ISRCTN11380198 https://doi.org/10.1186/ISRCTN11380198

Effect of computational thinking on the executive functions of school-age children

Submission date 31/01/2023	**Recruitment status** No longer recruiting	[_] Prospectively registered [X] Protocol
Registration date 12/06/2023	**Overall study status** Completed	[_] Statistical analysis plan [_] Results
Last Edited 03/07/2025	**Condition category** Other	[_] Individual participant data [_] Record updated in last year

Plain English summary of protocol

Background and study aims

Executive functions are cognitive processes associated with the brain's prefrontal cortex; Those are significant predictors of academic performance and daily functioning. In recent years they have investigated different intervention programs and their effects on executive functions in clinical and educational contexts.

A recent field of study is research on the effects of computational thinking training on children's executive functions. The current research will contribute to this field of study. This study aims to investigate the effects of computational thinking training based on connected and disconnected activities on the executive functions of children with typical development from 10 to 11 years old.

Who can participate?

Fifth-grade primary school children from 9 to 11 years old from public educational institutions in Ibagué will participate in this study.

What does the study involve?

Children's participation involves the following activities:

1. Give informed assent in which they agree to participate in the stadium.
2. Participate in an individual evaluation of executive functions, which will be carried out by a specialized psychologist blinded to the group assignment. Seven validated and recognized neuropsychological tests will be applied, and a computational thinking test will be in the validation process. This evaluation will be carried out in 2 sessions of 20 minutes during weeks 2 and 3 of the study (pre-test), it will be repeated in weeks 14 and 15 (post-test), and it will be repeated in weeks 26 and 27 (follow-up).
3. Participate in computational thinking training based on disconnected and connected activities. Offline activities will be done at code.org and makecode through a portable device and micro-bit microprocessor. The training sessions will be held twice a week, lasting 90 minutes, and will take place in the system rooms of the "Leonidas Rubio" educational institution. The training will last ten weeks, for a total of 20 sessions. The data of the children to be included in the study will be those who comply with more than 70% of the intervention. The intervention will be carried out by two clinical trial researchers, and during each session, the teacher in charge of the school year will be present and accompany the children. The assignment of the groups will be carried out in

two moments; the first group will participate from week 4 to week 13, and the second group from week 16 to week 25. The assignment to the groups will be carried out randomly.
(added 30/06/2023): Initially, the intervention was designed in 20 sessions, twice a week, for ten weeks. However, since educational robotics activities require more time to develop, it has been decided to extend the training to 24 sessions, twice a week, for 12 weeks of intervention.

Parent involvement involves the following activities:
1. Attend informational meetings.
2. Read and sign the informed consent giving authorization for your participation and that of your children.
3. Fill out the sociodemographic questionnaire.

What are the possible benefits and risks of participating?
No risks

Where is the study run from?
University of Tolima (Colombia)

When is the study starting and how long is it expected to run for?
May 2022 to November 2023

Who is funding the study?
University of Tolima (Colombia)

Who is the main contact?
Professor Carolina Robledo Castro, crobledoc@ut.edu.co.

Contact information

Type(s)
Principal investigator

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Additional identifiers

Protocol serial number
UT430121

Study information

Scientific Title
Effect of a training in computational thinking based on connected and disconnected activities on the executive functions of typically developing fifth graders

Acronym
CT&EF

Study objectives
Training in computational thinking based on connected and disconnected activities has a positive effect on the executive functions of typically developing fifth graders

Ethics approval required
Old ethics approval format

Ethics approval(s)
Approved 12/12/2022, Bioethics Committee of the Universidad del Tolima (University of Tolima, 10th street, 5th avenue, Cooperamos building, 4th floor, Tolima, Colombia; +57(608)2772040; comitebioetica@ut.edu.co), ref: 430121

Primary study design
Interventional

Study design
Interventional randomized controlled trial

Study type(s)
Treatment

Health condition(s) or problem(s) studied
Executive function in typically developing fifth graders

Interventions
Current interventions as of 30/06/2023:

Experimental arm
The experimental group's children will train in computational thinking based on disconnected and connected activities named “Cogni Machine”. The training consists of 24 sessions of 60 minutes each, twice a week, for a total of 12 weeks. The training sessions will be in groups and take place in the computer rooms of the participating educational institution.

In each session, the children will participate in disconnected and connected computational thinking activities:
• During sessions 1 and 2, children will only participate in unplugged activities.
• During sessions 3 through 20, children will participate in unplugged and plugged activities.
• From sessions 3 to sessions 8, the plugged activities will take place on the code.org block coding platform.
• From sessions 9 to 16, the plugged activities will be carried out with the micro:bit microprocessor and the makecode block coding platform.
• From sessions 17 to 24 educational robotics activities with micro:bit will be incorporated.

Control arm
The children in the control group will participate in a usual treatment (HT) during the same number of sessions and hourly intensity; the children will participate in standard technology and computer classes. During these classes, the children carry out activities related to the use of the computer and application packages such as Microsoft office. These sessions will be held in the computer room of the educational institution and will be directed by the computer teacher.

Since the intervention will be applied in a school context, the allocation to the intervention arms will be group. Therefore one fifth-grade class will be assigned to the intervention group and another fifth-grade class to the TAU (treatment as usual) control group.

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

The investigator taking the measurements (pre, post, and follow-up) and the statistician in charge of data analysis will be blind to the group assignment. However, given the nature of the intervention and the fact that the control group will not receive an intervention other than treatment as usual (conventional computer classes), there will be no blinding and, therefore, no blinding of the participants.

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Previous interventions:

Experimental arm
The experimental group's children will train in computational thinking based on disconnected and connected activities named “Cogni Machine”. The training consists of 20 sessions of 60 minutes each, twice a week, for a total of 10 weeks. The training sessions will be in groups and take place in the computer rooms of the participating educational institution.

In each session, the children will participate in disconnected and connected computational thinking activities:
• During sessions 1 and 2, children will only participate in unplugged activities.
• During sessions 3 through 20, children will participate in unplugged and plugged activities.
• From week 3 to week 8, the plugged activities will take place on the code.org block coding platform.
• From weeks 9 to 20, the plugged activities will be carried out with the micro:bit microprocessor and the makecode block coding platform.
• As of week 14, educational robotics activities with micro:bit will be incorporated.

Control arm
The children in the control group will participate in a usual treatment (HT) during the same number of sessions and hourly intensity; the children will participate in standard technology and computer classes. During these classes, the children carry out activities related to the use of the computer and application packages such as Microsoft office. These sessions will be held in the computer room of the educational institution and will be directed by the computer teacher.

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Intervention Type
Behavioural

Primary outcome(s)
The children's executive functions will be evaluated with standardized neuropsychological tests with evidence of reliability and validity in the pre-test, post-test and 3 month follow-up.

1. Measured sequential planning with the Tower of London.
2. Visuospatial planning measured with the BANFE-2 labyrinth test.
3. Cognitive flexibility measured with the Wisconcin letter test.
4. Inhibitory control measured with the stroop test.
5. Working memory measured with the visual span tests, digits, letters, and numbers from the WISC-5 battery of tests.
6. Visuo-spatial working memory measured with the Corsi cube test.

Key secondary outcome(s)
Current secondary outcome measures as of 30/06/2023:

Measured at pre-test, post-test, and 3 month follow-up:
1. Variable computational thinking skills measured using a test Computacional thinking test-CTt by Román-González (2015, 2017, 2018)
2. Sociodemographic variables measured with the sociodemographic questionnaire designed and validated by Cordoba, Robledo & del Basto (2020)
3. The metacognition variable will be measured with the metacognition test and the metamemory test of the prefrontal scale of the BANFE-2 battery.
4. Variable attention measured with Test d2 and Trail Making Test.
5. Test of satisfaction and adherence to the intervention.

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Previous secondary outcome measures:

Measured at pre-test, post-test, and 3 month follow-up:
1. Variable computational thinking skills measured using a test designed for study
2. Sociodemographic variables measured with the sociodemographic questionnaire designed and validated by Cordoba, Robledo & del Basto (2020)
3. Variable metacognitive processes in writing measured with the metacognition test

Completion date
23/11/2023

Eligibility

Key inclusion criteria
1. Children of both genders
2. Children from 9 to 11 years old
3. Children enrolled in fifth grade of primary school in a public educational institution.
4. Children without previous experience in computational thinking training.
5. Children with typical cognitive development.

Participant type(s)
Healthy volunteer

Healthy volunteers allowed
No

Age group
Child

Lower age limit
9 Years

Upper age limit
11 Years

Sex
All

Key exclusion criteria
1. Children with uncorrected visual limitations.
2. Children have physical limitation that prevents them from participating in the activities.
3. Children with a history of underlying neurological disease.
4. Children with pharmacological treatment for some type of neurodevelopmental or neuropsychiatric disorder.

Date of first enrolment
14/02/2023

Date of final enrolment
03/03/2023

Locations

Countries of recruitment
Colombia

Study participating centre
Educational Institution "LEONIDAS RUBIO VILLEGAS"
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Sponsor information

Organisation
University of Tolima

ROR
https://ror.org/011bqgx84

Funder(s)

Funder type
University/education

Funder Name
Universidad del Tolima

Alternative Name(s)
University of Tolima, UT

Funding Body Type
Government organisation

Funding Body Subtype
Universities (academic only)

Location
Colombia

Results and Publications

Individual participant data (IPD) sharing plan
The datasets generated during and/or analysed during the current study will be available upon request from Carolina Robledo-Castro, crobledocz@ut.edu.co

IPD sharing plan summary
Available on request

Study outputs

Output type	Details	Date created	Date added	Peer reviewed?	Patient-facing?
Protocol article		22/08/2023	03/07/2025	Yes	No
Participant information sheet	in Spanish		13/02/2023	No	Yes