**Parents’ voices: Exploring parents’ thoughts, feelings, and beliefs on early childhood robotics education**

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# **Abstract**

Early Age Robotics (EAR) education has become extremely popular throughout the world. It has proven to be not only interesting and enjoyable, but also effective at helping even the youngest of children develop skills and reap educational benefits. But what about their families? Are parents as happy with EAR programs as are the children? What do parents actually know about EAR? What are their beliefs and wishes regarding it? In this novel longitudinal and empirical study, we seek to answer these questions and succeed in refuting some commonly held beliefs. This study is based on a unique EAR program that we have run since 2016 for over 2000 children. We also introduce a new model, called PEAR (Parents in EAR), offering practical proposals for enhancing and expanding robotics education. This study analyzed surveys submitted to 203 parents whose children (aged 5–7) studied technology and robotics as a compulsory component of their kindergarten or first-grade curriculum. Four parental components were distinguished and analyzed: beliefs, involvement, satisfaction, and intentions. We uncovered an interesting phenomenon of parents becoming transformed from being passive consumers of the educational system into new, twenty-first-century parents, more confident about their ability to learn and to help promote their children’s abilities. Like their children, they are more motivated and involved, and ready to invest in both their own and their children’s learning. Also encouraging is the gender equality found in this technological area.

# **Introduction**

It is generally agreed that a good Early Age Robotics (EAR ) education can prove highly beneficial for students. It is also acknowledged that the role that parents play in the education of a very young child is even more important than that played later when the child is older. The question arises whether the role of parents is equally important when it comes to EAR. What is (and should be) the parents’ role in robotics education? What, moreover, do parents know and feel about robotics education and their role in it? To date, the research has not addressed the deeper issues of the beliefs, feelings, involvement, and influence of parents in the context of EAR. Indeed, there is even a lack of systematic, empirical knowledge of what is really going on in these costly educational projects.

Among some commonplace beliefs are: robotics is difficult; the study of robotics is not interesting; robotics is not for girls because they have little desire to study it and less aptitude (than boys do) for excelling at it; robotics should be taught only from high school onward; parents cannot understand robotics; it is impossible for parents to be involved in their children’s robotics education; learning robotics skills is boring; and both parents and children are more motivated by competitiveness than by inquisitiveness (mastery motivation is less important than performance motivation).

Scholarly interest in this area has grown recently, but many studies are deficient in certain key aspects, including: the small number of respondents; the brief time span of the research: the impossibility of assessing the respondent’s genuine feelings, or his/her reluctance to be honest; the narrowness of the populations from which the samples are drawn; and the skewing of samples due to the fact that only parents and children who choose to participate in EAR programs (and are prepared to make a special effort to do so and pay a substantial sum of money for it) are included in the surveys.

Our thirteen years of research on EAR and five years of running the highly specialized project described here have generated a wealth of data and knowledge. One of the unique aspects of this research is the emphasis it places on parents, leading to the important results we have found that can now be applied to developing a vital model for PEAR (Parent in Early Age Robotics).

The PEAR model should include a knowledge base as well as all other components of a paradigm: epistemology, ontology, methodology, and axiology (Kivunja & Kuyini, 2017; Kuhn, 2012). It should have a strong theoretical basis, but also awareness of the genuine (though sometimes not explicitly articulated or realized) feelings, beliefs, and actions of parents.

We employ a three-pronged approach to constructing the PEAR model, taking into account theory, findings from real-life experiments, and finally, some fundamental guidelines emerging from these two components. Our findings are positive, refute many commonly held beliefs, clarify the feelings of parents, and allow us to propose a vital methodology. Through the PEAR model, we can witness a tectonic shift, with parents of both female and male children actually being far more supportive of their children and open to involvement in EAR than was previously believed. These positive attitudes need to be channeled, and we propose various ways to encourage this process.

# **Literature review**

Studies show that parental engagement in their child’s education has a positive effect on his or her academic achievements (Driessen, Smit, & Sleegers, 2005; Fan & Chen, 2001; Hill & Tyson, 2009; Jacobs, 1991; Leung, Lau & Lam, 1998; Powell et al., 2012). Indeed, the mere perception of a high level of parental involvement has a significant impact on achievement (Barwegen et al., 2004). Indeed, there is a voluminous body of literature on the subject (Boonk et al., 2018; Hill & Tyson, 2009; Jeynes, 2003; Patall, Cooper, & Robinson, 2008; ), showing that the involved parent appears to be motivated to actively play a constructive role, demonstrates a strong sense of efficacy in helping the child learn, and has a positive perception of life (Green, & Hoover-Dempsey, 2007). Parental engagement in the learning activities of preschoolers at home has been shown to have a positive association with academic achievement. Several research studies suggest that enrichment activities, such as storytelling, singing, teaching numbers and letters, problem-solving activities, and game playing improve children's literacy skills (Durand, 2011; Fantuzzo et al., 2004; Manolitsis, Georgiou, & Tziraki, 2013) and reading ability (Wen et al., 2012; Youn, Leon, & Lee, 2012). However, other studies also reveal that not all programs have the same impact. Depending on the program’s design, it can lead to a positive correlation, negative correlation, or a lack of any correlation between parental involvement and student achievement (Fan & Chen, 2001).

An individual’s beliefs are based on personal knowledge and result from conclusions that he or she draws from experience (Lavonen, Jauhiainen, Koponen & Kurki-Suonio, 2004). Beliefs are far more influential than knowledge with regard to discerning the ways in which individuals frame and organize tasks and problems, and are also stronger predictors of behavior (Bryan, 2012). Parents’ beliefs and feelings towards a specific subject can affect their child’s desire to study it. Parent-child communication can motivate the child’s learning and influence his or her desire to study a specific subject (Davalos, Chavez, & Guardiola, 2005; Jeynes, 2007). A parent’s knowledge of a topic or willingness to increase his or her own knowledge of it may increase a child’s desire to study and to have positive associations with the topic (Feng, Lin, & Liu, 2011).

Robotics in Education (RiE), or EAR, is basically teaching children how to construct and program robots. Children perceive it as a fun activity and an exciting learning environment (Eck et al., 2014; Eguchi, 2014; Sullivan, 2008; Zviel-Girshin, & Rosenberg, 2018). Several studies show that playing with robots can improve a child’s learning abilities (Connolly et al., 2012; Piaget, 1962; Prensky, 2001). Others have shown that children as young as four-years-old are capable of successfully building and programming simple robots (Sullivan & Bers, 2016; Sullivan, Kazakoff, & Bers, 2013). The use of robotics in education can improve children’s attitudes toward technology and science education (Benitti, 2012; Cejka, Rogers, & Portsmore, 2006; McLemore & Wehry, 2016). Educational robotics is also an effective learning tool for promoting and encouraging students to learn STEM subjects. It offers rich opportunities for integrating not only STEM, but also many other disciplines, including reading, social studies, music, and art into education. Finally, as educational robotics offers students an opportunity to explore ways of working together, it fosters collaboration, enables them to express themselves, and to create and think critically and inventively with the help of technological tools (Eguchi, & Uribe, 2017; Zviel-Girshin, Luria, & Shaham, 2020).

# **Evolution of the parental model**

The role of the parent in education did not change significantly for millennia until the last two centuries. Although this evolution has been continuous, it can be roughly divided into three major stages:

· home schooling until the nineteenth century

· formal institutionalized schooling, which has existed for approximately a century, from the second half of the nineteenth century until the first half of the twentieth century

· a blend of formal and informal technologically aided individualized learning, somewhere along the scale between institutionalized and home schooling, and usually taking place in a combination of formal and individually managed learning environments

Historically, a child’s education has always been a main parental responsibility. Every parent performed this duty to various degrees of success, according to his or her means and beliefs. Every child received some kind of “home education” through various activities, tasks, experiences, as well as exposure to environments and a range of influence and expectations from parents or the entire family. Knowledge and skills were transferred from parent to child.

A common practice in the late Middle Ages was an apprenticeship, that is, an arrangement supervised by craft guilds or the town government in which a child learned an art, trade, or profession under a master. In such a situation, the master became the parental surrogate in the educational process while the child was still young (quite young by modern standards).

Clergy, too, could replace the parent in the child’s education as in the church’s grammar or cathedral schools, which provided free education to boys. Few (if any) girls, however, were educated at proper institutions. Most were taught merely basic reading and writing skills (if any) at home. Only in the last centuries has compulsory school attendance become the norm in most countries. From the time of Napoleon to that of Bismarck, this policy was quickly adopted and adapted by governments that needed better workers and soldiers. By the twentieth century, governments made education compulsory for all children (boys and girls). In modern compulsory education, children are entrusted by parents to an educational institution, where they learn subjects and topics determined by a state or private curriculum.

This means that today, parents can delegate the responsibility for educating their child to the government. Nonetheless, they still serve as their children’s learning models. Parent’s beliefs, feelings, and attitudes toward education can inspire their child’s desire to learn and help them make their lifelong educational journey enjoyable and fascinating.

In recent decades, parental engagement in their children’s education has once again come to play an important role, and parents have become far more knowledgeable and involved in their children’s schooling. Reasons for this shift include rising income, higher educational levels, more involvement by both parents, especially fathers, more spare time, fewer offspring per family, greater awareness of the importance of skills, knowledge, education, and time spent with children, disappointment with the quality of formal educational institutions and their pace of adapting to changing times, greater technological prowess, the widespread availability of educational material (e.g., the internet), gamification, the multi-media nature of learning and teaching processes, the desire to learn by teaching, a home-schooling culture, and the more rapid maturation of children.

# **EAR project**

## **Basic information about the program**

In 2016, a novel robotics educational program that promised to serve as “a springboard that would enhance technological thinking and learning values in early childhood” was initiated by the Heffer Valley (Emek Heffer) and Zemer local councils in Israel. The program involved both Jewish and Arab kindergartens and schools, with a mainly Jewish population in the Heffer Valley regional council and a predominantly Arab one in the Zemer local council. It also catered to religious groups, ranging from ultra-religious to secular.

The aim of the program was to integrate robotics into science and technology classes in a playful way that would offer each child the best introduction possible and help the child acquire essential twenty-first century skills. This was a unique program in that general education and kindergarten teachers were meant to play the important role of robotics instructors. Trained with the assistance and support of program managers, these teachers became knowledgeable about their students and were able to develop special relations (as parental surrogates) with them.

In this program, kindergarteners and first-graders were required to study technology and robotics as a compulsory, not elective component of the curriculum. The program was funded in part by private donations, and in part by the Heffer Valley regional council. The private money made it possible to implement the principles of economic and gender equality, since parents were not required to contribute any additional fees for participation in the program. The program was approved by the Israeli Ministry of Education, while a Scientific Officer in the Israel Ministry of Education granted it special official certification for conducting research. This privilege allowed researchers to perform various assessments and evaluations, gather data, conduct interviews, and organize activities related to the program. All parents signed waivers that permitted the program to use private information, including photographs.

## **Research population**

The present study focuses on the parents of the children who participated in this program in two adjacent regional councils, Heffer Valley (Emek Heffer) and Zemer. The demographic details of these groups and some basic data can be found in Table 1.

Table 1. Demographic data from the two councils participating in the research

|  |  |  |
| --- | --- | --- |
|   | Heffer Valley | Zemer |
| General population | 41,100 | 6,567 |
| Number of children in kindergarten | 2152 | 365 |
| Number of children in elementary school | 4655 | 729 |

Comparisons between the two group were conducted. Although these populations seemed so different in nearly every aspect, the study found similarities between them on all points regarding the EAR program. The finding that the EAR program evoked a highly positive degree of involvement in parents of all significant sectors is a very important one. Our results and discussion thus relate across all sectors of our multicultural society.

The program began in 2016 with four kindergarten and seven first-grade classes in two schools in Heffer Valley, and five first-grade classes in one school in Zemer. It was later extended to five kindergarten and twenty first-grade classes in six different schools. In 2020, before the onset of the COVID-19 pandemic, a total of 586 children had planned to join the program.

## **Basic program goals, principles, and description**

The program has several goals that can be accomplished via robotics education. These include increasing children’s confidence in using technology, enhancing technology and science education as well as computer and technology literacy, and building children’s self-confidence, self-efficacy, and belief in their personal capabilities (Zviel-Girshin, Luria, & Shaham, 2020). An additional goal was to help children acquire essential twenty-first century skills, such as collaborative problem-solving, teamwork, communication, creativity and imagination, and critical thinking (Binkley et al., 2010; Dede 2010;).

One of the principles of this program is to provide a variety of learning opportunities and experiences for each child regardless of gender, economic status, and cultural background. It was for this reason that two specially tailored programs have been developed: one for kindergartens, and the other for elementary schools. An additional key principle is to provide children with teachers with whom they are already familiar, that is, with personal, familiar educators rather than strangers. These were local, “everyday” general education teachers who were provided with the support they needed to teach the required content. Special training workshops were developed for the teachers participating in the program: one for those working in kindergartens, the other for those working in elementary schools. The workshops explained the goals of the program, its basic principles, and EAR’s aims. The workshops also included age-appropriate tools and adaptations of special equipment, information on various pedagogical constraints and environments, and an array of robotic tools and activities.

In most robotics programs, a robotics expert from outside the school spends a specified amount of time (once per week, twice per week, once every two weeks, etc.) in the classroom. This expert generally brings the required robotics equipment to the class and then takes it with him or her at the end of the session. In some cases, the equipment remains at the school while the expert goes back and forth to conduct robotics classes and activities. In our program, one of the key features from the outset was that general education and kindergarten instructors taught the robotics content on their own. In addition, all of the robotics equipment remained on-site at the kindergarten/school and was available throughout the academic year, so that the students could thus use the equipment in a more informal way. Thus, in a sense, the kits became their personal property and the robots their own creations.

## **Program description in kindergartens**

A special robotics lesson was added once a week to the kindergarten curriculum. The main piece of equipment was the LEGO Education WeDo kit, which comes with an especially easy-to-use programming environment that can be installed on a desktop computer or tablet. The program was installed on computers placed in a dedicated “robotics area” of the kindergarten classroom, which also included robotics kits and computers.

A local kindergarten teacher taught a variety of robotics and technology related topics. A different kindergarten teacher—a so called “expert”—joined the local teacher and visited each kindergarten for an hour every week or two to help the local teacher with robotics education and with bolstering or improving his/her confidence in the subject. At the beginning of the program, the role of this expert was to reinforce the local instructor, but over time, the presence of the expert made it possible to break the children down into smaller groups, so that lessons became more personal. Working with smaller groups (two to four children), teachers were better able to stimulate the children’s natural curiosity by asking questions and encouraging each of them to think, and were able to offer different solutions and explanations for them (National Research Council, 2007; Schweigruber, Duschl, & Shouse, 2007). In addition, at each session, several groups of two to four children received special, individualized training in which they were asked to perform extra activities, explain their choices, predict the outcomes of some of their decisions or solutions, find alternative solutions, or solve extra challenges.

After the lesson and the robotics expert’s departure, the robotics kits remained available to all the children for future exploration and play. Each child was given free daily access to a specifically dedicated “robotics area” in the kindergarten, which included robotics kits, computers, and constructed models or projects. The kindergarten teacher could also use robots and tools for other activities and continue robotics education by assigning various self-study activities to interested pupils throughout the week.

## **Program description in elementary schools**

In elementary schools, the robotics lesson was added to the first-grade curriculum. The main equipment in this case was LEGO Education WeDo 2.0, a kit specially designed for elementary schools, and accompanying materials that included an eLearning program, that helped teachers master the WeDo 2.0 Core Set and WeDo 2.0 Curriculum Pack that covered life, physical, earth, and space sciences, as well as engineering. Other kits were similarly used.

Here, too, a “local” general education teacher taught the robotics class. Each lesson amounted to two academic hours per week. During the lesson, the class was divided into two groups: while one remained in the regular classroom with the regular teacher, the other moved to a science classroom, where a science teacher who had completed training in the field of robotics helped the children perform a robotic activity or solve a problem in robotics or technology. Each group was later divided into smaller teams (two to four members) who worked together on collaborative problem-solving assignments. A mediated learning approach that included both direct instruction and open-ended, student-directed inquiry (Suomala, & Alajaaski, 2002) was employed in both classrooms. Direct instruction consisted of short lectures and/or multimedia demonstrations of learning concepts, principles, models, problems, and activities. Open-ended, student-directed inquiry required students to work in teams to solve problems, programming, and design challenges. While some of the challenges were well defined, others were intentionally loosely defined, leaving room for creativity and imagination.

In the elementary schools, a different robotics “expert” was added to the robotics team (i.e., the regular class and science teacher). The role of this expert was to help the teachers understand the required learning content (in terms of the well-defined syllabus), to bring up new or interesting ideas, questions, and challenges, and to provide solutions to technical difficulties and issues.

In elementary schools, the robotic kits were stored after the lesson was over and were unavailable to children until the next robotics lesson the following week. There were no additional robotics activities during the school week.

At the end of the school year, all teams received a general task, a final project that they were supposed to solve with the help of robots. This final project was on specific topics, such as how robots can help humans on the moon, how they can be used to help domestic and wild animals, or how robotic devices can be used in a child’s room. Models of the final projects along with descriptive posters were presented at the school’s annual exhibition. Afterwards, all participating schools were invited to a hackathon—a “Robotics Day”—at the Heffer Valley Science Center, where they presented their work to other children, teachers, family members, and local authorities.

# **Method**

The participants in this questionnaire-based survey were the parents of the children who participated in the robotics program. Here we present the descriptive statistics of both the sample and the questionnaires, as well as a deeper analysis of some of the questions.

The research sample included 203 parents of children in the robotics program, 32.5% of them male (66) and 67.5% of them (137) female.

The median age of the participants was 39, ranging between 28 and 55-years-old. In terms of their educational background, the distribution was 12% engineering, 22% social sciences, 4% natural sciences, 15% economics and management, 7% humanities, and 40% other.

The research tool included a questionnaire that was filled out by the parents at the end of the school year. The questionnaire referred to the participation of their children, 117 (58%) of whom were boys and 86 (42%) of whom were girls, in the robotics program on the kindergarten or first-grade level. Parents had to express their agreement with each statement on a Likert scale of 1 to 5. As the normal distribution assumption was rejected in favor of the Kolmogorov-Smirnov test (Corder & Foreman, 2014), we could not apply parametric methods and therefore used non-parametric statistics.

Among the advantages of our survey were its total anonymity, its extended time frame (since 2016), a greater number of observations and surveys, more sophisticated questionnaires designed to uncover deeper, inner feelings, and a large and representative sample of a general population with a broad variety of ethnicities, religious beliefs, socioeconomic statuses, educational levels, and computer skills.

# **Results**

The distribution of the parents’ responses to statements regarding their abilities is presented in Figure 1. Most parents expressed a positive attitude toward technology. Most also felt that they were skilled at using computers, while only a tiny minority claimed to have problems using new technological devices.

**Figure 1.** Distribution of the responses on parents’ technological abilities.

Parents’ beliefs are summarized in Figure 2. A substantial majority of them agreed on the importance of teaching robotics in early childhood and saw no differences in boys’ and girls’ desire or ability to learn technological subjects (approximately 70%, 80%, and 90%, respectively).

**Figure 2**. Parents’ beliefs on the importance of teaching robotics as well as the existence of gender differences in the field.

Figure 3 summarizes the findings on the satisfaction of parents and their involvement in their child’s robotics training. To obtain the true feelings of parents, the question regarding satisfaction was reformulated in several separate questions. The results show great satisfaction; between 85% and 95% were happy with the program. The questions on whether the parent wanted his/her child to continue with program the following year and whether she/he would recommend it to others were the most revealing. Both got very high marks, approximately 95% and 88%, respectively.



**Figure 3.** Distribution of responses

Some highly significant correlation in the responses was found using Kendall's tau-b correlation tests. These are presented in Table 2. The \*p < .05 correlation is light grey and marked with one asterisk, and the \*\*p < .01 correlations is dark grey and marked with double asterisks.

Table 2. Kendall’s tau-b correlations between the responses to the 16 statements

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Statement | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| 1. It is very easy for me to learn new technology. | 1 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 2. Technology helps me be more efficient. | .394\*\* | 1 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 3. I usually have difficulty with a new technological device at home. | -.441\*\* | -.144\* | 1 |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 4. I spend a lot of time "fighting" with technological devices. | -.484\*\* | -.301\*\* | .519\*\* | 1 |   |   |   |   |   |   |   |   |   |   |   |   |
| 5. I am skilled at using the computer. | .559\*\* | .331\*\* | -.364\*\* | -.406\*\* | 1 |   |   |   |   |   |   |   |   |   |   |   |
| 6 I want to learn more about robotics. | .258\*\* | .237\*\* | -.115\* | -.151\* | .230\*\* | 1 |   |   |   |   |   |   |   |   |   |   |
| 7. Technology in general interests me. | .404\*\* | .348\*\* | -.205\*\* | -.262\*\* | .386\*\* | .694\*\* | 1 |   |   |   |   |   |   |   |   |   |
| 8. It is important to teach robotics in kindergarten/ first grade. | 0.065 | .286\*\* | -0.012 | -0.020 | 0.069 | .423\*\* | .360\*\* | 1 |   |   |   |   |   |   |   |   |
| 9. I believe that differences exist in boys’ and girls’ desire to learn technological subjects. | -0.090 | -0.064 | 0.008 | .152\* | -0.070 | -0.113 | -.147\* | -.133\* | 1 |   |   |   |   |   |   |   |
| 10. I believe differences existence between boys’ and girls’ ability to learn technological subjects. | -0.120 | -0.068 | 0.057 | .124\* | -0.077 | -0.116 | -0.073 | -0.095 | .477\*\* | 1 |   |   |   |   |   |   |
| 11. I am glad that my son/daughter participates in a program that enhances 21st-century skills and values through robotics. | 0.043 | .250\*\* | -.125\* | -0.112 | 0.121 | .288\*\* | .237\*\* | .506\*\* | -0.081 | -0.129 | 1 |   |   |   |   |   |
| 12. My son/ daughter frequently tells me about the robotics program. | 0.015 | .151\* | 0.019 | 0.025 | 0.058 | .314\*\* | .297\*\* | .234\*\* | 0.107 | .147\* | .288\*\* | 1 |   |   |   |   |
| 13. I feel connected to the robotics program. | 0.033 | .129\* | -0.015 | 0.006 | 0.046 | .381\*\* | .326\*\* | .303\*\* | -0.004 | 0.055 | .265\*\* | .546\*\* | 1 |   |   |   |
| 14. Thanks to the robotics program in which my son/daughter participates, I have learned new things that I did not know before. | -0.031 | 0.065 | .132\* | .127\* | -0.054 | .297\*\* | .240\*\* | .306\*\* | 0.026 | 0.086 | .156\* | .443\*\* | .563\*\* | 1 |   |   |
| 15. I am happy that my son/daughter will continue to participate in this program next year. | 0.049 | .186\*\* | -0.046 | -0.100 | 0.119 | .305\*\* | .259\*\* | .560\*\* | -0.080 | -0.038 | .648\*\* | .282\*\* | .305\*\* | .214\*\* | 1 |   |
| 16. I would encourage other parents to get schools to integrate robotics programs in their children's kindergarten or school. | .149\* | .277\*\* | -0.074 | -0.114 | 0.091 | .351\*\* | .287\*\* | .572\*\* | -0.121 | -.158\* | .554\*\* | .333\*\* | .369\*\* | .306\*\* | .657\*\* | 1 |

 \**p* < .05 \*\**p* < .01

The results of the Chi-Square test for irrelevance (Table 3) of the parent’s gender to his/her response to each statement reveals independence in all the statements (p>0.05), i.e., the parent’s response does not depend on his/her gender. The same test of the connection between the child’s gender and the parent’s response to each statement again reveals independence in all statements (p>0.05), meaning that neither the parent’s nor the child’s gender influenced the responses.

Table 3 Chi-Square test for independence results

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| The statement | Parent's gender Pearson Chi-Square value | Sig. | Child’s gender Pearson Chi-Square value | Sig. |
| 1. It is very easy for me to learn new technology. | 4.548 | 0.337 | 8.577 | 0.064 |
| 2. Technology helps me be more efficient. | 5.883 | 0.117 | 1.204 | 0.752 |
| 3. I usually have difficulty with a new technological device at home. | 8.391 | 0.078 | 5.842 | 0.211 |
| 4. I spend a lot of time “fighting” with technological devices. | 5.278 | 0.260 | 1.675 | 0.795 |
| 5. I am skilled at using the computer. | 6.764 | 0.149 | 4.758 | 0.313 |
| 6. I want to learn more about robotics. | 4.131 | 0.389 | 6.086 | 0.193 |
| 7. Technology in general interests me. | 4.501 | 0.342 | 1.475 | 0.831 |
| 8. It is important to teach robotics in kindergarten/first grade. | 2.919 | 0.571 | 6.520 | 0.164 |
| 9. I believe that there are differences between boys’ and girls’ desire to learn technological subjects. | 0.973 | 0.914 | 1.685 | 0.793 |
| 10. I believe that there are differences between boys’ and girls’ ability to learn technological subjects. | 1.524 | 0.882 | 7.571 | 0.109 |
| 11. I am glad that my son/daughter participates in a program that enhances 21st-century skills and values through robotics. | 4.929 | 0.295 | 2.868 | 0.580 |
| 12. My son/daughter frequently tells me about the robotics program. | 1.275 | 0.866 | 3.139 | 0.535 |
| 13. I feel connected to the robotics program. | 0.651 | 0.957 | 5.435 | 0.246 |
| 14. Thanks to the robotics program in which my son/daughter participates, I have learned new things that I did not know before. | 1.192 | 0.879 | 2.117 | 0.714 |
| 15. I am happy that my son daughter will continue to participate in this program next year. | 8.700 | 0.069 | 5.310 | 0.257 |
| 16. I would encourage other parents to get schools to integrate robotics programs in their children's kindergarten or school. | 7.923 | 0.094 | 3.318 | 0.506 |

The Independent-Samples Mann-Whitney U Test (Table 4) revealed no significant differences between the median answers of male and female parents in all statements (p>0.05) with the exception of, “I usually have difficulty with a new technological device at home" (p=0.45). The same test comparing differences between parents of boys and girls identified significant ones only in the statement “It is very easy for me to learn new technology” (p=0.026).

Table 4 Comparisons between the median answers of a) male and female parents and b) parents of boys and girls

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| The statement | Parent’s genderZ | Sig. | Child’s genderZ | Sig. |
| 1. It is very easy for me to learn new technology. | -0.521 | 0.603 | -2.227 | 0.026\* |
| 2. Technology helps me be more efficient. | -1.129 | 0.259 | -0.708 | 0.479 |
| 3. I usually have difficulty with a new technological device at home. | -2.009 | 0.045\* | -0.091 | 0.927 |
| 4. I spend a lot of time “fighting” with technological devices. | -0.085 | 0.933 | -1.139 | 0.255 |
| 5. I am skilled at using the computer. | -0.053 | 0.958 | -1.126 | 0.260 |
| 6. I want to learn more about robotics. | -1.162 | 0.245 | -0.774 | 0.439 |
| 7. Technology in general interests me. | -1.860 | 0.063 | -0.701 | 0.484 |
| 8. It is important to teach robotics in kindergarten/first grade | -0.589 | 0.556 | -0.335 | 0.738 |
| 9. I believe that differences exist between boys’ and girls’ desire to learn technological subjects. | -0.098 | 0.922 | -0.654 | 0.513 |
| 10. I believe that differences exist between boys’ and girls’ ability to learn technological subjects. | -0.452 | 0.651 | -0.483 | 0.629 |
| 11. I am glad that my son/daughter participates in a program that enhances 21st-century skills and values through robotics. | -1.142 | 0.254 | -0.809 | 0.418 |
| 12. My son/daughter frequently tells me about the robotics program. | -0.054 | 0.957 | -0.253 | 0.800 |
| 13. I feel connected to the robotics program. | -0.331 | 0.741 | -1.734 | 0.083 |
| 14. Thanks to the robotics program in which my son/daughter participates, I have learned new things that I did not know before. | -0.422 | 0.673 | -1.057 | 0.290 |
| 15. I am happy that my son/daughter will continue to participate in this program next year. | -0.652 | 0.514 | -1.331 | 0.183 |
| 16. I would encourage other parents to get schools to integrate robotics programs in their children’s kindergarten or school. | -0.294 | 0.769 | -0.253 | 0.801 |

\**p* < .05

# **Discussion**

The results here prove that many common negative beliefs about robotics education are no longer true. Parents are more knowledgeable, have greater faith in their children, and are more motivated to be involved and support them in these studies. As is evident from Figure 2, most parents understand the importance of teaching children robotics at an early age and do not think that there are gender differences among children regarding their desire or ability to learn technological subjects. According to the results, 70% strongly agreed and an additional 17% agreed with the statement “It is important to teach robotics in kindergarten/first grade.”

In general, the results show that most of the parents felt very comfortable with computers and technological devices. More than 88% believed that technology helped them be more efficient in everyday life and tasks. The majority (33% strongly agreeing and 25% agreeing) expressed a general interest in technology.

Parents today are far more technologically savvy, and the savvier they are, the more they want their child to study robotics at an early age. They also want to be as involved in this education as much as they can. This new involvement makes them happier and more connected with their child.

Over 53% of parents reported that they wished to learn more about robotics, leading to the conclusion that parents, too, should be offered knowledge about robotics as part of the EAR program. Parents reported that they lacked sufficient knowledge of new robotics. Yet only 24% of the parents reported that they actually learned something new from their children’s robotics program.

EAR created a new family bond. The majority of the children in the program shared their robotics experience with their parents. Thirty-three per cent strongly agreed and 24% agreed with the statement “My son/daughter frequently tells me about the robotics program.”

One problem that arose was that some parents did not feel sufficiently connected to the program. Measures need to be taken to involve these parents more fully in the program. Not all parents needed program managers to draw them in, but only a third felt connected on their own. The statement “I feel connected to the robotics program” divided parents into three groups of practically equal size:

• 34% strongly disagreed or disagreed

• 31% remained neutral

• 35% strongly agreed or agreed

On the other hand, these results could be interpreted as a positive sign: a third of the parents felt strongly connected due to their children’s interaction in the family. The program did not, in fact, explicitly require parental involvement. Nonetheless, many features of the EAR program could be used to strengthen parents’ involvement in and connection to their child’s activities. Let us examine, for example, some of the involvement that occurred in the program. During the school year, parents received biweekly or monthly updates on the program. Every week, new robotics artifacts meant to be shown to the parents were placed at the entrance to the kindergarten. Children spent the final two months of the program working in teams on their final projects, in which they had to define a problem and its solution with a robot or a robotic device, build and program this robotic device, and design a poster presenting the problem, its solution, an explanation of the working model, and pictures. At the end of the school year, all family members, as well as additional children and teachers, were invited to the Robotics Day activities at school, kindergarten, and the Heffer Valley Culture and Pleasure Center, where teams of two to four children presented their final projects, robot models, and posters at the exhibition. Later all the schools and kindergartens participating in the program were invited to visit a “Robotics Day” event at the Heffer Valley Culture and Pleasure Center and present their projects. This “Robotics Day” marked the culmination of the program.

The crucial finding here lies in the enthusiasm over future participation in the robotics program and the respondents’ strong feelings about EAR. Responses showed that 94% of parents would be very happy to have their child continue the robotics program the following year (with 83% strongly agreeing and an additional 11% agreeing). Also, 87% of the parents said that they would encourage other parents to demand robotics program in their children’s schools/kindergartens (with 83% strongly agreeing and an additional 11% agreeing). As mentioned in the introduction, parent-child communication can motivate a child’s learning and influence his/her desire to study a specific subject. A previous study (Zviel-Girshin, Luria, & Shaham, 2020) shows that 90% of the boys and 88% of the girls in the program would be happy to participate in a robotics program the following year. A summary of the parents’ data indicates the same. Children and parents obviously agree on their high appreciation of EAR education and wish to study robotics on a higher level.

# **The PEAR model**

In this program, we also witnessed the transformation of parents. From passive bystanders and mere consumers of the educational system, they grew more confident about their own ability to learn and help, and about their child’s abilities. They felt more motivated, involved, and wanted to be even more involved. By the end of the year, they were ready to invest in their own and their child’s learning.

In terms of the relations between teachers and parents, we saw maximum involvement, bidirectional communication, as well as support and a feedback channel for children. In terms of the parent’s relations with the child, the parent played a multitude of roles, including teacher (in the classic sense, with the functionality of a classroom instructor), facilitator, supplier of resources (educational and other), mentor (based on the great respect and importance of father and mother figures), coach (through management of training, development, and the application of strategy and tactics), creator (showing by example in apprenticeship studio model), leader (leading the child through the learning process with empathy and sympathy), counsellor (whenever the need arose for listening and understanding), helping hand (literally helping with tasks as a team member), and student (allowing the child to learn through teaching).

Using the ABC (Affective, Behavioral, Cognitive) model for PEAR, we can characterize and understand each parent with a numerical measure of each of the following: affect according to subject, kind, behavior, and cognition. With subject, we measure general feelings about the child, his/her education, EAR, his/her particular robotics program, and the role of parents in PEAR. With kind, we measure motivation, positive attitude, hope, optimism, and satisfaction. Behavioral components may include time, learning, communication, and participation. With cognition, we can measure beliefs as well as the knowledge of robotics, the child’s EAR program, and the actual child.

The principles presented here can serve as a sound basis for future research; they can and should be used in empirical surveys and by educators working in EAR.

# **Conclusion**

This research has provided some important insights that could have an immediate impact on EAR education programs through the addition of PEAR (Parent in Early Age Robotic) education.

We began by refuting certain negative views about parents in this context. Although such views may have had some validity in the past, this is no longer the case. We can now be quite positive about parents in early robotics education. Not only has it become a very popular activity with objective educational advantages, but, as our research has clearly shown, parents of all kinds and persuasions have strong positive feelings about it. It has made them believe in their children (of both genders) as well as in their own ability to get involved in, learn, and help very young students. Involved already, parents hope to become even more involved in these programs, which they see in such a positive light.

Parents were distinguished by and analyzed according to their beliefs, involvement, satisfaction, and intentions. Our analysis of parents’ beliefs indicate that they accepted the desire and ability of their children (of both genders) to study robotics at a very young age, trusted that they knew enough about the field to help their children, and felt that their children should continue studying robotics. Our analysis of parents’ involvement demonstrates that they were involved and felt confident with technology, felt a connection to EAR, and contributed to and learned from their children’s study. The study confirms parents’ satisfaction with technology, their willingness to learn more about robotics, and their satisfaction with their children’s participation in an EAR program. Our analysis of parents’ intentions reveals their intent to register their children in a higher level EAR program and to recommend EAR programs to others.

This attitude is part of education’s evolution from an institutionalized form to one that demands greater family involvement. This quite significant transformation should be considered and used by EAR stakeholders, especially designers, managers, and instructors. Close cooperation between the institution and the family will greatly improve the outcome of EAR programs. This type of cooperation is based on that of the PEAR model, which defines the EAR personae, institutions, and the relations between them. It allows for the development of procedures, communication channels, and cooperation tools such as online knowledge bases.

Some proposals for EAR programs are: a priori construction, real-time evolutionary formative assessment of family PEAR, follow-up feedback and support (parent scaffolding), greater involvement of parents in every aspect of the program, some home, remote, and in situ instruction for parents, individual and family-oriented monitoring of the psychological aspects of the program, ambient EAR with home and mobile extensions, and gamification for both parents and children.

Further research could refine the PEAR model. The family unit as a whole as well as its inter- and intra-relations should be a topic of serious study. The PEAR model and the design of EAR programs with consideration for the results and proposals presented in this paper will have a variety of positive effects on the entire family as well as on educational achievement.

# **Acknowledgments**

The authors would like to thank Riki Rubin, the Head of Heffer Valley Culture and Pleasure Centre, for all her help and support in conducting current research.

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