PERU

Bringing 21st Century Learning to Peru

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1. Context and aims

LEGO Education's work in Peru has been underway for almost two decades and was significantly enabled by an important research project in 1998, carried out by Educational Psychologist Ivan Montes Iturrizaga under the supervision of Dr. Seymour Papert and his staff at the Media Lab at Massachussetts Institute of Technology, Cambridge, USA.

The research measured the impact of a project named INFOESCUELA (since renamed Robotica), which was a Government initiative designed to bring technology into schools and to change the pedagogical practice from instructive "learning by memory" to technology-driven, multidisciplinary approaches to learning.

LEGO materials were used in 130 schools and tests were carried out with a control group and an experimental group, making it was possible to compare results between students who used LEGO materials and students who did not.

The findings showed that students who had explored principles of physics, maths and programming by building LEGO constructs showed improved understanding of those subjects.

But what was perhaps even more noteworthy was that those students also demonstrated improved performance in Spanish and a higher measure of self-esteem.

Since 1998 LEGO Education's partner in Peru 1ST Wernher van Braun has continued to campaign for more effective pedagogy and improved standards in teaching science and technology, through the use of hands-on resources.

In 2009 this work was furthered strengthened when the Peruvian Ministry of Education joined the One Laptop Per Child, OLPC, project and put out a tender to companies to develop appropriate teaching resources for those pcs. Part of the requirements was to design a student centred pedagogical approach to science and environment education, with focus on inquiry.

LEGO Education set about developing a simple robotics program for primary school students and subsequently won the tender.

At the same time the ministry also gained assistance from the Inter-American Development Bank, IDB, to research and validate the approach and the impact on science and environment education.

In September 2012 IDB presented initial findings of a pilot study, which examined not just the LEGO Education program, but also other initiatives designed to address human and environmental science and maths teaching.

This latest quantitative research, although different from the initial 1998 research in its nature, adds more evidence to the proposition that hands-on learning has a direct and measurable impact on student performance in core subjects. Section 4 of this report documents those findings in more detail.

Meanwhile, there is another important theme that emerges consistently from research; that success is not just down to hands-on, experiential learning, but it is also largely influenced by the skills and confidence of the teachers.

Interestingly Papert also touched on this in 1998 when he commented in the introductory paragraphs of the research report:

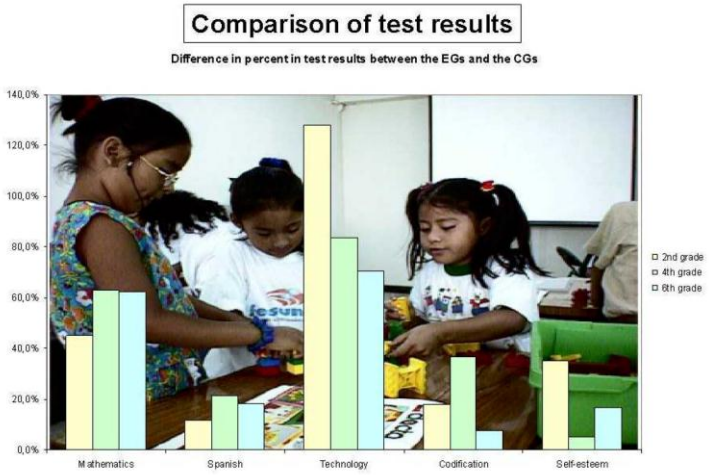
"An essential component of excellence in educational practice is a large dose of personal creativity by the educators. This means that every educator should also be a theorist and innovator. What I would really like to do is to discuss the many ways in which this project could provide a context for teachers as well as students to learn creatively."

The most recent pilot study suggests that it is not simply a question of providing engaging, hands-on resources, but also of managing systematic implementation of new methods and materials through teacher training.

The real task might be to change mindsets and build confidence in the teacher population so that they adopt new technologies in a way that ensures that their students become effective learners through experience – learning by making, learning by doing.

This is certainly not unique to Peru. The rapid development of digital technology is having a major impact on teachers and eacher training and support is likely to become a key success factor in delivering engaging and relevant education for the 21st century.

So it is interesting to look toward developing countries such as Peru, because as Papert said in a letter to the Peruvian MoE in 1998: "Seeing educational excellence in developing countries encourages me in my belief that at the end of the day it will be countries that proudly see themselves as driven by a need and a desire for development that will lead the shaping of the learning environment of the digital age."



2. The project expands

The research into INFOESCUELA resulted in an ongoing expansion of the use of computers and LEGO® materials by about 100 primary and secondary schools each year up to 2009.

The desired impact however was often limited because schools typically had too few resources for students, and teachers lacked the training and confidence needed to really embrace and teach science and technology.

So when the One Laptop Per Child, OLPC, program entered Peru, a welcome opportunity arose for the Government to considerably expand its efforts to raise the standards of education at a national level. The Government initiated a tender program to find partners able to develop relevant educational content for the pcs.

With the support of 1ST Wernher van Braun, LEGO Education entered the tender program. It meant the company should develop a primary school robotics solution that would be compatible with OLPC.

The result was **WeDo** – a simplified version of the renowned LEGO MINDSTORMS® Education solution which incorporates icon-based computer programming tools with LEGO technic bricks, gears and motors. In short WeDo became a 208 piece kit for students, working in pairs, to build and program sensor-driven hungry alligators, fast-moving goalkeepers, groaning giants from fairytales and whatever else their imagination could come up with. The kit addresses principles of physical science in a cross-curricular, playful way.

In 2010 an agreement was signed between 1ST Wernher van Braun and the Ministry of Education to equip 20,000 primary schools throughout Peru with training, hardware and software, worth approx 1100 USD per school.

3. The programme

The full scale of the project is to deliver the following:

- 130,000 LEGO Education WeDo robotics kits.
- 30,000 teacher guides with technical content aimed at guiding elementary school teachers. Includes activities and contextualized learning sessions.
- 20,000 institutional licenses for WeDo software for Linux/Sugar and 10,000 licenses for Microsoft Windows for teachers training.
- 20,000 construction guides of 12 LEGO models.
- 70,000 pedagogical setting banners for classrooms.
- Training of 50 specialists from the Ministry of Education - Department of Educational Technology in Educational Robotics.
- In person training for 8,000 teachers (so far) conducted in 24 regions of Peru.
- 20 hours contact per school.
- Virtual training via the Internet (www.aprenderhaciendo.edu.pe) for 7,000 teachers, worth 100 hours:

Course	Hours
Technological Scientific Concepts	30
Educational Robotics – WEDO	40
Curriculum Planning – Primary	30
	100

The objectives are to enable teachers to provide lessons in which:

- Children are provided with challenges designed to increase their daily experiences and to capture their interest.
- Teachers promote the development of learning communities, where students work in teams to develop their own solutions to the problems of science.
- Students are given time to reflect on their solutions and bring their ideas.

- Students are presented with a follow up on ideas and encouraged to apply new knowledge to additional challenges.
- Teaching is diversified to meet the needs of all types of students, offering different entry points, learning tasks and results tailored to individual needs.
- Expectations for every child must be high and teachers must demonstrate that they believe every student can learn.

4. Key Findings

Inter-American Development Bank, IDB

At the time that the Government took on OLPC, it also won the support of the Inter-American Development Bank (IDB) to complete a pilot study of the impact of this project. The study would not just look at the use of LEGO materials to teach physcial science and maths, it would also study the impact of other resources to teach human and environmental science.

Data collected prior to the implementation of the new resources offered a disturbing picture of science education in Peru. Less than 16 percent of principals reported that their school had sufficient textbooks, less than 17 percent indicated that they had sufficient pedagogical literature for teachers. Less than 9 percent said the school had enough materials to teach science experiments. More than 70 percent of teachers had received no training in science or the environment in the last 10 years.

The research consisted of three components. First "an experimental designed evaluation to estimate the causal impact of the new pedagogical approach on scholastic achievement of the students".

Second, surveys of principals, teachers, parents and students to obtain socio-demographic information of the schools and the students' families.

And third, a qualitative evaluation to further understand the context of the treatment and the evaluation.

The pilot study covered 106 schools in the region of Lima with, 53 treated and 53 non-treated schools, and a total of 2,771 third grade students. Baseline exams were applied in science and environment as well as mathematics and reading comprehension to students starting third grade and again at the end of the year (2010 academic year running from April to December).

The survey of the schools' principals aimed to obtain information on the number of students and teachers, the school's facilities, equipment and didactic materials and the school's climate. The survey of teachers collected baseline data on diverse aspects of teaching science and the environment in their school and to their students. A socio-demographic parent survey was given to the students to be brought home, answered by their parents and returned in closed envelopes.

The quantitative research tools were complemented by a qualitative evaluation. The qualitative evaluation consisted of visits in situ to eight schools, four each from the treated and non-treated schools.

Findings

As shown in Panel A of Table 3 below there were no impacts on the Human Body and Environment modules (columns one to four) and the overall test score (columns seven and eight). However, there was a significant effect on the Physical World module, in which LEGO materials and teacher training were implemented, with an estimated impact of 0.18 standard deviations (column six).

The IDB report states: "The results show that this new pedagogical method is more effective than those traditionally used in Peruvian schools; despite the fact that the application of the new method was for less time than planned.Further, the size of the effect is higher than that found in the majority of studies on interventions aimed at improving test scores at the school level (see Glewwe et al, 2011)."

The report however, highlights that the reasons for not improving results in the other sections, was largely due to materials not being used effectively.

Furthermore, qualitative evidence corroborates that the program generated interest in pupils regarding this module. Indeed, teachers pointed out that school attendance had always been a problem. However, when plans to use the LEGO kits were preannounced, pupils who were often absent began to come more regularly on those days. Then teachers stopped pre announcing the days that the LEGO kits were to be used resulting in an increase in assistance for all the days. Teachers also reported how children started to identify machines that their parents used at work and understanding scientific concept such as pulleys.

Table 3: Overall Results - Science and the Environment

Dependent Variables:	Science & Environment							
	Human Body		Environment		Physical World		Overall	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Overall Effects								
Treatment effect	0.02	-0.03	0.08	0.03	0.22**	0.18**	0.15	0.10
	(0.09)	(0.06)	(0.10)	(0.07)	(0.10)	(0.08)	(0.11)	(0.07)
Observations	2536	2373	2536	2373	2536	2373	2536	2373
Panel B: Effects by Gender								
Girls	-0.06	-0.06	-0.03	-0.03	0.10	0.10	0.02	0.02
	(0.10)	(0.07)	(0.11)	(0.07)	(0.11)	(0.09)	(0.12)	(0.08)
Additional effect on Boys	0.14	0.06	0.20**	0.11	0.24***	0.16**	0.25***	0.15**
	(0.09)	(0.08)	(0.08)	(0.07)	(0.08)	(0.08)	(0.09)	(0.07)
Observations	2536	2373	2536	2373	2536	2373	2536	2373
Panel C: Geographical Effects								
Rural	-0.23	-0.18	-0.20	-0.16	0.02	0.09	-0.14	-0.08
	(0.14)	(0.12)	(0.18)	(0.13)	(0.16)	(0.13)	(0.18)	(0.13)
Urban	0.07	0.01	0.16	0.10	0.26**	0.20**	0.21	0.14*
	(0.10)	(0.07)	(0.12)	(0.07)	(0.12)	(0.09)	(0.13)	(0.08)
Observations	2536	2373	2536	2373	2536	2373	2536	2373
Panel D: Geographical Effects by Gender								
Rural - Girls	-0.29	-0.21	-0.30	-0.23*	-0.10	-0.03	-0.26	-0.18
	(0.18)	(0.14)	(0.19)	(0.13)	(0.18)	(0.15)	(0.20)	(0.14)
Rural - Boys	-0.17	-0.15	-0.10	-0.09	0.14	0.21	-0.02	0.02
	(0.16)	(0.15)	(0.20)	(0.17)	(0.17)	(0.14)	(0.20)	(0.17)
Urban - Girls	-0.00	-0.02	0.06	0.06	0.15	0.14	0.10	0.08
	(0.11)	(0.07)	(0.12)	(0.08)	(0.14)	(0.11)	(0.14)	(0.09)
Urban - Boys	0.13	0.04	0.25*	0.15	0.36***	0.26**	0.32**	0.20**
	(0.11)	(0.09)	(0.14)	(0.09)	(0.13)	(0.10)	(0.14)	(0.10)
Observations	2536	2373	2536	2373	2536	2373	2536	2373
Baseline controls	No	Yes	No	Yes	No	Yes	No	Yes

Estimated standard errors clustered at the school level are in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. All scores are expressed in standard deviations with respect to the control group. Estimations in columns one, three, five, and seven are obtained by estimating the model without controlling by the initial test scores. Therefore, we used all the observations, 2,536, at the end line thus included pupils that were not tested at the base line. The reported estimations in columns two, four, six, and eight are controlled for initial exam results of each pupil therefore includes pupils that were tested at the base line and the end line, that is, 2,373 pupils.

The report also looked at differences between geography, gender and potential side effects on other subject areas including mathematics and reading comprehension. It found that boys tended to perform better than girls, and that high performers continued to retain their 'advantage', which suggests that teaching should be organised in ability groups so that the lessons could be better differentiated. It also did not find evidence of improved scores in other subject area, but suggests that this may still be proven over a longer study period.

Generally there was no impact on the intervention of teachers' perceptions regarding their work. However, there was one significant exception. There was a negative impact on teachers' perception that it is necessary first to teach theory and only afterwards practice. This question was intended to capture whether teachers had achieved what the methodology was looking for: to shift away from in class explanations to practical examples using the LEGO kits.

This result shows that the teachers in the treatment group at least in rhetoric successfully managed to shift away from the traditional focus on science history and the memorization of concepts.

The report concludes:

> *"The quality of education in Peru is a major problem as evidenced by the country's low performance on national, regional and international standardised tests. The need for evidence of what improves the quality of education is a crucial policy issue.*
>
> *In this paper we present the findings of an experimental evaluation of a new student centred pedagogical approach in the teaching of Science and Environment at the third grade level in Peru.*
>
> *Despite complications resulting in only a partial implementation of the pilot we find positive and significant improvements in test scores of students taught with the new method.*
>
> *A challenge for an eventual scale-up of the program consists in ensuring that all students benefit from the new teaching methods, particularly girls and students in rural schools. This is a critical policy design issue in a country with an inequitable distribution in the quality of education and learning outcomes."*

5. Next steps

1ST Wernher van Braun will continue to implement the use of LEGO materials and to train teachers in Peru to adopt a more faciltative approach to teaching, that blends theory with practice in an engaging way. There are a number of hurdles and opportunities.

At Primary Level:

Only 8,000 teachers have so far been trained among the 20,000 schools (the total potential number of teachers who could benefit from training is 200,000). There are insufficient resources to match demand.

Many schools are too poorly equipped to implement the new technology. About 30 new buildings have been created in response to this need, but many are still lacking.

Training needs to be repeated and additional teaching materials provided in order to keep the momentum going. There is only one Teachers Guide per school which is not sufficient. Additional funding is needed.

1ST Wernher van Braun has now developed a **Diploma in Educational Robotics** for Elementary Teachers, with support and advice from Professor Mitchel Resnick of MIT in Boston. Resnick is a research fellow of the LEGO Learning Institute and a valued advisor to the LEGO Group.

The diploma addresses technology, creative engineering, control and automation and robotics, and aims to explore:

- Learning through research
- Encouraging creativity
- Promoting experimentation
- Improving teaching methods
- Improving understanding of physics and mathematics.
- Strategies for developing math, science and environment, social and personal communication skills through specific technological experiences.

At Secondary Level:

The use of LEGO Education resources as Secondary School level has been comparitively limited, but there has been a project in Lima covering 20 secondary schools using LEGO MINDSTORMS Education materials, which is a more advanced version of WeDo for students aged 10+. Many of the teachers trained in these schools however have left and the schools urgently require new training.

A further 29 secondary schools have been identified to extend this project, but a decision to move ahead has been pending for 2 years.

The Institute of Von Braun is also currently developing training materials and a secondary school diploma, while also promoting education robotics across the country through seminars and exhibitions.

Robotics Competitions

Peru has an opportunity to participate in global robotics championship events such as FIRST LEGO League, which involves hundreds of thousands of teams and schools across the US, Latin America, Canada and Europe, and the World Robot Olympiad, which also operates globally.

Competitions have proven to be hugely effective in motivating students to choose science and technology subjects at school and to pursue careers in science and engineering.

Higher Level

There are also opportunities to promote robotics education in universities and colleges, although there is currently a misconception in Peru that MINDSTORMS is just for kids. More evidence of the use of the concept at university level is needed.

6. Sources

Study of Educational Impact of the LEGO Dacta Materials, INFOESCUELA, MED, 1999

The Pedagogy of Science and Environment: Experimental Evidence from Peru, IDB, Office of Evaluation and Insight, Working Paper, September 2012