychologically is of utmost importance. Avoiding harm must be the top priority when designing a robot. Additionally, harm induced by robots can also involve impairment of people's privacy. *Privacy,* relating to robots will thus be discussed in the next chapter.

2.3 Privacy

Despite the many promising characteristics of robots nowadays, robots create privacy issues. As robots get more and more sophisticated, they are equipped with "the ability to sense, process, and record the world around them" (Calo 2012: 187). Especially, interactive robots need to be able process and collect a vast amount of information in order to be able to move around on their own, recognize faces and interact with humans. This autonomous navigation, face recognition and conversation-ability are the primary reasons why robots are said to harm peoples' privacy.

Their service, however, is only possible through data collection and detailed information gathering. People need to be aware that while sophisticated robots constitute a lot of benefits, there is also the danger that their privacy is affected.

While the robot's ability to record and store information seems rather unfavorable, there is also a beneficial aspect to it. The main privacy implication that current robots raise is that surveillance is easily made possible. But, surveillance must not be exclusively negative, as stated by Calo (2012):

> One could also imagine the purposive introduction by government of social machines into private spaces in order to deter unwanted behavior by creating the impression of observation. Nor is the implication of robot for privacy entirely negative – vulnerable populations, such as victims of domestic violence, may one day use robots to prevent access to their person or home and police against abuse (189).

Thus, besides identifying the disadvantages of robots concerning privacy, Calo also recognizes that roboticists "begin to develop privacy-enhancing robots" (191) which are designed to protect and improve the privacy of individuals. For example, robots "that shield the home or person from unwanted attention" (Calo 2012: 191). Indeed, people may feel safer with robots present which look after their belongings like an alarm system.

Still, one must argue that constant observation is one of the main negative implications that robots pose. According to Calo (2012), robots can affect human's privacy in three different ways. These are *direct surveillance, increased access, and social meaning* (cf. Calo 2012).

Firstly, robots' design and ability to sense and process "greatly magnify[ies] the human capacity to observe" (Calo 2012: 187). Current robots, "due to their mobility, size, and sheer, inhuman patience" (Calo 2012: 191) make direct surveillance not only possible but increasingly easy. Take for instance military robots like drones which are used to monitor spaces and also people. Observation is increasingly easy due to the robots' abilities: they are able "to scale walls, wriggle through pipes, fly up to windows, crawl under doors, hover for days, and hide at great altitudes […]" (Calo 2012: 189). Besides the physical abilities, military robots "can be equipped with cameras, laser or sonar range finders, magnetic resonance imaging (MRI), thermal imaging, GPS, and other technologies" (Calo 2012: 189). Direct surveillance, however, is not only limited to the military. Rumor has it that reporters consider the use of robot paparazzi. Thus, using robots to follow and observe celebrities. Also, private persons are free to buy or rent drones in order to "survey property, secure premises, or monitor employees" (cf. Calo 2012: 190) [7].

A second way how robots violate human's privacy is that they have access to spaces which where once protected. In particular, the robots used at home do have access to all kinds of private information. The government or even hackers could easily access this sensitive information. Home robots can be equipped with similar features that military drones have. For example, "sensors, […] cameras, sonar or laser

[7] In Austria, there are very strict laws and regulations regarding drones. Violation, like flying too close to someone's property and recording or exceeding height, can result in fines up to €250 000 or 6 months in prison.

rangefinders, odor detectors, accelerometers and global positioning systems (GPS) (Calo 2012: 192). At first sight, these characteristics might not seem problematic and one might argue that the robots needs these features to perform its services. The issue here, however, is the fact that such robots are often connected to the Internet.

> Several varieties of home robots connect wirelessly to computers or the Internet, some to relay images and sounds across the Internet in real time […]. [Some] can be controlled remotely via the Internet and broadcast both sound and video to a website control panel (Calo 2012: 192).

The fact that this information is so easily accessible represents severe privacy threats to people. Imagine for example, your robot scans every centimeter of your house which is then uploaded somewhere on the Internet. There it can be accessed by the government, the manufacturer, or any person capable of hacking. Indeed, even private persons, namely hackers, could hijack the information (cf. Calo 2012: 194).

Calo (2012) also mentions the danger of physical intrusions. He for instance talks about the possibility that a hacked robot could be programmed to “pick up spare keys and place them in a position to be photographed for later duplication” (194). Criminals would be able to access the house with very little notice.

There is a third way in which robots implicate human’s privacy, namely the social effects that go hand in hand with the robot’s human-like design. As mentioned before, humans anthropomorphize robots and thus treat them as if they were real persons. They have a tendency to give machines social meaning. Think about sexbots, some people can even be intimate with robots, love them, trust them, and speak with them as if it was a real human partner. They regard them as persons. But what about the fact that such machines must process and store a lot of personal information in order to be social? Such robots record and store intimate information about your personality. If a robot is treated like a real partner, people share the most intimate information with it. Were this to happen in a 'normal' relationship between two humans one can assume some sort of discretion. But can one assume discretion by a robot? Obviously not. As social robots must store the information somewhere, it can in principle be accessed by any outsider who would otherwise not have access to such sensitive information. Calo (2012) argues on this account that "the government and industry could accordingly use social robots to extract information with great efficiency" (197).

Furthermore, it must be argued whether one can behave in a natural manner while a robot being present. As social robots are perceived as humans, one might develop "the sensation of being [constantly] observed and evaluated" (Calo 2012: 196). Psychologically speaking, such a sensation leads to a feeling of constant 'psychological arousal' (cf. Calo 2012: 196). People behave differently when being watched, they are more alert and mind their manners. Additionally, the absence of privacy in the sense of being alone can “cause not only discomfort and conformity, but also outright psychological harm” (Calo 2012: 196).

In this section I have argued that social robots raise privacy issues in three main ways. Namely, that direct surveillance is easily possible, that private information can easily be accessed and that people may experience feelings of being watched while a robot being present and thus start making behavioral changes and because of feelings of discomfort.

Having introduced various social robots and discussed the main ethical implications, I will now turn to the classroom environment. I will start by introducing technologies currently used in the classroom and then begin to focus on teachers.

3. Examples of Technology used in the classroom

Nowadays, technology is constantly emerging and thus making novel and exciting teaching and learning methods possible. In general, one could argue that technology can be used to help and supplement learning. According to Webster and Murphy (2008), digital technology can, if used appropriately and strategically, “enhance learning and teaching” (1). More specifically, digital technology must nowadays be an issue when it comes to teaching and learning. This becomes apparent, when analyzing the current student body. Our students are described as

> Gen-X, Millennial’s, the Nintendo and Net Generation; these students blog, play games in immersive 3-D worlds, listen to podcasts, instant message friends, listen to music, author their own video for www.youtube.com and collaborate on the creation of ‘digital stories’ for their ePortfolio. Their default reference library for research has become ‘Google’ […] (Duffy 2008: 32).

Students, nowadays sometimes called ‘digital natives’, absorb information differently; often more quickly and respond to input differently than the students 20 years ago (cf. Duffy 2008). This altered student body requires different teaching approaches. Most importantly, it requires methods which are engaging for our ‘digital natives’.

Take for instance “the evolution of computer and Internet technologies [that] have made it easy to access learning contents from almost anywhere, anytime, and at a user pace" (Jou 2008: 17). Students are accustomed to the fact that content can be accessed instantly. To inform oneself about something means no more than asking Google which provides instant responses and answers. Currently, various different technologies are used in the classroom. These either help to support teaching while being in the classroom or can even substitute the classroom (i.e. e-learning). In what follows, three examples of (digital) technologies will be given, namely YouTube, E-learning, and tablets.

Duffy (2008), for example, investigated "strategies for using new media in teaching and learning" and analyzed YouTube as an example. He argues that videos on YouTube, can be "a means towards achieving learning goals and objectives" (Duffy 37). Using YouTube, most importantly, should not mean watching television as "video learning shouldn't be passive" (37). It should rather be regarded as tool for fostering learning; a 'vehicle for discovery' to use Duffy's (2008) words.

There are numerous guidelines provided relating to the "use of videos to promote active viewing and maximize learning" (37-38). For instance,

- Giving students a specific responsibility while viewing, for instance introducing the video with a question, give them things to look for, e.g. unfamiliar vocabulary, or an activity that will make the program's content more clear or meaningful. This should keep students 'on task' and direct the learning experience to the lesson's objectives.

- Have students produce [their own] short video relating to a specific content and then have them upload it to YouTube. These videos can then be shared and discussed during various lessons.
- Ask students to take notes while watching in order to help them to develop note-taking skills. [8]

These are just some ideas about how videos can be successfully incorporated into a learning context. They show that it can be easily incorporated and definitely advantageous for the students as they are more engaging than dull monologues by the teacher. Also, they appear to the current student body as a vast amount of leisure-time is spent on YouTube anyway. Hence, when using YouTube, the students' leisure-time activities are transformed into educational activities.

Another example that gives teachers an innovative way to communicate content are information and communication technologies (ICT) or alternatively called e-learning. E-learning is another way to deliver instructions, namely by means of "various media and ICTs, particularly Web-related technology" (Chuah 2007: 39). According to Gabor and Ing (2007), ICTs can either be used occasionally in order to enhance learning or it can be the "primary mode of delivery" (147). It is argued that ICTs, such as Blackboard, WebCT, video conferencing, email, synchronous talk and alike, can help "to provide better access, convenience, and flexibility" (Chuah 2007: 37-38) to

[8] These ideas are taken from Duffy 2008 67-38.

students, and especially to adult learners where occupational duties are often omnipresent. Consequently, E-learning developed into a prominent solution for either supporting learning in the classroom or to "support occupational opportunities for adult learners", allowing them continued education alongside work.

However, while many realize the potential of ICT, findings show "that currently e-learning courses are not engaging and motivating and some even show that lack of interactivity is the main obstacle that limits the development of e-learning" (Chuah 2007: 38). Hence, online teaching requires more than "just the transformation of the paper to electronic form" (Chuah 2007: 44). Teachers must ensure active contributions on the part of the students. This can be achieved by adding Web-based learning to an e-learning course. Such internet-based learning, like Moodle, WebCT or Blackboard enable teaching and learning via the web by means of electronic mails, discussion forums, chat rooms, online delivery of materials, online assessment, online grading and so forth" (Cheung 2008: 219). Cheung (2007) lists various advantages of web-based learning, for instance

> incorporating multimedia into learning materials, presenting real-time contents through video conferencing, providing discussion forums and chat rooms, allowing convenient and continuous updates of learning materials, and encouraging learner-centered and goal-oriented delivery strategy which can take into account the differences among learners (220).

A further example of technology in the classroom is the tablet computer. Research shows that it “is seen as a promising way to facilitate students’ learning process” (Ifenthaler and Schweinbenz 2013: 525). While some may argue that tablets constitute a distraction, various advantages are mentioned concerning the use of tablet-PCs, which makes them increasingly attractive for the classroom environment. These range from “the availability of tools such as simulations, cameras and microphones, to eBooks and digital text books, to interactive learning networks and instant feedback” (Ifenthaler and Schweinbenz 2013: 525). Furthermore, tablets have a high mobility together with an instant usability. In a study conducted by Dündar and Akcayir (2013) about ‘implementing tablet PCs in schools’, students’ attitudes towards tablet PC use was investigated. Students perceived the tablets to be highly useful and beneficial. Their feedback was throughout positive as they found the tablet

- To “make education entertaining”,
- to be useful as it ends “the necessity of carrying books because the textbooks are on the tablet PCs”,
- to make homework easier
- to increase their interest in class (cf. Dündar and Akcayir 2013: 44)

Only a minority of students regarded the tablets as distraction and reported ”increased antisocial behavior and decreased communication with friends” (cf. Dündar and Akcayir 2013: 44) as many spent the breaks with the PC instead of talking to their schoolmates. Also, teachers regarded the “classes to be more enjoyable” and reported that “students’ motivation increased by tablet PCs usage” (Dündar and Akcayir 2013: 45). Some, however, uttered concerns about their skills and felt not confident enough to operate the tablets. They asked for more instructions and guidelines as well as seminars as they had to “spend considerable time [to] learn how to use tablets” (Dündar and Akcayir 2013: 45). Furthermore, teachers felt a bit out of control as they were not able to “monitor the screens of all the students” (Dündar and Akcayir 2013: 45). All in all, teachers as well as students has a positive attitude towards an implementation of tablet PCs in the classroom.

By the time one gets accustomed to this kind of technology, the tablet offers an infinite number of possibilities on how to integrate the tablet in the classroom. Including a class blog app, camera apps where students can design albums (for instance about a field trip, or a science experiment), note-taking apps where notes can be shared, Google Maps for geography, and translation apps for language classes. Thus, taking all the possibilities into account one must argue that tablet PCs can be a very effective way of learning. Of course, it can create distraction but the teacher is in the position to keep this to a minimum.

What most of these new technologies have in common is the unique experience of being in control. Students can be in control and learning is placed into the hands of the learner (cf. Duffy 2008: 33). This makes learning much more active and less passive. Students are no more in the role of listeners but can actively participate in various activities during the lesson. There is no doubt that active participation during a lesson is more beneficial and effective than letting instructions wash over oneself. Indeed, restrictions concerning internet use and time spent with the tablet (for instance no use during breaks) must be introduced.

Furthermore, students nowadays love technology. Who has not yet seen a small child playing with its parents' smartphone? Using technology in the classroom is up to date. As mentioned before, students nowadays need different stimuli. In fact, one must argue that it is more difficult to "entertain" them and to get their attention. Technology could arguably help to positively affect their attitude towards learning (cf. Dündar and Akcayir 2013: 45). Still, according to Abas and Khalid (2008), technology "needs to be utilized with care and discrimination" (161). They argue that the question is not about if one should use technology in education but how to use it. Learners can only benefit if technology is implemented appropriately. Thus, as proposed by Düner and Akcayir, teachers need additional material and guidelines on how to best implement technology in the classroom. Only then can technology increase efficiency in education.

A fairly new technology that is beginning to enter the education field is the robot. A robot differs greatly from technology currently used in classrooms. Robots can be autonomous, display human-like features and could possibly take over and replace teachers. Numerous kinds of different robots a currently used in education. These include simple processors with wheels as well as humanoid robots.

3.1 Robot Teachers

While robots have already been used as tools and means to explain certain concepts in science classes, mathematics and engineering lessons for quite some time (see for example *Thymio* below), there is now a trend to use them as teachers, i.e. as social robots who take the role of the teacher or act as classroom companions (see for instance *SAYA* below). Research suggests that using robots in the classroom as innovative technology has considerable potential to enhance human learning (cf. Kory Westlund et al. 2017: 1) and to improve children's motivation (Chevalier et al. 2016: 16). Also, Serholt et al. (2016) argue that "robots will have the potential to facilitate children's learning and function autonomously within real classrooms in the near future" (1).

3.1.1 Why replace human teachers by robots?

Besides these aforementioned benefits (increased motivation and thus better learning outcome), the question arises why one would propose to replace teachers by technology or more specifically robots in the first place. In other words, what is the social economic context behind such a proposal? What benefits arise from this intended replacement? Researchers argue that robots can help provide (quality) education to everyone, increase engagement, and safe money and time. It is thus inferred that robots can ultimately help to improve education.

Zhou (2016) refers to various advantages that arise from the introduction of robots in the classroom. On top of all, he mentions “an urgency to improve the [current] education system” (Zhou 2016, TEDx Talks).

Still today, not every child has the opportunity to receive high-quality education or to even receive education at all. This is often due to the income of the family. Zhou (2016) identifies “*family income* as one of the best predictors of a child’s success in school [and argues that] this has created this huge inequality in the world.” Obviously, there is a need for equality in education. According to Zhou (2016) technology can “bring quality education to everybody and [gives] everyone an equal opportunity to participate.” Robots can be deployed (almost) anywhere and thus making it possible to provide teachers to children which would otherwise not have access to education.

Amongst those students who do receive education, Zhou (2016) mentions chronic disengagement towards learning (40-60%). Researchers, like for instance Chang et al. (2010) and Weinberg and Yu (2003) identify the “unique learning experience” (Chang et al. 2010: 13) that is created using technology in the classroom. Learning with technology is less characterized by ‘instructionism’ but more by ‘constructionism’ (cf. Papert (1993). For instance, robots used in engineering classes help to boost motivation as “students learn from designing and assembling their own robots” (Chang et al. 2010: 13) while formerly, students took in a rather passive role only listening to instructions. Thus, technology and especially robots could help to tackle the issue of disengagement by increasing motivation on behalf of the students.

Another benefit identified by Zhou (2016) is personalization. Personalized teaching refers to a teaching style which considers every single student in a classroom and identifies all the individual strengths, weaknesses, learning styles and alike. But can such personalized learning be possible with one single teacher responsible for 30 students? This indeed seems heavy. Would it then not be better to use a robot? Or even 30 different robots per 30 students? Could personalized learning then be possible? Can a robot which accompanies the student from the first day of school until graduation be able to give better instructions than a single human teacher instructing 30 students?

High-quality education must be coupled with a teacher’s understanding of the student’s “readiness, preference and interests” (Zhou 2016). It should be “engaging the learners, capturing their imagination and building on skills like critical thinking or creativity” (Zhou 2016). Furthermore, teachers should allow students to learn at their own pace.

There is no doubt that a personal (human) tutor would be able to give the best possible teaching to an individual student. It involves a much deeper connection and bond between teacher and student; the teacher would know the student’s strengths, weaknesses and would thus be able to prepare and teach exactly the things the student needs. However, as Zhou (2016) rightly discerns, “society does not have the resources on the human capital or the financial [means] to really achieve this”. An arguable way to solve this problem could be the use of robots. Robots could be designed to meet all the individual needs of its students and thus making personalized learning possible.

Here, however, Zhou (2016) does not speak of replacing teachers but empowering them with technology that could help safe them time and offer various advantages. So instead of replacement, one could argue for cooperation. Giving teachers more time, they could create more “human oriented and deeply creative and emotional learning environments” (Zhou 2016). Robots could be responsible for carrying out the tasks that require no human-like interaction. Thus “allowing teachers to really focus on what matters, [namely] the students and the relationship they have with their students.”

In reference to the role that a robot can play in the classroom, Sharkey (2016) identifies four distinct scenarios which represent the range of roles a robot can play in the classroom. These are

Scenario 1: Robot as Classroom Teacher

Scenario 2: Robot as Companion and Peer

Scenario 3: Robot as Care-eliciting Companion

Scenario 4: Telepresence Robot Teacher (cf. Sharkey 2016: 287).

Scenario 1 and 2 are examples of ways how robots could be used to support a human teacher as the teacher is not replaced. Here, the teacher is still in charge of the whole class. (S)he is the one who decides what is being taught, when it is taught, and how it is taught. The robot, on the contrary, is used for "implicit rather than explicit teaching" (Sharkey 2016: 287). Thereby, helping to make the content more accessible. Again, one could use the example of the engineering class: while the human teacher may be the authoritative figure and the explicit source of knowledge, the robot could be used to make certain concepts visual and thus more tangible. This can help to avoid full replacement and safe teacher's time. In turn, it provides students with a valuable experience.

In Scenario 1 and 4, the robot replaces the human teacher. In the former, scenario 1, the teacher is fully represented by a robot and acts as "an authoritative classroom teacher" (Sharkey 2016: 286). In the later, scenario 4, the robot is still operated by a human, however, the human teacher is physically replaced, hence absent. The robot is remotely controlled, thus the teacher does still have the power to lead the lesson and can, if necessary, intervene.

As mentioned above and as it will become obvious after my discussion about the ethical implications concerning the introduction of robot teacher, one must argue that the scenarios where the teacher is not fully replaced but supplemented by a robot seem to be the more rational ones. Various arguments that speak in favor for this argument will be presented in section number six.

3.1.2 Examples of Robots Currently used in the Classroom

By now, social robots are capable to interact with students in an almost natural way. This is due to their ability to mimic human speech, gestures, facial expressions, and gaze. Kory Westlund et al. (2017) argue that "young children will not only treat social robots as companions and guides, but will also readily learn new information from them" (1). Robot teachers are thus a valuable source as they can "serve as mediators of educational processes" (Haschimoto et al. 2013: 133).

Currently, there are numerous robots being tested and used in classrooms. Some of which will be introduced here.

Thymio II[9]

Thymio II is a robot which displays the least or rather zero human-like characteristics. Its primary purpose is to familiarize people, whatever their age, with robotics. Thus, “allows students to discover the basic notions of robotics and computer science” (Chavelier 2016: 18).

It is an educational robot which has been developed to raise teachers’ motivation to use robots in the classroom. Teachers often perceive robots “to be unreliable, expensive, and limited” (Chevalier 2016: 16). Thymio II is therefore made more affordable (about 100 USD) and comes with corresponding educational material for the teachers. Furthermore, training programs are offered to facilitate its use to enhance teachers’ attitude and acceptability towards robots. (cf. Chevalier 2013: 17). Teachers should be educated in the dealing with robots whereby their desire to use robots in the classroom should increase. This is important as teachers must also be convinced of the benefits of robots. Ultimately, the teachers’ motivation to use robots in the classroom will affect the students’ attitude.

While Thymio II is a great tool to educate students in programming, the focus in this paper lies more on social robots that act as teachers. Robots such as SAYA or

[9] Picture source: Robohub

RoboThespian for example, are educational robots where “children are encountering an apparently social being, and are not involved in programming, or building it” (Sharkey A. 2016: 284).

SAYA[10]

The android robot *SAYA*, for instance, is a robot whose outward appearance resembles a female teacher. She can mimic emotional facial expressions, head and eye movements, and speech. She is however, unable to move her arms and legs (cf. Hashimoto et al. 2013: 133 and Sharkey 2016: 284). Originally, she was

[10] Picture source: The Telegraph

designed to accomplish "emotional communication between human and robot through verbal and non-verbal communication" (kobalab 2011: 0:17-0:27min.) but is now increasingly used in classrooms.

SAYA was built by Hiroshi Kobayashi, professor of the university of Tokyo, who was not looking to find a substitute or replacement for teachers but rather for a new technology which can be used to teach students *about* technology (NTD.TV 2009). Professor Kobayashi's main aim to build it was, among other things, the shortage of teachers:

> In the countryside and in some small schools, there are children who do not have the opportunity to come into contact with new technology, and also there are few teachers out there that can teach these lessons, so we also hope to be able to develop this robot so it can be remotely controlled to teach these classes (NTD.TV 2009: 0:59-1:16 min).

The builder's intention shows one big advantage of robotic teachers: children who do not have access to education could obtain lessons as robots can be utilized almost anywhere.

According to students' statements, SAYA was very well perceived by students: "It's so much more fun than regular classes" or "It was great seeing the robot moving and speaking" (NTD.TV 2009: 1:22-1:34min). The real teacher, however, thinks that the robot still needs improvement: "I think on the one hand I am impressed that they've got robots to go this far, but on the other hand they still have a long way to research before they create a truly robotic teacher" (NTD.TV 2009: 1:40-1:51min).

Indeed, when watching a lesson where SAYA is used as the teacher it is very impressing[11]. It also becomes clear, however, that SAYA needs a lot of improvement. The lesson seems unengaging as SAYA is motionlessly standing in front of the class while monotonously reciting the content of the lesson. One quickly becomes bored and it is rather exhausting to listen to the robot. Obviously, a robotic teacher also needs to mimic some of the gestures humans perform while giving a presentation. This has been tried to accomplish with *RoboThespian*.

[11] see for example Kobayashi's youtube channel: 'kobolab'

RoboThespian[12]

The robot *RoboThespian* “is a full-body humanoid robot” (Hashimoto 2013: 133). This one is, contrary to SAYA, able to move its legs and arms but has a rather mechanic appearance. Unlike SAYA, it can only display facial expressions by changing the color of its face and show emotions through blending its eyelids, eyes animation and jaw dropping (cf. Hashimoto 2013: 133). Its body is made of “white aluminum with pneumatic muscles […], dc motors, and passive spring elements to help simulate human body motion” (Verner et al. 2016: 75).

RoboThespian can either act on its own with the help of preprogrammed scripts or via teleoperation. When in autonomous use, the robot uses all features it has been programmed with including its communication capabilities. It can blink, squint with its eyes and use prerecorded audio files. In the case of teleoperation, the operator can “command the robot to use simple movements, such as turning, basic gesture, and live interaction” (Verner et al. 2016. 76). Furthermore, the operator can choose

[12] Picture source London Science Museum

between some programmed responses to communicate with its environment. A small high-resolution camera on its head is used for observation of its surroundings.

Before testing RoboTespian in a science lesson, Verner et al. (2016) tried to mimic the behavior and gestures of human teachers. They made sure to follow the concept of *teacher immediacy* in which “teachers are recommended to enact immediacy behaviors, verbal and nonverbal, that reduce [a psychological distance between the teacher and the student], e.g. use gestures, visual contact, and various facial and vocal expressions when talking to the class” (76). Accordingly, they programmed the robot with the following features:

– Moderate gestures integrated temporally with the speech they accompany.
– Occasional turning of the robot torso and head and gaze shifting from side to side to raise awareness that the robot is communication with the entire classroom.
– Turning the torso and head and directing the gaze toward the slide projected on the screen to emphasize the importance of the content.
– Hand gestures, such as finger counting, pointing, opening arm in invitation, etc., to add subtle dramatization to the speech (Verner et al. 2016: 76).

All these characteristics enhance the teacher-student-communication. They are important, as letting the robot recite a preprogrammed script, like SAYA does, is not at all engaging. Students need to stay motivated and should not lose interest in the lesson just because of an unnecessary distance between students and teacher.

Both SAYA and RoboThespian have been tested in a science lesson on the topic *levers* given to two sixth grader classes. During these lessons, the robot was used in the autonomous mode where the robot mediated explanations, examples, assignments, and correct solutions as well as in the Wizard of Oz mode (teleoperated) for other parts of the lesson (cf. Verner et al. 2016: 80).

Hashimoto et al. (2013) assert that in both lessons the learning objectives could successfully be achieved. They further argue that the majority of pupils was motivated and willing to participate in the activities and that they enjoyed interacting with the robot teacher (cf. Hashimoto 2013: 134). If fact, most students perceived and regarded the robot's lesson as a very positive experience.

Having introduced some robots that are currently used in the classroom one must now focus on the various functions of a teacher to answer the question whether robots could take over the role of teachers.

4. The various functions of a teacher

Considering the ethical implications which are to follow in the next part it is important to note that educating students is just one key aspect of the responsibilities of teachers. According to Sharkey (2015), “there are requirements for being a good teacher that a robot is unlikely to fulfil” (47). Indeed, teachers take on various roles in the classroom. Broadly speaking, a teacher is the person who has the expertise to assist his or her students to acquire knowledge of a certain subject. Simply put, this means teachers help children learn. Learning does not only mean acquiring knowledge in a subject but learning includes so much more. For instance, learning also includes acquiring behaviors, values and skills. Thus, teachers must provide the best possibilities for an effective learning environment.

Karavas-Doukas (1995) undertook a study with experienced teachers where he investigated teachers’ perceptions of their functions in the classroom (in Hedge 2014: 27). The study shows that teachers see themselves in the following roles:

1) **Source of Expertise (46.4%)**
   Informant, input provider, information provider, resource, source of knowledge, instructor, presenter, actor, pedagogist.
2) **Management roles (35.7%)**
   Manager, organizer, director, administrator, public relations officer, arranger.
3) **Source of advice (53,5%)**

Counsellor, advisor, personal tutor, psychologist, listener.

4) **Facilitator of learning (64.2%)**

   Learning facilitator, helper, guide, catalyst to group discussion, prompter, mediator.

5) **Sharing roles (17.8%)**

   Negotiator, participant, student, cooperator.

6) **Caring roles (25%)**

   Friend, sister/mother, caretaker, supporter.

7) **Creator of classroom atmosphere (14.2%)**

   Entertainer, motivator, source of inspiration.

8) **Evaluator (10.7%)**

9) **Example of behavior and hard work (3.5%)**

(Hedge 2014: 28-29)

The list above shows how broad-ranging the functions and responsibilities of teachers are. What becomes evident from this study is that teachers are indeed not just resource person but that there are a whole lot more duties they should fulfill. It becomes also obvious that there are main functions, namely source of expertise, management roles, source of advice and, at the very top, facilitator of learning. Most important to mention here is that more that 53 percent of teachers see themselves as counsellor, advisor, listener and psychologist. This proves that teaching does not only involve the communication of knowledge but also a lot of duties on an emotional level.

Source of Expertise and Facilitator of Learning

Almost half of the teachers (46.4%) see themselves as source of expertise. Meaning that the teacher is the person who provides the students with information and materials to achieve the desired objectives. It must be stated, however, that teachers, in their roles as educators, must perform much more than just reciting the content of the lesson. In explanation, teachers must not only broadcast their knowledge but engage students in meaningful lessons and make sure, through all kinds of activities, that the material is accessible to every student in the classroom:

> A good teacher will identify the zone of proximal development for a child based on a detailed understanding of that child's capabilities, and will be able to teach them just what they need to know, just when they need to know it (Sharkey 2015: 47).

By doing so, teachers must consider students' individual learning styles, abilities, and personalities. This means adjusting to students' needs and incorporating them in the teaching. It is thus important to realize pupils as individual learners with varying strengths and weaknesses. Blindly reciting material is not sufficient and will not result in an optimal learning outcome. At the moment, however, it seems that this is exactly what robots would do. They lack the social capacities to adjust their teaching to the various students.

Imagine for example all the individual learning styles in a classroom. It seems doubtful that robots can adjust to all the different learning styles in a classroom. Some students may prefer learning with visual aids like pictures, images and maps (visual learning style). Other learners understand new content best by listening and repeating the content (auditory learning style). Some may prefer reading and writing about new information: such students may need to copy every word to understand it (reading and writing). Others may need to have tactile representation of information (kinesthetic learning style). These learners need more physical input than listening to a lecture. They learn by doing something, for example they understand how a clock works by building one.

Of course, this task is also difficult for human teachers but it seems more doable for humans as they have the social understanding and can see what other people need. I do not say that robots cannot provide visual or auditory input but the challenge lies in recognizing what the students need. And this is indeed the part which seems difficult to realize when designing are robot. Indeed, “the idea that a robot could identify what a pupil needs to know seems […] challenging” (Sharkey 2015: 47).

Emotional Supporter

Secondly, as teachers spend a large amount of time with their students, they must also provide physical, emotional, and intellectual support for students. For instance, if a student gets hurt, the teacher must not only take care of the child’s physical wounds but also of its emotional wounds and comfort it. In this function teachers "help to socialize their pupils, acting as attachment figures and as role models, and inspiring an empathic view of fellow humans" (Sharkey 2015: 47).

Here, one of the more implicit but indeed essential functions is the teacher's responsibility to act as a role model. As teachers play a vital and influential role in the students' lives, they are "expected to be morally upright individuals who display good character", live by "moral virtues, such as fairness and honesty […]" and "adhere to professional codes of conduct" (Lumpkin 2008: 45). Ultimately, it is the teacher's duty to teach character and moral virtues to students and to help students to develop into morally responsible individuals. According to Lumpkin (2008), the moral virtues a teacher should have and teach to their students are *honesty*, *trust*, *fairness*, *respect*, and *responsibility* (all five summarized as *integrity*).

Honesty. Whether a teacher displays honesty, very much depends on his or her sincerity and truthfulness. Thus, "by telling the truth and acting in an honorable way" (Lumpkin 2008: 47), teachers set an example and can thus act as role models. Examples of honesty among teachers involve for instance grading students' papers according to a rubric, treating students' records confidential and, it entails "not lying, cheating, or staling as teachers fulfill their professional responsibilities" (Lumpkin 2008: 47). It can be argued that as soon as students realize that the teacher is behaving honestly, they start imitating this behavior and implicitly learn the virtue of honesty.

Trust. Students must feel like they can trust their teacher. Trust can not only play an essential role for the students' academic outcome but also for their character development. Lumpkin (2008) for instance argues that "trust builds self-confidence in students as they learn to depend on their teachers [which] help[s] them grow and develop" (47). In the classroom, there must be an atmosphere of openness; for example, students should be allowed and encouraged to turn to the teacher for assistance when having difficulties with academic as well as personal issues. There should be no instances of judgement or embarrassment when students struggle or make a mistake, but encouragement to try again. Thus, when students trust their teacher, they can exploit and realize their full potential.

Fairness. For students to sense fairness, it is important that all of them have the same opportunities. This does not necessarily mean that students are treated equally, but that all students are seen as individuals with their own strengths, weaknesses and characters. Thus, for a teacher to be fair it is essential to give "all students an equal opportunity to get a good grade for improvement" (Lumpkin 2008: 47). Thereby, students are encouraged to try at the best of their ability and do not get dishearten by making comparisons to others. Of course, when it comes to punishment, it should be the same for the best and the weakest student. Treating someone with fairness is very much connected with respect, a virtue that is of utmost importance in a community like the classroom.

Respect. Teaching students to respect their classmates begins with the teacher's unbiasedness to treat everyone equally, "regardless of their ethnicity, race, gender, socio-economic status, or individual characteristics or abilities" (Lumpkin 2008: 48). Showing respect for others, ultimately means caring for others; thus "being sensitive to and considerate of their feelings" (Lumpkin 2008: 48). By treating students the way the teachers themselves want to be treated, they are showing students how to behave and treat others respectfully. They will not only receive respect in return but will generally enable students to treat others with respect.

Responsibility. Taking responsibility not only means being accountable for your actions but also being in charge of your actions. The former, mainly concerned with accepting your duties and the consequences for your actions and the later with a decision-making power to act responsibly and morally right. By showing responsibility and thus being a role model to students, teachers for instance demonstrate that they "are well prepared for each class" (Lumpkin 2008: 48). A teacher, for example, who promised to hand back a corrected test must take the responsibility for this duty and uphold to students' expectations by handing it back in time. Thus, by fulfilling their duties, teachers display responsibility.

Manager

Thirdly, robots must also be able to control students' behavior and take responsibility for them. It seems rather unlikely that a machine could ever "have the social understanding" (Sharkey 2015: 47) to control students. There is an endless spectrum of different situations which require individual actions which in turn require an understanding that helps the teachers to decide what to do. Could a robot be programmed to react to situations in the best possible way? For instance, comfort students in an empathic way when it is needed but also castigate them if the situation requires it.

Let us very briefly consider an example, which becomes increasingly prominent in schools: the problem of bullying. Teachers must intervene and support students when bullying occurs. Could a robot acquire the social capacities to counteract a complex issue like bullying, i.e. educate students and show them how to behave responsibly and respectfully? Here, Lumpkin (2008) argues that "if bullying does occur, students must be instructed on fairness, respect, and responsibility so they will know how to behave more appropriately toward others" (47).

Intervention against this undesirable behavior can be "sanctioning bullying through loss of privileges, detentions, and suspensions. Alternatively, one may focus on empowering the victim or on mediation between bullies and victims" (Veenstra et al. 2014:1135). These interventions have been successful, however, to really prevent bullying from happening, teachers must also focus on the social context in the classroom. Of, course, punishment is appropriate, but in order to eliminate bullying for good, teachers need to establish a respectful classroom environment. Here the virtues discussed earlier come into the picture again. Bullying is just one of many issues that can arise in a classroom environment. It is hard to imagine that a robot could sufficiently deal with such situations.

Having discussed some of the main functions of teachers, the question remains whether a machine could take over. As stated in this chapter, teachers not only function as resource person but also as motivator, attachment figure, role model, controller and person in charge. Furthermore, teachers play a big role in socializing children and in helping them to develop into responsible adults. In general, one could say that teachers have two major roles in the classroom:

> [Firstly], to create the conditions under which learning can take place: the social side of teaching; [and secondly] to impart, by a variety of means, knowledge to their learners: the task oriented side of teaching (Beltrán).

All the functions have a big impact on a student's development. Thus, when not performed well or more specifically not present at all, it can have consequences on a student's life. Hence, it is argued that replacing human teachers by robots could result in severe developmental impairment on the side of the students. Sharkey & Sharkey (2010) for instance argue, when discussing nannie-robots, that "it is possible that exclusive or near exclusive care by a robot could result in cognitive and linguistic impairments” (173).

The idea of robots taking over the teaching seems even more redundant when bearing in mind that the teacher-student relationship is of utmost importance for successful academic and personal achievements. Various authors have studied the importance of a positive teacher-student relationship and found it to be indispensable.

5. The importance of a positive teacher – student relationship

The relationship between students and their teacher plays an essential role in the classroom (Baker 2006, Berry & O'Connor 2009, Hamre and Pianta 2005, Kesner 2000, Klem & Connell 2004, Serdiouk et al. 2016, Song et al. 2016, Gurland & Evangelista 2015). According to Gurland and Evangelista (2015) "closeness, conflict, and other dimensions of teacher-student relationship quality (TSRQ) predict various academic outcomes, including achievement […] as well as indices of social adjustment, such as aggression, antisocial behavior, and peer acceptance" (879-880). Thus, it is argued by various researchers, that "improving students' relationships with teachers has important, positive and long-lasting implications for both students' academic and social development" (cf. Rimm-Kaufmann and Sandilos: APA[13]). Also, Baker (2006) argues that the relationship to the teacher not only "shapes children's engagement in social discourse [but also] affects children's social behavior and their readiness to learn" (212).

While just a positive relationship between teacher and student cannot be the only sufficient factor for a beneficial learning outcome, a supportive teacher can lead students to "higher level of achievement" (Rimm-Kaufmann and Sandilos). A relationship which is characterized by conflicts and negativity can put "children at risk of school failure" (Hamre and Pianta 2005: 949). It is not difficult to agree with

[13] American Psychological Association

the argument that “a strong personal connection to [the] teacher” (Rimm-Kaufmann and Sandilos) is more helpful for a constructive learning environment than constant criticism and resentment on behalf of the teacher.

But how does a positive teacher-student relationship look like? How can it be fostered and accomplished by the teacher? A positive teacher-student relationship is mainly characterized by three features, namely “low conflict, a high degree of closeness and support, and little dependency” (cf. Birch and Ladd (1997), Rimm-Kaufmann and Sandilos, Pianta and Steinberg (1992)).

Closeness

According to Birch and Lach (1997), *closeness* implies “the degree of warmth and open communication” which can be found between the teacher and the students. It is argued that ‘being close’ to the teacher can have beneficial effects concerning the students’ attitudes towards school and may also promote higher involvement or engagement in school (cf. Lach and Birch 1997, Baker 2006). Baker (2006) argues that feelings of closeness and relatedness to the teacher

> are associated with a host of positive school attitudes, including motivation, success expectations, interest and satisfaction with school, and academic self-efficacy in addition to more traditional indicators of school competence, such as grades (12).

Thus, it can be stated that a warm relationship between teacher and student should be sought as it can not only foster children's motivation and performance but also their adjustment to school.

Similarly to the argument of closeness, Berry and O'Connor (2009) indicate that teachers must be able to "effectively [read] children's emotional needs" (3). Emotional support plays a key role in an advantageous teacher-student relationship. Children need to have the feeling that their "teachers are involved with them" (Klem and Connell 2004: 262) and thereby sensing that the teacher cares about them. Higher emotional support can result in increased engagement. Rimm-Kaufmann and Sandilos report a case where "firth graders [due to their relationship to their teacher] said they were willing to exert more effort to understand the math lesson".

Furthermore, Kesner (2000) points out, when referring to the attachment theory[14], that "there is no other nonfamilial adult that is more significant in a child's life than his or her teacher" (134). Thus, if the relationship is positive, teachers can "serve as protective factor for children at risk for academic failure (Kesner 2000: 134) and lay the foundation for the development of children's social competencies (cf. Seriouk et al. 2016).

[14] *Attachment theory* implies that children form important relationships to significant adults besides their parents, like for instance teachers. These relationships are significant as they affect the child's socioemotional development and skills. For more information consult Bowlby 1980 *Attachment and Loss*. New York: Basic Books.

Dependency

In contrast to closeness, *dependency* is a factor in the teacher-student relationship which, when too high, can interfere with successful school performance. It describes the degree of reliance "on the teacher as a source of support" (Birch and Lach 1997: 63). Thus, a student, too dependent on the teacher, may develop a negative attitude towards school, as (s)he feels lonely and overwhelmed (cf. Birch and Lach 1997: 63). Optimally, for a positive learning environment, there is a high degree of closeness and a rather low degree of dependency. It was found that students who were too dependent toward their teacher "had lower academic achievement […] and more behavioral problems (e.g., poorer work habits, more discipline problems)" (Rimm-Kaufmann and Sandilos).

Additionally, for a quality-relationship, students need to sense some degree of autonomy. Teachers should support children's autonomy in providing them with opportunities where they get the chance "to make choices, demonstrating to them that their opinions and perspectives are valued, encouraging them to pursue activities or solve problems in their own behavior with only a minimum of imposed controls" (Gurland and Evangelista 2015: 881).

Conflict

It is not difficult to agree with the argument that a relationship characterized by conflict is especially harmful for the students themselves and for the learning environment. Such an environment is marked by “discordant interactions and a lack of rapport between the teacher and the child” (cf. Birch and Lach 1997: 63). Conflictual relationships may deprive students of a source of support and could “foster feelings of anger or anxiety in young children” (Birch and Lach 1997: 63). Consequentially, students’ attitude towards school is marked by negativity. This may lead to less involvement, less motivation and even withdrawal from school (cf. Baker 2006: 213).

Also, “the degree of negativity in relationships, including conflict between children and teachers […] is associated with poor academic and social behavior” (Baker 2006: 213). Berry and O’Connor (2009), for instance, found that “children with low levels of teacher conflict and dependency […] had fewer disciplinary problems” (3). They also indicate that children with a less conflictual relationship towards their teacher could develop better social skills than students with poorer relationships.

In general, when focusing on the relationship between teacher and students it must be argued that “children who [are] positively involved with their teacher, [are] are expected to perform better academically [and] to be more positively engaged with the school" (cf. Birch and Lach 1997: 64). Thus, teacher can be made co-responsible for both the academic and social development.

Another perspective, which puts its primary focus on relationships and developed during the growing feminist movement in the 1970s, is the *relational-cultural theory (RCT)*. It assumes that humans strive for relationships, more specifically they long for healthy, what Jean Baker Miller coined, 'growth-fostering relationships'. It is argued that such "relationships contribute to healthy functioning and flourishing" (cf. McCauley 2013). Miller proposed the following characteristics, the "five good things", of growth-fostering relationships (cf. Jean Baker Miller Training Institute (JBMTI) 2017):

1. A sense of zest or well-being that comes from connecting with another person or other persons.
2. The ability and motivation to take action in the relationship as well as other situations.
3. Increased knowledge of oneself and the other person(s).
4. An increased sense of worth.
5. A desire for more connections beyond the particular one.

On the contrary, outcomes of disconnection are defined as "diminished energy, diminished action, confusion, diminished sense of worth and isolation" (Hartling 2003). As the theory is mainly about human development, the five characteristics are essential for human growth. It further puts emphasis on the notion that “individuals grow in connection with one another” (Alvarez and Lazzari 2016: 45). Thus, it is argued in RCT that relationships are the prerequisite of human growth.

A further key concept in RCT is mutual empathy. Empathy is seen as “one of the critical ingredients in constructing a [beneficial] relationship” (Freedberg 2007). Miller and Stiver (1997) define is as “the capacity to feel and think something similar to the feelings and thoughts of another person that exists in all people” (27). Could a robot ever be programed to feel empathy?

Thus, again it must be argued that a beneficial relationship between teacher and student is important for the students’ development. But is a robot capable of occupying this role? Can a robot form a beneficial relationship with its students and thus contributing to the child’s academic and social performance? If not, could the replacement by robots “result in the development of psychological problems and contribute to the rise of violent conflict?” (cf. McCauley 2013), as proposed by West Carolyn (2008) and Hartling, Miller and Jordan.

If, as pointed out by numerous researchers, the relationship between teacher and student is of major importance for the child’s psychological as well as academic development can it be ethical to replace this significant figure by a machine? What would be the ethical consequences if a robot would replace a human teacher? The ethical issues associated with the use of robots in the classroom with be the focus of the next section

6. Ethical Issues associated with robot teachers

Cleary, children and especially students find the idea of being taught by a robot exciting. On first sight, this excitement could arguably result in increased motivation, better learning outcomes and ultimately in better grades. However, as grades are not the only essential aspect in a school environment and teachers take on more than the role of broadcasters of knowledge, the use of robot teachers raises ethical issues and thus must be handled with caution.

Borestein and Pearson (2012), for instance, wonder whether such “a technological intervention [i.e. robot as teacher] is likely to advance or hinder human flourishing” (251). Whitby (2012) argues that “we cannot be sure that our caring technologies are capable of meeting all the relevant psychological needs” and that “there is clearly a risk of severe psychological damage” (238). Chevalier et al (2016) report a study which investigated students’, teachers’ and parents’ perceptions about the use of robots in schools. They conclude that “although students and parents thought more highly of the use robots in schools than did teachers, none wanted robots to replace teachers” (17). Clearly, one must argue that the introduction of robots in the classroom and thereby the replacement of human teachers does raise ethical challenges.

The ethical problems associated with robot teachers in the following paragraphs are identified as: (1) loss of human contact, deception, and attachment; (2) control and responsibility; (3) and privacy.

5.1 Loss of human contact and deception

While Coeckelbergh (2015) argues that children nowadays are “highly computer-literate people or even digital natives” and that “the present generations […] will demand these electronic technologies to be in place (3), it is the assumption of various others (see for example Sharkey 2016, Sparrow and Sparrow 2006) that robots constitute some form of deception. Issues concerning loss of human contact, deception and attachment caused by robots are very much intertwined.

Nowadays, robots’ appearance and their behavior can be increasingly human-like and it becomes increasingly simple to avoid the uncanny valley. Ultimately, given the fact that the robot is responsive, seems sentient and pays attention to the students, it cannot be denied that such characteristics are arguably forms of deception.

Critics of such arguments might oppose that nowadays “the attribution of animacy to objects possessing certain key characteristics is part of being human” (Sharkey and Sharkey 2010: 167). According to Kate Darling, a Research Specialist at the MIT Media Lab, this is not new. People can “emotionally relate to objects” (Darling 2016).

They have always bonded with their belongings. Think for instance about a man's relationship to his car; the car is loved and worshipped like a human being. Darling (2016), however, argues that this effect is more intense with robots as they easily mistaken to be real due to their physicality, their ability to move and their anthropomorphism.

Of course, also children, surrounded by seemingly alive objects, respond emotionally to them. Take for example modern toys which are able to imitate visual, behavioral or auditory characteristics of animacy. Nobody would argue that such toys are forms of deception but that such characteristics "make it into a cute creature" (Sharkey and Sharkey 2010: 167). Opponents further argue that the attachment formed to a seemingly animated toy is no different from the attachment that children might form to a robot. One might counter, however, that there is indeed a big difference between robots and animated toys. Sharkey and Sharkey (2016), for instance, point out that

> the difference with a [human like] robot is that it can still operate and act when one is standing next to it or even when the child is alone with it. This could create physical, social and relational anthropomorphism that a child might perceive as 'real' and not illusion (167-168).

Sharkey and Sharkey (2010) locate animated toys in the "let's pretend – category" (167), meaning that children are aware of the fact that toys are not animated objects but always need a controller who controls the robot's behavior. The child knows that the toy can only move, speak, sing or whatever functions it might have since the child or any other person pushes a button or uses a remote control. A robot on the other hand, does not remain in this “let’s pretend- category” (Sharkey and Sharkey 2010: 167). It can move and speak without human intervention; of course, only if it is programed to act autonomously. Ultimately, children are deceived and made believe that the robot is animated even though it is not alive and is not in the least a human being.

This deceptive appearance and behavior of robots “as real social entities could lead [students] to form attachments to them” (Sharkey 2016: 288). Students and especially young children, might even be tricked into thinking that robots are “capable of or worthy of attachment” (Sharkey 2016: 288). They might form an emotional attachment to their robotic teacher as its behavior and appearance is so convincing. However, as this attachment is not reciprocal but deceptive it must be considered unethical. Consider, for example, Sparrow and Sparrow (2006) who argue against the use robots in elder care: “to intend to deceive others, even for their own subjective benefit is unethical, especially when the result of the deception will actually constitute a harm to the person being conceived.”

While students getting intentionally physically hurt by a robot seems unlikely (as for instance in the movie *iRobot*), there are indeed some emotional and social risks involved which could harm the students. Sharkey (2016) mentions that students might expect too much from the robot. In this respect, she argues that

> The idea of deception and the creation of a convincing illusion give rise to several important issues relating to the emotional attachments that might, or might not develop between children and classroom robots. […] if a classroom robot is presented as a friendly companion, the children might imagine that the robot cares about them (290).

This pseudo-attachment could result in severe trust issues on behalf of the pupils. Children could easily get hurt when they realize that "any kind and emphatic feelings that [they] have for the robot are definitely not reciprocated" (Sharkey 2016: 290). Also, Serholt et al. (2016) provide an example, when quoting Kanda et al. (2007) which raises severe ethical concerns. They argue that "robots do not simply fulfill instrumental function […], but instead they are intentionally designed to evoke social bonding and fulfill the need for social interaction" (Serholt et al. 2016: 2). It is mentioned that robots can be equipped with

> A pseudo-development mechanism which mean[s] that the longer child interacted with the robot the more behaviors the robot displayed, and the more personal information it shared (Serholt et al. 2016: 2).

While robots are indeed able to display some form of social bonding, it is fake and deceptive. Children are made believe that the robot is attached to them. The question arises whether it is any better if this attachment is simulated or just not present at all. By this simulation of feelings, pupils' ability to form relationships could become impaired as "they thought the robot was their friend, but came to realize that the robot was just a programmed entity" (Sharkey 2016: 290).

Furthermore, Sharkey (2016) mentions the risk that students would eventually prefer relationships to robots as "they might get used to being able to tell their robot companion what to do. In other words, some of their learning about social skills could be impeded" (290). Taking this into account, Sharkey (2016) argues that children might develop an abnormal understanding of how to treat other people due to its relationship to the robot". She claims that children could behave in a cruel or mean way to robots and "as a result learn that bad behavior in friendships does not have any consequences" (Sharkey 2016: 290).

In sum, there are various risks concerning loss of human contact and deception that result from placing a robot in the role of a classroom teacher. Teachers must function as attachment figures and role models. This role of the teacher is significant as it not only helps "the child to feel secure, and [enables it] to explore their environment" but also helps "to socialize the child, as they adopt the adult's behavior and values and are encouraged to interact harmoniously with other children" (Sharkey 2016: 291). There is no doubt that such an attachment is impossible to form with a robot, as it does not respond to the child's emotions, feelings and needs. Thus, students solely instructed by robots may lose an important figure in their lives.

Furthermore, when considering the importance of teacher-student relationship, it must be regarded as contra-productive. The teacher's role to support the students both academically and emotionally must be maintained. Otherwise, there is a clear risk that students could fail in both these fields.

5.2 Control and responsibility

Using robots as teachers in the classroom ultimately means putting them "in charge of human beings" (Sharkey 2016: 291). A robotic teacher must be able to "exert control over human" and by doing so must be "able to recognize and prevent disruptive behavior" (Sharkey 2016: 291). After all, as the teacher is responsible for the students, it is his or her duty to "keep children safe from physical [as well as emotional] harm" (Sharkey and Sharkey 2010: 164). When it comes to robots, assigning responsibility is difficult and not thoroughly solved yet.

Coeckelbergh (2016), when discussing the responsibility ascription of self-driving cars, is of the assumption that "the agent needs to be in control of what [s]he is doing. If we lack control, we are not responsible" (750). As a robot is not able to control his behavior but is only a programmed entity which has no autonomy, one cannot easily make it responsible for its actions. Even though "the machine may [seem to] be in control […] it is doubtful if it really "knows" what it is doing, since this seems to suppose consciousness" (Coeckelbergh 2016: 754). In the classroom, controlling students means making “ethical decisions; decisions for instance about when to praise or castigate children for their behavior” (Sharkey 2016: 292). Or deciding to take another path when realizing that the prepared lesson plan does not work out as planned.

Such decisions, however, require what Dennett (1976) calls *third order intentionality*. Meaning that “someone has intentional states referring to intentional states of someone else who in turn refer to other intentional states” (Neuhäuser 2015: 136). Simply put, this means that robot teachers would need to be able “to discriminate between different kinds of behavior” (Sharkey 2016: 292) and to recognize the children’s intentions behind their actions in order to analyze its behavior. This is not as straightforward as it might seem on first sight, as the following example illustrates:

> A quite child could be studying, or sullenly refusing to participate. A vociferous child might be actively contributing to the class discussion, or interfering with it (Sharkey 2016: 292).

Robots might think that just because a student is raising its voice, it is disturbing the lesson; when in reality, it just could be excited and motivated to participate. The question arises whether a robot could be capable of recognizing the intentions behind children’s actions if it does not have intentions itself.

Furthermore, robotic teachers need the capacities to know what a child would do next. This way it could, like a human teacher, take actions beforehand by “encouraging good behavior and discouraging bad behavior” (Sharkey 2016: 292).

At the moment, it seems doubtful that a robot could exert authority and control over a class as they lack the “understanding of the intentions behind people’s actions, and [the] understanding of values and anticipation of the direction in which events are unfolding” (Sharkey 2016: 292).

Additionally, in order to make right decisions one needs a sense of morality. Without morality, robots could never decide whether a behavior is good or bad. Even if it would have the best pre-programmed rules, right decisions are very much situation-dependent. One decision or rule might seem right in one situation but completely out of place in another. Resulting from a robot’s inability to make right decision it seems rather inappropriate to put them in charge of students and young children.

As already mentioned before, teachers must make sure that students are safe and well. This leads to the problem of responsibility and determining who is accountable if something would happen; for instance, if a student gets hurt. If an accident happens in a regular classroom with a human teacher in charge, it is out of question whom to blame: it is always the teacher who is responsible for his or her students. In the case of a robot teacher this question cannot be answered that easy.

Sharkey and Sharkey (2010) claim (with regard to robot nannies) that it “would be ridiculous” to hold the robot responsible as “that would be like holding a knife responsible for a murder” (183). This comparison regards robots as mere tools, which means that the parents would be responsible, as they are the ones “using” the robot to take care of their child. In the case of classroom teachers then, would it be the headmaster who made the decision to introduce robots into the classroom or the parents who agreed on their introduction? Is it the programmer who developed the robot? As Sharkey and Sharkey (2010) propose:

> there is a potentially long chain of responsibility that may involve the carer, the manufacturer and a number of third parties such as the programmers and the researches who developed the kit (184).

Before these problems and questions about control and responsibility are not solved, a robot can clearly not be in charge of humans and thus it is difficult to use robots as teachers. At the moment, one must argue that robots can only serve as additional learning tools to enhance and reform traditional classrooms.

5.3 Privacy Issues

It is a common assumption that knowing a student ultimately "leads to greater learning gains" (Serholt et al. 2016: 3) and thus helps making a good teacher. Robotic teachers like human teachers need to be able to recognize their students, give personalized feedback, and adjust to their strengths and weaknesses; simply put: robots must know their pupils. At first sight, this does not mean that students' private life is intruded. On closer examination, however, it becomes obvious that "social robots can affect the privacy of individuals" (Sharkey 2016: 287). In order to identify students to the best of their abilities, robots are programmed to collect personal information about students:

> Classroom robots need to store an extensive amount of data of individuals in order to create personal profiles that can take into account previous interactions. [This might include] video captures, facial expression capturing, speech recognition, or other physiological data such as galvanic skin response (Serholt et al. 2016: 3).

Authors like Sharkey (2016), Serholt et al. (2016), Kanda et al. (2007) have uttered concerns about “whether this type of data collection has the potential to infringe on people’s privacy” while claiming that such social robots could turn into “a surveillance system where others may access the data” (Serholt et al 2016: 3). Technology makes it possible to directly monitor individuals and store information. Sharkey (2016) claims that “the privacy of individuals would be intruded upon if a social robot was used to enable direct surveillance” (287). She argues that “people might consider themselves to be alone and unobserved” (Sharkey 2016: 287) while, in reality, they are being observed in their everyday private routines.

Also, Calo (2011) points out that “robots are equipped with the ability to sense, process and record the world around them” (940). Thus, can be equipped with sensors which make it possible to not only interact responsively with the pupils and to recognize them but also to record and store the information. Kanda et al. (2007)

describe “how the robot they used kept record of which children had interacted with it, and even of friendship groups amongst the children” (quoted in Sharkey 2016: 288). Clearly, if this is the case one must admit that students’ privacy is severely affected.

Serholt et al. (2016) argue that, in their research on robots within elderly care, “older adults […] are not positive toward being monitored by robots or other technologies” (3). Being constantly observed evoked “feelings of intrusion, vulnerability, and confinement” (Serholt et al. 2016: 3). While this research concerns elderly people, there is little doubt that the result would be any different from a student’s perception when being monitored and recorded. Undoubtedly, this would affect the students’ behavior. Who could possibly behave in a natural manner if one is constantly under the pressure that one is being monitored, recorded and (probably at a later stage) analyzed?

Critics argue that students would “perceive [the] robot to threaten their privacy” (Serholt et el. 2016: 3) and that their freedom and their trust in the teacher would be impaired. The child would no more talk about its problems as the idea of ‘should be treated in confidence’ would be lost. How could pupils consult their teacher, if the teacher is a robot who is recording everything it is saying. Robot teachers would make it “possible to record a child’s entire life” (Sharkey and Sharkey 2010: 165).

Students will be constantly observed and monitored even though they might think they are alone.

Unfortunately, that is exactly the opposite of what students need. Besides being instructed in a subject they need to have someone, apart from their parents and friends, to talk to about their problems, fears, and all kinds of concerns; in other words, an attachment figure who they can turn to and trust in all kinds of matters.

Furthermore, despite the psychological consequences described above, there is the possibility of hacker attacks. As shown in the section above about privacy issues concerning social robots (section 2.3), robots are not immune to hackers. Research has found “robotic technologies to be highly insecure in a variety of ways that could pose serious threats to people and organizations they operate in and around” (Cerrudo & Apa 2017 from IOActive Labs). Clearly, in the case of robot teachers it is important that they are well secured and difficult to hack.

Hacking could concern stealing all the information stored in the machine. Pagallo (2013) for instance, argues that robots’ data collection is “out of control” as they are able to “replicate and spread all the data they collect without any human ’in the loop’” (502). One might argue that students’ personal information (for instance grades, behavior) is already recorded (even written down), but this information is kept in private. People who have access to it (teacher, headmaster) are obliged to treat such information confidential. Pagallo (2013), however, argues that

> A new generation of robots will be connected to a networked repository on the internet so as to allow such machines to share the information required for object recognition, navigation and task completion in the real world (502).

Such a “world wide web for robots” (Pagallo 2013) puts people’s informational privacy at risk. Imagine for example a student who seeks the teacher’s advice for a personal problem. In the case of a robotic teacher, the machine records every single word the student utters, uploads it to the internet where it is stored. This cloud can not only be accessed by machines (cf. Pagallo 2013) but is vulnerable to hacker attacks. People could have access to information that would otherwise never left the school.

Such hacker attacks, however, do not only infringe people’s informational privacy. Additionally, research suggests such self-propelled machines could turn into “dangerous tools capable of wreaking havoc and causing substantive harm to their surroundings and the humans they’re designed to serve” (Cerrudo & Apa 2017). Take for instance Alpha 2, a humanoid robot “that can teach, be a personal assistant, or provide entertainment” (Burgess 2017). Cerrudo and Apa (2017) hacked Alpha 2 and thus were able to get the robot to continuously stab a tomato with a screwdriver. The two researchers also reported that “the same attack allows accessing most of the robot’s built-in modules, microphones, body control, databases, network cards, VPN secrets, [and] face recognition modules” (Burgess 2017).

Research indicates that a robot can not only be turned into a stabbing machine and thus cause severe physical harm to humans but could also be used to spy on people through its camera or microphone. Such safety dangers must be taken especially seriously when it comes to children. It cannot be tolerated that students may get the feeling of being constantly monitored or may fear for their safety because of possible hacking of their teacher. If such robots are to take on the role of a teacher it must be made sure that students can still share confide information and secrets without their privacy being violated.

7. Conclusion: Use under limited circumstances?

In this paper, I tried to answer the question whether robots could be capable of replacing humans in the role of a teacher. In order to answer the question, I started with a description of robot ethics and addressed the need for ethical reflection concerning social robots, i.e. robots that are in close human robot interaction and thus must be handled with caution.

For closer examination of these issues, I provided the reader with four examples of social robots. These examples are sexbots, care robots, military robots, and self-driving cars. I have argued that all of these robots have their advantages, as they are built to make human's lives easier. Take for instance, a care robot which can support a nurse in lifting a patient or a sexbot which can make a person feel less lonely by keeping him or her company. Still, despite the many promising characteristics of such robots, there are nevertheless many unresolved issues which give reason for hesitation and reservation.

There is for example the question about agency and responsibility. Who can be made accountable for a robot's action? What if the robot's behavior is flawed? Is it the programmer who designed the robot? The manufacturer? The user or the owner? Also, when considering the robots' close interaction with humans, there must be some kind of ethical framework which the robot adheres to. But who can decide how such a framework looks like? And is it even possible to install some moral code into a robot? What about ethical dilemma, like the ones I have provided in section 1.2.4 about self-driving cars? Can the autonomous car decide which person to injure or kill in such ‘trolley problems’?

Another major issue concerning social robots is *safety*. Robots, first and foremost, must be safe. The actions of social robots directly affect humans and thus any risk of malfunction must be eliminated. It must be argued that robots can constitute harm to humans. On the one hand, there is physical harm and on the other hand there is psychological harm.

I have also argued that social robots can infringe human’s privacy. The technology of robots makes it possible to monitor, observe and record all kind of information which would otherwise not go public. There is the threat of constant surveillance which is made easy by robots.

I have then provided three kinds of technology currently used in the classroom, these are YouTube, e-learning and tablet-Pcs. If used appropriately these can be very beneficial in a learning environment and thus boost the students’ motivation and increase their engagement.

In the next step, I have discussed three kinds of teacher robots which are currently used. These are Thymio II, SAYA and Robothespian. I have shown that these robots are well received by students and that the learning objectives could be achieved.

I have also shown what it means to be a good teacher. Being a good teacher does not only depend on being an expert in one's subject but also on one's social capabilities. By this I mean that teachers take on various roles, roles that help to establish a relationship to their students. A good relationship forms the basis for a positive learning environment. Teachers need to be lecturer, motivator, role model, attachment figure and controller of the students. If this is not the case, severe consequences and ethical issues concerning loss of human contact, deception, and privacy and responsibility issues arise. I have presented various arguments why a robot could and should not fully replace a human teacher. It bears many risks including students losing an attachment figure and role model. I argued that teachers help to shape students and as a robot is only a programmed machine which is imitating human life, it does not have the emotional and social capacities to help students to develop into social beings.

Concerning a positive teacher-student-relationship, I argued that students, solely taught by robots, could develop an impaired ability to form relationships and are put at risk of school failure. This argument is brought forward by various authors who argue that the relationship between teacher and students can lay the foundation for good academic and social development on behalf of the students.

Besides the risks on a social and academic level, there are issues concerning students' privacy. Robots as teachers constitute severe infringement of privacy as they make it possible to record and monitor students. There is also the risk of hacker attacks. As robots store a lot of information, possibly on the internet in the cloud, this information can easily be accessed by hackers. Additionally, there is the danger that robots' software gets hacked and thus is controlled by malicious criminals who could program the robot to perform all kinds of (dangerous and harmful) actions.

Furthermore, I have argued that robots cannot be made responsible for human beings. They do not have the moral capacities to assess human behavior nor is it possible to make them accountable for any failures.

Taking all the functions of teachers as well as the relationship between students and teacher into account while having in mind what ethical implications it has when human teachers are replaced by robots, I argue that this replacement should be handled with caution. As teachers constitute an important figure, I argue that teachers should not be fully replaced by robots. They could, however, support humans in their teaching. In my opinion students would greatly benefit from a mixture of human and robotic teaching. In that way, teacher and robot could complement each other and ultimately students would receive the best teaching.

Thus, I conclude that I do not support replacement of human teachers but I am indeed positive about the concept of cooperation between human teacher and robot teacher. Clearly, one must argue that "they can sometimes offer a beneficial educational experience that might otherwise not be available" (Sharkey 2016: 294).

Those robots which have been tested all contributed to a positive learning environment and, most importantly, students welcome robot teachers. Thus, humans could share their responsibilities with robots. By cooperating with robots, teachers could make sure that all the emotional and psychological needs of students could still be met. This could be beneficial for all parties involved. Teachers could save time and let the robot take over some parts of the lesson. Teachers would consequently be able to offer more time for extracurricular issues, for example as a source of advice or for individual learning problems. One could imagine the robot to be an assistant, taking over all the roles which do not exclusively require a human, for instance as information provider and answering all the questions that arise. In conclusion, as I do not want to reject the idea of robots in the classroom, I am very much in favor of having robots assist human teachers.

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9. Abstract

Robots are increasingly used in non-industrial settings. These social robots, like for instance sexbots, robots in elderly and child care, military robots and self-driving cars provoke various ethical challenges. Mainly, these issues concern the question about responsibility and agency as well as safety and privacy. Given the sudden prominence of teacher robots, the need for an ethical evaluation arises. Can a robot replace a human teacher? The author comes to the conclusion that this is not desirable as teachers constitute an important figure in a student's life. Teachers must fulfill various functions; besides their role as source of expertise and facilitator of learning, they must ensure to emotionally support students on their way to graduation. Furthermore, robots are not capable of establishing a positive teacher-student relationship which is considerably significant for the student's academic and social development. Finally, when taking into account the ethical implications like deception, loss of human contact, control and responsibility and privacy, one must further disapprove the replacement of human teachers. Still, one should not reject the idea of robots in the classroom. As shown above, technology and robots can have beneficial effects on the students' motivation and engagement. Therefore, robots could indeed take on a role in the classroom, namely as a sort of assistant of the human teacher. A cooperation between teacher and robot could thus bring the most benefits for teachers and students.

10. Zusammenfassung

Roboter findet man immer häufiger in nicht-industriellen Umfeldern. Solche Roboter, wie zum Beispiel Sex-Roboter, Roboter für die Betreuung älterer und kleiner Kinder, Militärroboter und auch selbstfahrende Autos, lösen die verschiedensten ethischen Probleme aus. Größtenteils betreffen diese Probleme die Frage nach der Verantwortung, Sicherheit und Privatsphäre. Zunehmend werden Roboter auch als Lehrer eingesetzt. Bei der Beantwortung der Frage ob Roboter Lehrer ersetzen können kommt die Autorin zu Schluss, dass dies nicht erstrebenswert ist, weil die Lehrperson eine wichtige Figure im Leben eines Schülers bzw. einer Schülerin darstellt. Sie nimmt nicht nur die Rolle der Wissensvermittlung ein, sondern gibt auch die nötige emotionale und soziale Unterstützung. Viele Autoren argumentieren, dass die Beziehung zwischen Lehrperson und SchülerInnen von großer Bedeutung in Bezug auf den schulischen Erfolg und die soziale Entwicklung ist. Ethische Streitpunkte, wie Täuschung, Verlust von menschlichem Kontakt, Kontrolle und Verantwortung, sowie Privatsphäre geben Grund zur Ablehnung von Roboter Lehrern. Jedoch sollte man die Idee von Robotern im Klassenraum nicht komplett ablehnen. Technologien und auch Roboter haben erwiesenermaßen Vorteile, wie zum Beispiel erhöhte Motivation seitens der Schüler und Schülerinnen. Um Robotern dennoch eine Rolle in der Schule zukommen zu lassen könnte man sie als

Assistenten der Lehrpersonen benutzen. Eine Kooperation könnte die meisten Vorteile für sowohl SchülerInnen als auch LehrerInnen bringen.