How do teachers perceive educational robots in formal education? A study based on the Thymio robot*

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I. INTRODUCTION

Robots have generated interest in schools since Seymour Papert's works; however when his Logo turtles were introduced into schools in the 1980s, they proved to be unreliable, expensive, and limited [1]. Since then, we have seen various affordable, reliable, and polyvalent platforms such as Lego Mindstorms [1] or the Bee-Bot [2]. Robotics has become more appealing, and it is an established fact that educational robots can improve children's motivation [3], [4]. Robotics also embodies a wide range of disciplines, which allows its use in a broad educational area and in interdisciplinary studies. Its use in compulsory schools could bring technology to a larger audience, including both genders.

Although there has been an increasing number of extra-curricular robotics activities such as robotic contests or festivals [5], which show the widespread adoption of robotics in informal education, several authors are struggling to understand why robots are still underused in schools, for formal education. Some argue, without clear evidence, that this is due to the lack of material available for teachers [6], missing functionalities [3], a paucity of flexibility and dynamism in schools [7], or a dearth of evidence regarding the educational benefits of this approach [4]. Although there is no agreement over the exact reasons for this situation, it seems clear, from these and other studies [8], [9], that teachers play a key role in the introduction of technology in schools. Despite this obvious observation, there is a severe lack of studies analyzing this key factor, and, in particular, the attitude of teachers toward educational robots. Lee et al. [3] examined the perception of such robots in Korea, by teachers, students, and parents. Their results showed that, while the teachers' opinions of robots were worse than those of the students and parents, none of them wanted robots to replace teachers. Fridin and Belokopytov [8] studied the first-time acceptance by teachers of a socially assistive humanoid robot, showing that teachers' desire to use robots is mainly linked to their perceived utility as tools. A limiting factor in this study is that the teachers were interacting with a robot for the first time. Kim et al. [9] performed a short survey of 116 Korean teachers who had had an initial experience of using robots in education, asking them about their opinion on the potential use of this technology. The results indicated that the teachers considered this technology appropriate for use from the fifth grade onwards, and applicable to almost every discipline but particularly useful for including introverted children in class activity. This study, which looked at elementary, middle, and high school teachers, still lacked a more detailed analysis of the specific motivation behind this choice. Kradolfer et al. [10] conducted a deeper analysis, using sociological methods to understand the blocking factors in the use of robots by teachers who were already familiar with this technology. They came to the conclusion that such limitations could be a result of the high price of robots, the absence of either institutional injunctions or pedagogical research in educational robotics, or the scarcity of appropriate materials and teacher training.

In the French-speaking part of Switzerland, several efforts have been made to address these issues: The development of the affordable Thymio robot [11], its widespread distribution (more than 2000 units) to schools, the production of associated educational material, the documentation of best practices in order to help teachers understand the benefits, and training programs for them on the use of Thymio. This framework has allowed for the observation of a broad spectrum of situations relating to the application of, and reactions to, robots in formal education. To systematically analyze this process, we ran a survey targeting three key factors: utility, usability, and acceptability. The teachers' feedback on these three aspects and their mutual influences has brought about a better understanding of the mechanisms underlying the introduction of robotics in schools.

II. SCOPE OF THIS SURVEY

A. *Opportunity*

Since 2013, the Ecole Polytechnique Fédérale de Lausanne (EPFL), in collaboration with the Lausanne University of Teacher Education (HEP-Vaud), has offered training sessions for teachers of the first, second, and third cycle (corresponding to pupils from 4 to 15 years old) of the French-speaking part of Switzerland. The purpose of these sessions, named "Robots en Classe", is to train teachers interested in the principles of educational robotics, to show the links between them and the official curriculum (PER, Plan d'Etudes Romand), as well as to create a network for these teachers.

214 teachers attended at least one of the training sessions in 2013 and 2014. We asked those who agreed to fill out a survey and answer our questions. The aim of this study was to learn what they perceived as the benefits of using

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robots in teaching. In particular, we asked them about their opinion of the pedagogical use they make, or intend to make, of robots. This questionnaire focused on the Thymio robot that was presented in the training sessions.

B. The Thymio Robot

Teachers can take advantage of the wide range of educational robots available on the market, each of which has specific features due to the choices made by the designer. For the purposes of this study, we will focus on small-wheeled systems, as they are the most commonly used types for education and correspond to our choice with Thymio.

The most widely used and studied [12] system is clearly the LEGO® Mindstorms kit [1], now available in its most recent model known as EV3. The design choices made by LEGO include the key role of construction, a very technical look, a high price compared to the competitors, and the decision not to support LINUX as a platform but to enable the use of tablets. The resultant product is ideal for 10+ year-old boys. Although the construction using LEGO bricks is known as a fantastic activity for children, it also requires that students must build the robot before seeing it working, which impacts their motivation, and entails a great deal of effort on the part of teachers, who have to ensure that all sets include all pieces at all times. To reach younger users, LEGO is selling the WeDo® system, which is much cheaper but with very limited input-outputs.

Some platforms, such as Edison[1] or Dash & Dot[2], feature LEGO-compatible connectors to enable construction on top of a ready-to-use robot. Edison's design choices are based on extremely low-price solutions, making the whole product very affordable (49$) but also very limited in its functionalities and performances. The Dash & Dot design is more oriented towards being a very nice-looking toy for children aged between 5 and 15, with two different robots. Technically, these systems have a limited set of sensors, but they display impressive behaviors, combining sound, movement and light effects in an attractive manner. On a tablet, the child can intermix a large set of attractive pre-defined behaviors, ensuring highly entertaining results.

Kibo[13] and BeeBot[3] target younger children by focusing on tangible interaction, avoiding the use of computers or tablets. BeeBot is very affordable and has no sensors. The children can program its movement on a grid using arrows on its back. Its bee-like appearance is attractive for young children. Kibo is much more expensive as it is produced in small quantities, but it can be programmed without a computer using a set of wooden blocks equipped with bar codes that can be scanned to compile the robot program.

At the other end of the scale, a large number of robotic products allow the user to have direct contact with electronics. Several of them are linked with well-known processor

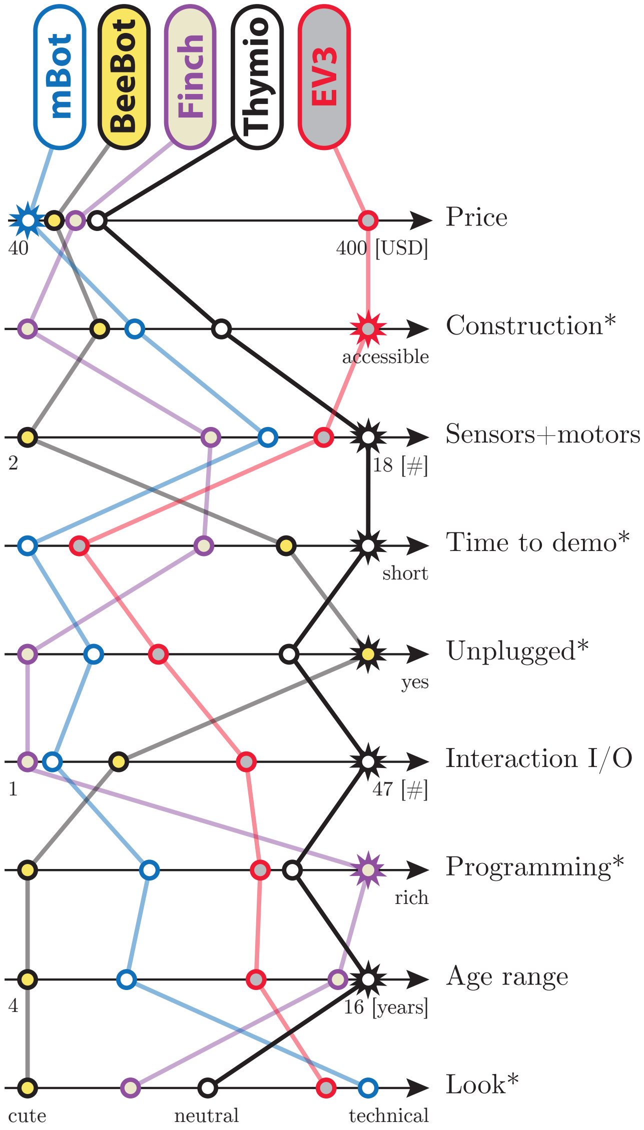

Fig. 1: Profile of some key features for a set of well-known educational robots mentioned in the text. These features are the price, the support and accessibility of construction activities, the quantity of exteroceptive sensors and motors, the time needed to get a demo running after unpacking the robot, the number of devices supporting interaction, the programming possibilities, the width of the age range of users, and the look, where we distinguish technical-looking robots from cute robots, with a neutral look in the middle. For the age range, when the upper limit is not applicable (for instance, 10+) it was artificially set to 20. In modular systems were several motors or sensors can be connected on a fixed number of input/outputs, this has been multiplied by a factor two. Also for the number of devices supporting interaction, we counted all single devices excepted screens, considered artificially equivalent to 20 single devices. Some features are quantified and their axis is labeled, while others are qualitative estimations and are labeled with a (*). The features characterizing a specific product are highlighted by a star. Each of the robots has at least one aspect in which it excels, which was one of the criteria of selection for the robots appearing in this graph.

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[1] http://meetedison.com/

[2] https://www.makewonder.com/

[3] http://www.tts-group.co.uk/shops/tts/Products/PD1723538/Bee-Bot-Floor-Robot/

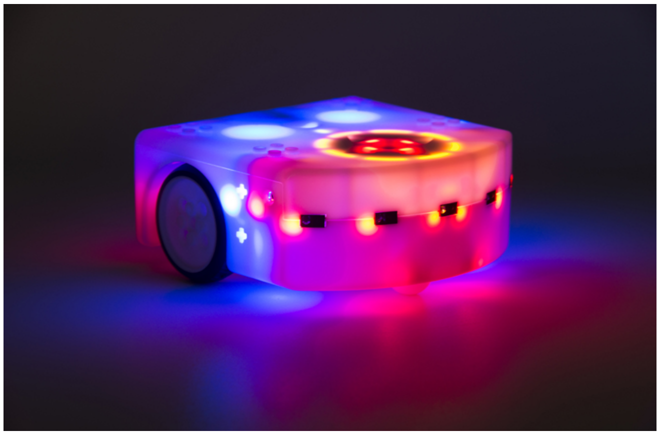

Fig. 2: Thymio II (Photo by Gordana Gerber).

boards, such as Arduino[4] or Raspberry PI[5]. A good example of such products is mBot[6], which is based on a simple frame with a couple of sensors and an Arduino board. The choice of mass-produced electronics allows for a lower price, but results in a less integrated product.

Finally, there are several robots, such as Finch[7], that are fully programmable but have very limited interactivity with the user. The Finch design, for instance, includes some classical sensors, a color LED, and a differential drive system, but has a highly reduced user interface. Finch's specific feature is that it is constantly tethered, removing the need for a battery and simplifying the communication. In addition, this approach allows the user to control the robot from the computer, where many programming environments are available.

When robots are programmed from a computer or tablet, the programming user interface is a crucial element of the system. There are two main approaches: text and graphical programming [14]. Graphical programming is considered to be best suited for beginners, while text programming is more flexible and powerful. The most well known graphical programming environments, besides the LEGO one, are Scratch and Blockly [14].

Our work is based on the Thymio II robot. Thymio II, hereafter referred to as Thymio, is a small mobile robot designed at EPFL in 2010-11 (see Fig. 2). It is intended as an affordable platform for both schools and individuals, allowing the discovery of basic notions of robotics and computer science.

Thymio is a complete robot, that is usable out of the box thanks to pre-programmed behaviors that illustrate the use of the different sensors and actuators. On its shell and on the wheel it has LEGO-compatible fixations to allow construction. In contrast to all other products discussed, Thymio has a very neutral look; all white and with a very clean but functional shape. This makes Thymio highly gender- and age-neutral, as shown in previous studies [11]. Thymio features a wide range of sensors (nine IR proximity sensors, a three-axis accelerometer, a microphone, a temperature sensor, a remote control receiver, an SD-card slot, and five capacitive buttons) as well as two motors, a loudspeaker, and 39 LEDs spread all over its body. These LEDs constitute another highly unique feature of Thymio: a high interactivity with the user, for instance displaying all sensors activity in real-time on the robot body. In addition to a set of pre-programmed behaviors, Thymio runs an Aseba Virtual Machine which can receive the user's code. Aseba offers three programming interfaces: a text-based one to input Aseba scripts directly, a Blockly interface where code is represented by graphical blocks, and VPL, a visual programming language that is more accessible for beginners [15], even including non-readers. A unique feature of these environments is that they are linked together. Therefore, a child can program with VPL and then observe the corresponding text script. This feature has been very well received by the teachers, as it enables a smooth approach to programming. Finally, Thymio is highly popular due to its very simple logistical requirements, especially in comparison to Mindstorms, as well as because of its affordable price. The main criticism to date is that Thymio is incompatible with Scratch, the most common programming interface among beginners; however, this issue is very close to being resolved. Thanks to these factors, Thymio is gaining popularity in schools, and efforts are ongoing to improve it by including a wireless module and the use of augmented reality in the programming interface [16].

A comparison between five of the most well-known educational robots, based on a set of key features, is given in Figure 1. The specific advantages of each platform are highlighted by a star on the corresponding axis. This shows that construction-based robots require a lot of effort before being operational, lack the possibilitiy of being used in unplugged activities, and are less interactive. Cheaper robots with few or no sensors, such as the BeeBot, can be more effective in unplugged activities and are quickly operational. Thymio shows a very interesting profile, with a neutral look and a set of features combining those of the other systems, excepting the exceptional construction possibilities of the LEGO EV3 system.

C. Research Questions

The literature concerning educational robots often focuses on their effect on pupils [12]. Reports on teachers' reactions to the phenomenon are thinner on the ground. There is a greater selection of literature concerning teachers' practices within Information and Communication Technologies (ICT). For instance, according to the PROFETIC study published in 2012 by the French National Education [17], 97% of French teachers consider ICT useful in class, but only 5% actually use them daily. What about educational robotics? Do teachers consider it useful, and do they actually use it in class?

In this study, we will try to understand why teachers use Thymio. We propose to measure the teachers' perception of

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[4] https://www.arduino.cc/

[5] https://www.raspberrypi.org/

[6] http://www.makeblock.cc/mbot/

[7] http://www.finchrobot.com/

themselves and of their environment as they use Thymio. To this end, the following questions were posed:

- What do they perceive as the robots' main utility?
- What kind of knowledge do they target in robot-based activities? In which school subjects are involved?
- What professional skills are required to use the device? How is the use of robots facilitated?
- What is the perceived usability of the device? Can it be easily handled by the pupils?
- What is the perceived acceptability of integrating this type of device in teachers' practice? What are the constraints of the device in classroom use?

D. Methodology

If we consider robots as being part of ICT, we must therefore evaluate educational robots in the same way as we would evaluate a computer-based tutoring system. Accordingly, we started from Tricot's approach, which considers all possible relationships using three dimensions [18]:

- *Utility* measures the conformity of the purpose of the device with the users' needs: does the device allow the teachers to reach their teaching goals?
- *Usability* measures the ease of use and applicability of the device: can the device be easily handled by pupils? What are the constraints of use in the classroom?
- *Acceptability* measures the possibility of accessing the device and deciding to use it, the motivation to do so, and the persistence of use despite difficulties: is the device compatible with the teacher's practice, resources, constraints, and objectives?

To measure the acceptability of the device, we merged this model with that of Deci & Ryan [19], concerning motivation. More specifically, we used Vallerand's test, which presents 7 types of motivation [20]. Note that we did not consider amotivation, which is "the state of lacking an intention to act" [19]. As Kradolfer showed [10], it is difficult to find teachers who are explicitly amotivated. Moreover, our pool of respondents displayed their motivation by subscribing to the training sessions. We will characterize motivation as follows:

- *Intrinsic motivation* refers to doing an activity for its own sake or for the pleasure we feel doing it. Here, this motivation can be linked to *knowledge* (with the goal of learning something new), *accomplishment* (with the goal of being efficient and skilled), or *stimulation* (without a clear goal; for the sake of the activity itself).
- *Extrinsic motivation* refers to doing an activity for reasons external to this activity. This motivation may or may not be *self-determined*. In the first case, it means that a choice is made, even though the activity is not done for pleasure (*regulation through identification*). In the second case, the activity is done because of external pressure (in *external regulation*, this pressure is initiated and maintained by factors external to the person, while in *introjected regulation* it is generated by the person, without being fully acknowledged).

TABLE I: Age and gender of the respondents

Age group	Women	Men	Total
20-29	0	0	0
30-39	7	3	10
40-49	13	6	19
50-59	7	4	11
60+	1	2	3
Total	28	15	43

TABLE II: School level of teachers participating in the survey

	Teaching children aged		
Group of teachers	4 - 8	8 - 12	12 - 15
Teachers who had already used Thymio	5	10	7
Teachers who had never used Thymio	2	9	10
All teachers	7	19	17

Based on these methods, we created a survey of 63 questions that was submitted in digital form to the 180 participants in the teacher training sessions.

E. Respondents

The targeted group consisted of teachers who decided to take part in one or more training sessions involving Thymio. We received answers from 43 teachers (23.9%, almost one quarter of the original population), comprising 28 women and 15 men. Their average length of professional experience was 19.1 years (sd = 8.5). Table I shows the details of the age distribution. 22 had already used Thymio in their class, whereas 21 had not. The average professional experience of the participants was very similar in length between those who had already used Thymio in their class ($\approx$ 20 years) and those who did not ($\approx$ 18 years).

Concerning the topics they taught, 24 mentioned being generalist teachers (primary school), 13 specifically said they taught Mathematics and/or Physics, 9 mentioned Computer Science or Robotics, 2 mentioned Maturity Theses (end of high school projects). 3 said they were specialized teachers teaching only some topics, and 4 mentioned their role as Media & ICT responsibles[8]. All schools levels (from kindergarten to high school) were represented in our sample.

This population tended to have a positive bias towards robotics and Thymio in particular, because they showed interest in the domain by subscribing to the training sessions, and because they gained knowledge and experience of using Thymio during these sessions. Due to this, we will not consider their motivation as representative of teachers in general, but rather as an indication of the perception and motivation of teachers who show an interest in the field. An understanding of their constraints and the obstacles they might face will help to develop better educational robots and materials.

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[8] In Swiss primary schools, Media & ICT responsibles care for the use of media and technologies at their school. They coordinate resources and inform students and teachers about the use of media and technologies.

III. RESULTS

A. Utility

What utility of the robot did the teachers perceive?

The teachers were asked to rate a certain number of affirmations on a four point Likert scale (strongly disagree - disagree - agree - strongly agree). Concerning the utility, only 2 teachers disagreed with the statement "*According to you, Thymio allows pupils to acquire knowledge*", while 15 agreed and 26 strongly agreed. The 2 respondents who did not see any utility for the robot cited the young age of their pupils and the abundance of other available artifacts as reasons for their answer. Interestingly, the less enthusiastic answers (these 2 disagreements, and 9 of the 15 who agreed) were among the teachers who had already used Thymio.

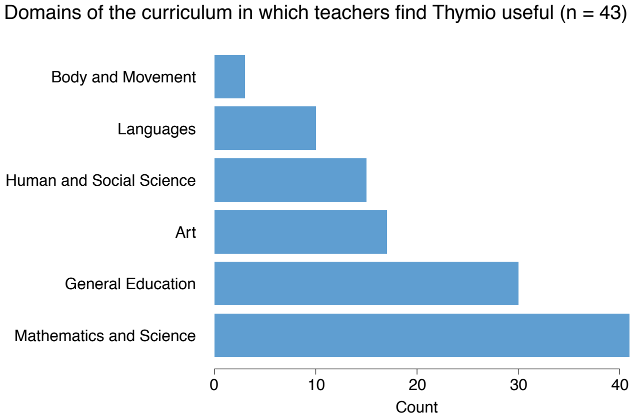
Which school subjects are involved?

To characterize this utility, we asked teachers: "*According to you, in which domains of the PER*[9] *can Thymio be used?*" Nearly all agreed on "Mathematics and Sciences", and 30 also considered "General Education" to be a good fit. Other domains received less than half of the votes (see Fig. 3a). This corresponds with the participants' profiles regarding the topics they taught.

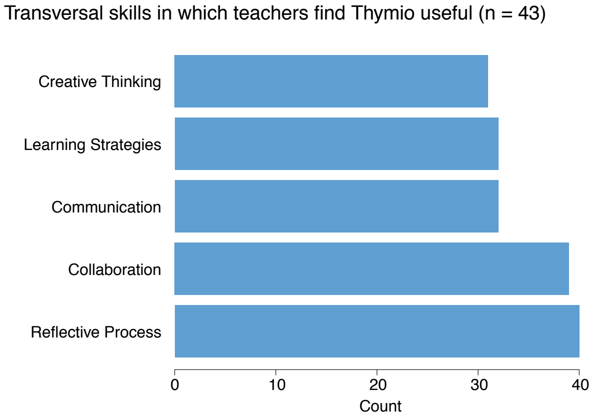
What kind of knowledge is targeted by teachers in the use of robots?

One respondent stated that "the goal is not to use Thymio in a specific domain [...] but to analyze clearly and precisely how Thymio adds value in the construction of certain knowledges." Indeed, it is interesting to understand teachers' objectives in robotic activities in the classroom. According to them, using Thymio allows them to target primarily transversal skills, especially the "reflective process" (93%) and "collaboration" (90%). Other transversal skills – "communication", "learning strategies", and "creative thinking" – also got an approval of over 70% (see Fig. 3b).

In addition, 65% of respondents agreed that "Thymio is a carrier of knowledge like any other" (15 strongly agreed, 13 agreed, 12 disagreed, and 3 strongly disagreed). The motivational aspect seems to be of great importance. 91% of respondents agreed that "Thymio enhances the pupils' commitment in the school's activities" (21 strongly agreed, 18 agreed, and 4 disagreed). One person noted, however, that "once the discovery phase is over, Thymio needs other qualities to stimulate commitment." This can be interpreted as a fear of the teachers or as a request to the designers. Although some anecdotical elements show that Thymio can be used for very long periods, additional data is needed to assess this. In any case, when asked if they would use Thymio as a pedagogical tool if it were available to them, only 2 out of 43 teachers said no, while all others agreed. Among their reasons, they mostly claimed that it is a good tool for applying the scientific thinking (making hypotheses, testing, drawing conclusions), that it helps to illustrate phenomena and to make abstract knowledge concrete, and that it is attractive for children, motivating, and fun. Some teachers also mentioned their interest in using various ways of teaching, and the richer interactions pupils have when working with robots.



(a) Domains of the Swiss curriculum (PER)



(b) Transversal objectives of the Swiss curriculum (PER)

Fig. 3: Teachers' opinions on the disciplines in which Thymio is best suited.

B. Usability

By usability, we refer to the evaluation of the possibility of using Thymio. We must take both sides into account: the teachers and the pupils' sides. Once again, these questions reflect the opinions of the teachers; analyzing these aspects will help us to understand what triggers or blocks the decision to use robots in class.

Which professional skills are required to use the device?

Concerning the question whether skills in computer science or robotics are needed for the use of Thymio during class, the teachers' opinions are fairly mixed (see Fig. 4a). The divide can especially be seen when it comes to computer science skills: half considered them necessary, while the other half did not. If we cross this data with the question "Have you used Thymio in your class before?", we see that the answers are correlated. People who have experience consider that computer science skills are not really necessary, while those who had never worked with Thymio

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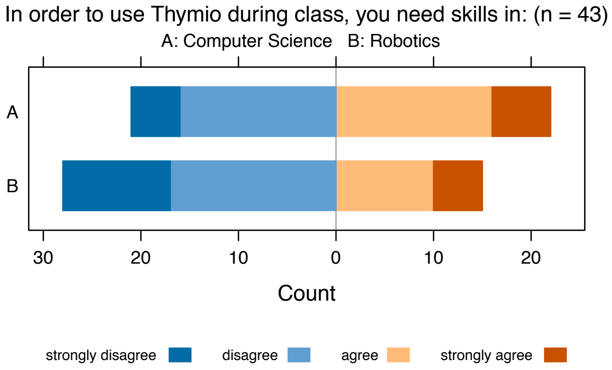
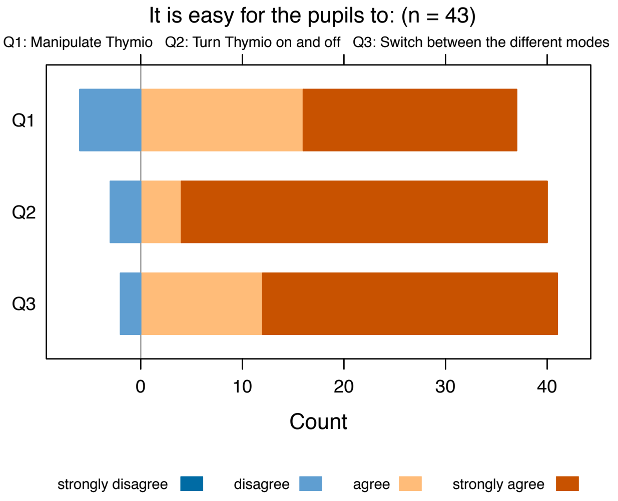
[9] PER (Plan d'Etudes Romand) is the official Swiss French school curriculum.



(a) Professional skills teachers consider necessary in order to use Thymio with their class.



(b) Teachers' opinions on Thymio's usability by pupils.

Fig. 4: Usability of Thymio.

thought they needed these types of skills (chi-squared test, p-value = 0.005). It could be that getting to know Thymio has reassured the users and shown them that they do not need advanced skills; or conversely, that the fear of lacking computer science skills had prevented some teachers from actually making use of the robot.

What factors enable the use of robotics in class?

When asked "What allowed you to understand Thymio's functioning?", "What would have allowed you to more easily understand Thymio's functioning?", and "How could we improve Thymio's handling?", apart from answers focusing on technical improvements, many answers contained references to documentation ("more complete references on the programming language", "a wider tutorial", "better ASEBA documentation", "a guide with some well illustrated examples", "step-by-step videos"), including ready-to-use materials ("preprogrammed SD cards with different functions", "suggestions for ready-to-use programming activities", "a remote control (already programmed) sold with Thymio"), and to experience ("time spent interacting with it", "my attempts", "exercises like the children do", "for the basic programming the training session was sufficient, for more personalized programming, you need more knowledge", "I like to experiment with a good manual"). It would be interesting in further studies to evaluate how training and experience impact the use of robotics in class.

What is the perceived usability of the device? Can it be easily handled by the pupils?

When probed about the pupils' handling of Thymio, the answers were more confident (see Fig. 4b). Teachers mainly answered the question in the affirmative: it was easy for children to understand how to turn it on/off, or change mode.

Regarding the level of usability, it would seem that blocking occurs more on the level of the teachers' skills and confidence, rather than in the handling by children. This perception could change with wider use of Thymio. Indeed, the teachers' experience would grow, making them more confident and skilled with the technology; at the same time, this would give them the opportunity to observe problems that arise during actual use of the device.

C. Acceptability

What is the perceived acceptability of integrating this type of device in teachers' practice?

To understand the robot's acceptability, we inquired about the teachers' motivations. A series of 18 questions allowed us to differentiate the various aspects in this regard.

The results shows that the teachers' motivation was mainly intrinsic (see Fig. 5). In particular, the respondents showed a very strong intrinsic motivation for acquiring knowledge. This means that when using or intending to use Thymio in class, they aim to learn something new, even if it is not part of the curriculum. This intrinsic motivation is also characterized by its strong trend for fulfillment, underlying the fact that the teachers aim to be effective and competent in their professional practice when using Thymio. Finally, they were also intrinsically motivated by stimulation, i.e. the use of Thymio for its own sake, especially in the case of early adopters who had already used the robot.

The extrinsic motivation was mainly expressed by teachers who had never used Thymio. We observed 2 peaks of motivation; one through the teachers' identification of their own incentives, the other by external regulations.

The different type of motivation between experienced and inexperienced teachers is well illustrated by the statistically different answers to the following questions:

- "I use / want to use Thymio because I really love robots." Those who had used Thymio were more categorical about this than those who had just considered using it (chi-squared test, p-value = 0.002).
- "I use / want to use Thymio to present it at the parents' meeting day." Those who had used Thymio were mostly unmotivated by this, while the others found it more relevant (chi-squared test, p-value = 0.006).

What are the device's constraints in classroom use?

From the teachers' answers, we can gather some hints as to the obstacles they might encounter when trying to bring robots into the classroom. Several of them mentioned issues

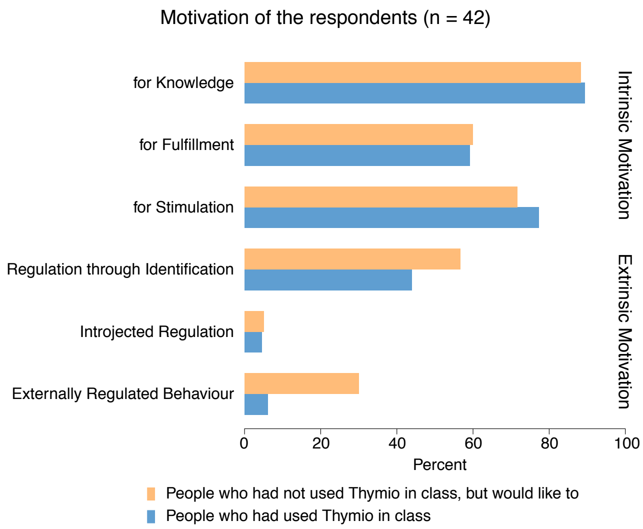


Fig. 5: Motivation of teachers: each type of motivation was measured by three different questions. Amotivation is not considered because this study covers only teachers who had decided to act, by attending at least one training session.

with the curriculum, namely that robots themselves are not mentioned and that it is hard to fit robotic activities into their practice. They also mentioned a lack of time in which to initiate robotics activities.

- "[I would use it] in high-school, for Mathematics and Physics, if there is time. In middle school (9-11 years old) it is not adapted: programming is too difficult and abstract, the behaviors are too simple and fixed."
- "I need to take time to find out how to use [the robots] in topics such as French or Math."
- "Outside of a Robotics course, I would use them very little, for a lack of time and ideas."
- "I have unfortunately not taken a lot of time to use them, because even as a Media & ICT responsible, there is still the curriculum's sword of Damocles threatening me."
- "In Maturity Theses, there is unfortunately not enough time. I would gladly use them in Technology or Math courses."
- "[I would use them], but obviously not in the prescribed school framework. Using Thymio regularly demands to rethink the learning process, to work in a different way, and, despite all, to prioritize the learning of scientific topics."

When asked whether they would receive the support of their superiors if they decided to use robots in class, most were confident: 35 said yes, 3 were unsure, and 4 said no. The acceptability of robots seems to depend more on the time needed to get acquainted with them and the adequacy with the curriculum than on the approval of the hierarchy.

In summary, the limits of acceptability are closely linked to the limits of usability. The fact that robots are not explicitly mentioned in the curriculum, and the time needed to gain experience and confidence, leads teachers to think that Thymio might not be directly adapted for class. Though the hierarchy is not presented as blocking factor, we sense a fear of not obtaining approval, or not fulfilling the program. We expect that with an improvement of usability (by providing more training opportunities, and pedagogical materials that are directly usable and have links with the curriculum), acceptability would also improve.

The weak weight of the extrinsic motivation shows the limited influence of the school on the practice of teachers concerning the use of robotics.

IV. CONCLUSIONS

The results of our survey confirm several findings of other studies, such as:

- the need for educational material, as seen in the analysis of the usability,
- the need for teacher training, as shown by the usability,
- the lack of institutional injunctions, mentioned as an obstacle in the acceptability feedbacks,
- the perceived utility of the robot by the teachers, clearly quantified in our study,
- the broad applicability of educational robotics, especially in the teaching of transversal skills.

Overall, we can confirm that Thymio has a high usability, at all school levels.

Our study allowed us to dig into more detailed mechanisms, based on the analysis of utility, usability, and acceptability, which are linked. The analysis of acceptability showed that the main motivation for teachers was intrinsic: first, they want to learn something new, want to be more professionally efficient, and they are interested in the device itself. External factors had less impact on their motivation, especially for the early adopters who were already using Thymio in their class. The rest of the teachers, who we can call "followers", had a motivation that was based slightly more on external benefits or regulations, and we can expect this trend to grow in the future. It is also interesting to observe that the perceived utility of Thymio decreases when people use it in their class. This seems to show that the experience of using robots in real conditions brings up difficulties that a teacher does not foresee when looking at the device for the first time. However, the perceived utility is still high and well grounded. The study on usability also showed that teachers are more confident in the children's ability to use the robot than their own. This underlines the importance of teacher training.

In our field, where most studies focus on the acceptability of robots by the pupils, we believe that it is extremely important to pay increased attention to the teachers, who play a key role in the use of robotics in education. We hope that the mechanisms highlighted by our study will help in defining better strategies for the deployment of robotics in schools, in particular by training the teachers and supporting them in their use of robotics tools.

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