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Exploring computational thinking, executive functions, visuospatial skills and experiences with toys in early childhood

Submission date 05/04/2024	**Recruitment status** No longer recruiting	[_] Prospectively registered [X] Protocol
Registration date 11/04/2024	**Overall study status** Completed	[_] Statistical analysis plan [_] Results
Last Edited 21/05/2026	**Condition category** Other	[_] Individual participant data [X] Record updated in last year

Plain English summary of protocol

Background and study aims

The present controlled trial aims to identify the cognitive processes and skills involved in the development of computational thinking (CP) in children in early childhood and how these processes can mitigate existing inequalities in computing related to gender and other cultural factors.

A pilot test was conducted previously, and its results contributed the current study's design. Previous studies have shown evidence of the impact of computational thinking-based interventions on various cognitive processes and the correlation between computational thinking skills and other important cognitive processes. This study aims to investigate the relationship between the development of computational thinking and the development of visuospatial skills and executive functions. Additionally, this study will explore the impact of gender stereotypes in toys on these variables.

Who can participate?

Preschool children aged 5 to 6 years.

What does the study involve?

Teacher participation involves the following activities:

1. Reading and signing the informed consent form authorizing their participation.
2. Supporting the intervention activities in computational thinking and educational robotics.

Parent participation involves the following activities:

1. Attending information meetings.
2. Reading and signing the informed consent form authorizing their participation and their children's.
3. Filling in the socio-demographic questionnaire.

Children's participation involves the following activities:

1. Participating in an individual assessment of executive functions, which will be conducted by a specialized psychologist and blinded to the group assignment. Six measurement instruments will be applied: five validated and recognized neuropsychological tests and a computational thinking

test, also validated. This assessment will be carried out in 2 sessions of 20 minutes during weeks 1 and 2 of the study (pre-test) and repeated in weeks 7 and 8 (post-test).
2. Participating in computational thinking activities using educational robotics with the ROVERSA device. The training will last four weeks and consist of one-hour workshops twice a week, for a total of eight training sessions. The intervention will be carried out by previously trained early childhood education teachers. The experimental group will participate in the intervention from weeks 3 to 10.

What are the possible benefits and risks of participating?
None

Where is the study run from?
University of Virginia (USA)

When is the study starting and how long is it expected to run for?
April 2024 to March 2025

Who is funding the study?
University of Virginia (USA)

Who is the main contact?
Professor Camilo Viera Mejía, cvieira@uninorte.edu.co

Contact information

Type(s)
Public, Scientific, Principal investigator

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Additional identifiers

Protocol serial number
2403-6461

Study information

Scientific Title

Exploring the effect of computational thinking activities in the development of executive functions, visuospatial skills in early childhood

Acronym
PCCOGINFANCIA

Study objectives
1. Training in computational thinking with the ROVERSA device positively affects the executive functions and visuospatial skills of children aged 5 to 6 years.
2. Gender stereotypes with toys can impact the visual-spatial and numerical reasoning skills of 5- and 6- year-old children.

Ethics approval required
Ethics approval required

Ethics approval(s)
Approved 21/03/2024, Comité De Ética en Investigación del Área de la Salud de la Universidad del Norte (Km. 5 vía Puerto Colombia, Barranquilla, 080020, Colombia; +576053509509; comite_eticauninorte@uninorte.edu.co), ref: 2403-6461

Primary study design
Interventional

Study design
Cluster randomized controlled trial

Study type(s)
Efficacy, Treatment

Health condition(s) or problem(s) studied
Executive functions, visuospatial skills, and computational thinking skills in 5- and 6- year old children with typical development

Interventions
Experimental Group

Session 1 – Introduction to robots and ROVERSA
0-15 min What makes a Robot?
15 – 25 min Introducing ROVERSA – The parts of ROVERSA and simple demonstration
25-50 min In groups, play with ROVERSA.
50-60 min Whole group discussion about the parts and commands of ROVERSA

Session 2 – Unplugged – I am the robot, I am the programmer, I do the debugging
0-15 min The teacher demonstrates the activity. One student volunteers to press the cards, one student is the robot, and the teacher does the debugging. The debugger also sets the goal at the beginning of the activity, but start with simple straight or L paths.
15-30 min Switch roles – The teacher presses the cards as a programmer, while one student behaves as a robot and the other one as a debugger.
30-55 min Students work in groups of three, changing roles after one activity has been completed.
55-60 min Reflecting and final remarks.

Session 3 – ROVERSA – Simple challenges – Planning with cards
0-10 min The teacher demonstrates how the planning with cards works with the L challenge. Provide one or two examples on how to plan a program for the robot to get to a point, by placing the arrows in the template.
10-15 min The teacher introduces the three challenges (line, L, S), and provide a paper-sheet for students to complete the programs.

15-50 min Students work in the challenges using ROVERSA, and write the programs in the paper-sheet. If needed, the teacher may provide additional challenges to students who complete everything early.
50-60 min Discussing the solutions of the children and providing feedback

Session 4 – Unplugged – Addressing Common Mistakes with Planning Cards
0-15 min Counting the number of steps – The teacher leads the discussion of examples when the robot needs to move a different number of steps. Adds one card per step that is counted as a group.
15-30 min Turning is not moving – The teacher leads the discussion of examples when the robot needs to turn and move forward a different number of steps. Adds one card per step that is counted as a group.
30-45 min Mental Rotation – The teacher leads the discussion of examples when the robot needs to turn in different directions. Adds one card per step that is counted as a group.
45-60 min Practice time for students with the teacher providing feedback

Session 5 – ROVERSA - Let's challenge each other
0-60 Children work in groups (size number depending on the number of ROVERSAS). They take turns to challenge each other

Session 6 – Unplugged – Open the map, getting to places
0-15 The teacher brings a grid map with objects distributed among the cells and repeats the activity of programmer, robot, and debugger, showing two or three examples of how a robot would arrive at a place.
15-50 Children work in groups (size number depending on the number of ROVERSAS). They take turns to challenge each other as programmers, robots, and debuggers.
50-60 min Discussing the solutions of the children and providing feedback

Session 7 – ROVERSA – Open the map, getting to places
0-60 The previous session is repeated, but now using ROVERSA

Session 8 – ROVERSA – Creating Stories
0-5 The teacher introduces the activity.
5-20 The children should invent a story using the figures and characters that are part of the grid.
20-40 The children should plan the program for the ROVERSAS (up to five of them) to move around the grid and represent the story.
40-60 Testing the solutions with the available ROVERSAs

Control Group
The children in the control group will be placed on a waiting list for the duration of the intervention. After the post-test, they will participate in the same intervention as the other group.

To ensure concealment, a researcher external to the study will assign each group to one of the arms using the sealed envelope method.

The researcher responsible for taking measurements (pre-, post-, and follow-up) and the statistician in charge of data analysis will be blinded to group assignment. However, due to the nature of the intervention and the fact that the control group will not receive the intervention simultaneously with the experimental group, participants will not be blinded.

Intervention Type
Behavioural

Primary outcome(s)
Cognitive processes of children measured before and after the interventions:
1. Visual working memory measured with NIH ToolBox Battery List Sorting Test.
2. Visuospatial working memory measured with Corsi Cubes from the WMIII battery.)
3. Visuospatial planning measured with Labyrinths from the BANPE battery.
4. Cognitive flexibility measured with Dimensional Change Card Sorting from the NIH ToolBox battery.
5. Inhibitory control measured with the Flanker Task from the ToolBox NIH battery.
6. Spatial Rotation measured with the Spatial Rotation Test from the NEPSY-II battery.

Key secondary outcome(s)
Cognitive processes of children measured before and after the interventions:
1. Computational thinking skills will be measured using the Beginners Computational Thinking Test (BCTt).
2. To capture children's toy stereotypes, children will be presented with various toys along with two photographs (a boy's face and a girl's face), and we will ask: "One of these friends is very good at playing with this toy.
3. Socio-demographic variables will be measured with a socio-demographic questionnaire.

Completion date
20/03/2025

Eligibility

Key inclusion criteria
1. Both male and female children.
2. Children aged 5 to 6 years.
3. Children who are enrolled in preschool.
4. Children who have not received prior training in computational thinking.

Participant type(s)
Healthy volunteer

Healthy volunteers allowed
No

Age group
Child

Lower age limit
5 Years

Upper age limit
6 Years

Sex
All

Total final enrolment
0

Key exclusion criteria
1. Children who have uncorrected visual impairment.
2. Children who have physical limitations that prevent them from participating in activities.
3. Children with a history of underlying neurological disease.
4. Children receiving pharmacological treatment for any type of neurodevelopmental or neuropsychiatric disorder.

Date of first enrolment
01/04/2024

Date of final enrolment
01/08/2024

Locations

Countries of recruitment
Colombia

Study participating centre
Universidad del Norte
Km 5 Via Puerto Colombia
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080020

Sponsor information

Organisation
University of Virginia

ROR
https://ror.org/0153tk833

Funder(s)

Funder type
University/education

Funder Name
University of Virginia

Alternative Name(s)
The University of Virginia, UV, UVA

Funding Body Type
Government organisation

Funding Body Subtype
Universities (academic only)

Location
United States of America

Results and Publications

Individual participant data (IPD) sharing plan
Data will be shared upon request - cvieira@uninorte.edu.co

IPD sharing plan summary
Available on request

Study outputs

Output type	Details	Date created	Date added	Peer reviewed?	Patient-facing?
Protocol article		28/12/2024	21/05/2026	Yes	No