Code to learn with Scratch?

A systematic literature review

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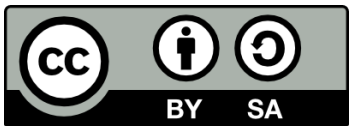
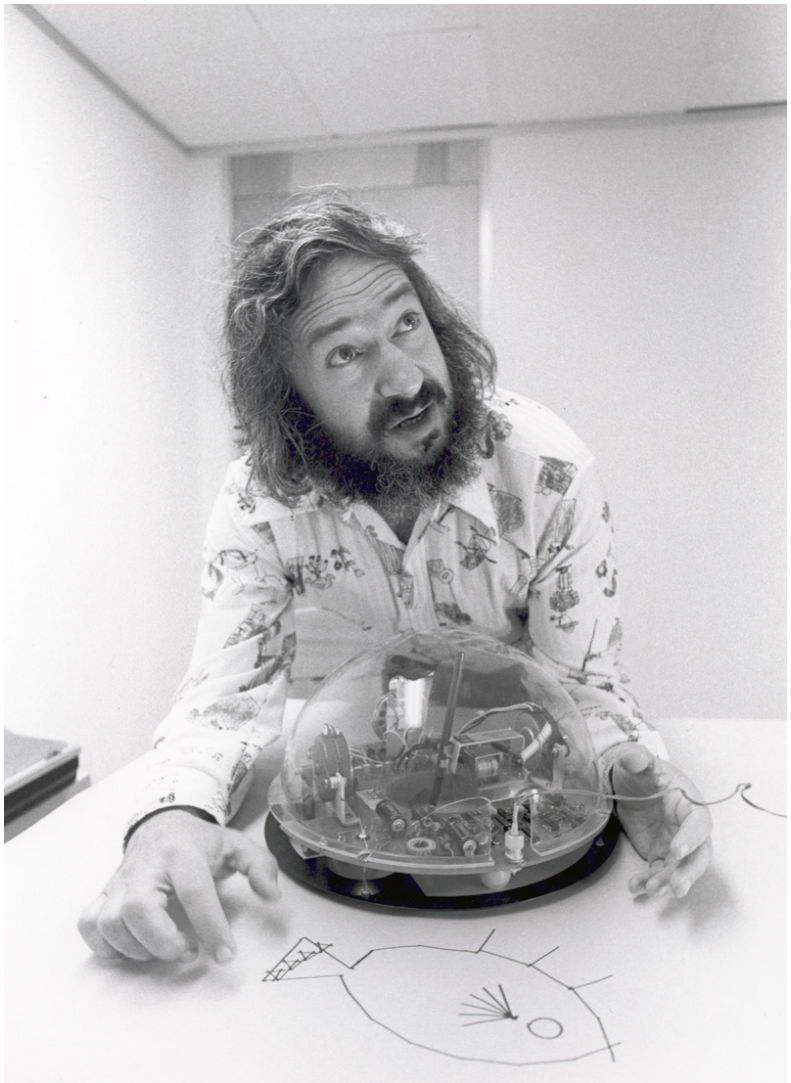


Code to learn (I)



Logo programming language

- Developed in the 1960s
- Its educational impact was intensively investigated in the 70s and 80s
- Students' improvements in maths (and other disciplines) were proved
- "Disappeared" from the educational landscape since mid-90s

Seymour Papert's picture: jgora.net

Code to learn (and II)

New visual programming languages

- Alice, Greenfoot, Kodu, **Scratch**
- Code.org, EU Code Week, Africa Code Week, ArabCode.org
- If there is no evidence showing educational impact of programming, this resurgence of programming in schools could disappear in a few years.

Research questions

- **RQ1. What K-12 subjects have used programming with Scratch as an educational resource?**
- **RQ2. Is programming with Scratch a good educational tool that enhances student learning?**
- **RQ3. What other skills are developed while learning to code with Scratch?**

Background picture: rebel-performance.com

Methodology

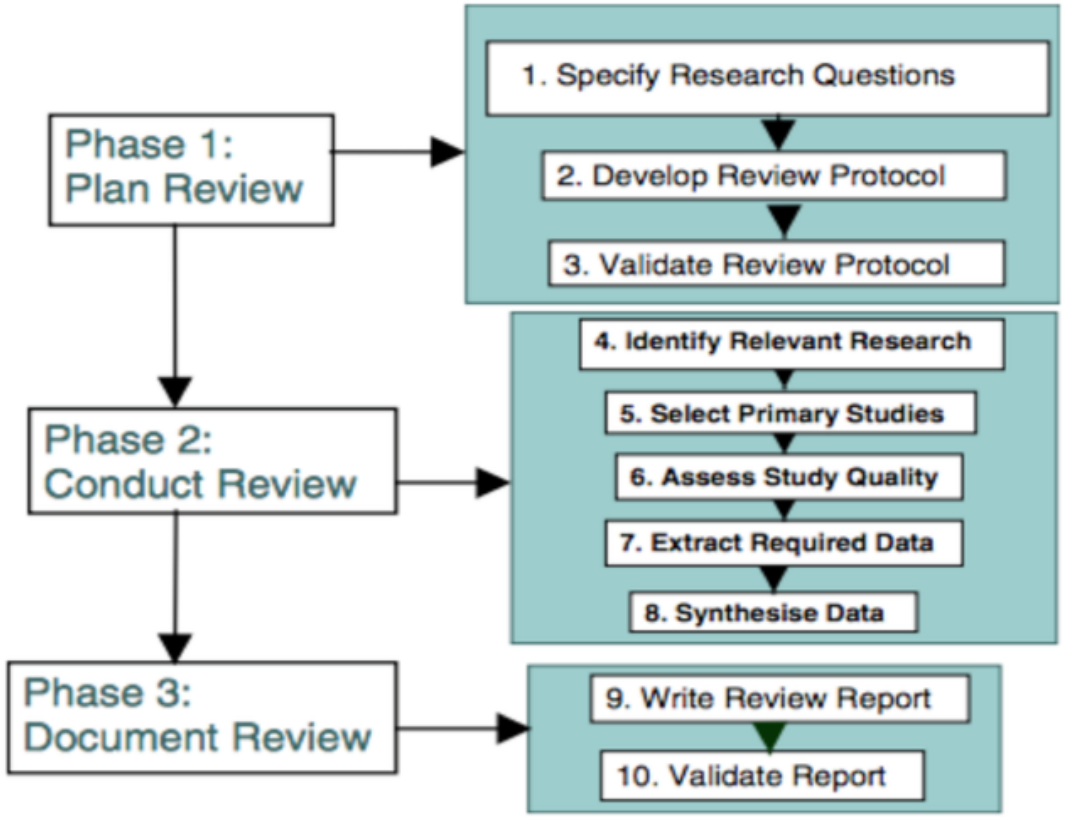


Figure: Systematic literature review process

Source: *Guidelines for Performing Systematic Literature Reviews in Software Engineering*

Selection of primary studies

Out of 107 located articles, the final number of selected papers is 15.

Motive of exclusion	**Number of papers**
Focused on programming	32
No evidence provided	7
University students	7
Out of context	41
No English version	2
Articles not accessed	3

Table: Summary of article exclusion

Findings, RQ1

Paper	Age	Subject	Environment
[21]	Middle School	Mathematics	School
[22]	5th grade	Mathematics, Language Arts	Summer camp
[23]	3rd grade	Mathematics	School
[24]	5th grade	Science	School
[25]	5th grade	Science	School
[26]	10-14 years old	Storytelling, Creative writing	After school
[27]	12-14 years old	Writing	School
[28]	4th-5th grade	English as a second language	School

Table: Subjects learned through coding with Scratch

Findings, RQ2 (I)

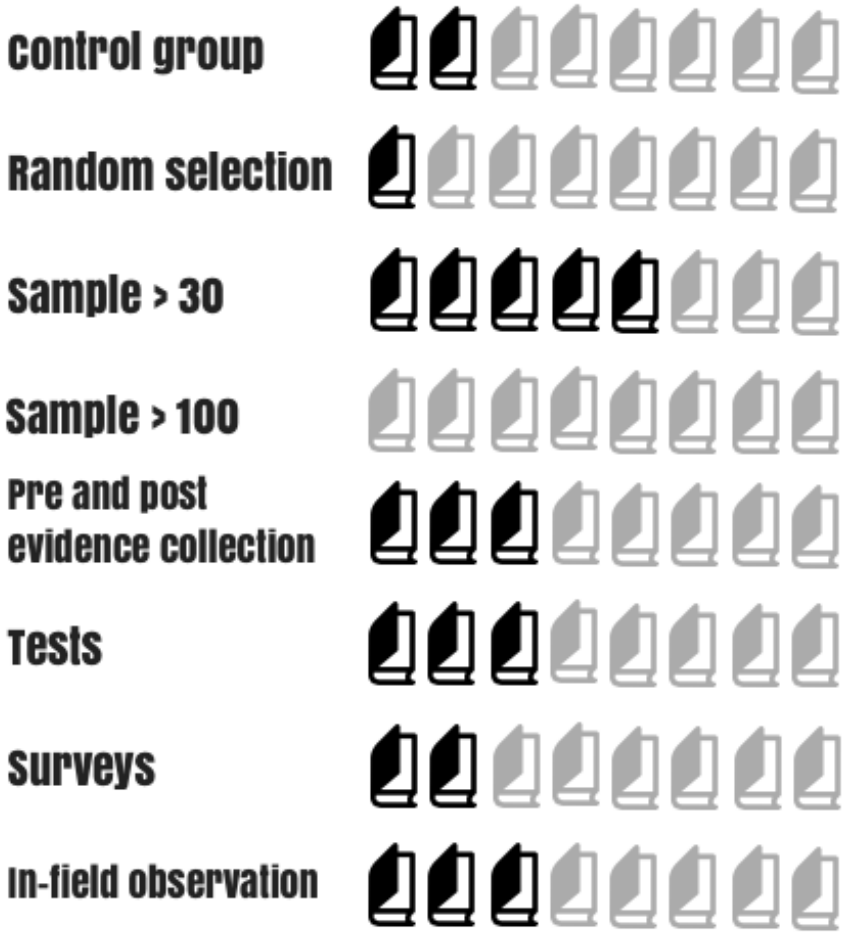


Figure: Description of the 8 papers under investigation for RQ2

Findings, RQ2 (and II)

Subject	Paper	Proved results	Non-proved results
Maths	[21]	Significantly more positive attitudes towards maths	
	[22]	Test scores in maths highly correlated with programming performance	
	[23]	Improvements at comparing numbers and establishing order	No differences at spatial location
Science	[24]		How or if learners deepened their science knowledge
	[25]	61.5% reported a better understanding of science	
L. arts	[26]	60% indicated their storytelling skills improved	
	[27]	Effective framework for facilitating digital composition	
English	[28]	Experimental improved more than control groups	

Table: Programming with Scratch to learn other subjects

Findings, RQ3 (I)

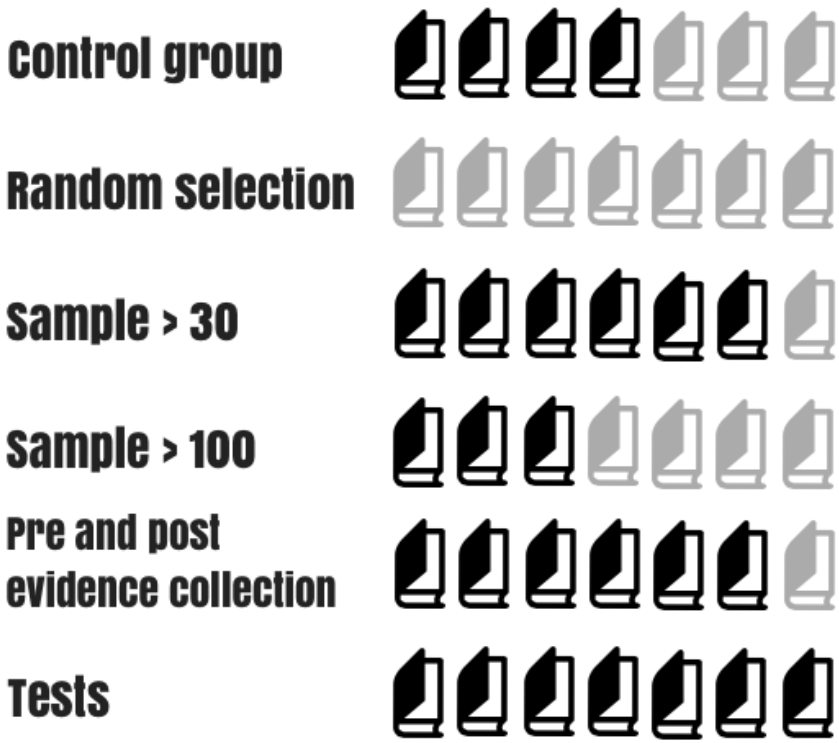


Figure: Description of the 7 papers under investigation for RQ3

Findings, RQ3 (and II)

Paper	Proved results	Non-proved results
[25]	Better performance in logical thinking and problem solving	
[30]	Students in the treatment group show improvement in their problem solving skills at a rate greater than those in the control group	
[31]	Improved problem solving ability	
[32]	The effect on problem solving abilities is significant, especially at the reason of prediction	No significant effect on logical reasoning skills
[33]	Improved problem solving skills and reasoning practices	
[34]	Increase in self-confidence in problem solving ability	No significant differences in problem solving skills
[35]	Increase in logic, creativity and learning skills	

Table: Skills developed by programming with Scratch

Conclusions

- Programming with Scratch to learn other subjects
  - 8 studies
  - Very promising outlook
  - Most investigations did not follow basic recommendation for education research
- Programming with Scratch to develope other skills
  - 7 papers
  - Positive results
  - Most investigations used control groups, pre- and post-tests, and samples bigger than 30.
- **It is necessary to conduct further research with larger samples to justify the use of programming as an educational tool in K-12**

Background picture: flamingcow.co.uk

Future Work

We are performing a **broader systematic literature review**, not restricting the programming language to Scratch, in order to:

1. Identify **potential differences of different programming languages**
2. State **stronger conclusions** regarding the usefulness of **computer programming as an educational tool** for primary and secondary students

Background picture: Simon Cunningham

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