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The competent Computational Thinking (cCT) test : Development & validation of an unplugged CT test for upper primary school

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Computational Thinking (CT) is integrating formal education

CT is starting to be considered as
- a universally applicable attitude and skill set
- as important as reading, writing and arithmetic (Wing, 2006)
- not specific to those interested in computer science & maths
- an example of "models of thinking" (Li et al., 2020)

That is why there is an increase in both research around CT and in the initiatives seeking to equip K-12 students with CT skills (Basu et al., 2020), including formal education settings (Weintrop et al., 2021, some even starting from kindergarten (Bocconi et al., 2016)

There is a lack of reliable & validated CT tests in upper primary school

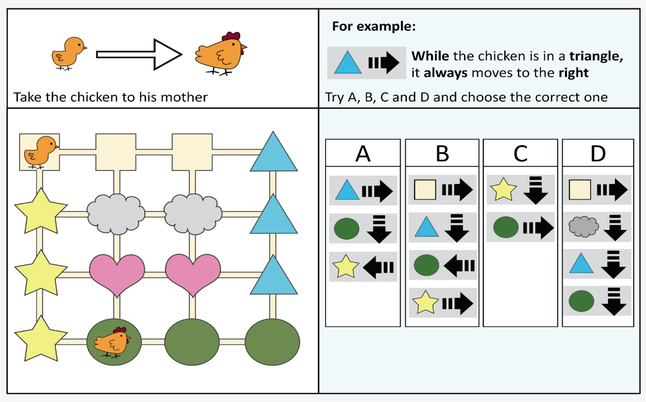
Relkin and Bers (2021) explain that "CT assessment is important to
- [document] learning progress,
- [measure] lesson effectiveness,
- [assist] in curriculum development
- [identify] students in need of greater assistance or enrichment"

→ It is thus crucial to design **developmentally appropriate** and **reliable** tools to assess CT (Hsu et al., 2018) across compulsory education and **validate** them with **experts** and **psychometrically**

However there is a lack of validated tools for upper primary school
- Most effort have focused on secondary & tertiary education
- Few tests exist for kindergarten (Relkin & Bers, 2021), and lower primary school (Relkin et al., 2020, Zapata-Cáceres et al., 2020)

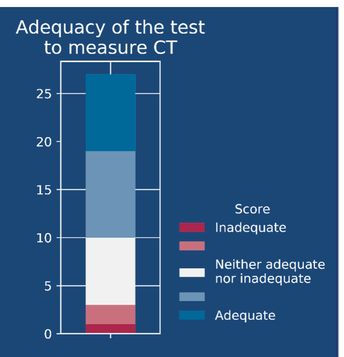
The competent CT (cCT) test fills said gap

- Adapted in terms of format & content from the BCT test (Zapata-Cáceres et al., 2020)
- The cCT test includes 25 multiple-choice questions of progressive difficulty
- The cCT test addresses notions of sequences, loops, conditionals and while statements
- The cCT test has undergone expert and psychometric validation with 37 domain experts and over 1500 students in grades 3 and 4 (ages 7-9)



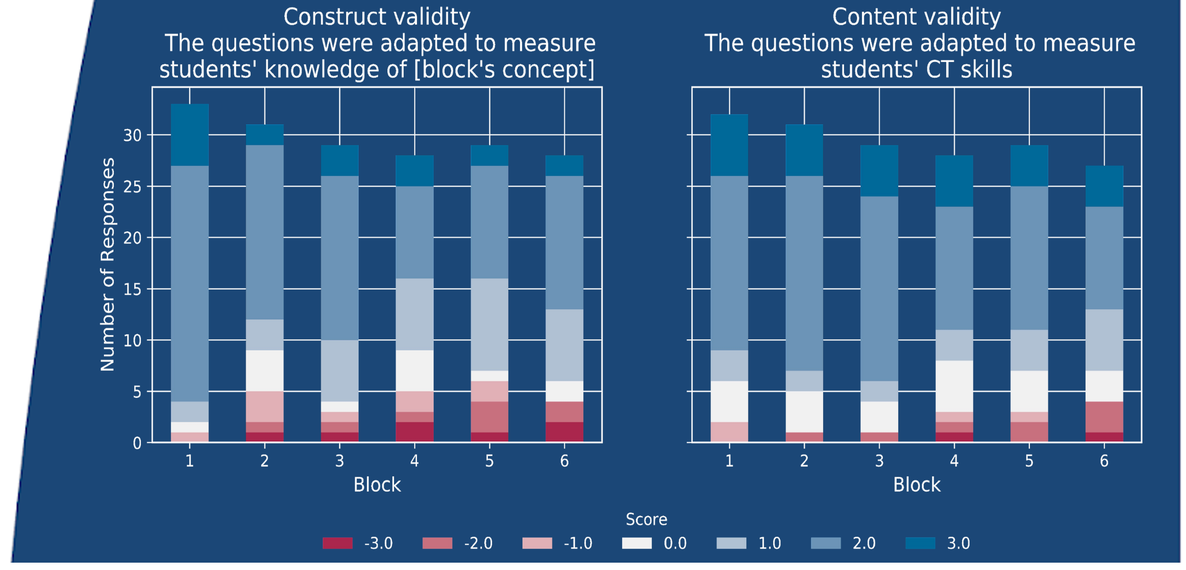
The cCT test is valid

Face validity 63% of experts believe the test adequately measures upper primary school students' CT skills, 26% were neutral, and just 11% disagreed



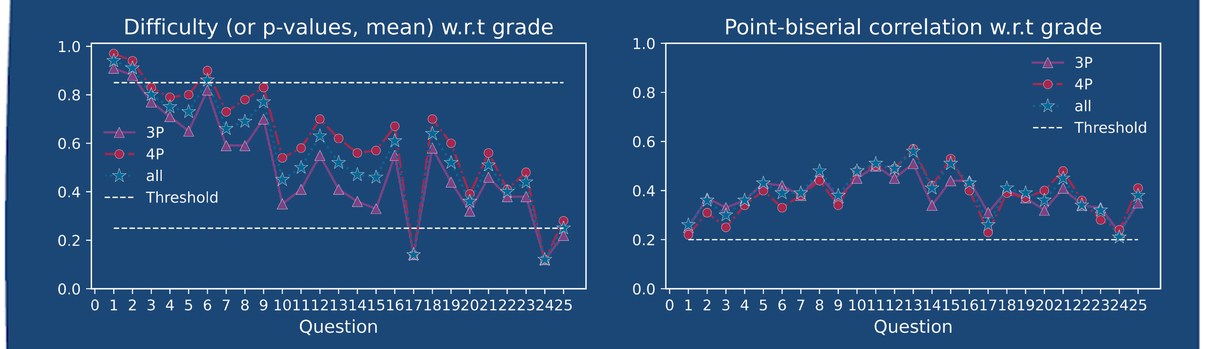
Construct validity
- Experts consider the blocks of questions adapted measures of the concepts
- Confirmatory factor analysis shows that the test fits well $\chi^2(215)=528$, $p<.0001$; $\chi^2/df=2.5$; CFI=.963; TLI=.956 ; RMSEA=.031 ; SRMR=.032

Content validity the experts believed each block of questions was an adequate measurement of CT skills but highlighted that the cCTt does not assess CT in all its dimensions (notably computational perspectives and practices)



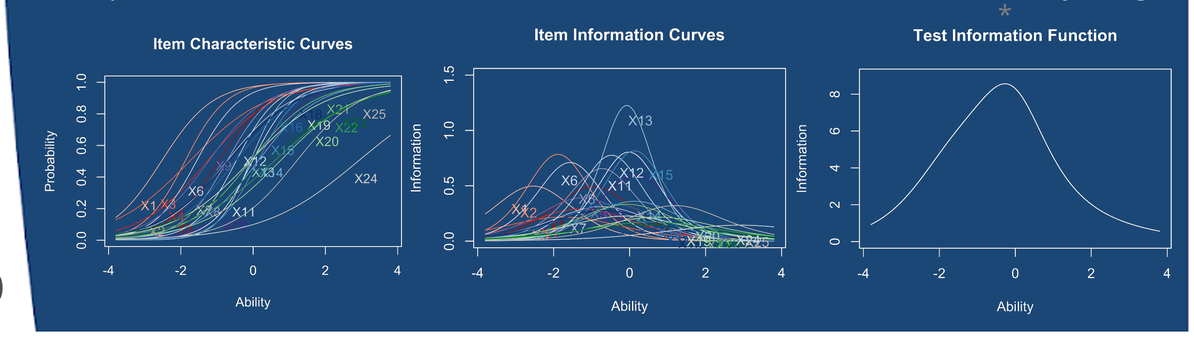
The cCT test is reliable

Reliability through classical test theory (CTT)
- The internal reliability is high (Cronbach's α= .85) according to Taherdoost (2016)
- Most questions have adequate difficulty (between 0.85 and 0.25)
- All questions have acceptable point biserial correlation (>0,2)



Reliability through item response theory (IRT)
- A 2 parameter model is used to model the test and considers that difficulty and discrimination vary across items

The IRT analysis confirms that the test 1) has questions of increasing difficulty, 2) is adapted to discriminate between students in the low and medium ability range *



The cCT test comes in multiple formats

Shortening through Confirmatory Factor Analysis (CFA)

41% of the experts considered the test to be too long, and teachers' feedback following the test administration supported this view. It is therefore important to consider how the test may be shortened.

Using CFA to identify questions exhibiting high correlations with other questions or factors, an iterative shortening procedure was applied to provide 3 versions of the cCT test

- The cCTt-25 which meets all traditional model fit statistics' thresholds
- The cCTt-17 which covers the same breadth of constructs but has removed a certain number of redundancies
- The cCTt-15 which is the fastest and most focused test

See the paper here

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