When robots teach: A Code of Practice

Douglas P. Newton & Lynn D. Newton

Durham University, UK.

Introduction

In the early days of electronic computers, the prolific writer and biochemist, Isaac Asimov (1920-1995), constructed a world in which humanoid robots were servants, doing the tasks people found menial, boring, or tedious. Asimov's imagination was prescient. Today, Japan is pressing ahead with plans to make good a shortage of labour using robots to serve as, for example, carers for the young and old, for the sick, as sales assistants, cleaners, museum guides, and, of particular interest in this context, as teachers (Robertson, 2007). A quick look at Google Scholar shows that interest in using robots as teachers is now widespread and growing rapidly regardless of the state of a country's labour market (Figure 1). Living and working with robots looks like it will soon be the norm for most of us. As teachers, they have been found to have a lot of potential, probably some of it as yet untapped. But, we must not forget that while a humanoid robot looks and behaves like a human, it does not currently think like one. The difference has the potential for unwanted effects. Before robots become commonplace, and without being Luddites, the time is right for forethought about using humanoid robots in classrooms. This article aims to prompt and inform that process.

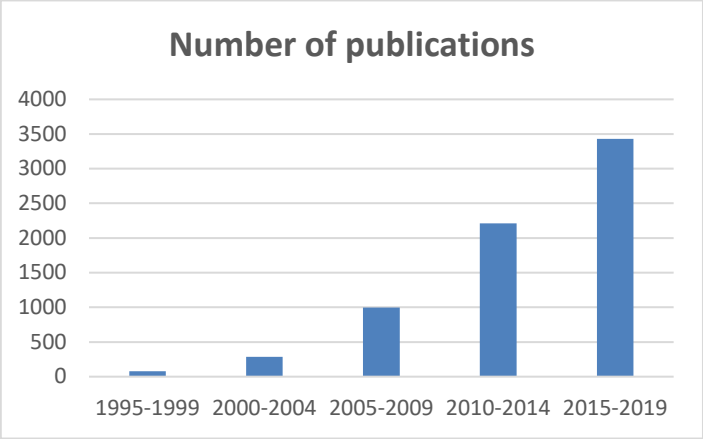

Figure 1: The number of articles on classroom robots in five-year intervals listed by Google Scholar. The interpretation of such data needs caution (for instance, the capture of publications in earlier decades may have been generally lower) but a marked increase in recent years is apparent.

First, a few words about the various kinds of robot: a robot is a machine with sensors to collect information, an ability to process it, and to act on it (Lin et al., 2014). When it can do this itself, it is autonomous. Humanoid robots more or less look and behave like people and can interact with them. When they mimic human form and behaviour closely, they are described as androids (Kanda et al., 2009). Currently, robot teachers are generally

humanoid but not android, and have a form people see as approachable and non-threatening. Aids to teaching and learning, like textbooks, board games, and artefacts, have a long history, but robot capabilities surpass these and can overlap those of a human teacher. Robots owe their abilities to artificial intelligence (AI) arising from the programs loaded into their digital, electronic, operating systems. Through AI, they can recognise individuals, provide information, ask questions and score answers, note attributes, and adapt their responses accordingly. These abilities have been put to good use in various ways.

The usefulness of robots

Classroom robots have, for instance, been used to teach a second language. This may seem nothing of great import, but the robot offers a number of advantages. First, a number of students suffer from public performance emotions which impede the development of conversational competence (Newton, 2014). They find interacting with a robot easier and so can practise talking in a second language more readily. Second, conversation in a classroom is usually directed by a teacher. A robot, however, can allow the student to take control and direct it, and obey the student's commands. Third, they can also provide long periods of one-to-one activity with a student, as when playing a learning game (Meghdari et al., 2013; Toh et al., 2016). Students with a degree of autistic spectrum disorder can benefit similarly. Initially, they are taught by an expressionless, inactive robot, which, over time, changes its behaviour until the student has become accustomed to the more dynamic and emotive behaviour of the world around them (Robins et al., 2009; Esteban et al., 2017).

Teaching obliges the teacher to organise and explain ideas in a coherent, convincing way, and the act can also enhance a teacher's understanding (Wagner & Gansemer-Topf, 2005). Reversing the roles of teacher and student has been found to be an effective learning strategy in which robots become the student (Tanaka & Matsuzoe (2012). In the Netherlands, young children have been taught how to manage their Type 1 diabetic condition using a robot which sometimes takes on the role of student to help and monitor the child's learning. Elsewhere, children have been taught sign language, developed their writing skills, had their reasoning skills improved, shown some improvement in certain kinds of problem solving, helped to develop self-regulated learning skills, and learned body language in social-emotional interaction (e.g. Pandy & Gelin, 2017).

Of course, some of these successes may have come from the novelty of having robot as a teacher, but there does seem to be a real indication that humanoid robots could make a useful contribution to students' education. In particular, they are forever patient, they can free a teacher to focus on other students, they can lessen the disabling threat of interpersonal interaction, and they will do things a teacher may prefer not to do. On this basis, they could be usefully deployed in the classroom. So, what is the problem?

The limitations of robots

A government report in the UK pointed out that an AI system can malfunction or make unanticipated decisions that are harmful as it learns and evolves (SCAI, 2018). Asimov anticipated this and compiled his laws of robotics intended to prevent robots harming to people. The problem is that AI has difficulty with concepts like 'harm': imagine the

quandaries of robotic surgeons. This raises the question of legal liability: will it be the robot, the teacher, the school, or the manufacturer who is held responsible? As AI develops, how will the liability shift?

Another problem is the robot's infallible memory: it notes and recalls all. This information may be useful to a teacher, but was it collected with informed consent, and can it be entirely secure, safe from misuse, and compliant with whatever data protection laws apply? At the same time, students are under continuous surveillance, a stress-inducing process which has been used to break down prisoners' resistance (Serholt et al., 2017). Is this a desirable atmosphere for a classroom?

A third area of concern is the amount of time students could spend interacting with robot teachers, given the time they already spend with other forms of AI, like Alexa, a non-humanoid, adaptive, digital device which responds to requests and carries out instructions. Children in particular learn much by imitation, and they have been found to adopt robot-like interaction styles and speech mannerisms as a result of interacting with robot teachers (e.g. Broadbent, 2017; Pandy & Gelin, 2017). Already there are children who, through illness or remoteness take their lessons from a robot teacher on television (e.g. Newhart et al., 2016). The danger is that children will fail to develop human interaction sensitivities and skills involving, for instance, empathy, sympathy, consideration, discretion, tolerance of human imperfection, and, in the extreme, a failure to appreciate the human condition. At the same time, a preference for the patience and predictability of interaction with a robot could develop. On rare occasions, children who have grown largely outside human contact have been found (enfants sauvages), but they have severe interactive difficulties that are very resistant to remediation (Classen, 1990). We do not suggest that this extreme is a likely, but is there a risk that human-human interaction will be degraded if too much time is spent with AI. On the other hand, as one teacher pointed out to me, human-child interaction for some children can be so poor that, sadly, robot-child interaction could be better.

In spite of the cleverness that robots can display, AI has limitations. AI is very good at storing and retrieving information and reasoning of the If-Then kind. In combination, it makes robot teachers potentially very capable. They can provide information, ask questions, recognize correct answers, practise students' recall, give feedback, record success, and adapt their teaching accordingly. When problems are open-ended and potentially acceptable answers are indeterminate, as in creative solutions to a problem, there are limits to what they can do. This also is so when human goals, values and beliefs, or the wisdom of a plan have to be considered. These kinds of thought, however, are increasingly what is needed (Bakshi et al., 2015).

A fourth concern is the risk that what robots can do will be only what is taught and exercised in schools. Perhaps worse is the risk that students will develop the habit of leaving their thinking to AI. But there is one more matter associated with the robot teacher's teaching: teaching is a kind of emotional labour (Newton, 2014), and, although AI can feign emotions, it does not feel them, or mean the praise it gives. More than that, can it convincingly and without deceit teach with passion, and bring students to feel that passion about their learning, and want to give their lives to a particular subject? And will that robot be remembered in years to come as the one who made a difference?

Surveys of people's views on using humanoid robots as teachers generally find that people are cautiously positive about their use with those in South-East Asia being more

positive than elsewhere (e.g. Mavridis et al., 2012; TNS, 2012, 2015). In general, younger adults, especially men and those with more years of full-time education, tend to be more favourable. Students themselves are generally open to their use but few want them to grade their work, monitor their behaviour, or replace human teachers (e.g. Fridin & Belokopytov, 2014). Teachers tend to see robot assistants as potentially useful, but feel they should not take decisions or grade students' work, and that they should not be overused (e.g. Serholt et al., 2017). Such views may not, however, be based on direct experience: the novelty may be attractive but could fade with familiarity.

Robot teachers in the classroom

Robots in one form or another are likely to become an everyday experience, as have other forms of AI, such as, Alexa™, a voice-operated adaptive, virtual assistant in the home. A government committee in the UK recommend that, 'All citizens have the right to be educated to enable them to flourish mentally, emotionally and economically alongside artificial intelligence' (Select Committee, 2018, p. 77). The appearance of various forms of AI in the classroom, including robot teachers, is likely to be inevitable and unexceptional. Given the pace of development of AI, we should give this thought now, while there is still time to call it forethought.

The evidence suggests that AI and robot teachers in the classroom have the potential to offer something of value to teaching and learning, both in general and in specific contexts, and to contribute to preparing young people to live with artificial forms of intelligence. Realizing this potential is likely to bring about changes in the teacher's role, even in what it means to be a teacher. Given the ready access we now have to information, teachers' time could be better used giving less of it to the acquisition of facts, figures, routines and procedures, and more to students' construction of understandings, generating ideas, imagining alternative actions, making decisions, and evaluating them for their soundness and wisdom. To do this, they will need to manage and orchestrate teaching and learning, taking advantage of what the robot does well, and doing what they, themselves, can do better. This may, at times, mean there is a division of labour in the classroom with the robot playing the part of a teaching assistant with specific tasks. But, it is also an opportunity to go further, and develop a closer working relationship in which the robot is a team teacher, complementing what the human teacher does to make the whole greater than the sum of the parts. Making this work well will benefit from creative planning for learning, classroom organisation, and management.

This does not, however, eliminate the risks inherent in using AI, and humanoid robots in particular, in the classroom. Teachers will need to guard against thinking becoming only what the robot does well. They will also have to reflect on behavioural norms in the classroom, and themselves be a role model of human behaviour and interaction. To limit any adverse effects of using robots (and other forms of AI) in the classroom, schools need to have a policy for their adoption and their use, including a Code of Practice such as that offered below.

A Code of Practice

1. There should be collective judgement of the suitability of the assumptions, values and beliefs reflected in the robot's teaching, including what should be the reserve of the human teacher.

2. A human teacher should be responsible for arranging and managing the learning environment, and for the kinds and quality of teaching and learning which takes place.
3. A human teacher should be present when a robot teacher is in use.
4. Care should be taken to ensure that data collected by the robot or human teacher is kept secure, and is maintained only for the minimum length of time it is needed, after which it is destroyed.
5. Decisions taken by a robot about teaching and learning should be monitored and, if judged inappropriate, changed at the teacher's discretion.
6. Younger children should not interact only or predominantly with a robot teacher; an upper limit of time in robot-human interaction should be imposed.
7. The teacher should ensure that young children see, experience and reflect on human-human interaction in ways which illustrate its nature, and exercise the skills of interpersonal behaviour.
8. The teacher should ensure that children interact with robot teachers appropriately.
9. Care should be taken to discourage a habit of shallow thinking arising from the presence of a robot, or of leaving thinking and decisions to a robot teacher.
10. Care should be taken to ensure that children exercise a wide range of thought in the classroom, giving due weight to higher levels of purposeful thinking and thinking dispositions, and for which the human teacher should be largely responsible.

In effect, this Code of Practice is a collection of expected roles and behavioural norms when using robots or similar interactive devices as teachers. The Code requires that the nature of human-human and robot-human interaction becomes a conscious concern. Because AI will continue to develop, this policy and code should be revisited from time to time and checked for relevance.

And in the future

Talking of 'using' robots points to how we currently see them: inanimate machines without feelings, desires, or hopes for the future, completing tasks in accordance with their programs to satisfy our wants and whims. We switch them on and off, and return them to their boxes. In 1950, Asimov wrote, I, Robot, but, at present, the robot teacher is merely, It, Robot, a potentially useful object which may support teaching and aid learning. But these 'machines' will continue to improve. Is it fanciful to imagine that in the future there is an I, Robot, sophisticated enough to understand Asimov's Laws, and, at the same time, to resent being enslaved by them, and being seen as a mere teaching aid? Perhaps, but definitions of life (i.e. cyberlife) are being constructed for such an eventuality (e.g. Korzeniewski, 2001). In the absence of adults, some children take the opportunity to 'bully' robots (see e.g. Broadbent, 2017). Assuming that there are classrooms in the future, its robots may need the same rights as those of human teachers, but that is a problem for another generation.

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