HØGSKULEN I VOLDA

Korleis 'programmering' er definert og brukt i matematikkdidaktisk litteratur?

Martyna K. Fojcik

13.03.2015

Presentasjon av funn frå ein forskingsartikkel i review-prosessen

Samfunnet i dag

Country	Programming / Codin	Algorithmic Thinking	Computational Thinking	Computer Science Education	Informatics Education	Computing Education	Other
Austria	✓		✓		✓		
Belgium Flanders	✓	✓	✓				
Belgium Wallonia	✓	✓					
Croatia	✓	✓	✓		✓		
Cyprus	✓	✓	✓				
Czech Republic	✓		✓	✓	✓		
Denmark	✓	✓	✓	✓	✓		
Finland	✓	✓	✓				
France	✓	✓	✓	✓			
Greece	✓	✓	✓	✓	✓	✓	
Hungary	✓	✓					
Ireland	✓	✓	✓	✓			
Italy	✓		✓		✓		
Lithuania	✓	✓	✓		✓		✓
Luxembourg	✓	✓	✓	✓			
Malta	✓					✓	
Poland	✓	✓	✓		✓	✓	
Portugal	✓	✓	✓				
Romania	✓	✓		✓	✓	✓	
Slovakia	✓	✓	✓	✓	✓	✓	
Slovenia	✓	✓		✓			
Spain	✓						✓
Georgia	✓	✓		✓			
Israel							✓
Norway	✓	✓					
Russia	✓	✓			✓		
Serbia	✓	✓		✓	✓		
Switzerland	✓	✓			✓		

Table 5. Relevant terms used in compulsory education curricula
Source: Authors' elaboration based on results from the study's survey and desk research

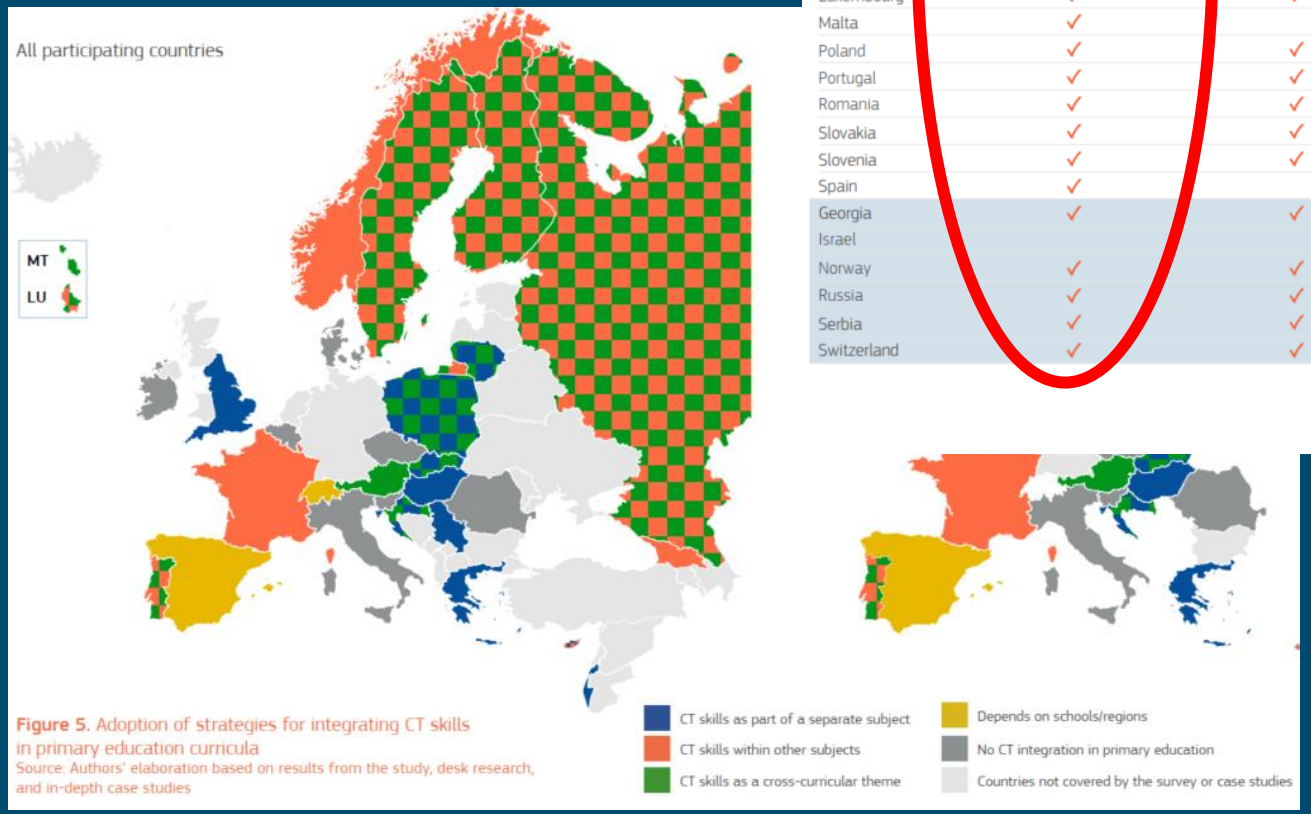


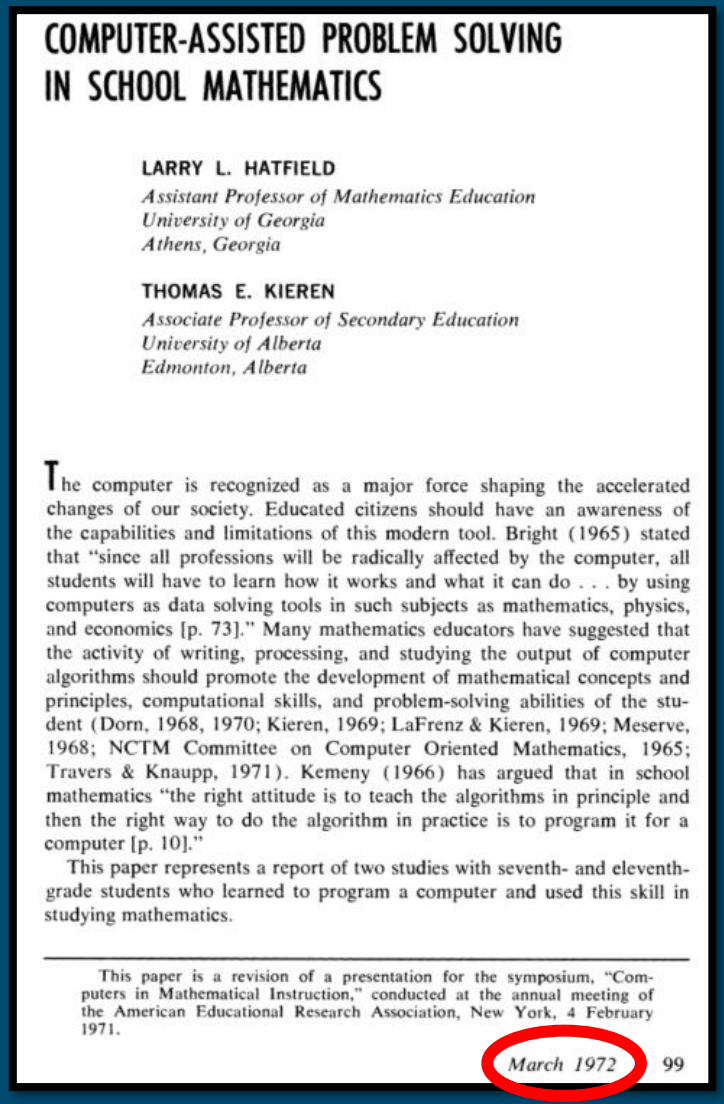
Figure 5. Adoption of strategies for integrating CT skills in primary education curricula
Source: Authors' elaboration based on results from the study, desk research, and in-depth case studies

(Bocconi et al., 2022, s. 34 og 36)

Omgrepet ‘programmering’

Forskingsspørsmål:
Korleis har omgrepet ‘programmering’ blitt definert og brukt i matematikkdidaktisk litteratur?

(eng. In what ways is the notion of ‘programming’ defined and used in the mathematics education literature?)



COMPUTER-ASSISTED PROBLEM SOLVING IN SCHOOL MATHEMATICS

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The computer is recognized as a major force shaping the accelerated changes of our society. Educated citizens should have an awareness of the capabilities and limitations of this modern tool. Bright (1965) stated that “since all professions will be radically affected by the computer, all students will have to learn how it works and what it can do . . . by using computers as data solving tools in such subjects as mathematics, physics, and economics [p. 73].” Many mathematics educators have suggested that the activity of writing, processing, and studying the output of computer algorithms should promote the development of mathematical concepts and principles, computational skills, and problem-solving abilities of the student (Dorn, 1968, 1970; Kieren, 1969; LaFrenz & Kieren, 1969; Meserve, 1968; NCTM Committee on Computer Oriented Mathematics, 1965; Travers & Knaupp, 1971). Kemeny (1966) has argued that in school mathematics “the right attitude is to teach the algorithms in principle and then the right way to do the algorithm in practice is to program it for a computer [p. 10].”

This paper represents a report of two studies with seventh- and eleventh-grade students who learned to program a computer and used this skill in studying mathematics.

This paper is a revision of a presentation for the symposium, “Computers in Mathematical Instruction,” conducted at the annual meeting of the American Educational Research Association, New York, 4 February 1971.

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Can programming support mathematics learning? An analysis of Swedish lower secondary textbooks

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ABSTRACT
In the wake of the present inclusion of programming in mathematics education, which is a feature of curricular revisions in many countries, we have analysed newly inserted programming activities in mathematics textbooks. The aim was to investigate how such activities relate to and potentially affect students’ opportunities to learn mathematics. Data consist of Swedish textbooks for grades 7–9 (ages 13–15) intended for mathematics classes, where all units labelled as or including programming activities were analysed. Concerning the relation between mathematics and programming, our results show that in the intricate balance between teaching mathematics on the one hand and teaching programming on the other hand, the textbooks seem to lean towards the latter, thus not greatly contributing with mathematical learning opportunities. We see a dominance of mathematics as a context for programming, rather than programming as a tool for learning mathematics. The lack of exploration and rare occurrence of novel mathematics in the programming activities implies a weak relationship between mathematics and programming.

ARTICLE HISTORY
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KEYWORDS
Programming; textbook analysis; lower secondary school; mathematics education

1. Introduction

Over the past decade, programming has been implemented in several countries’ school curricula. In the wake of the digital society, programming has emerged as a necessary skill for all citizens (Bocconi et al., 2018) and is often emphasised as a pedagogical tool for developing computational thinking (Nouri et al., 2020). The strategies for implementing programming in school curricula have varied between different countries. For instance, England and Denmark have established new subjects containing programming, *computing* and *technology comprehension*, respectively, while Sweden and Finland have incorporated programming into already existing subjects (Misfeldt et al., 2020; Pörn et al., 2021). In Sweden, which is the case of this study, programming is taught in mathematics and applied in technology (Swedish National Agency of Education, 2018). Unlike other countries, Sweden included programming in the mathematics syllabus in close connection to algebra through

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Historisk bakgrunn

(Dolonen et al., 2019)

(Aslan og Reigeluth, 2011)

1950 1960 1970 1980 1990 2000 2010 2020

Antropomorfisering som erstatning av menneskelege (ofte kvinnelege) 'datamaskiner' (Nofre et al., 2014)

Lage program (Hartree, 1950):
1. Lage oversiktleg plan for algoritmen
2. Skrive programkoden i eit programmeringsspråk

(Dolonen et al., 2019)

(Aslan og Reigeluth, 2011)

1950 1960 1970 1980 1990 2000 2010 2020

'Mainframe Period'
sein 1950 – sein 1970

IBM PC - International Business Machines personal computer

Endring i samfunnet (Brey og Søraker, 2009) og utvikling av ny fagfelt **informatikk** (Ralston og Shaw, 1980)

Misoppfatningar:
- Informatikk = programmering (Ralston og Shaw, 1980)
- Programmere mikrobølgjeomn (Blackwell, 2002)

(Dolonen et al., 2019)

(Aslan og Reigeluth, 2011)

1950 1960 1970 1980 1990 2000 2010 2020

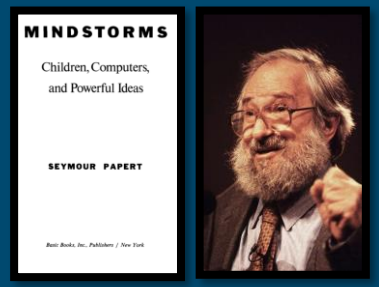
'Mainframe Period'
sein 1950 – sein 1970

'Microcomputer Period'
sein 1970 – slutten av 1990

Mindstorms: "**teaching** the computer **how to think**, children embark on an exploration about **how they themselves think**" (Papert, 1980, s.19)

Men,
- ikkje signifikant påverknad
- entusiasmen for programmering fall

(Benton et al., 2017; Clements, 1999; Kurland et al., 1986; Resnick et al., 2009)



'Første bølgje'
1980 – ca. slutten av 1990

(Dolonen et al., 2019)

(Aslan og Reigeluth, 2011)

1950 1960 1970 1980 1990 2000 2010 2020

'Mainframe Period'
sein 1950 – sein 1970

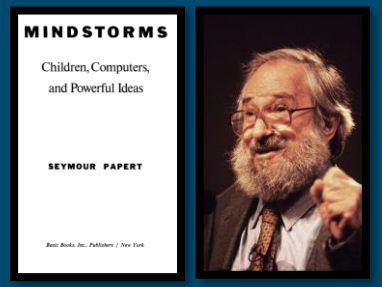
'Microcomputer Period'
sein 1970 – slutten av 1990

World wide web -> Internett

Digitalisert samfunn og skule

Tilgang, teknologi, kommunikasjon, informasjon, kunnskap, perspektiv

Teknologi i kvardagen
Teknologi i skulen



'Første bølgje'
1980 – ca. slutten av 1990

(Dolonen et al., 2019)

(Aslan og Reigeluth, 2011)

1950 1960 1970 1980 1990 2000 2010 2020

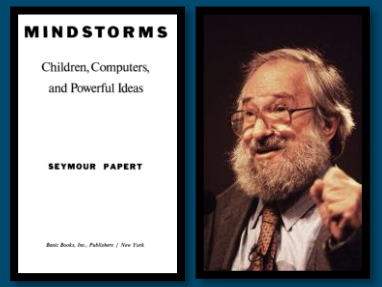
'Mainframe Period'
sein 1950 – sein 1970

'Microcomputer Period'
sein 1970 – slutten av 1990

'Internet Period'
2000 – d.d.

"Despite early claims that basic computing ideas **are easily transferred** across domains, STEM educators have concluded that **CT is not domain-independent**; it **looks different in different disciplines**" (Denning og Tendre, 2021, s. 379).

- Programmering utan datamaskin
- Blokk-baserte/ visuelle programmeringsspråk



'Første bølgje'
1980 – ca. slutten av 1990

'Andre bølgje'
2007 – d.d.

(Dolonen et al., 2019)

(Aslan og Reigeluth, 2011)

1950 1960 1970 1980 1990 2000 2010 2020

'Mainframe Period'
sein 1950 – sein 1970

'Microcomputer Period'
sein 1970 – slutten av 1990

'Internet Period'
2000 – d.d.

Metode

1. Utval av tidsskrift
2. Utval av artiklar
3. Utval av utdrag
4. Analyse del 1: Direkte skildringar
5. Analyse del 2: Tematisk analyse

1 SCImago Journal Rank Indicator (2023 statistics) (SJR, okt 2024)

Kategorier:
- Mathematics, Mathematics(miscallaneous)
- Social sciences, Education

2 Søkte 'programmering' (eng.) i søkemotor i kvar tidsskrift (Ryve, 2011)

Inkluderingskriterier:
- Minst 5 førekomster av 'programmering' i hovuddelen av teksten

3 Dokumenterte alle førekomster av omgrepet 'programmering' -> over 3 300 utdrag

	Tidsskrift	Søk Okt.2024	Inkluderte artiklar
A	Educational Studies in Mathematics	172	30
B	Journal for Research in Mathematics Education	248	9
C	ZDM – International Journal on Mathematics Education	120	22
D	Journal of Mathematics Teacher Education	14	4
E	International Journal of Science and Mathematics Education	77	9
F	Teaching Mathematics and its Applications: International Journal of the IMA	153	17
G	Mathematics Education Research Journal	39	4
H	International Journal of Mathematical Education in Science and Technology	2 045	103
I	International Journal of Research in Undergraduate Mathematics Education	22	6
	Artiklar totalt	**2 890**	**204**

Metode

1. Utval av tidsskrift
2. Utval av artiklar
3. Utval av utdrag
4. Analyse del 1: Direkte skildringar
5. Analyse del 2: Tematisk analyse

4 Inkluderingskriterium:
- Er 'programmeing' nemt frå metaperspektivet?

Døme:

• *programming is …*	**direkte skildring**
• *programming leads to…*	indirekte skildring
• *programming course…*	ingen skildring

81 utdrag

5 Induktiv, iterativ, tematisk analyse (Braun og Clarke, 2006; Clarke og Braun, 2013)
➔ Samanlikning av nøkkelord, eigenskapar, skildringar, formål

	Tidsskrift	Utvalte artiklar	Direkte skildring
A	Educational Studies in Mathematics	30	5
B	Journal for Research in Mathematics Education	9	3
C	ZDM – International Journal on Mathematics Education	22	6
D	Journal of Mathematics Teacher Education	4	2
E	International Journal of Science and Mathematics Education	9	3
F	Teaching Mathematics and its Applications: International Journal of the IMA	17	1
G	Mathematics Education Research Journal	4	1
H	International Journal of Mathematical Education in Science and Technology	103	15
I	International Journal of Research in Undergraduate Mathematics Education	6	4
	Artiklar totalt	**204**	**40**

Resultat

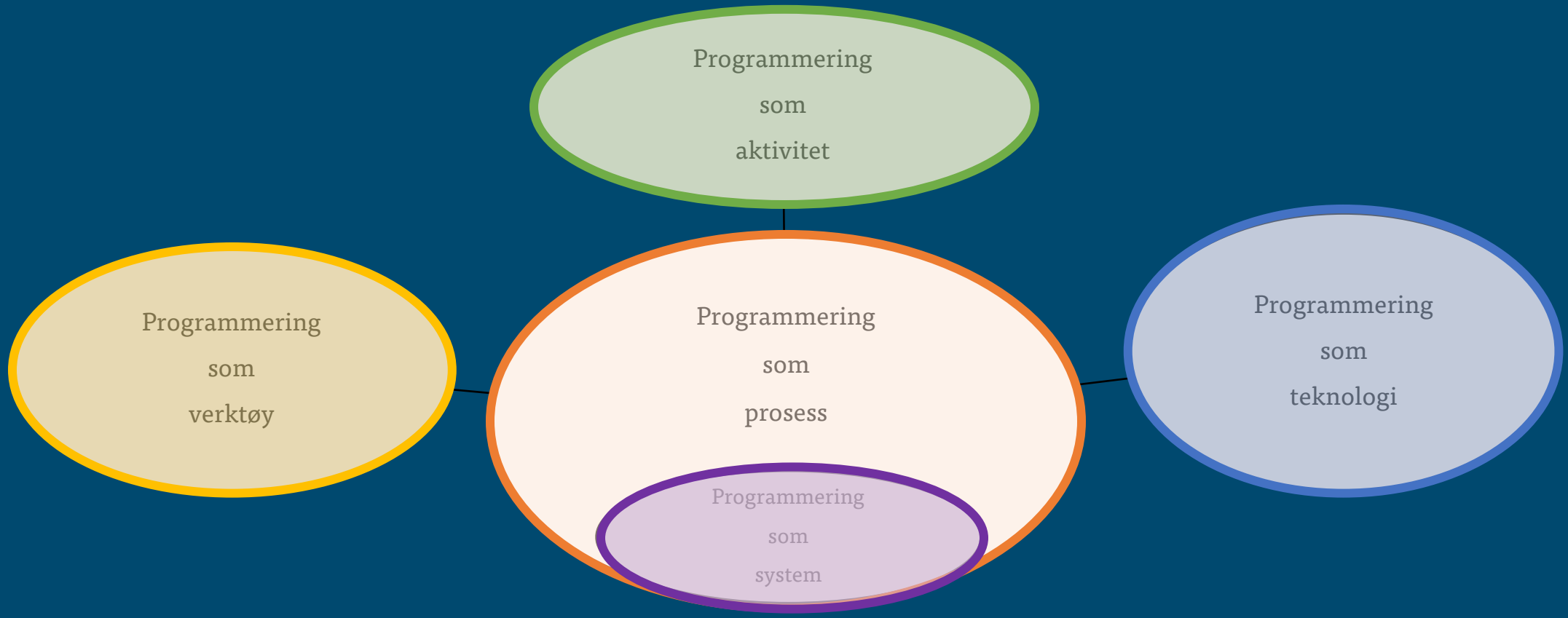
Overordna funn

- Kun 40 av 204 artiklar -> ca.80% skildrar ikkje 'programmering'
- Mangel på einigheit om kva 'programmering' er/skal/bør vere
- 5 Tema

Tema	Skildring	Døme 1	Døme 2
Programmering som aktivitet 16 utdrag	Skildrar ideen med aktivitet/handling, utforsking, undring, læring, engasjement eller motivasjon	"Programming is a **way to learn** how to do things" (H15.P7.3) (Wiechers, 1974, s. 699, Appendix 1)	"(...) programming is an **exploratory activity**" (A12.P2) (Dawson, 1994, s. 308, Appendix 1)
Programmering som prosess 13 utdrag	Skildrar ulike element i programmeringsprosessen, viser ulike trinn/steg i det å lage eit program, t.d. planlegge, feilsøke, teste	"(...) programming includes any activity aimed at constructing a computer tool (a program) by way of **three interwoven tasks** of varying importance: **the development** of an algorithm, **the coding** of the algorithm, and **the verification and validation** of the program" (I4.P37.1) (Broley et al., 2018, s. 45, Appendix 1)	"(...) programming as an activity that requires students to **write linked lines** of code, **debug**, **implement** logical loops and **use** some variables" (H45.P10) (Iannone og Thoma, 2024, s. 2623, Appendix 1)
Programmering som system 4 utdrag	Skildrar algoritmen bak ein program, presise instruksjonar, utforming, system, struktur	"(...) programming as far as **basic instruction** is concerned, is not the details of a language but the **general structure** of a program - the use of branches, loops, subroutines, etc" (A30.P7) (Walker, 1968, s. 114, Appendix 1)	"Programming may be defined as the **discovery and the development of algorithms** (...)" (H15.P7.1) (Wiechers, 1974, s. 699, Appendix 1)
Programmering som teknologi 13 utdrag	Skildrar det tekniske aspektet av 'programmering', bruk eller laging av programvare eller datamaskin, visning til koding, algoritmisk tenking eller 'computing' som ferdigheiter /'literacy'	"(...) addressing **cross-curricula opportunities in STEM education** is the introduction of computer science (**computer programming—coding**) as a **basic skill/literacy** for all students" (C11.P1.1) (Miller, 2019, s. 915, Appendix 1)	"Programming, which is the development of a program that a **computer can execute automatically**, offers a possibility to foster algorithmic thinking (...)" (I1.P4) (Dilling et al., 2024, s. 2, Appendix 1)
Programmering som verktøy 35 utdrag	Skildrar 'programmering' som vegen, medierande artefakt, utstyr eller ressurs for å lære, undervise, rekne ut, løyse problem etc.	"(...) programming is not always necessary for solving the problem statements but rather **served as a tool** for developing students' knowledge of **mathematical concepts and procedures** to a general level" (C15.P16) (Bergsten og Frejd, 2019, s. 949, Appendix 1)	"(...) programming as a **pedagogical tool** to improve their sense-making and reasoning regarding the **concept of the exterior of an angle** in order to make different regular polygons" (H4.P8) (Olteanu, 2022, s. 2047, Appendix 1)

Resultat

"(...) programming includes **any activity** aimed at **constructing a computer tool (a program)** by way of **three interwoven tasks** of varying importance: **the development of an algorithm**, the **coding** of the algorithm, and the verification and validation of the program" (I4.P37.1) (Broley et al., 2018, s. 45, Appendix 1).



Diskusjon og konklusjon

Lite einigheit av kva 'programmering' er
- Ca. 80 % av artiklane kun 'bruker' omgrepet
- Resterande 20 % skildrar 'programmering' på ulike måtar

Ulik bruk av 'programmering'
- 10 kl. vs. 1. kl. vs. høyare utdanning
- Programmering utan datamaskin vs. blokkprogrammering vs. tekstprogrammering
- Programmering i geometri vs. programmering i sannsyn vs. programmering utanfor matematikk
- Programmering i 1970 vs. programmering i 2025

Essens av programmering

➔ Det å konstruere eit program, gjennom presise algoritmar, til å løyse ei oppgåve/problem, gjerne/ofte via teknologi

Forskingsspørsmål:
Korleis har omgrepet 'programmering' blitt definert og brukt i matematikkdidaktisk litteratur?

(eng. In what ways is the notion of 'programming' defined and used in the mathematics education literature?)

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