

## Enhancing Creative Thinking through Coding: Evidence from an Experimental Study in Primary and Secondary Education



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### INTRODUCTION & AIM

#### Why coding and creative thinking?

Coding is more than a technical skill: it is a learning environment that can foster transversal competences. In this study, creative thinking is understood as the ability to generate ideas that are both original and appropriate to the task or context. The theoretical background combines computational thinking, divergent thinking, creative learning and Creative Computational Problem Solving.

#### The Coding&Learning project

Promoted by CREMIT with ST Foundation and NGO Acra, the project integrates coding, educational robotics and computational thinking within a pedagogical perspective along civic / media-educational, didactic-operational and pedagogical co-responsibility dimensions.

#### Research questions

- How does a coding, robotics and collaborative program affect students' creative thinking?
- What differences emerge between primary and lower-secondary students?
- What elements of transformation do trainers identify during the program?

#### Aim of the study

To investigate whether and how a coding and educational robotics program — designed as a meaningful, open-ended and collaborative learning environment — fosters creative thinking in primary and lower-secondary students.

### METHOD

#### Research design

Quasi-experimental mixed-methods study with pre- and post-test data collection. Each of 4 schools (2 primary, 2 lower-secondary) included one experimental class and one control class.

#### Participants

- 138 primary school students
- 153 lower-secondary school students
- 23 trainers involved in the educational program

#### Educational program

8-hour program, 4 sessions of 2 hours, with experimental groups engaging in coding and educational robotics activities, while control groups followed ordinary school activities.

- Primary school (3rd grade): sustainability, group work and creative problem solving; design of an ideal playground using unplugged coding and Minecraft Education.
- Lower-secondary school (2nd grade): intervention mission on global issues; analysis of strengths and weaknesses; use of an educational robot to design possible improvements.

#### Measuring creativity: the DAT

The Divergent Association Task (DAT, Olson et al., 2021) was used to measure verbal divergent thinking. Students enter 10 nouns that are as semantically distant as possible; the system computes a score based on the semantic distance between the words.

Procedure: pre- and post-test administration; comparison between experimental and control groups. Trainers were also administered pre- and post-course questionnaires.

Important limitation: the DAT measures only one component of creativity, namely verbal divergent thinking.

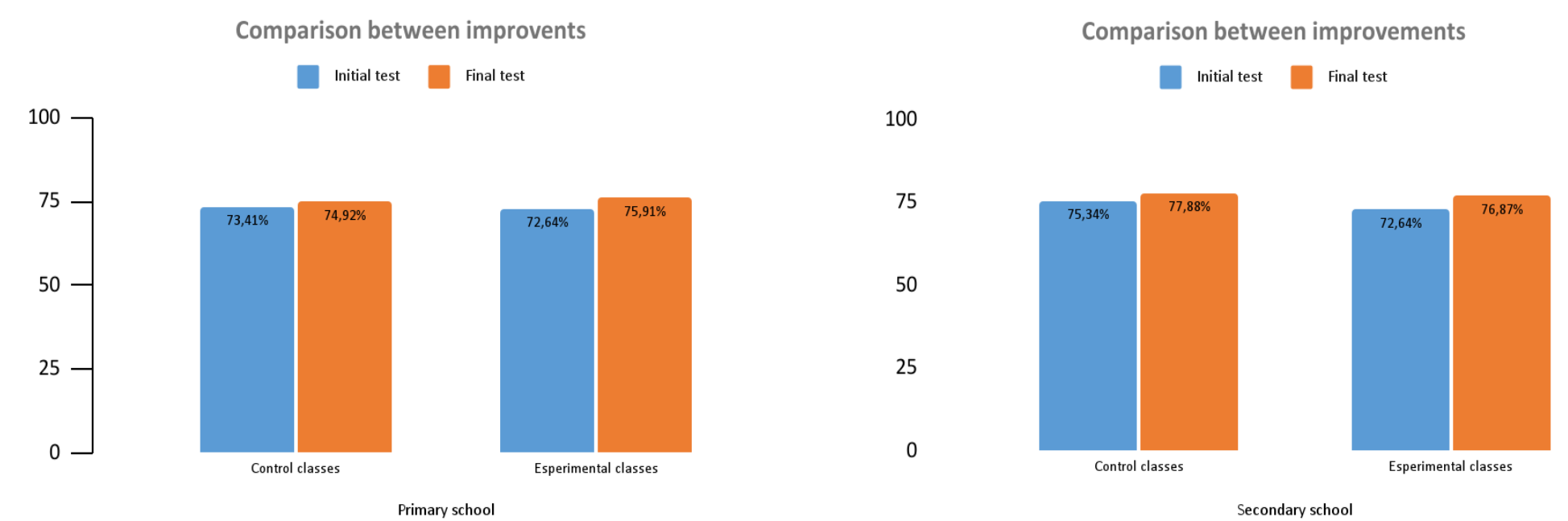
#### DAT score ranges (min / max)

Grade level	Control class	Experimental class
Primary school	65 / 81	45 / 52
Lower secondary	41 / 57	66 / 85

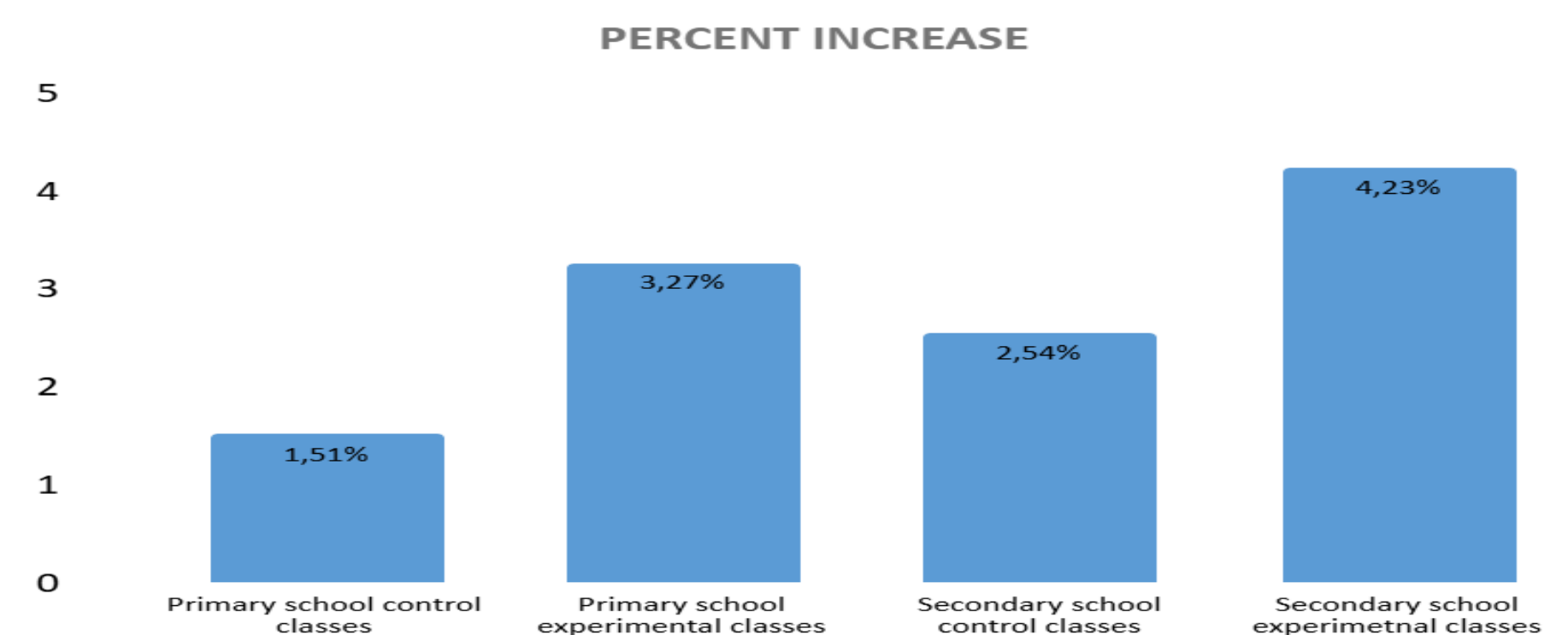
### RESULTS & DISCUSSION

#### DAT scores: average comparison

Pre/post-test DAT scores for control and experimental groups, in primary and lower-secondary



#### Distribution of individual improvements (% increase)



**+3.27%**  
Primary school  
creativity gain  
(vs. +1.51% control)

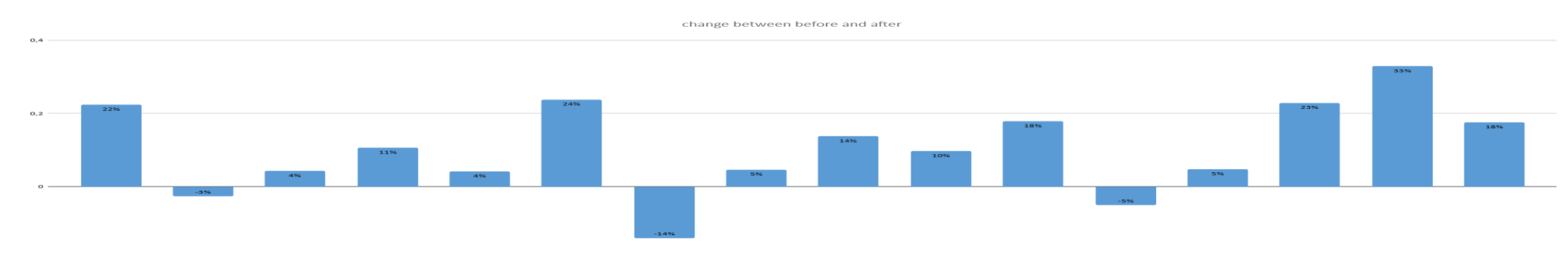
**+4.23%**  
Lower-secondary  
creativity gain  
(vs. +2.54% control)

**66.6%**  
of primary students  
improved (experimental)  
(vs. 52.3% control)

#### Key findings

- Coding activities enhanced creative thinking, especially in the experimental groups — most clearly in lower-secondary school.
- Two thirds of primary-school students in the experimental group improved their DAT score, against half of the control group.
- Gains were stronger when coding was design-based, open-ended and collaborative.
- Trainers describe coding as fostering creativity, not only logical thinking.

#### Trainers' perceptions: change before / after



Largest gains: making generalizations (+33%), independence (+24%), complex problem solving (+23%), logical-analytical skills (+22%), experimentation (+18%) and creativity (+14%).

### CONCLUSION

Coding does not foster creativity simply because students use technology. It supports creative thinking when embedded in meaningful, open-ended and collaborative challenges.

The study highlights the importance of valuing cross-curricular skills and of supporting teachers in adopting a pedagogical vision of coding.

*Coding is not only structure and sequence — it is creative construction.*

### FUTURE WORK / REFERENCES

#### Future work

Extend the design to more schools and age groups; combine the DAT with task-based and observational measures of creativity; deepen the analysis of trainer reflections to refine the pedagogical model.

#### Selected references

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