Conceptions and Misconceptions about Computational Thinking among Italian Primary School Teachers

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Outline

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Motivation

- Recognized importance of teaching CS in K-12 education
  - Need to teach scientific and cultural side of CS (fundamental in all aspects of our society), focusing on principles/methods rather than on systems/tools
  - **Teachers' conceptions** essential for a proper teaching of the subject

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- "Computational thinking" used to denote conceptual core of computer science or "the way a computer scientist thinks" [Wing, 2006]
- Lack of a widely accepted definition: "buzzword" with different meanings
  - People considering CT as new subject, different or distinct from CS
  - Dangerous and possibly wrong
  - Concerns shared eg. by [Denning, 2009, Armoni, 2016, Duncan et al., 2017]

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Many definitions

We analysed five definitions: [Wing, 2010]
[ISTE and CSTA, 2011] [Google, 2017]
[Brennan and Resnick, 2012] [CAS, 2014]

Most of them agree CT is:

- A **way of thinking** (thought process) for
- **problem solving**, given that
- formulation and solution can be understood and carried out by a **processing agent**

Moreover, they list some constitutive elements of CT. No agreement, but a lot of elements (of different kinds) shared.

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Main constitutive elements of CT

- **Mental processes**
  - *Algorithmic thinking*
  - *Logical thinking*
  - *Problem Decomposition*
  - *Abstraction*
  - *Generalization*
- **Methods**
  - *Automation*
  - *Data Collection, Analysis and Representation*
  - *Parallelization*
  - *Simulation*
  - *Evaluation*
  - *Programming*
- **Practices**
  - *Experimenting, iterating, tinkering*
  - *Test and debug*
  - *Reuse and remix*
- **Transversal skills**
  - *Create*
  - *Communicate and collaborate*
  - *Reflect, learn, meta-reflect*
  - *Be tolerant for ambiguity*
  - *Be persistent when dealing with complex problems*

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Research questions

We investigated knowledge level of CT among Italian primary school teachers

RQ1 which level of understanding do they have about computational thinking concept?

RQ2 how do they perceive the relation between technology and computational thinking?

RQ3 how much do they feel prepared to teach computational thinking?

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- `https://programmailfuturo.it`
  [Nardelli and Ventre, 2015, Corradini et al., 2017]
- increase awareness of Informatics as the scientific basis of digital technologies among teachers in Italian schools
- adapted Code.org learning material, plus a dedicated support website in Italian
- more than 1.6 million students out of 8 million
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- Questionnaire sent (Dec 2016, after CS Ed. Week) to 24,939 teachers enrolled
- 3,593 anonymous answers received.
- For this study, considered only **primary schools teachers who participated this SY for the first time** (N=972)
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Other than data collection about participation, the questionnaire contained relevant questions:

- Q1 "*In my view computational thinking is...*" (open question)
- Q2 *Being able to use technological devices means having developed computational thinking competences* (4-point Likert scale)
- Q3 *Computational thinking competences can be adequately developed in primary schools without using technological devices* (4-point Likert scale)
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972 answers

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- 77 completely out of scope

Analysis of remaining 779 answers:

- category proposals, based on literature review or on a first reading of the answers,
- agreement on a preliminary set
- initial assignment of answers to one or more categories
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Categories I

- **Fundamental** - absolutely necessary in CT def.
  - `PSOL` Problem solving
  - `MENT` Mental process or tool
  - `ALGO` Algorithmic thinking
  - `AUTO` Giving instructions/automation
  - `METH` Using/learning Informatics methods
- **Important** - important but not fundamental for a CT def.
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Categories II

- **Part-of** - somehow present in CT defs but not necessary for a well-formed one.
  - `MCOG` Meta-cognition
  - `TRAN` Transversal competence
  - `CREA` Creative thinking
  - `UNIT` Understanding information technology
  - `LANG` Programming language
  - `ITER` Iterative development
- **Misleading** - elements whose presence in CT def. takes away from a correct understanding.
  - `THPC` "Think" like a computer
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Measuring CT knowledge

- Assigned a weight to each category according to relevance (in our view, taking in account literature) for CT definition.
  - **Fundamental** (+2)
  - **Important** (+1)
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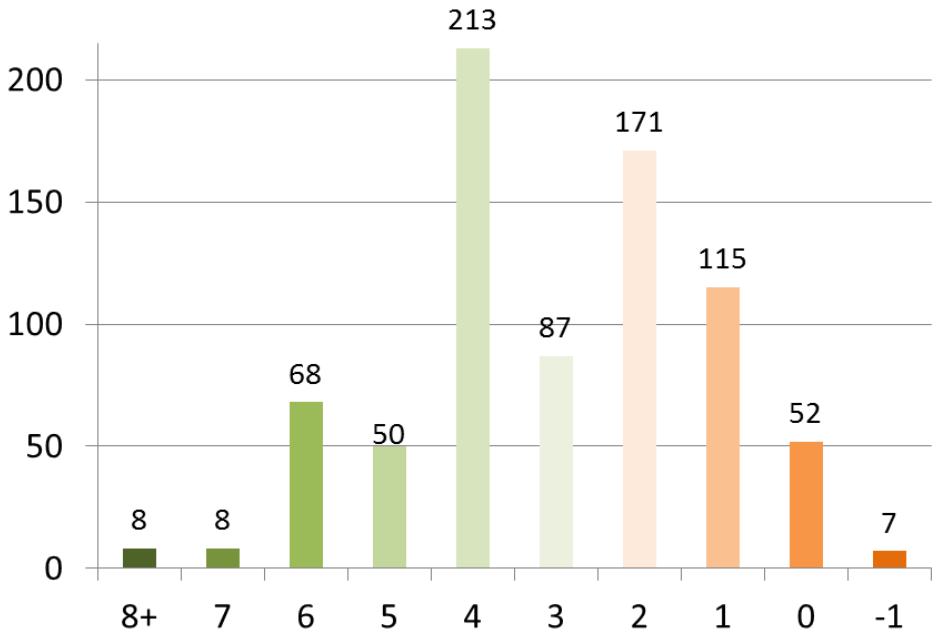

- **Good definition**: value ≥ 8 (1%)
- **Acceptable definition**: $8 >$ value ≥ 6 (10%)
  - c1: at least 3 fundamental (70)
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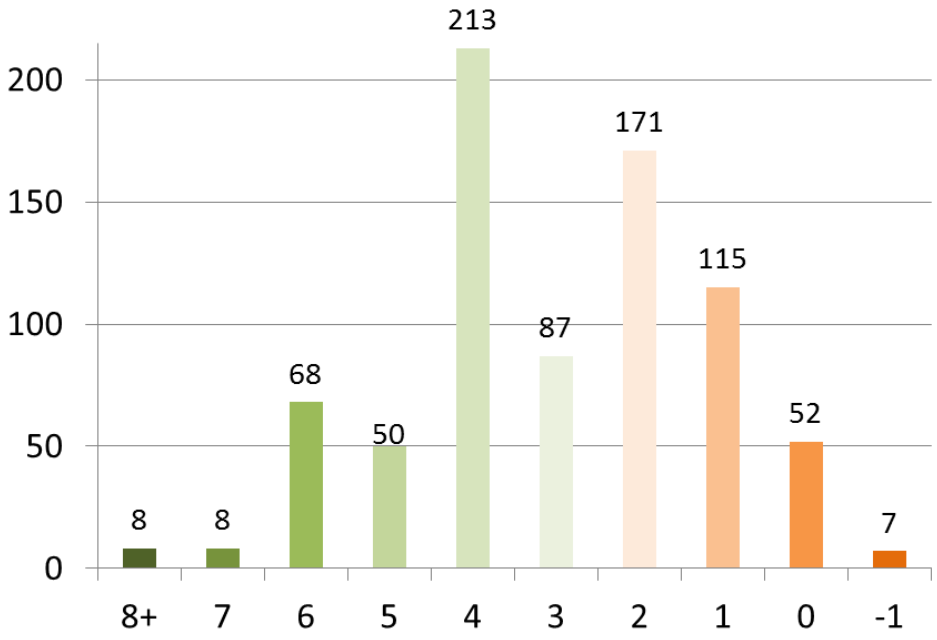

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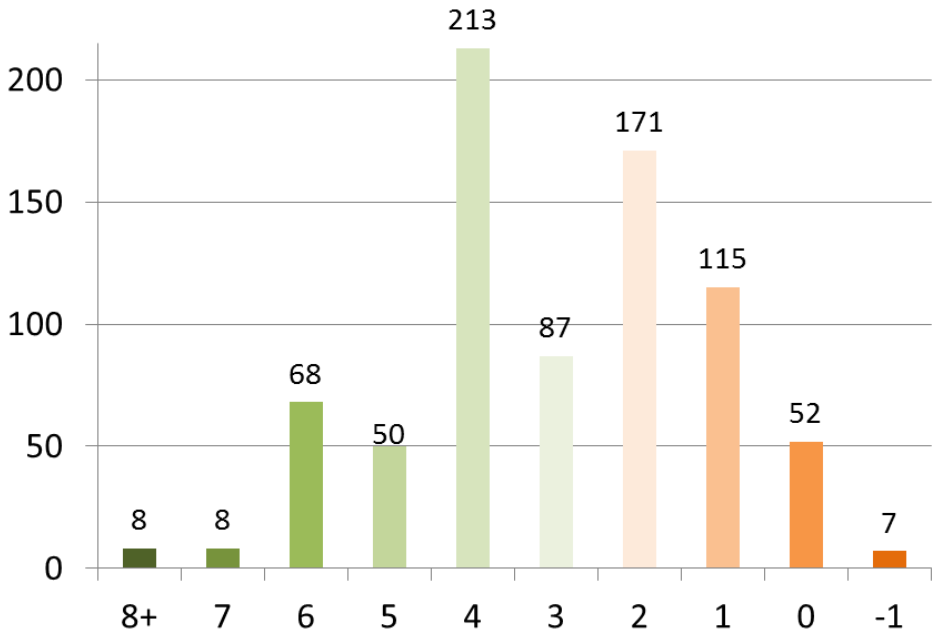

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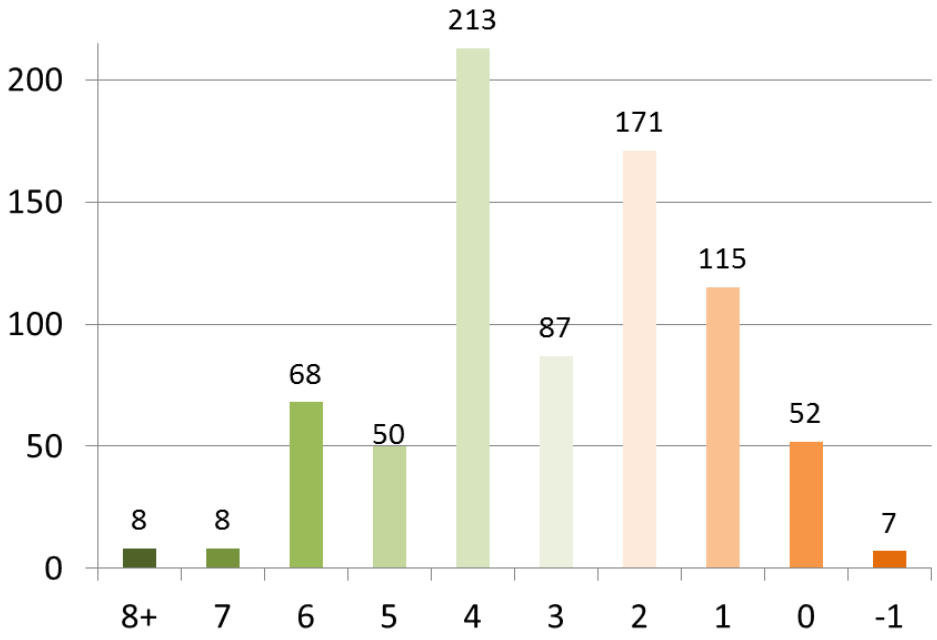

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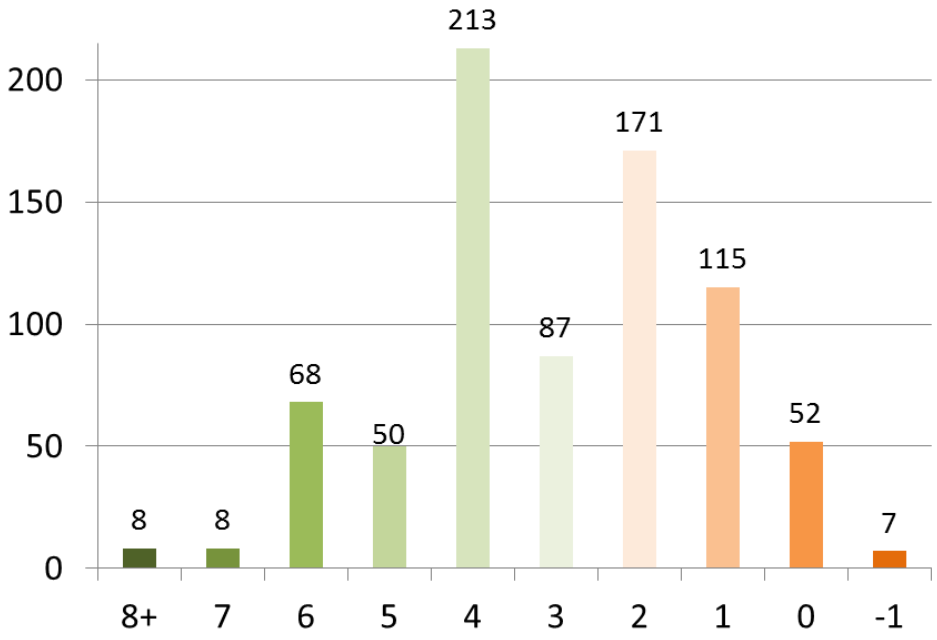

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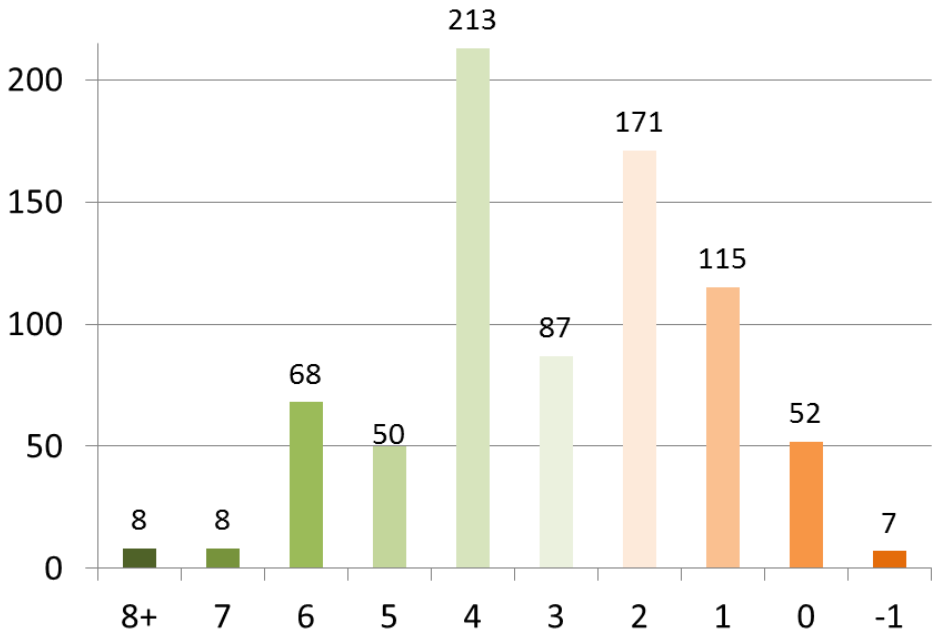

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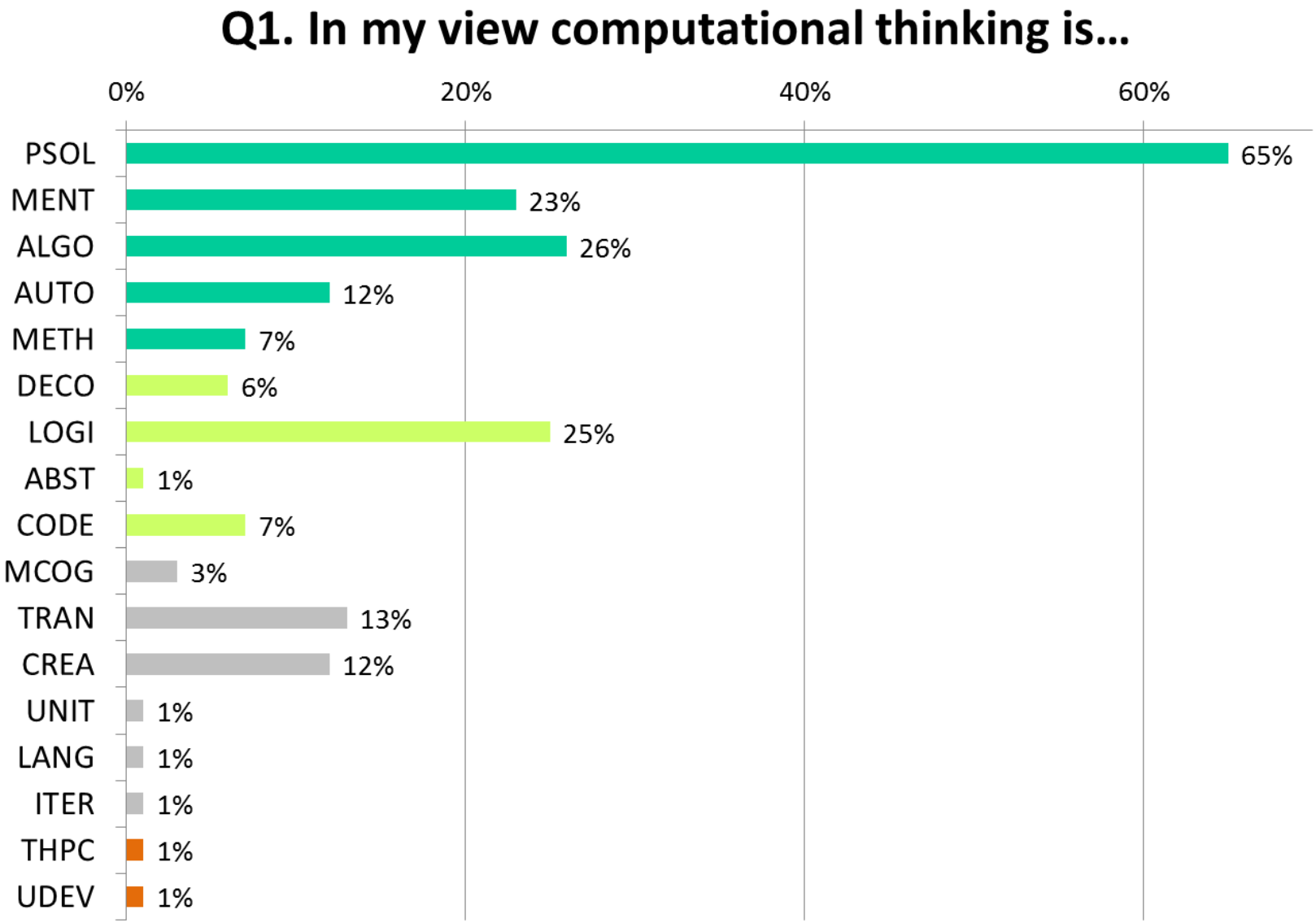
Frequency of each category



Acceptable answers

- Most of them belonging to the case **c1** (at least three fundamentals)
- High count of distinct sets (marked * in next slide) that capture a "good" definition of CT:
  - {PSOL, MENT, METH}
  - {PSOL, MENT, ALGO}
  - {PSOL, MENT, METH, TRAN}

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Acceptable answers distinct sets

Value	Count	Case	Labels										
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11	1		PSOL	MENT	ALGO		METH	DECO	LOGI	ABST		CREA	
9	1		PSOL	MENT	ALGO		METH			ABST			
8	3		PSOL	MENT	ALGO	AUTO							
8	1		PSOL	MENT	ALGO		METH				TRAN	CREA	
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6	17	*	PSOL	MENT			METH						
6	11	*	PSOL	MENT	ALGO								
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6	7		PSOL		ALGO	AUTO							
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Not acceptable answers & distinct sets

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4	51	PSOL, MENT
4	28	PSOL, AUTO
...		
3	24	PSOL, LOGI
3	11	PSOL, DECO
...		
2	80	PSOL
2	19	PSOL, CREA
2	11	MENT
...		
1	67	LOGI
1	13	CODE
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0	26	TRAN
...		

- PSOL alone or coupled with exactly one of MENT, LOGI, DECO, CREA: partial view of CS, given the absence of categories capturing the idea of *information-processing agent*
- Similar reasoning for MENT and LOGI: concern about considering CT somewhat distinct from CS.
- High count of TRAN alone: possibly derived from attempts to convince teachers of the importance of CT focusing on its transversal value as a general learning tool

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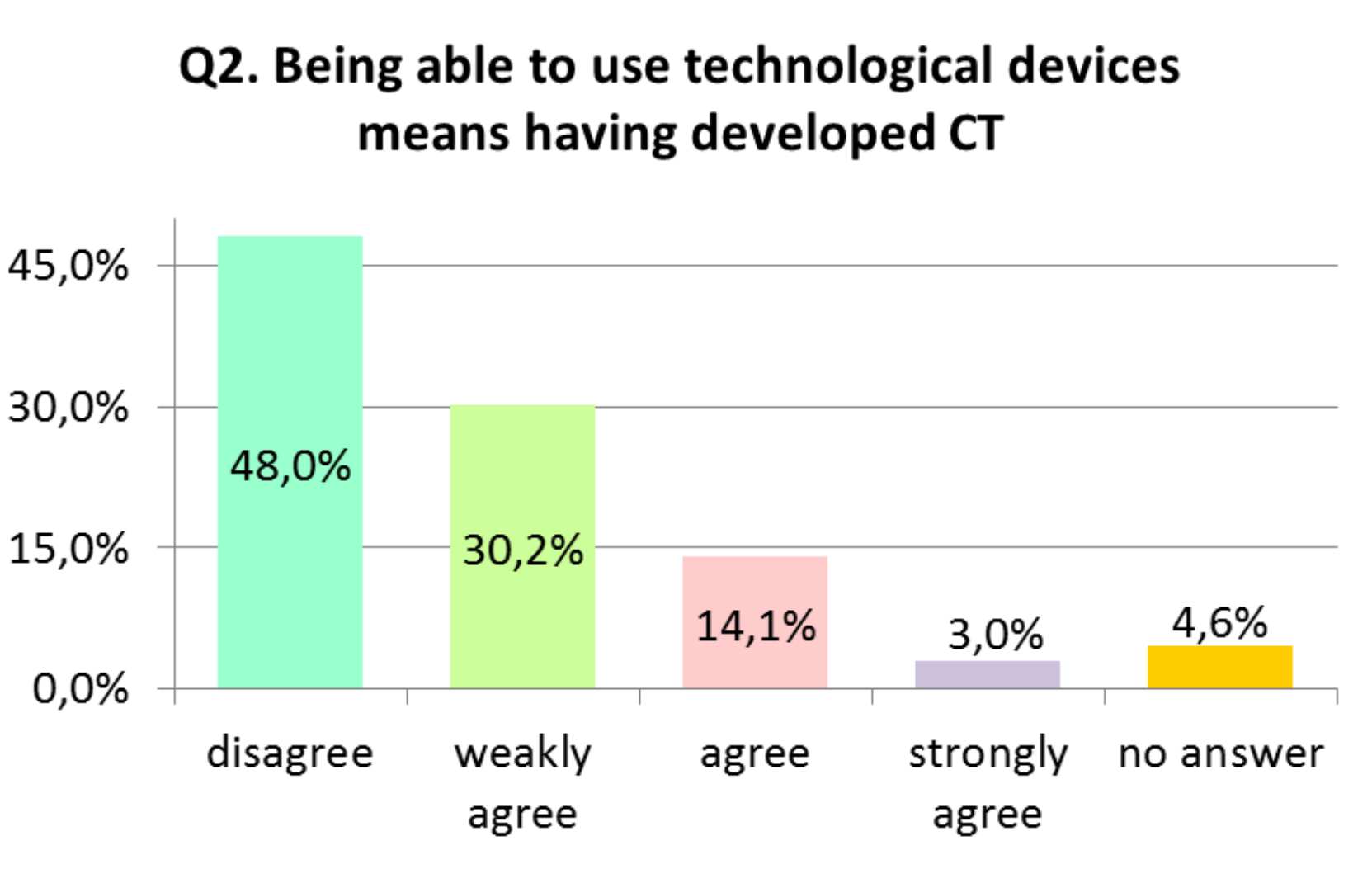
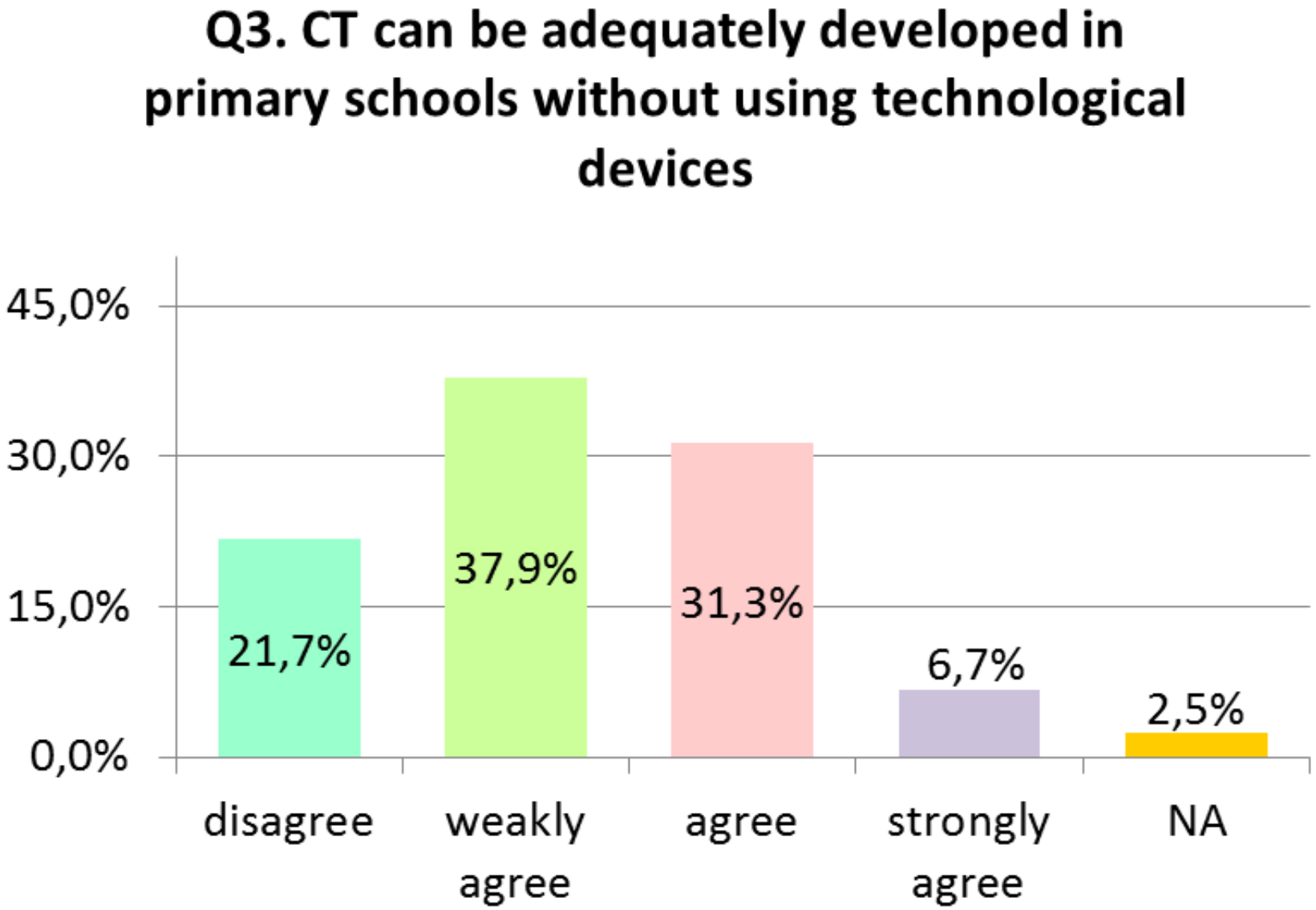
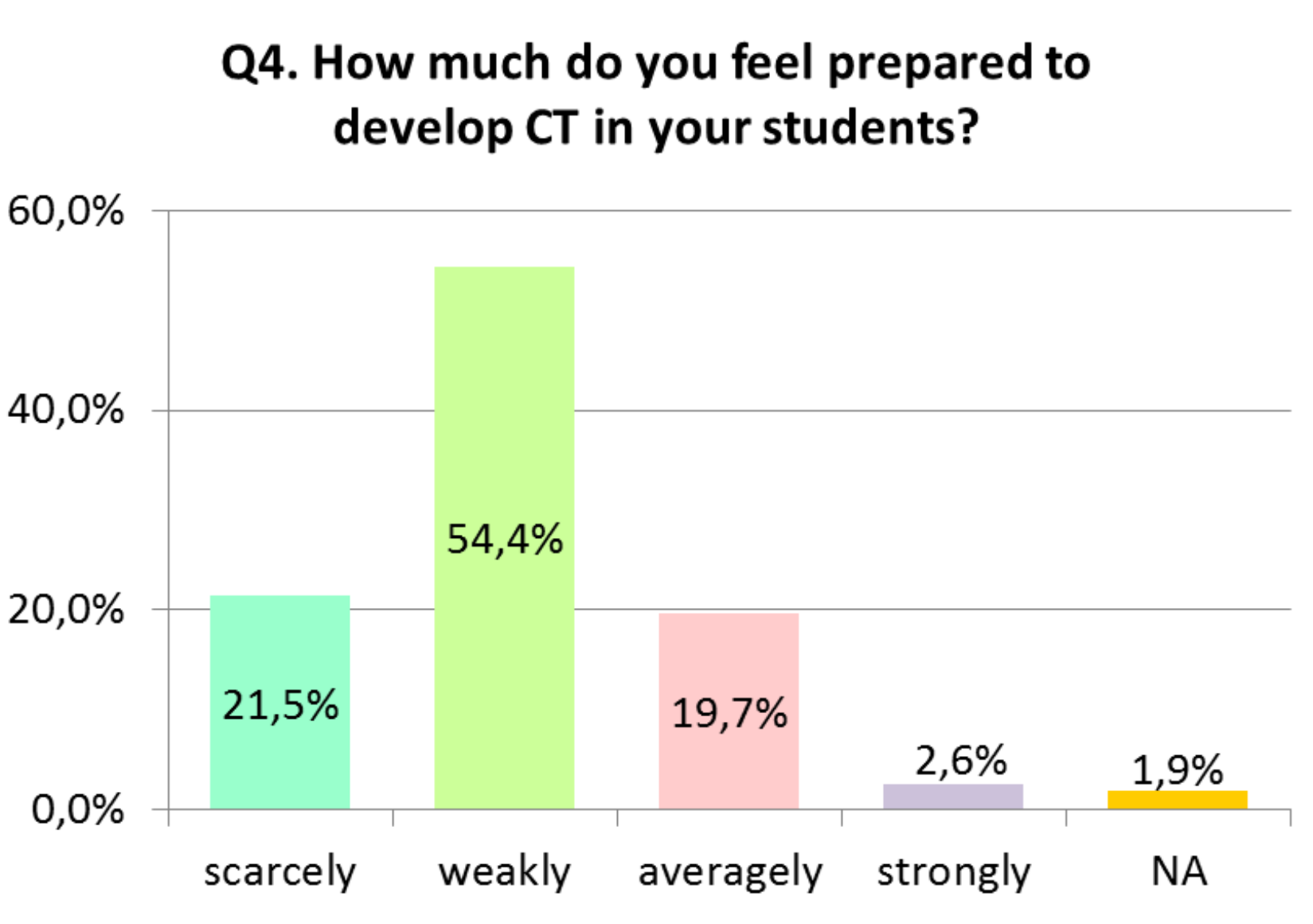
RQ2 - Technology and computational thinking I



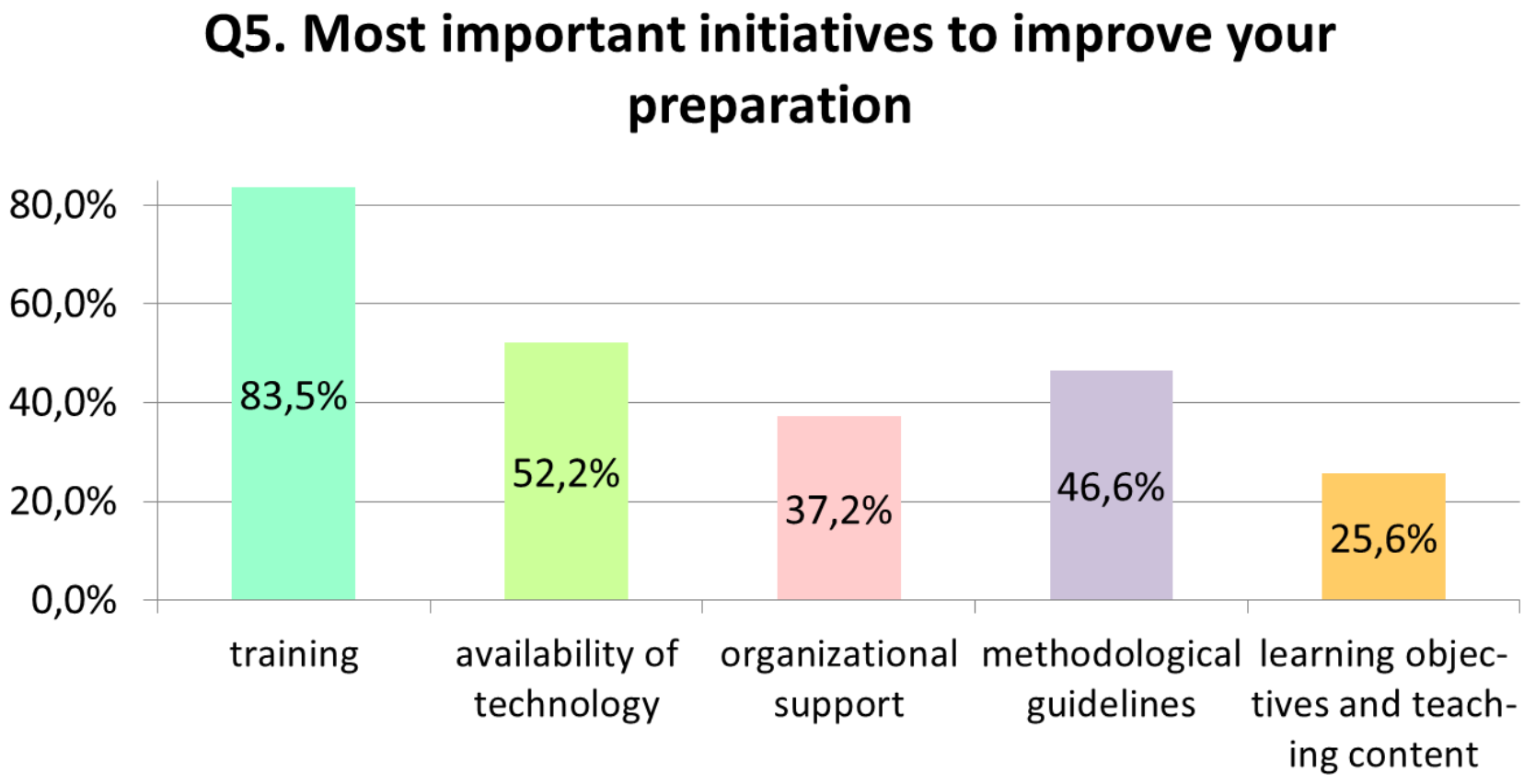
RQ2 - Technology and computational thinking II



RQ3 - Teachers' preparation I



RQ3 - Teachers' preparation II



Outline

Conclusions and further work

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- Vast majority of Italian primary school teachers doesn't have sound and complete conception about CT (**RQ1**).
- By contrast, it is sufficiently clear to them that (**RQ2**)
  - CS is not the use of IT
  - IT devices are not absolutely needed to develop CT
- teachers feel not prepared to develop CT competences in students, and mainly ask for specific training (**RQ3**).

Further work

- Consider answers from teachers at all school levels
- Possible differences between "new" teachers and those involved since the beginning in the project

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