# Factors Affecting the Implementation of Computational Thinking in the Curriculum

## The Case of Luxembourgish Fundamental Schools

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# Overview

Introduction

Methodology

Results & Discussion

Conclusion

Q&A

# Introduction

# Relevance

CT introduced as an interdisciplinary learning topic in fundamental schools in September 2020

Named **Coding**

# Based on the definition of Wing (2010)

"Computational thinking is the **thought processes** involved in **formulating problems and their solutions** so that the solutions are represented in a form that can effectively be carried out by an **information-processing agent**" (p. 1)

# I-CN & Coding Starter Kit

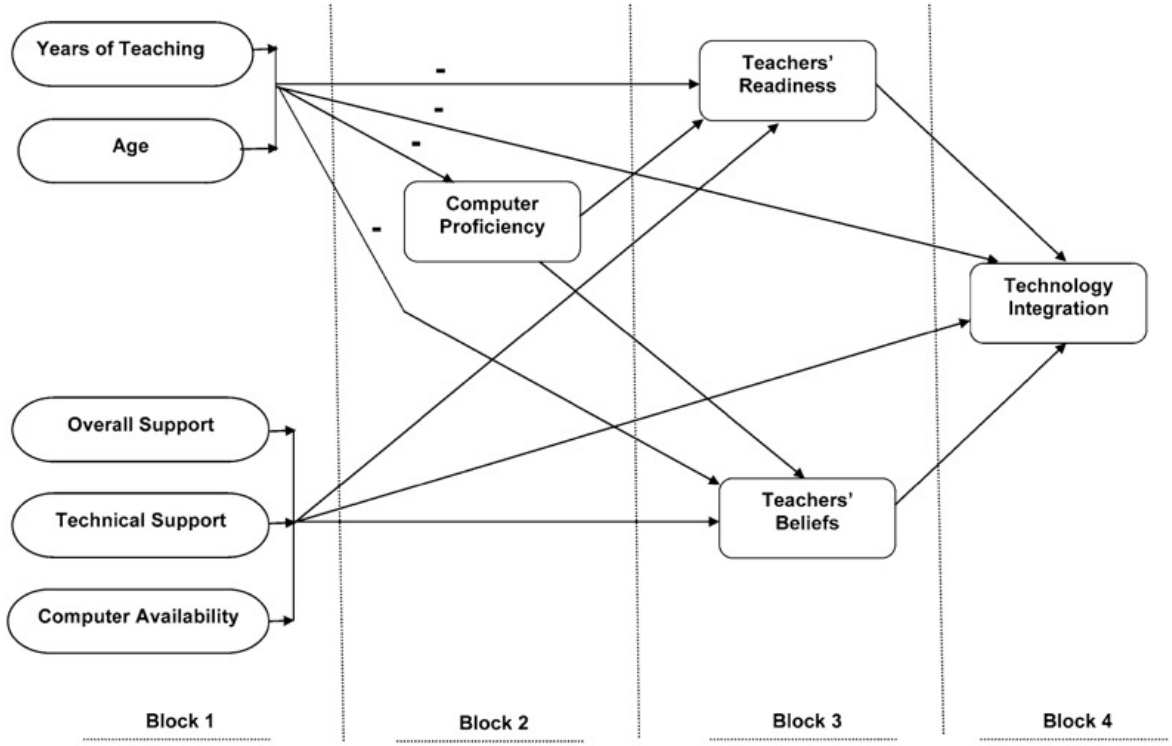
Recruitment of 16 I-CN (instituteur spécialisé en compétences numériques)

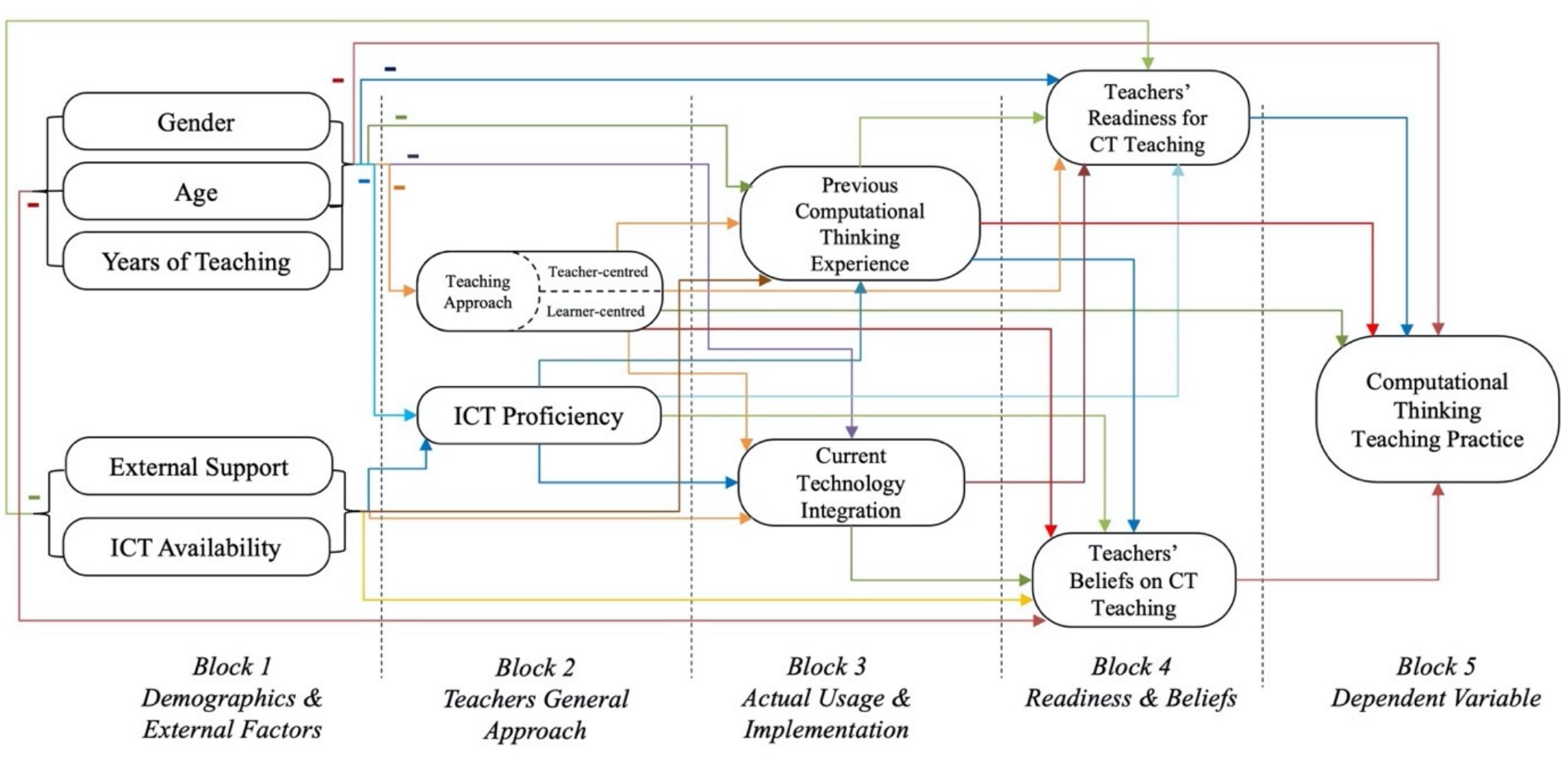
Coding starter-kit for Cycle 4 classes (K5-K6) in 2020
→ Cycle 1 - Cycle 3 (PreK–K4) in 2021

# Methodolgy

# Path Model Approach

- Using the Technology Acceptance Model (TAM) as starting point (Davis, 1989)
- Extended version of the model by Inan and Lowther (2010)




Gender
Age
Years of Teaching
External Support
ICT Availability
Teaching Approach
Teacher-centred
Learner-centred
ICT Proficiency
Previous Computational Thinking Experience
Current Technology Integration
Teachers' Readiness for CT Teaching
Teachers' Beliefs on CT Teaching
Computational Thinking Teaching Practice
Block 1
Demographics & External Factors
Block 2
Teachers General Approach
Block 3
Actual Usage & Implementation
Block 4
Readiness & Beliefs
Block 5
Dependent Variable

# General Research Questions

**RQ1**. What are the teachers' beliefs about CT?

**RQ2**. What are the teachers' attitudes towards CT? (Readiness)

**RQ3**. What are the teachers' beliefs on the integration of CT in education?

# Factor Related Research Questions

**RQ4**. What is the relationship between teachers' beliefs, readiness, and teachers' CT teaching practices?

**RQ5**. What is the relationship between teachers' previous CT experiences and their planned implementation of CT teaching practices?

**RQ6**. What is the relationship between teachers' current technology integration and their planned implementation of CT teaching practices?

**RQ7**. What is the relationship between previous CT experiences, the teachers' current technology integration and their readiness for CT teaching practices?

**RQ8**. What is the relationship between previous CT experiences, the teachers' current technology integration and their beliefs about CT teaching practices?

**RQ9**. What is the relationship between the teachers' demographic characteristics, their teaching approach and their CT teaching practice?

**RQ10**. What is the relationship between school characteristics and the teachers' CT teaching practices?

# Data Collection Instrument

Online Questionnaire with 41 items

Combination of standardised questionnaires covering the respective research sub-concepts

(Admiraal, 2017; Fessakis & Prantsoudi, 2019; Lowther et al., 2008; Papanastasiou & Angeli, 2008; Wozney et al., 2006)

# Participants

63 fundamental school teachers in Luxembourg

| Age | < 25 | 25-29 | 30-34 | 35-39 | 40-44 | 45-49 | 50-54 | > 55 |
|---|---|---|---|---|---|---|---|---|
| *Population* | 4,71% | 16,72% | 18,37% | 17,85% | 14,48% | 10,77% | 8,52% | 8,48% |
| *Sample* | 4,84% | 20,29% | 23,25% | 14,52% | 9,68% | 14,52% | 6,45% | 6,45% |

| **Gender** | **female** | | **male** | |
|---|---|---|---|---|
| | *pre-primary* | *primary* | *pre-primary* | *primary* |
| *Population* | 95,80% | 75,90% | 4,20% | 24,10% |
| *Sample* | 100% | 84,31% | 0% | 15,69% |

Note. Population data from 2018 as printed by OECD (2020)

# Results & Discussion

# Beliefs about CT

| | Count | % Cases |
|---|---|---|
| Logical Thinking | 55 | 87.3% |
| Coding | 44 | 69.8% |
| Logic Problem Solving | 44 | 69.8% |
| Planning | 41 | 65.1% |
| Algorithms/step by step instructions | 41 | 65.1% |
| Reflecting | 35 | 55.6% |
| Analysis | 31 | 49.2% |
| Critical Thinking | 27 | 42.9% |
| Tinkering | 27 | 42.9% |
| Collaborating | 21 | 33.3% |
| Creating | 20 | 31.7% |
| Use of Computers | 19 | 30.2% |
| Application | 19 | 30.2% |
| Debugging | 18 | 28.6% |
| Preserving | 1 | 1.6% |
| Total | 63 | |

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# General Beliefs about CT

| | | Count | % Cases |
|---|---|---|---|
| P1 | CT promotes creativity and innovation. | 51 | 83.6% |
| P2 | CT is the use of logical thinking to solve problems. | 48 | 78.7% |
| P3 | CT provides new ways to solve problems. | 46 | 75.4% |
| P4 | CT is associated with various scientific fields and can be taught in parallel with a variety of subjects. | 42 | 68.9% |
| P5 | CT includes the creation of general principles and their application to other situations. | 31 | 50.8% |
| P6 | CT is associated with critical thinking. | 27 | 44.3% |
| P7 | CT offers new ways of dealing with natural, social and other phenomena. | 21 | 34.4% |
| P8 | CT is another method of knowledge production, such as experimenting in the sciences. | 20 | 32.8% |
| P9 | CT is the understanding of how computers work. | 18 | 29.5% |
| P10 | CT concerns the application of IT principles for problem-solving in other scientific fields. | 13 | 21.3% |
| P11 | CT is synonymous with mathematical thinking. | 9 | 14.8% |
| P12 | CT includes the use of mathematical calculations to solve problems. | 9 | 14.8% |
| P13 | CT places more emphasis on knowledge creation than on the mere use of information. | 7 | 11.5% |
| P14 | CT is connected only with informatics and can be taught only in the context of informatics courses. | 1 | 1.6% |
| | Total | 63 | |

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# Teachers' Beliefs about CT

- Logical reasoning, problem decomposition, and algorithmic thinking
- Can promote creativity and innovation
- Helps develop general problem-solving principles applicable to other subjects
- Confusion with computer programming or technology use

# Categorization in 3 Groups

CT = mainly as logical reasoning

CT = mix of algorithmic thinking, abstraction, problem decomposition and logical reasoning

More diverse view on CT

# Teachers' Readiness for CT

| | strongly disagree | partly disagree | neutral | partly agree | strongly agree |
|---|---|---|---|---|---|
| Computational thinking is a skill that students should develop. | 0<br>0.0% | 5<br>7.9% | 18<br>28.6% | 18<br>28.6% | 22<br>34.9% |
| I am interested in integrating computational thinking into my teaching. | 1<br>1.6% | 4<br>6.5% | 4<br>6.5% | 27<br>43.5% | 26<br>41.9% |
| I can incorporate computational thinking into my teaching | 9<br>14.5% | 13<br>21.0% | 14<br>22.6% | 14<br>22.6% | 12<br>19.4% |
| I can't incorporate computational thinking into my teaching, but I will if I'm properly trained. | 7<br>11.3% | 4<br>6.5% | 8<br>12.9% | 24<br>38.7% | 19<br>30.6% |
| I would like to be educated on the teaching practices of integrating computational thinking into my teaching subject. | 0<br>0.0% | 1<br>1.6% | 3<br>4.8% | 31<br>50.0% | 27<br>43.5% |

# Teachers' Readiness for CT

CT = as a skill that students should develop,

→ positive or neutral perception

Teachers have a strong interest in implementing computational thinking into their teaching

Nearly all teachers show a high readiness to participate in training programs

High perceiveed knowledge = highest interst for CT teaching

# Categorization in 2 Groups

Feel confident and already claim to be able to implement some CT teaching practices

Would be willing to implement computational thinking practices if they were adequately trained

# Role of CT in Education

Role of Computational Thinking in Education

| | | Count | % Cases |
|---|---|---|---|
| P1 | Enhances the problem-solving capacity of all students. | 53 | 84.1% |
| P2 | It is a basic skill that all students should acquire. | 39 | 61.9% |
| P3 | It can improve the performance of students in related subjects. | 37 | 58.7% |
| P4 | It is an additional skill, which is not necessary for all students to develop. | 6 | 9.5% |
| P5 | It helps students think like computer scientists. | 3 | 4.8% |
| P6 | It helps “producing” IT professionals. | 2 | 3.2% |
| P7 | It concerns only students who intend to pursue studies and a career in related fields. | 2 | 3.2% |
| P8 | It is not necessary to integrate computational thinking into education | 2 | 3.2% |

# Useful Grade for CT Teaching

Useful Educational Grade for Computational Thinking

| | Count | % of Cases |
|---|---|---|
| Cycle 1 (pre-K) | 26 | 41.3% |
| Cycle 2 (K1-K2) | 37 | 58.7% |
| Cycle 3 (K3-K4) | 50 | 79.4% |
| Cycle 4 (K5-K6) | 61 | 96.8% |
| Secondary Education (K7-K12) | 57 | 90.5% |
| University | 37 | 58.7% |

# Teachers’ Beliefs about the Integration of CT in Education

- Enhances all students' problem-solving competences
- Basic skill that should be acquired
- Interdisciplinary character
- Cycle 4 (K5-K6) perceived as most appropriate for CT
- Robotic activities and unplugged activities as the most useful

# Direct Effects on the Integration of CT Teaching Practices

| Independent variables | Endogenous variables | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | TC teaching approach | LC teaching approach | ICT proficiency | Previous CT experience | Technology integration | Readiness | Beliefs | CT teaching practices |
| Gender | -.103 | -.062 | .15 | .084 | .166 | .108 | .008 | .015 |
| Age | -.162 | -.06 | -.009 | -.089 | -.127 | -.035 | .021 | -.069 |
| Years of teaching | .491* | .113 | -.453* | .055 | -.028 | .003 | -.051 | .011 |
| External Support | / | / | .120 | .349* | .052 | -.108 | -.115 | / |
| ICT availability | / | / | .053 | .03 | -.011 | .048 | .086 | / |
| TC teaching approach | / | / | / | -.215 | .069 | -.111 | .131 | .017 |
| LC teaching approach | / | / | / | -.253* | .061 | .211 | .152 | .044 |
| ICT proficiency | / | / | / | .257 | .412* | .074 | .234 | / |
| Previous CT experience | / | / | / | / | / | .534* | .511* | .352* |
| Technology integration | / | / | / | / | / | .057 | -.102 | / |
| Teachers' readiness | / | / | / | / | / | / | / | .275* |
| Teachers' beliefs | / | / | / | / | / | / | / | .234* |
| $R^2$ | .217 | .280 | .288 | .323 | .285 | .416 | .325 | .557 |

* $p < .05$

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| Independent variables | Endogenous variables | | | | | | | |
|---|---|---|---|---|---|---|---|---|
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| Gender | -.103 | -.062 | .15 | .084 | .166 | .108 | .008 | .015 |
| Age | -.162 | -.06 | -.009 | -.089 | -.127 | -.035 | .021 | -.069 |
| **Years of teaching** | **.491*** | .113 | **-.453*** | .055 | -.028 | .003 | -.051 | .011 |
| **External Support** | / | / | .120 | **.349*** | .052 | -.108 | -.115 | / |
| ICT availability | / | / | .053 | .03 | -.011 | .048 | .086 | / |
| TC teaching approach | / | / | / | -.215 | .069 | -.111 | .131 | .017 |
| **LC teaching approach** | / | / | / | **-.253*** | .061 | .211 | .152 | .044 |
| **ICT proficiency** | / | / | / | .257 | **.412*** | .074 | .234 | / |
| **Previous CT experience** | / | / | / | / | / | **.534*** | **.511*** | **.352*** |
| Technology integration | / | / | / | / | / | .057 | -.102 | / |
| **Teachers' readiness** | / | / | / | / | / | / | / | **.275*** |
| **Teachers' beliefs** | / | / | / | / | / | / | / | **.234*** |
| $R^2$ | .217 | .280 | .288 | .323 | .285 | .416 | .325 | .557 |

* $p < .05$

# Direct, Indirect and Total Effects on Readiness, Beliefs, and CT Teaching Practices

| | Teachers' readiness | | | Teachers' beliefs | | | CT teaching practices | | |
|---|---|---|---|---|---|---|---|---|---|
| | Direct | Indirect | Total | Direct | Indirect | Total | Direct | Indirect | Total |
| Gender | .108 | .107 | .215* | .008 | .072 | .080 | .015 | .130 | .144 |
| Age | -.035 | -.026 | -.061 | .021 | -.039 | -.018 | -.069 | -.041 | -.110 |
| Years of teaching | .003 | -.178 | -.175 | -.051 | -.107 | -.158 | .011 | -.140 | -.130 |
| External support | -.108 | .217* | .109 | -.115 | .211* | .096 | / | .186 | .186 |
| ICT availability | .048 | .028 | .076 | .086 | .033 | .120 | / | .064 | .064 |
| TC teaching appr. | -.111 | -.111 | -.222 | .131 | -.117 | .014 | .017 | -.133 | -.116 |
| LC teaching appr. | .211 | -.132* | .079 | .152 | -.135* | .017 | .044 | -.063 | -.019 |
| ICT proficiency | .074 | .16 | .234 | .234 | .089 | .323* | / | .231* | .231* |
| Prev. CT exp. | .534* | / | .534* | .511* | / | .511* | .352* | .267* | .618* |
| Tech. integration | .057 | / | .057 | -.102 | / | -.102 | / | -.008 | -.008 |
| Readiness | / | / | / | / | / | / | .275* | / | .275* |
| Beliefs | / | / | / | / | / | / | .234* | / | .234* |

* $p < .05$

# Direct, Indirect and Total Effects on Readiness, Beliefs, and CT Teaching Practices

| | Teachers' readiness | | | Teachers' beliefs | | | CT teaching practices | | |
|---|---|---|---|---|---|---|---|---|---|
| | Direct | Indirect | Total | Direct | Indirect | Total | Direct | Indirect | Total |
| **Gender** | .108 | .107 | **.215*** | .008 | .072 | .080 | .015 | .130 | .144 |
| Age | -.035 | -.026 | -.061 | .021 | -.039 | -.018 | -.069 | -.041 | -.110 |
| Years of teaching | .003 | -.178 | -.175 | -.051 | -.107 | -.158 | .011 | -.140 | -.130 |
| **External support** | -.108 | **.217*** | .109 | -.115 | **.211*** | .096 | / | .186 | .186 |
| ICT availability | .048 | .028 | .076 | .086 | .033 | .120 | / | .064 | .064 |
| TC teaching appr. | -.111 | -.111 | -.222 | .131 | -.117 | .014 | .017 | -.133 | -.116 |
| **LC teaching appr.** | .211 | **-.132*** | .079 | .152 | **-.135*** | .017 | .044 | -.063 | -.019 |
| **ICT proficiency** | .074 | .16 | .234 | .234 | .089 | **.323*** | / | **.231*** | .231* |
| **Prev. CT exp.** | **.534*** | / | .534* | **.511*** | / | .511* | **.352*** | **.267*** | **.618*** |
| Tech. integration | .057 | / | .057 | -.102 | / | -.102 | / | -.008 | -.008 |
| **Readiness** | / | / | / | / | / | / | **.275*** | / | .275* |
| **Beliefs** | / | / | / | / | / | / | **.234*** | / | .234* |

* $p < .05$

# Direct and Indirect Effects of Factors on CT Teaching Practices (1)

- Demographical factors = no statistically significant effect on CT teaching practices
- Years of teaching = indirectly negatively affected previous CT experiences
- No effects of ICT availability on any of the endogenous variables
- External support variables = a strong direct influence on previous CT experiences & a moderate indirect effect on teachers' beliefs and readiness

# Direct and Indirect Effects of Factors on CT Teaching Practices (2)

ICT proficiency = a strong direct effect on technology integration & a moderate indirect effect on CT teaching practices & total effect on teachers' readiness

Technology integration = no significant effect on beliefs, readiness, or CT teaching practices

Previous CT experiences = most substantial direct and indirect effects on teachers' readiness, beliefs and planned CT teaching practices.

# Conclusion

# Conclusion

| | |
|---|---|
| Help | Help teachers accurately define CT dimensions and practices |
| Clarify | Clarify misconceptions |
| Promote | Promote interdisciplinary activities |
| Demonstrate | Demonstrate the usefulness of CT practices in lower grades |
| Expose | Expose teachers to various relevant inspiring practices |

# Q & A