Developing Computational Thinking via the Visual Programming Tool Lego Education WeDo

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Introduction

The present study is conducted in the framework of Science, Primary Education and Computational Thinking.

New Curricula in STEM subjects → challenges of current and future society
current digital world

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Teaching practice must change

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Digital language and all the necessary skills

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Ability to program → solve problems
Computational thinking → working paradigm

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Abstract, logical, modeling & constructive thinking

Objectives

The **aim** of the present study was to know the students' perception about the use of the software Lego Education WeDo in the subject of natural sciences to promote the computational thinking.

We tried to test these **hypotheses**

H1. Students will learn to build and program 3D models with Lego WeDo.

H2. Students will think creatively to solve the problems.

H3. Lego WeDo will help pupils to know the relationship between cause and effect.

H4. The tasks developed will allow pupils to reflect about the possibilities they have, and to find the correct answer.

Method

The study focused on an innovative project of computational thinking, carried out in the state-funded school Santísima Trinidad in Salamanca, in Castilla-León, during the academic year 2015-2016.

Natural Sciences → Unit. Forces and machines

1. To understand the importance of machines, and classify them as simple and complex machines.
2. To list the most important simple machines and know how they work.
3. To know the three types of lever.
4. To understand the contribution of technological progress to meet people's needs.
5. To become familiar with some mechanical movements.

Method

Lego Education WeDo (Lego Group in collaboration with MIT).

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Lego Education materials support a process of learning that includes four phases: Connect, Construct, Contemplate, and Continue.

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To build and program two 3D models →

Dancing Birds

Smart Spinner

Method

We have employed a **Quantitative Research**

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Ex-post-facto, non-experimental design.

Semantic differential and test.

Descriptive and inferential analysis.

Research Phases

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1. We established the objectives and hypothesis of our research.
2. We selected the sample and instruments.
3. We carried out the register coding and data analysis to obtain the results and conclusions of our study.

Sample

Sample

- 52 Spanish pupils from the 4th grade of Primary education of the compulsory subject natural sciences with ages between 9 (53.8%, n=28) and 10 (46.2%, n=24).
- 48.1% were boys (n=25) and 51.9% were girls (n=27).
- All of them had knowledge of the use of computers, tablets and interactive whiteboard.
- The fifty-two pupils had participated in previous projects in which they had the opportunity to work with the visual programming tool: Scratch.
- 34.6% (n=18) were enrolled in the Robotics workshop, and had experience in the use of the 3D modeling software, Sketch Up.

Instrument

Instrument

⬇

Semantic differential & Test (adapted from the research led by García-Valcárcel)

Types of questions → open, close, short answers & 7-point Likert scale (1 is the most negative answer, and 7 is the most positive one).

Internal consistency → Cronbach's alpha, α=0.870.

Data Collection & Analysis

Data Collection

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We collected the data in the subject Natural Sciences during the academic year 2015-2016

Then these data were coded to enter them in the Statistical Package for the Social Sciences (SPPS) version 24.

Analysis

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We carried out the statistical analyses: descriptive statistics (frequencies and percentages), and inferential (the non-parametric test: Mann-Whitney U test).

Results

Students' Perceptions about the Development of the Project

The participants assessed very positively the project carried out about natural sciences and computational thinking.

The students considered that the project had been funny; they had loved this way of working; and wanted to learn more about the subject.

Semantic differential

It has been boring	6.77	It has been funny
I do not like this way of working	6.77	I love this way of working
I am no longer interested in this topic	6.77	I want to learn more about this topic

They emphasized that the teacher had explained clearly what they had to do; they considered that her help had been important; and emphasized her role as a guide, showing them what was right or wrong.

Semantic differential

The teacher has not given us clear instructions	6.71	The teacher has explained clearly what we had to do
The teacher has not helped us	5.88	The teacher has helped us
The teacher has not indicated what was right or wrong in our work.	5.81	The teacher has indicated what was right or wrong in our work.

The pupils also stated that the project had been useful and interesting; they had understood the activities, they had maximized time, they had learned more things than usual, and they had done them working in groups.

Semantic differential

It has been useless	6.69	It has been useful
It has not been interesting	6.63	It has been interesting
I have not understood what we have done	6.65	I have understood what we have done
I have lost time	6.17	I have maximized time
I have learned less things than usual	6.52	I have learned more things than usual
We have not done the exercises well, working in group	6.46	We have done the activities well, working in group

Regarding the items that referred to the computational thinking, we emphasized the positive results of the students' perceptions about the possibilities offered by Lego WeDo to build models in 3D and program them, as well as to learn to think creatively to make the 3D models, to reflect about the activities, to solve problems in a logical way, and to know the results of their decisions.

Semantic differential

I have not learned to build models in 3D	6.31	I have learned to build models in 3D
I have not learned to program	6.50	I have learned to program
I have not learned to think creatively to make the 3D models.	6.37	I have learned to think creatively to make the 3D models
The activities done with Lego WeDo have not allowed us to reflect	6.42	The activities done with Lego WeDo have allowed us to reflect
The project has not allowed us to solve problems in a logical way	6.29	The project has allowed us to solve problems in a logical way
Lego WeDo has not allowed us to know the results of our decisions	6.38	Lego WeDo has allowed us to know the results of our decisions

We calculated the Mann-Whitney U test to determine whether there were statistically significant differences (CI 95%) between boys and girls in their assessments of the items of the semantic differential. The data analysis indicated that there were statistically significant differences in the items that referred to:

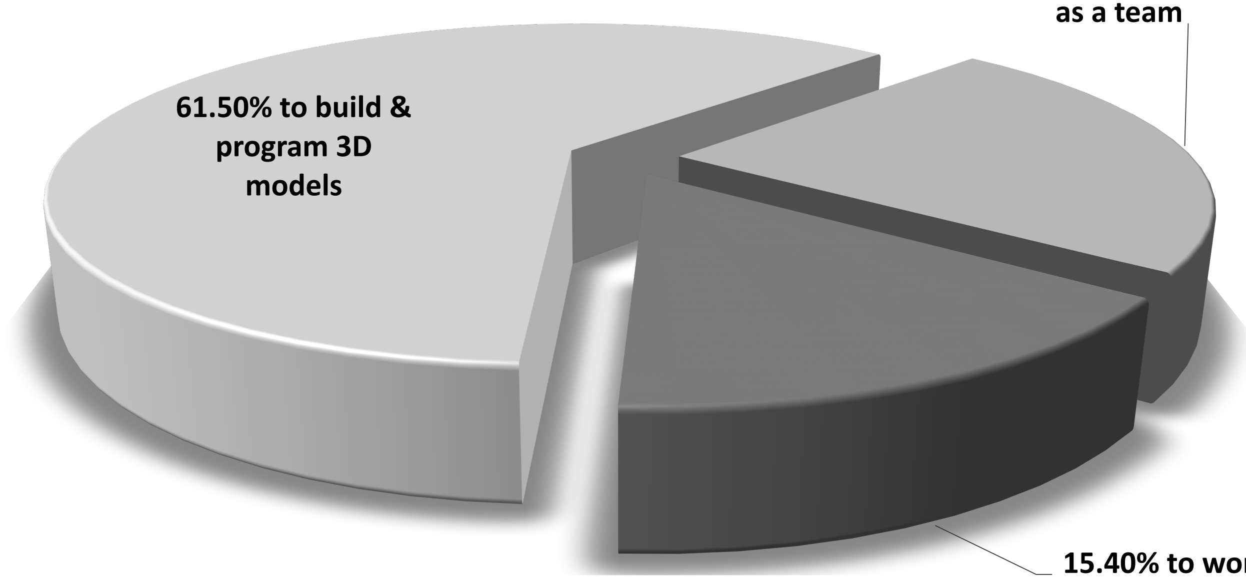
- I have learned to program (item 15).
- The activities done with Lego WeDo have allowed us to reflect (item 18).
- I have learned to build models in 3D (item 24).
- The project has allowed us to solve problems in a logical way (item 26).
- I have learned to think creatively to make the 3D models (item 27).
- Lego WeDo has allowed us to know the results of our decisions (item 28).

Independent-Samples Mann-Whitney U Test

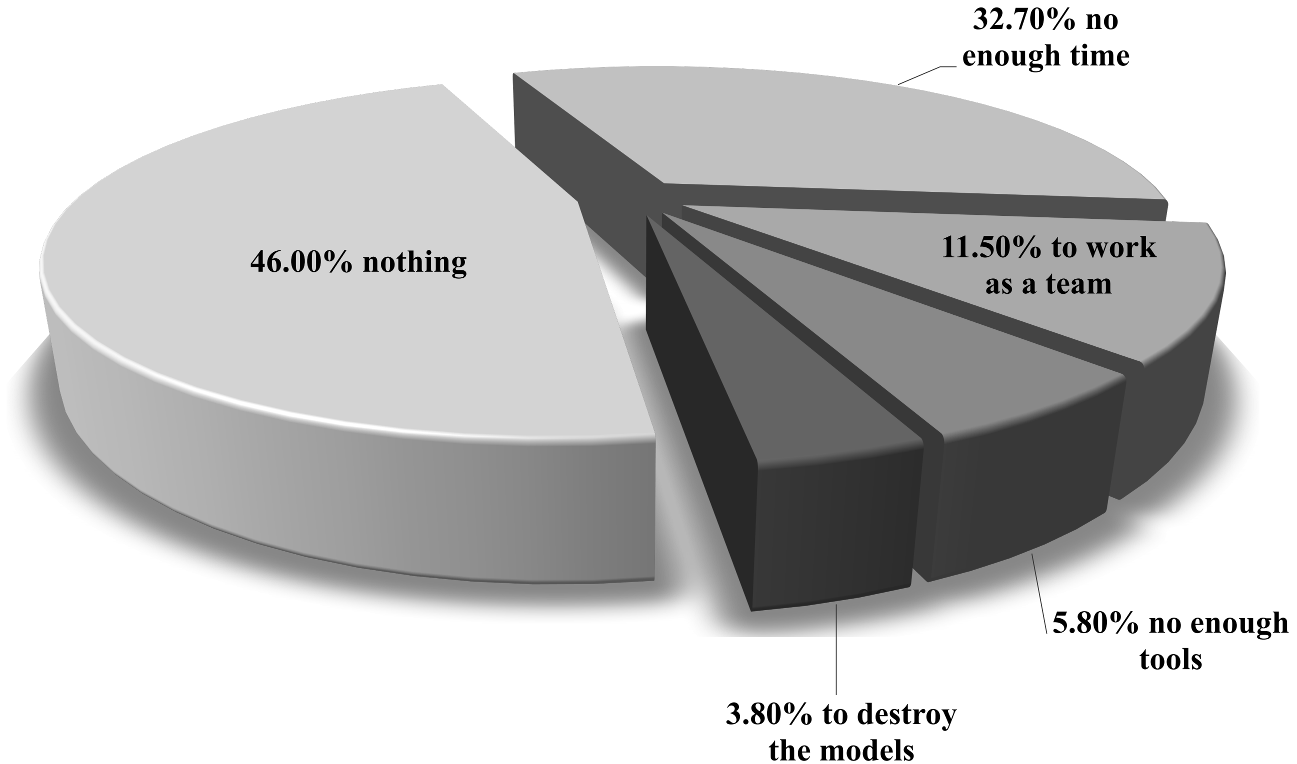
	Gender	Mean Rank	Sum of Ranks	Mann-Whitney U	Sig.	Z
Item 15	Boy Girl	35.58 18.09	889.5 488.5	110.50	.000	-4.813
Item 18	Boy Girl	14.42 37.69	360.5 1017.5	639.50	.000	-6.228
Item 24	Boy Girl	39.04 14.89	976.0 402.0	24.000	.000	-6.465
Item 26	Boy Girl	13.80 38.26	345.0 1033.0	655.00	.000	-6.448
Item 27	Boy Girl	13.42 38.61	335.5 1042.5	664.50	.000	-6.698
Item 28	Boy Girl	13.98 38.09	349.5 1028.5	650.50	.000	-6.472

Results

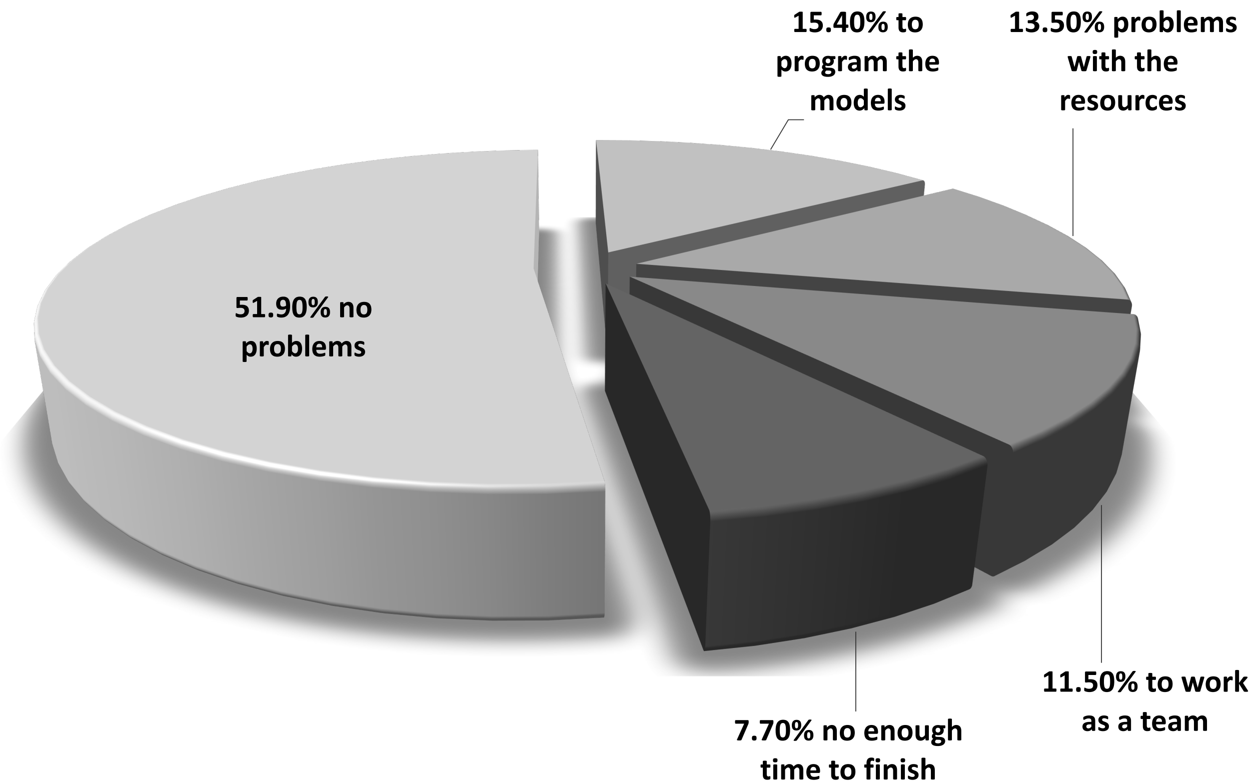
Students' Perceptions about the Strong and Weak Aspects of the Project



Students' Perceptions about the aspects they liked most



Students' Perceptions about the aspects they liked least



Students' Perceptions about the problems they had

Conclusions

The results from the semantic differential suggested the effectiveness of the project carried out in the subject natural sciences to increase the participants' awareness of the computational thinking.

There were evidences of the possibilities offered to:

- reflect and think creatively about the opportunities they had to fulfill the activities correctly
- know the results of their personal or group decisions
- solve the problems in a logical way

The students assessed very positively the teacher's role in the project → guide, and thought that her help was essential for the success of the project.

Conclusions

There were evidences of the students' satisfaction towards the project, considering it useful and interesting, considering it a perfect way of learning which motivated them to learn more about the discipline of natural sciences.

The use of Lego Education WeDo have allowed them to:

- understand better the activities
- work in groups
- learn more things than usual.

Our study and its results have proved the potential of the software Lego Education WeDo in the subject of natural sciences to:

- promote the computational thinking
- engage primary education students in programming, and problem solving.