Training Teachers from Diverse Disciplines to Teach Computer Science

Illinois Computer Science Summer Teaching Workshop

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The Israeli Context: Why the Study Started

A teacher shortage led to national training in computer science

Challenge

2011

MS Computer science entered Israeli middle schools

CS There were not enough dedicated computer science teachers

Response

PD A national training program was opened

Teachers from diverse disciplines were trained to teach computer science in middle school

This marked the beginning of large-scale teacher training for computer science in Israel.

A New Need in High School

A second wave of training began in 2022

Challenge

2022

HS — **A shortage of computer science teachers emerged in Israeli high schools**

3U — **The need was especially clear in the foundational 3-unit high school track**

Response

PD

A new national training program was developed

Teachers from diverse disciplines were prepared to teach 3-unit high school computer science

This training process became the focus of my study.

This program created the setting for examining how teachers from STEM and HASS backgrounds enter CS teaching.

How the Training Was Organized in Practice

Teachers were grouped by location, not by disciplinary background

1 Physical learning centers

The training took place in face-to-face regional learning centers.

Teachers were assigned by place of residence.

2 Mixed disciplinary groups

Teachers were not grouped by their original teaching discipline.

STEM and HASS teachers studied together in the same groups.

3 Research significance

The same training structure met teachers with different starting points.

This made the comparison between STEM and HASS especially important.

A uniform training structure met different professional resources, needs, and barriers.

Research Problem

The same training program met teachers with very different professional starting points

STEM teachers
Science, Technology, Engineering, Mathematics

- Often brought proximity to formal reasoning, mathematics, algorithms, or technology.
- Often entered with relatively high confidence in learning CS content.
- Needed support in translating knowledge into CS teaching practices.

HASS teachers
Humanities, Arts, Social Sciences

- Often brought strong pedagogical resources, mediation, inclusion, and sensitivity to learners.
- Often needed gradual development of content and technological knowledge.
- Needed scaffolding, practice, and sustained support.

The goal is not to decide which group is better, but to understand what training pathway helps each group succeed.

Study Purpose and Research Questions

Training teachers from diverse disciplines to teach computer science as a second subject

Study purpose

To examine the training process for teaching computer science as a second subject, focusing on motivations, perceptions of required knowledge, and differences between STEM and HASS teachers.

RQ1 - Motivation	What motivates teachers from diverse disciplines to participate in computer science teacher training, and how do STEM and HASS teachers differ?
RQ2 - Knowledge	How do teachers perceive the knowledge required to teach computer science, and how do STEM and HASS teachers differ?

Two linked questions: why teachers enter the training, and how they build the knowledge needed for teaching.

Two Complementary Theoretical Lenses

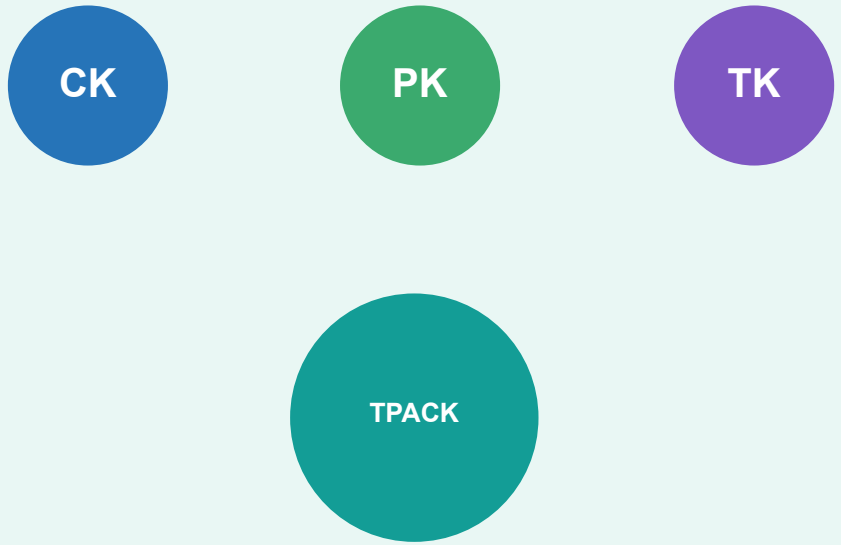
Eccles explains motivation; TPACK explains professional knowledge development

Eccles' Expectancy-Value Theory

1. **Expectancy for Success**
2. **Task Value**
3. **Perceived Cost**

Why do teachers enter and persist in training?

TPACK



How do content, pedagogy, and technology integrate in CS teaching?

How I Studied the Program

A mixed pilot study: primarily qualitative with descriptive quantitative data

3 training cohorts 2022, 2023, 2025

341 participating teachers 229 STEM | 112 HASS

100 completed training and placed in schools

7 questionnaires across the program

Data sources

Questionnaires
Interviews
Classroom observations
Documents and researcher journal

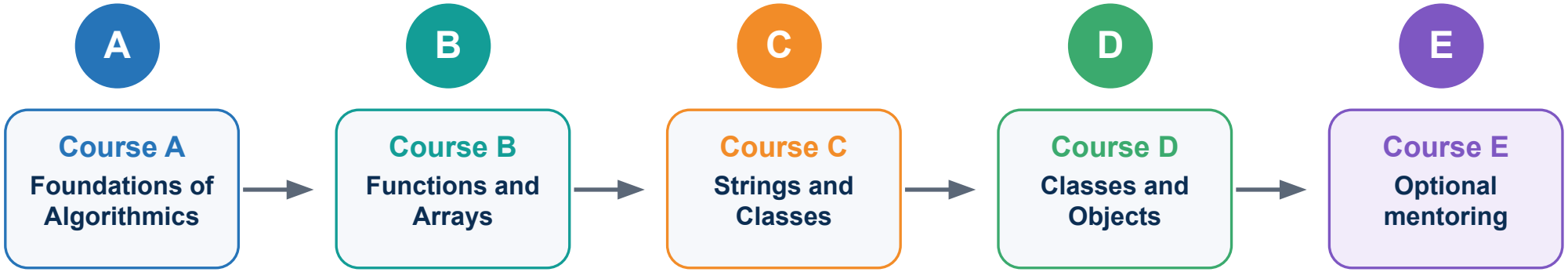
What happened after training?

Many teachers teach computer science as an additional subject, while still teaching their original subject for part of their teaching hours.

Analysis combined descriptive quantitative data with thematic qualitative analysis, comparing STEM and HASS teachers.

The Training Program Examined

A national program for preparing teachers to teach 3-unit high school computer science



Program structure

240 hours in four 60-hour courses
Increasing level of difficulty
Transition exam after each course; passing grade: 75

Pedagogical logic

Prior pedagogical knowledge served as a starting resource
CS content and technological knowledge were developed during training
The first year of teaching required continued support

The program was gradual, but STEM and HASS teachers experienced the transition differently.

Main Finding 1: Motivation Differs by Background - Eccles' lens

Analysis through Eccles' Expectancy-Value Theory

Eccles' lens | **Expectancy for Success** | **Task Value** | **Perceived Cost** | **Persistence**

	STEM teachers	HASS teachers
Expectancy for success	was grounded mainly in prior knowledge and proximity to scientific or technological thinking.	was built gradually through learner identity, persistence, and pedagogical confidence.
Task value	was mostly professional: expanding teaching opportunities and engaging with an intellectually interesting field.	was mainly identity-educational: accessibility, inclusion, and equal opportunity.
Cost	was mainly operational and cognitive: time, workload, logistics, and advanced content.	was broader: time, emotional effort, and identity vulnerability.

STEM teachers often entered through proximity to content
HASS teachers often entered through pedagogy, educational value, and persistence.

Main Finding 2: TPACK Develops Through Different Pathways

Analysis through the TPACK framework

TPACK lens | **CK** | **PK** | **TK** | **TPACK Integration**

	STEM teachers	HASS teachers
CK Content knowledge	Developed relatively quickly through proximity to mathematics, algorithms, or technology.	Developed gradually through practice, repetition, support, and success experiences.
PK Pedagogical knowledge	Helped organize prior knowledge into systematic computer science teaching.	Served as a central anchor and a compensatory resource for content and technology gaps.
TK Technological knowledge	Supported confidence, flexibility, and independent learning with tools and environments.	Began as a challenge and developed through guided practice and technical support.
TPACK Integration	Appeared as a didactic-technological expansion of an existing professional base.	Developed through gradual integration of new content and technology into an expanding teaching identity.

Same knowledge components. Different development pathways.

Pedagogical Capital as a Resource for HASS Teachers

A key contribution of the study: pedagogical strengths can support entry into CS teaching

What HASS teachers often brought

- Patience and sensitivity to learners
- Scaffolding and step-by-step explanations
- Differentiated teaching and alternative explanations
- A strong orientation toward inclusion and accessibility

What this helped them do

- Mediate unfamiliar CS concepts
- Break tasks into smaller learning steps
- Recognize students' confusion and respond calmly
- Build accessible learning paths for diverse students

Interpretation from the data

Because some HASS teachers experienced difficulty during the training, they often became especially attentive to students' difficulties in CS learning.

Pedagogical capital did not replace content knowledge, but it helped HASS teachers make computer science more accessible, gradual, and supportive for students.

Contribution Beyond This Study

The findings may inform future training programs when new technological school subjects emerge

- The study:

- provides a framework for designing computer science teacher training.
- shows that teacher background shapes motivation, perceived cost, &professional knowledge development.
- treats disciplinary diversity as a design principle, not only as a recruitment solution.
- highlights the role of pedagogical capital as a resource, especially among HASS teachers.

Future relevance

If a new technological school subject is introduced and teachers need to be retrained, the study suggests planning differentiated pathways from the beginning.

Example: if a new subject such as AI Science is introduced, STEM and HASS teachers should not necessarily be trained through the same pace, structure, and support model.

The Central Finding: Two Pathways into CS Teaching

Both groups can teach computer science, but they need different emphases, pace, and support

STEM pathway

Based on prior content or technological proximity

Faster development of CK and TK

Main need: didactic translation of existing knowledge

Professional expansion into CS teaching

Different strengths
Different needs
Same goal

HASS pathway

Based on pedagogical identity and persistence

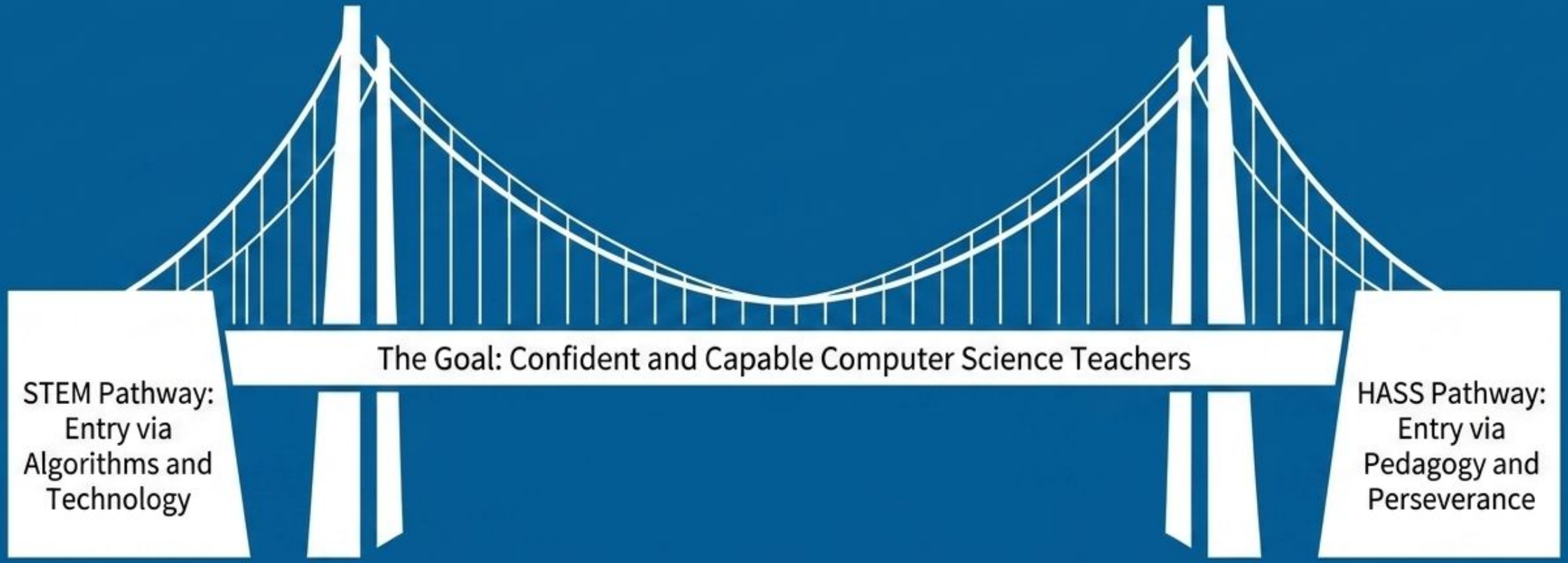
Gradual development of CK and TK

Main need: scaffolding, practice, and support

Expansion of teaching identity into a technological field

The difference between pathways is not a hierarchy. it points to the need for different training routes.

Two Pathways for Computer Science Teaching



Implications for CS Teacher training

Design principles derived from the findings

1 Map the starting point	2 Differentiate the pathway	3 Sustain support
- Disciplinary background	- Modular learning	- Accessible materials
- Prior CK, PK, and TK	- Different pace when needed	- Technical and pedagogical help
- Motivational profile	- CS-specific pedagogy	- Mentoring in the first year
- Perceived barriers	- Meaningful classroom tasks	- Professional community

In terms of Eccles:

strengthen expectancy for success, increase task value, and reduce perceived cost.

In terms of TPACK:

support the integrated development of content, pedagogy, and technology in the context of actual CS teaching.

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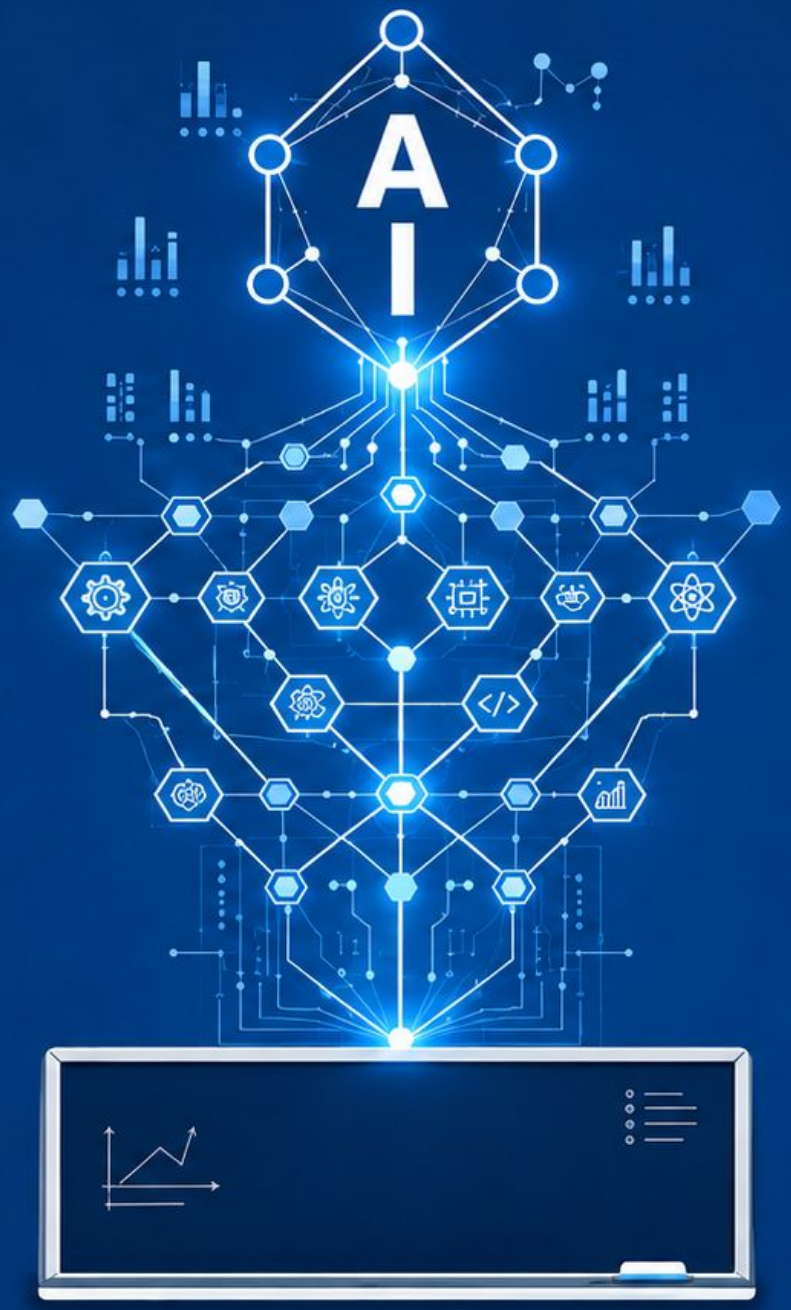

Beyond Computer Science

Preparing teacher training for future technological subjects

The findings may inform teacher training when new technological school subjects emerge.

1. **Map teachers' starting points**
   Prior disciplines, strengths, barriers, and support needs.

2. **Build differentiated pathways**
   Do not assume one pace, one structure, or one support model.

3. **Design from the beginning**
   Differentiation should be planned before the program starts.

Example: future training for AI-related school subjects should consider STEM and HASS teachers' different starting points.

Take-Home Message

Training teachers to teach computer science as an additional subject should not be one-size-fits-all.

STEM teachers and HASS teachers can both enter CS teaching.

They need different pathways, training emphases, and support.

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Thank you.

Questions? Comments?

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