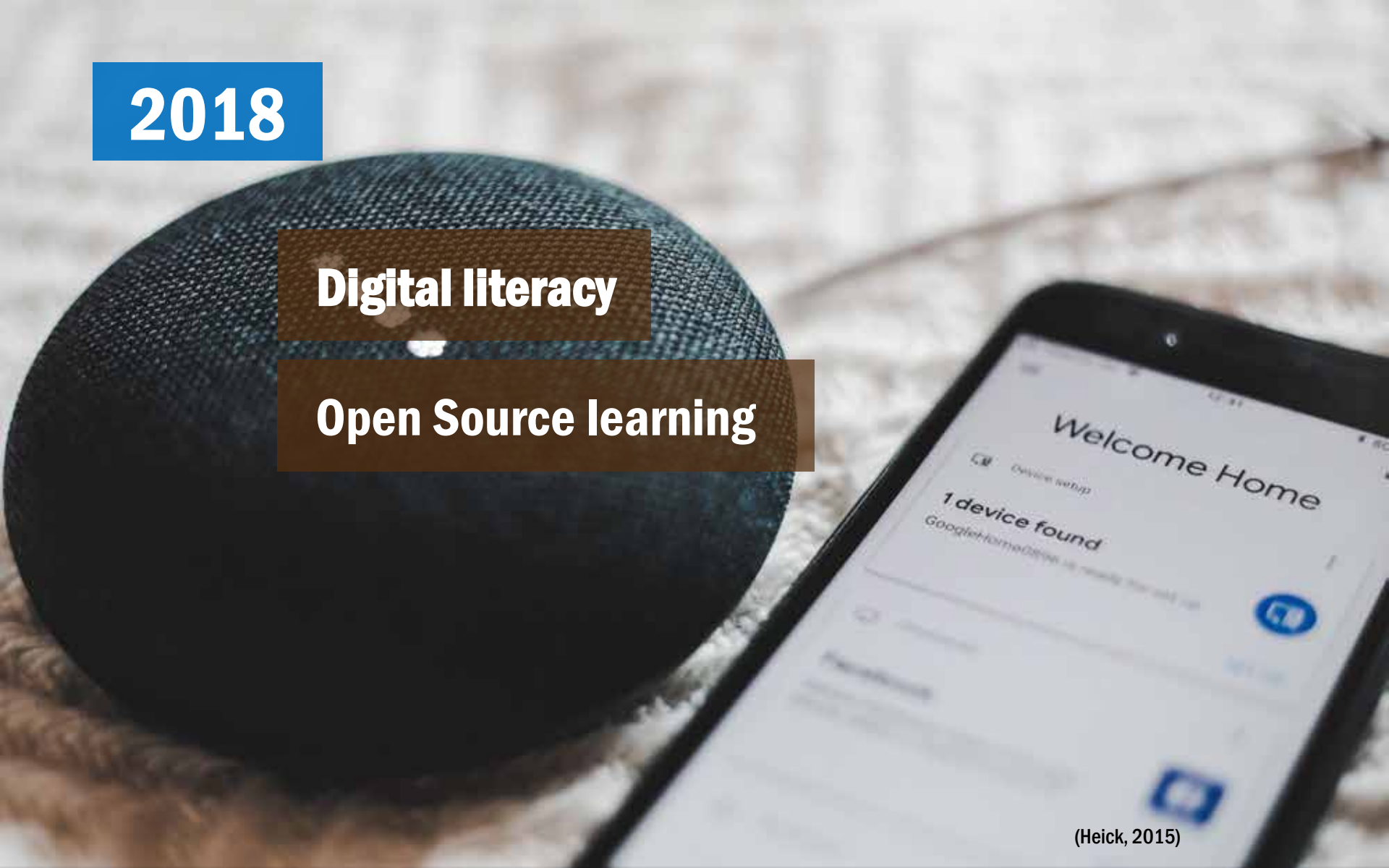
UiO : CEMO – Centre for Educational Measurement
University of Oslo

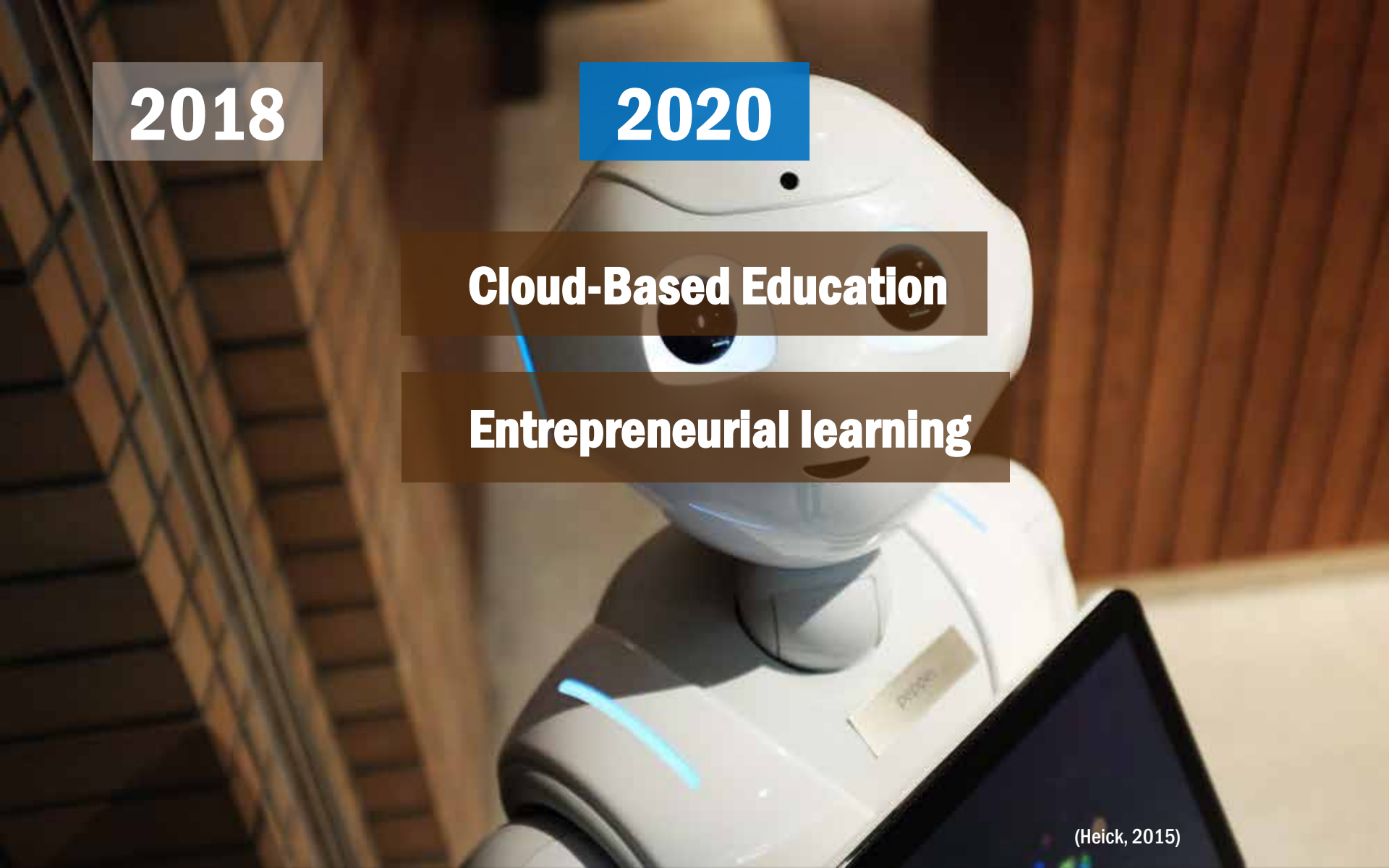
# Technology in Classrooms—
# Determinants and Consequences of Technology Integration

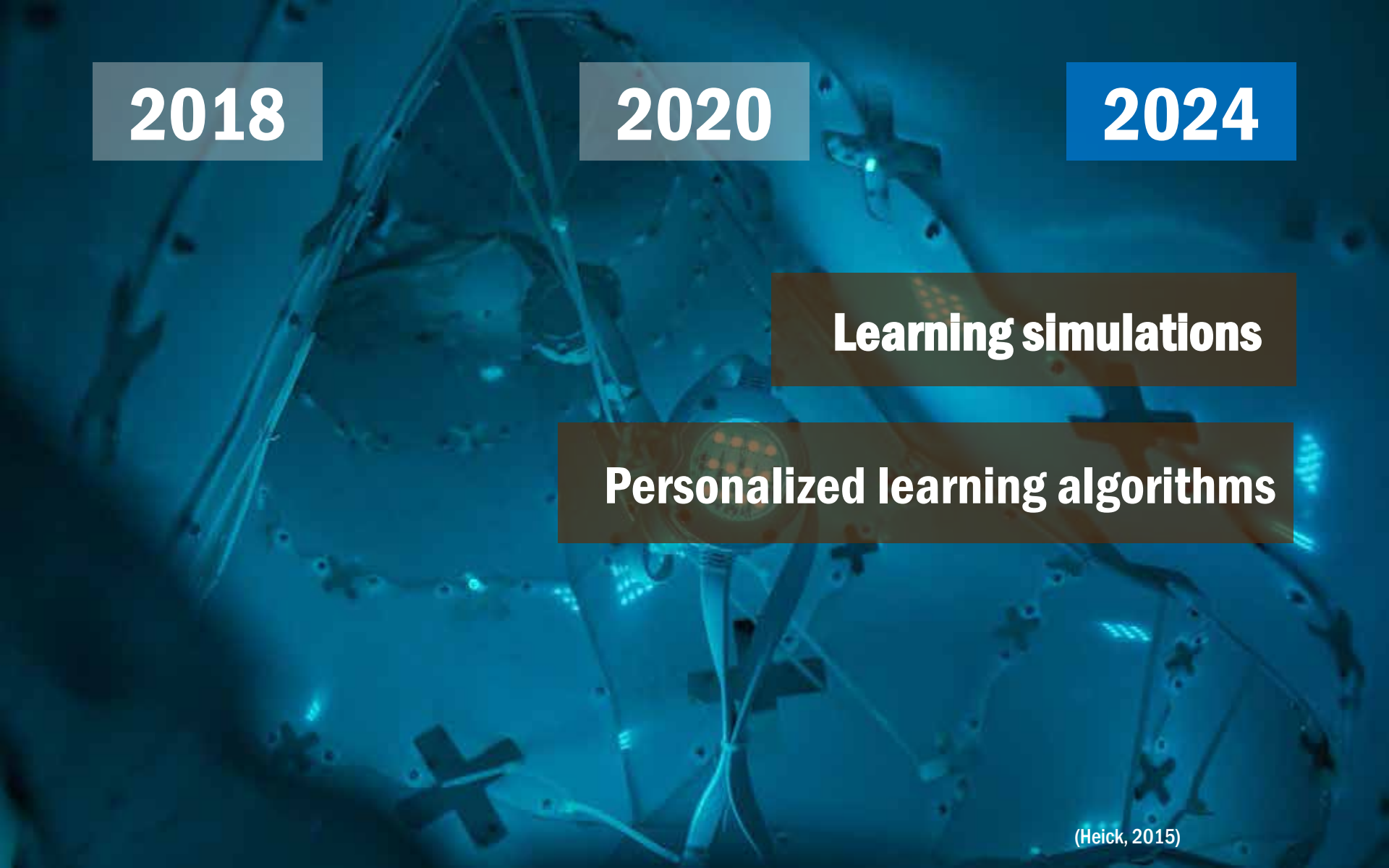
Ronny Scherer

Fachtagung IWM #Learnmap
Tübingen, 12 October 2018


2018
Digital literacy
Open Source learning
Welcome Home
1 device found

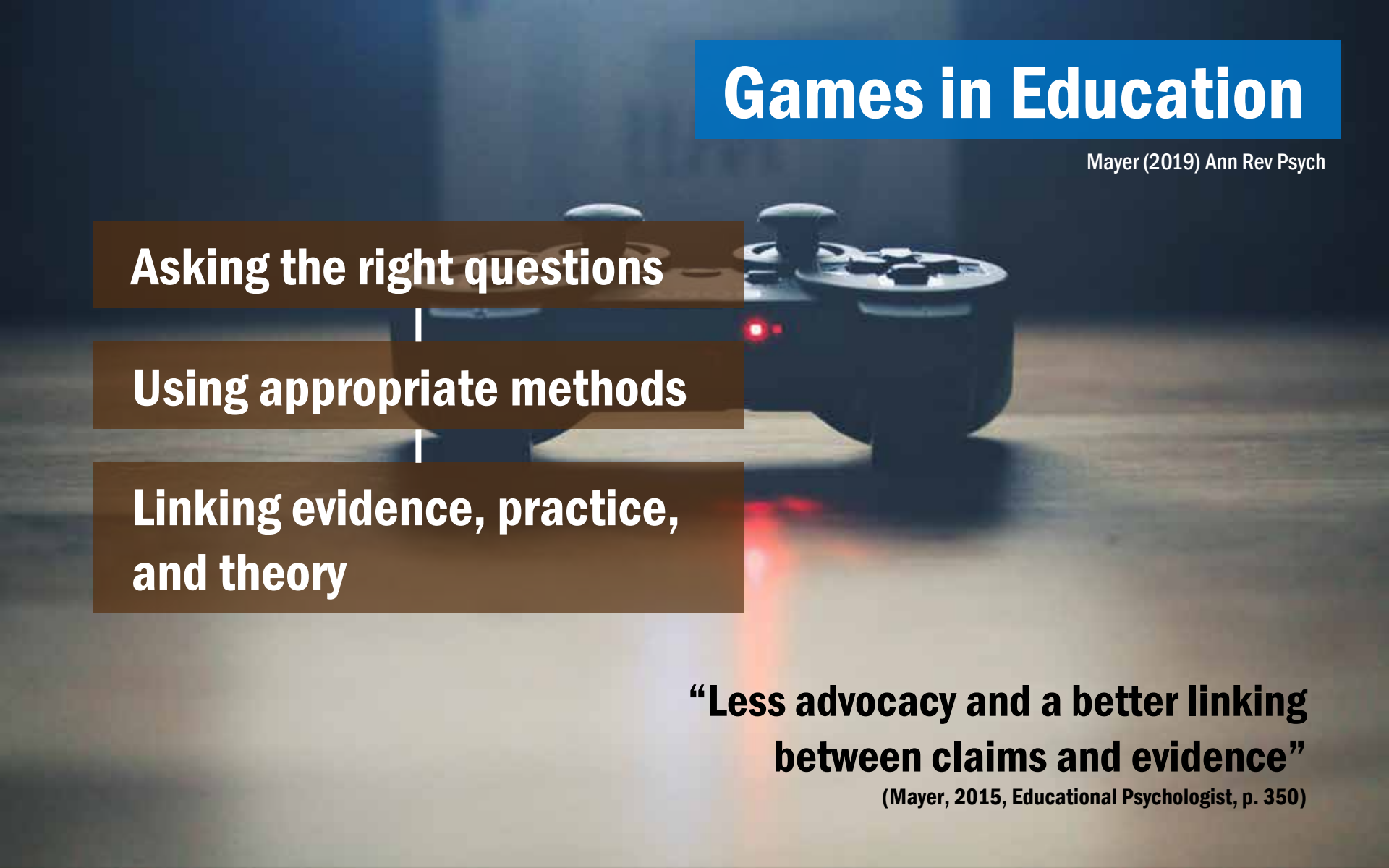
(Heick, 2015)


2018
2020
Cloud-Based Education
Entrepreneurial learning
(Heick, 2015)


2018
2020
2024
Learning simulations
Personalized learning algorithms
(Heick, 2015)

# Games in Education

Mayer (2019) Ann Rev Psych



**Asking the right questions**

**Using appropriate methods**

**Linking evidence, practice, and theory**

**“Less advocacy and a better linking between claims and evidence”**

**(Mayer, 2015, Educational Psychologist, p. 350)**

The Forgotten...
Debunking myths...
Challenging claims...

The Forgotten...

# Technology in Education

**Technology** is just a tool. In terms of getting the kids working together and motivating them, the **teacher** is the most important.

# Technology Acceptance

Behavioral intention (BI)
Technology use (USE)

**Outcome variables**

## Key factors

Perceived ease of use (PEOU)
Perceived usefulness (PU)
Technology attitudes (ATT)

**Mediating variables**

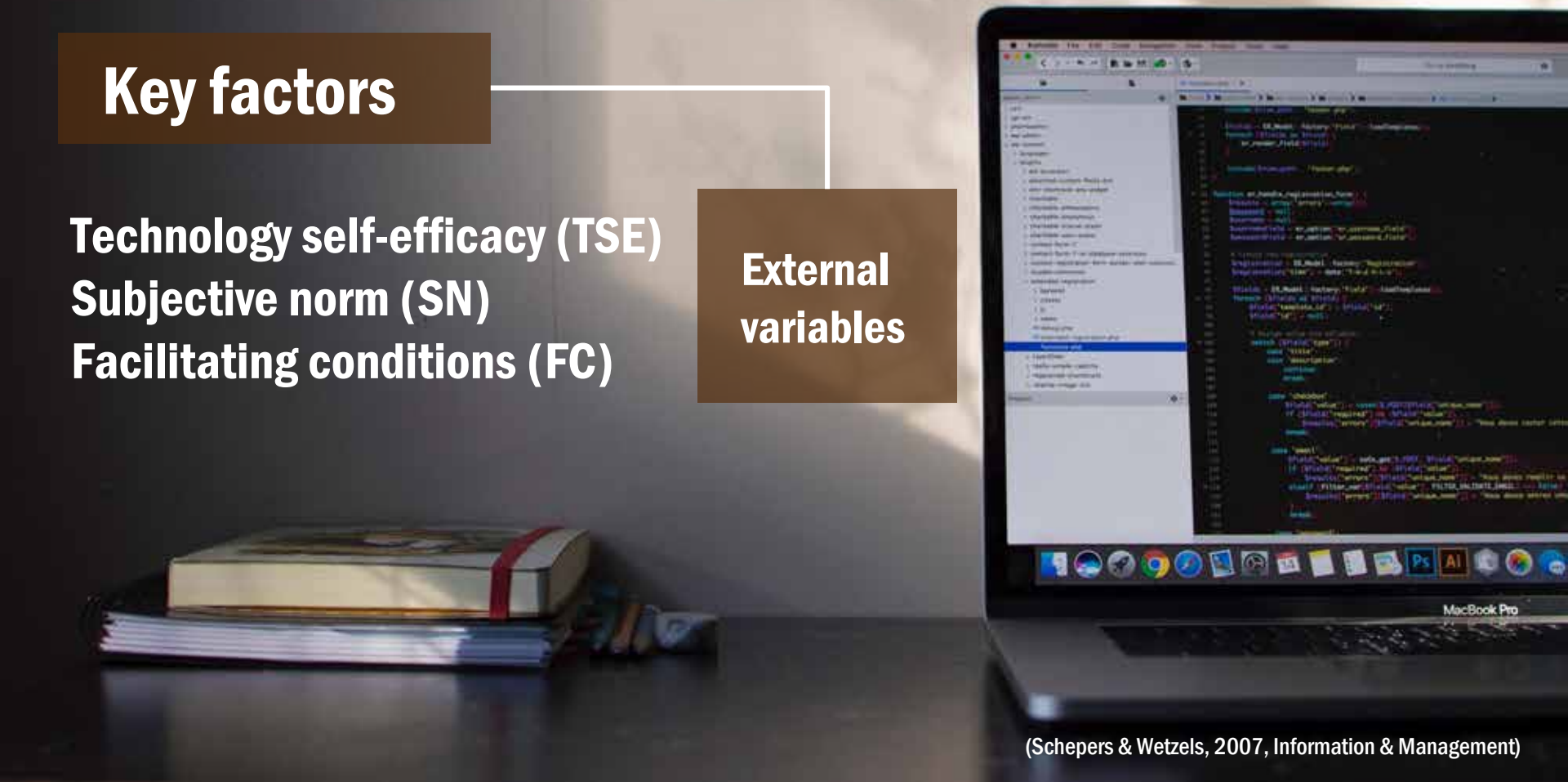
(Davis, 1989, MIS Quartely)

# Technology Acceptance

## Key factors

Technology self-efficacy (TSE)
Subjective norm (SN)
Facilitating conditions (FC)

**External variables**




(Schepers & Wetzels, 2007, Information & Management)

# Technology Acceptance

## Effects

**Between-sample variation in effects**

**Technology acceptance**

↓

**Behavioral intentions**

↓ ?

**Technology use**

?

**Diverse findings**

**Direct effect on tech use**

**BI-USE link**

(King & He, 2006; Schepers & Wetzels, 2007, Inf & Man)

# Meta-Analysis

## Method

Scherer et al. (2019) Comp & Educ

Initial search (n=2239)

↓

Initial screening (n=1826)

↓

Fine screening (n=363)

→

Coding (n=114)

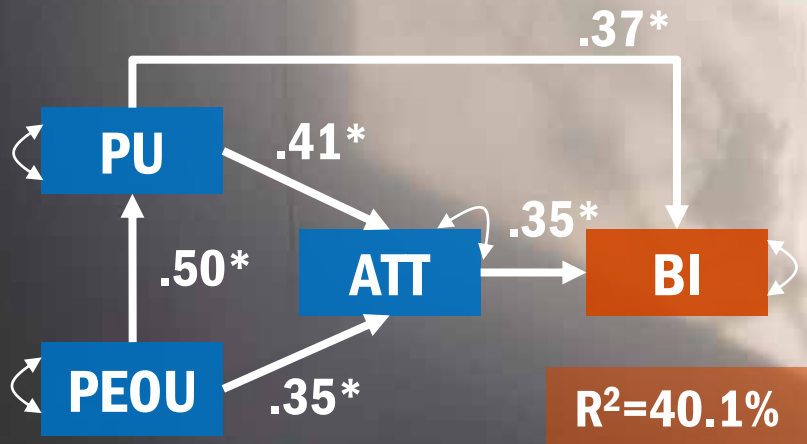
Teacher samples
Quantitative, > 2 variables
Positive definiteness

34357 teachers
1098 correlations
124 corr. matrices
8 TAM variables

# Technology Acceptance Model

## Effects of mediators

# Results




**Positive and significant effects on use intentions**

**Model fit**

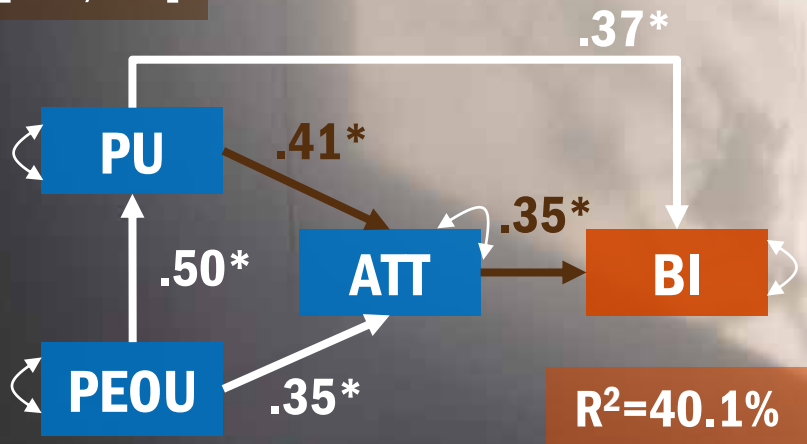
$\chi^2(1)=13.9$, $p<.01$, CFI=.982, RMSEA=.019

# Technology Acceptance Model

## Effects of mediators

# Results

**Indirect effect**
B=.14, 95% CI [.11,.18]




**Positive and significant effects on use intentions**

**Model fit**
$\chi^2(1)=13.9$, $p<.01$, CFI=.982, RMSEA=.019

# Technology Acceptance Model

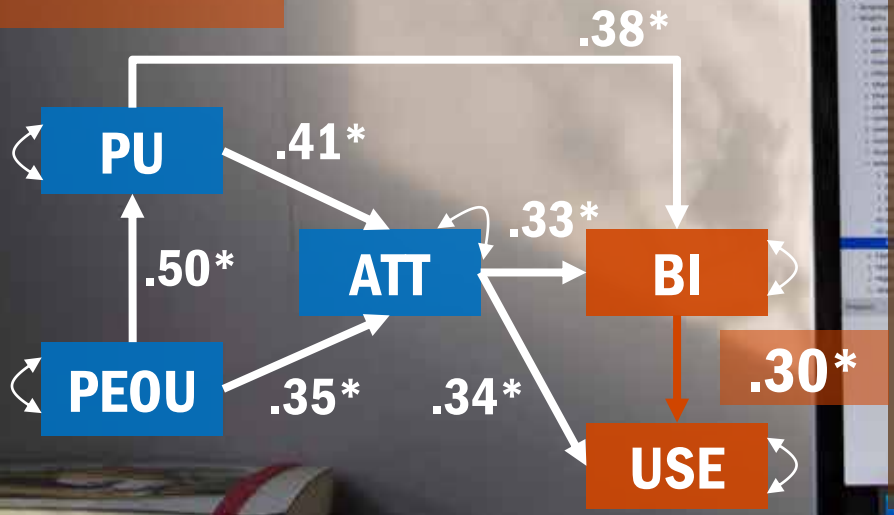
## The BI-USE link

# Results

**Moderation by experience and technology**

**In-service**
**B=.24***
**Pre-service**
**B=.40***

**General**
**B=.45***
**Specific**
**B=.24***



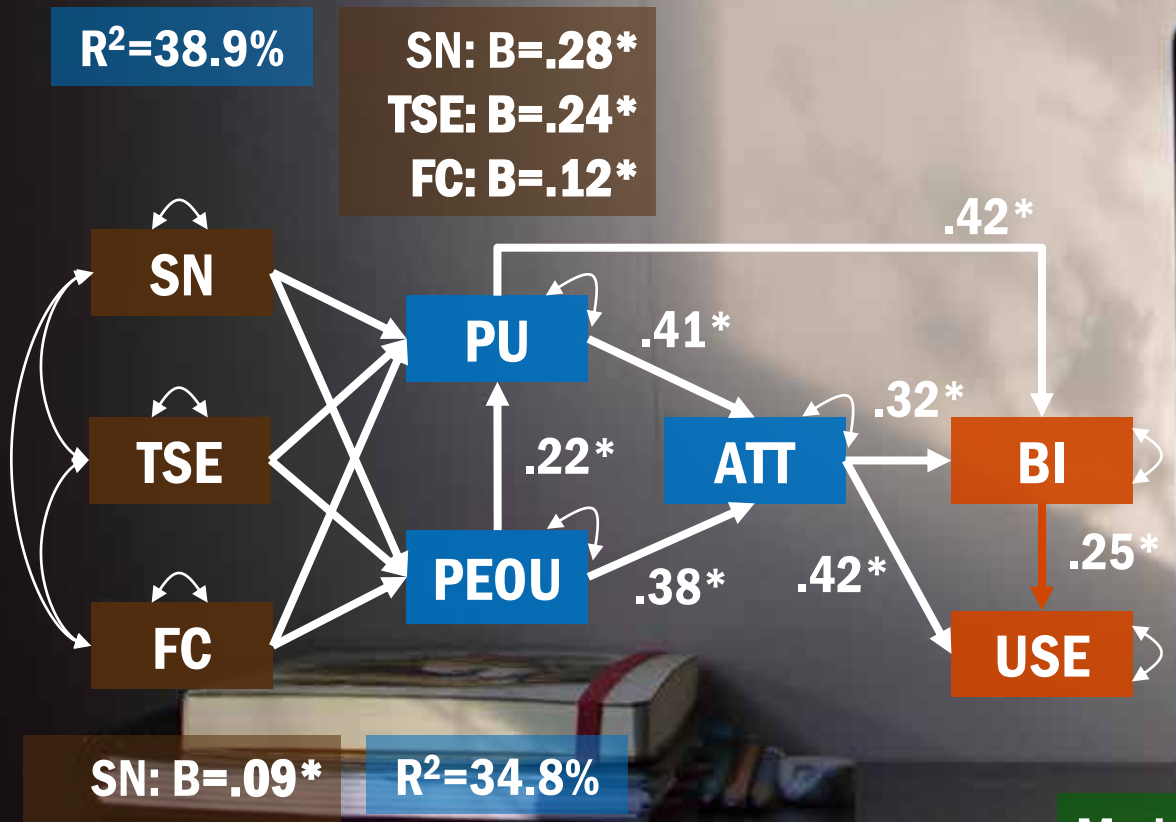

**Positive and significant link between intentions and use**

$R^2$=31.1%

**Model fit**
$\chi^2(3)=19.6$, $p<.01$, CFI=.996, RMSEA=.016

# Technology Acceptance Model

# Results




Positive and significant effects of external variables

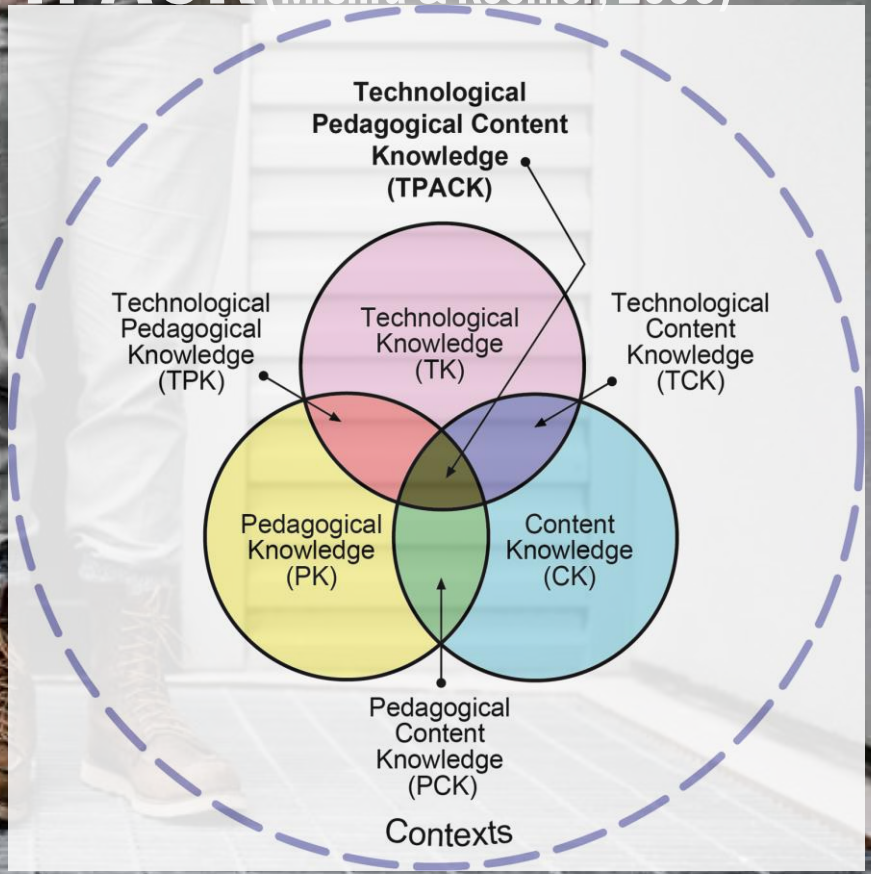
**Model fit**

$\chi^2(12)=129.8$, $p<.01$, CFI=.982, RMSEA=.017

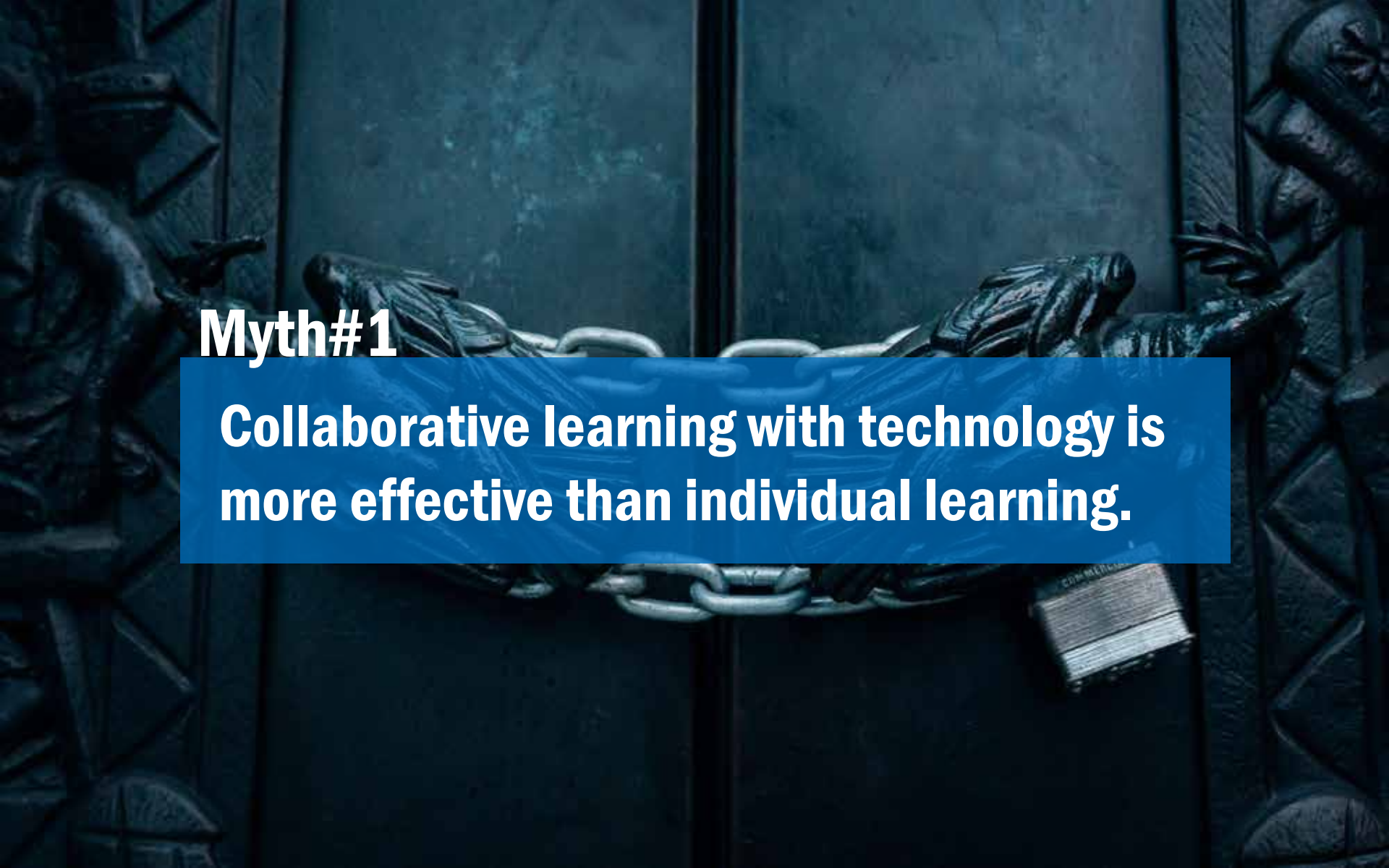
So what?
Complexity
Importance of beliefs
Weak BI-USE link

# What's next?

## TPACK (Mishra & Koehler, 2006)

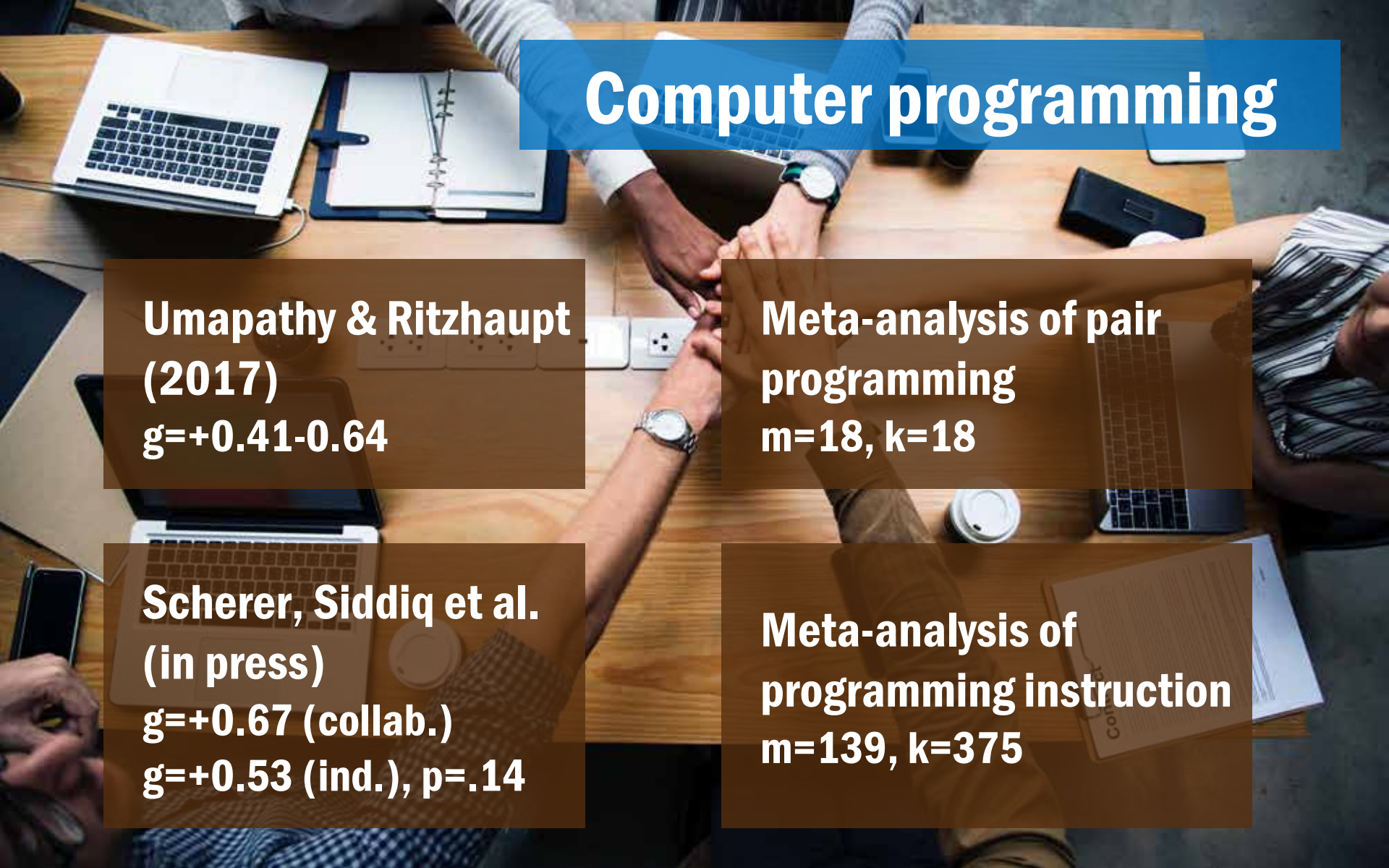


# Debunking myths...



## Myth#1

**Collaborative learning with technology is more effective than individual learning.**



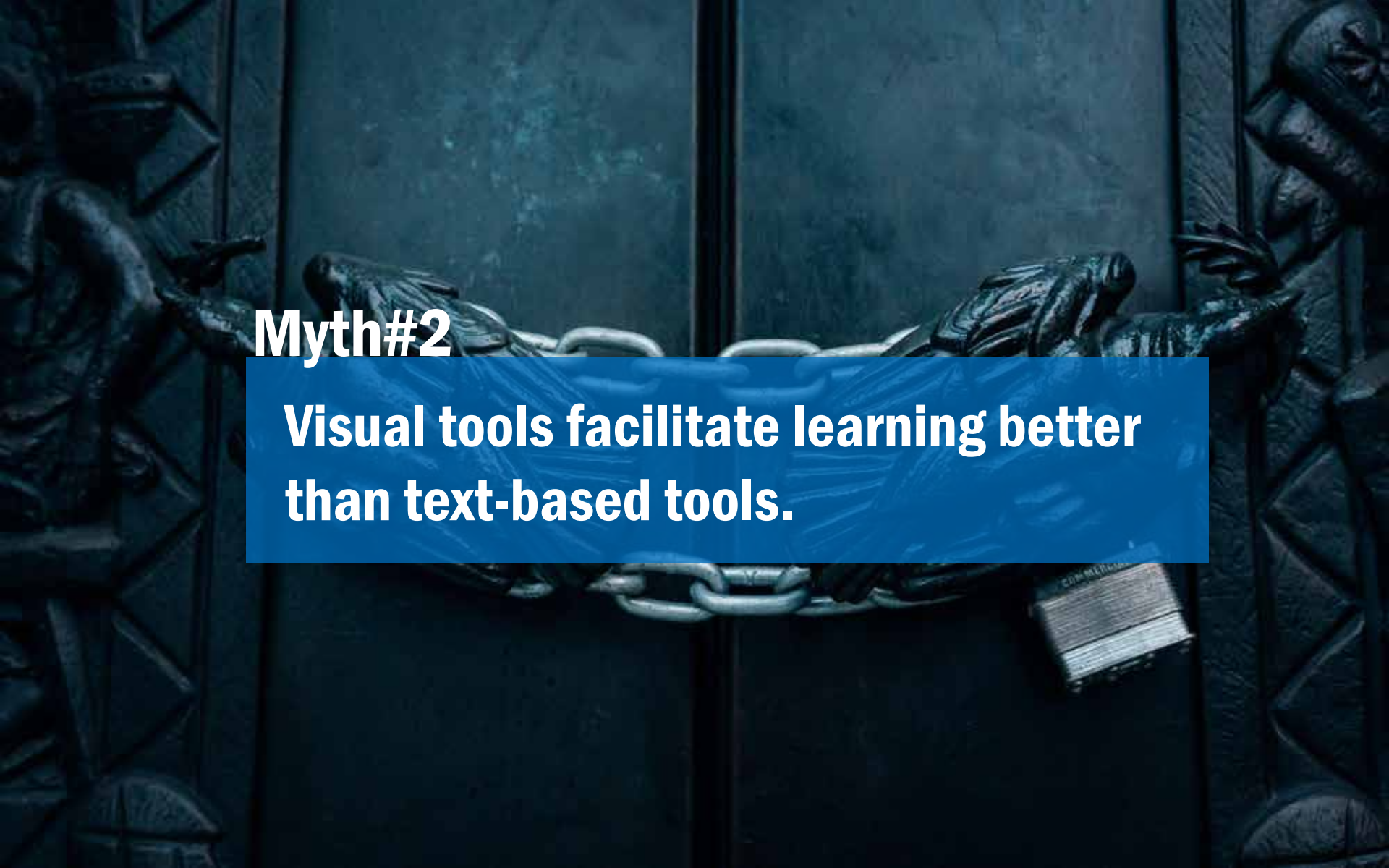
# Computer programming

**Umapathy & Ritzhaupt (2017)**
**g=+0.41-0.64**

**Meta-analysis of pair programming**
**m=18, k=18**

**Scherer, Siddiq et al. (in press)**
**g=+0.67 (collab.)**
**g=+0.53 (ind.), p=.14**

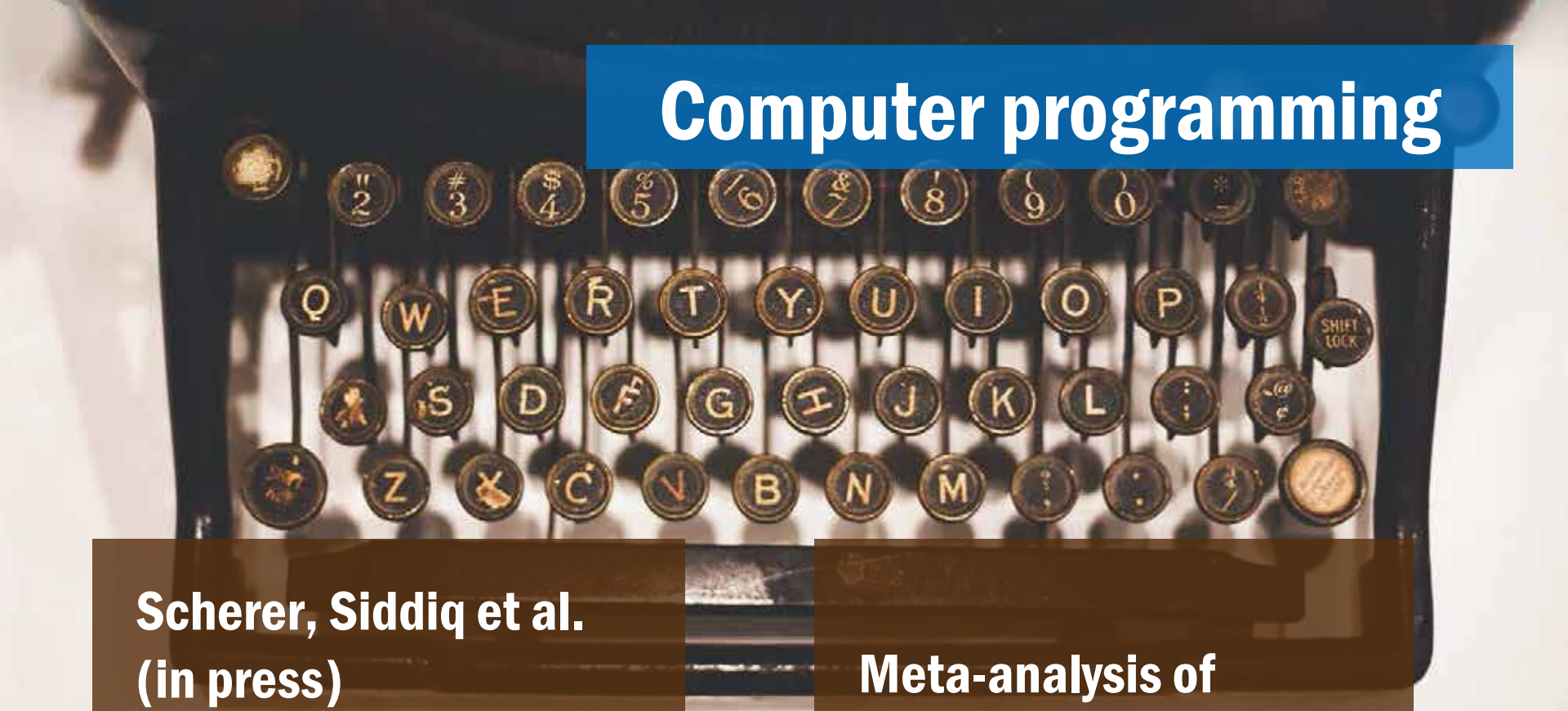
**Meta-analysis of programming instruction**
**m=139, k=375**



## Myth#2

**Visual tools facilitate learning better than text-based tools.**

# Computer programming

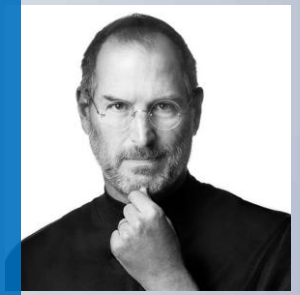



**Scherer, Siddiq et al. (in press)**
**g=+0.58 (visual)**
**g=+0.63 (text)**
**g=+0.40 (mixed), p=.38**

**Meta-analysis of programming instruction**
**m=139, k=375**

Challenging claims...
MacBook Pro

**Everybody in this country should learn how to program a computer… because it teaches you how to think.**



Learning to write programs stretches your mind, and helps you think better, creates a way of thinking about things that I think is helpful in all domains.

# Computational thinking

## Problem solving

Decomposition
Abstraction
Algorithms
Debugging
Iteration
Generalization

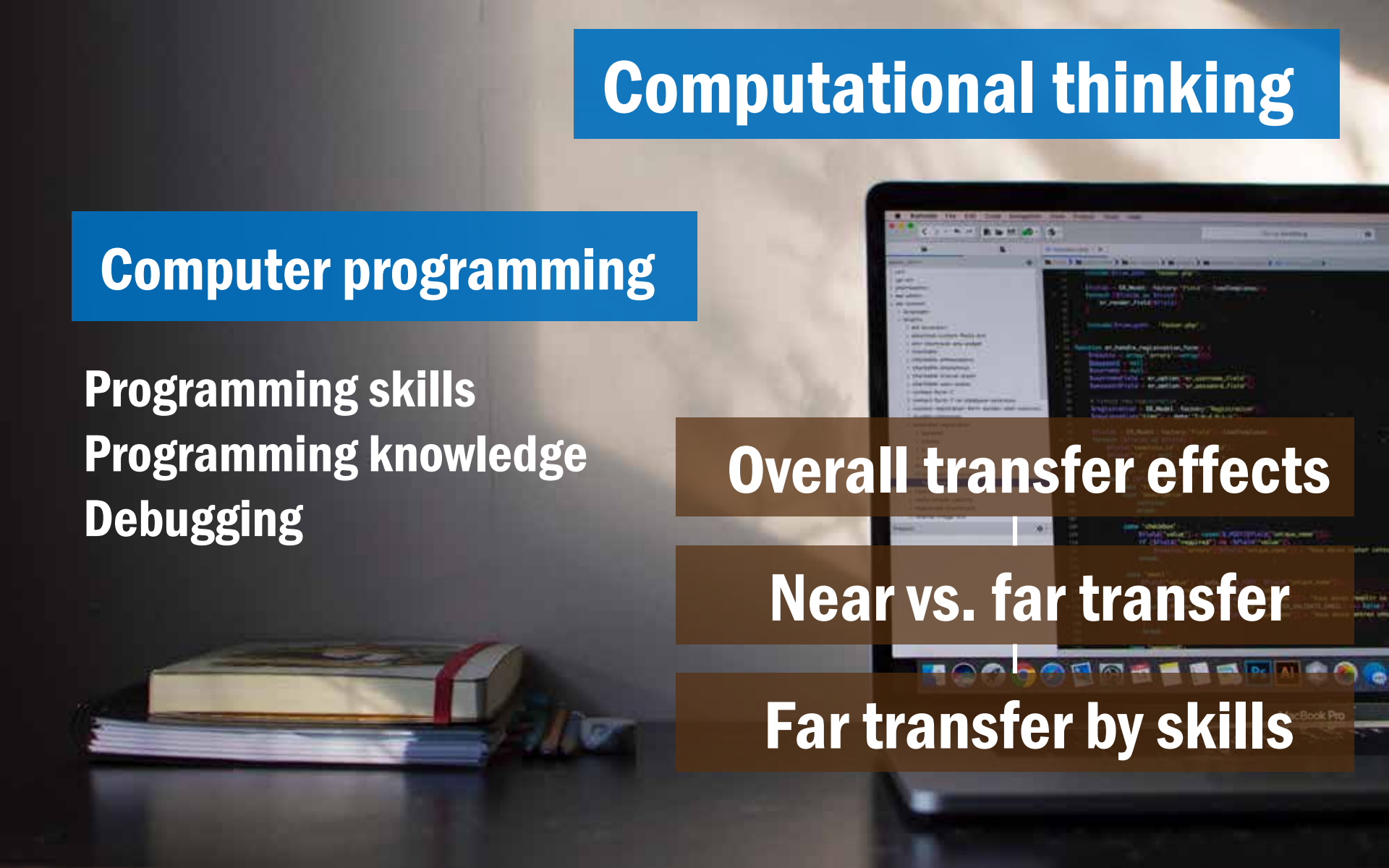
- Computational concepts
- Computational practices
- Computational perspectives

(Grover & Pea, 2013; Lye & Koh, 2014; Shute et al., 2017)

# Computational thinking

## Computer programming

Programming skills
Programming knowledge
Debugging



Overall transfer effects

Near vs. far transfer

Far transfer by skills

# Meta-Analysis

## Method

Initial search
(n=5193)

Initial screening
(n=708)

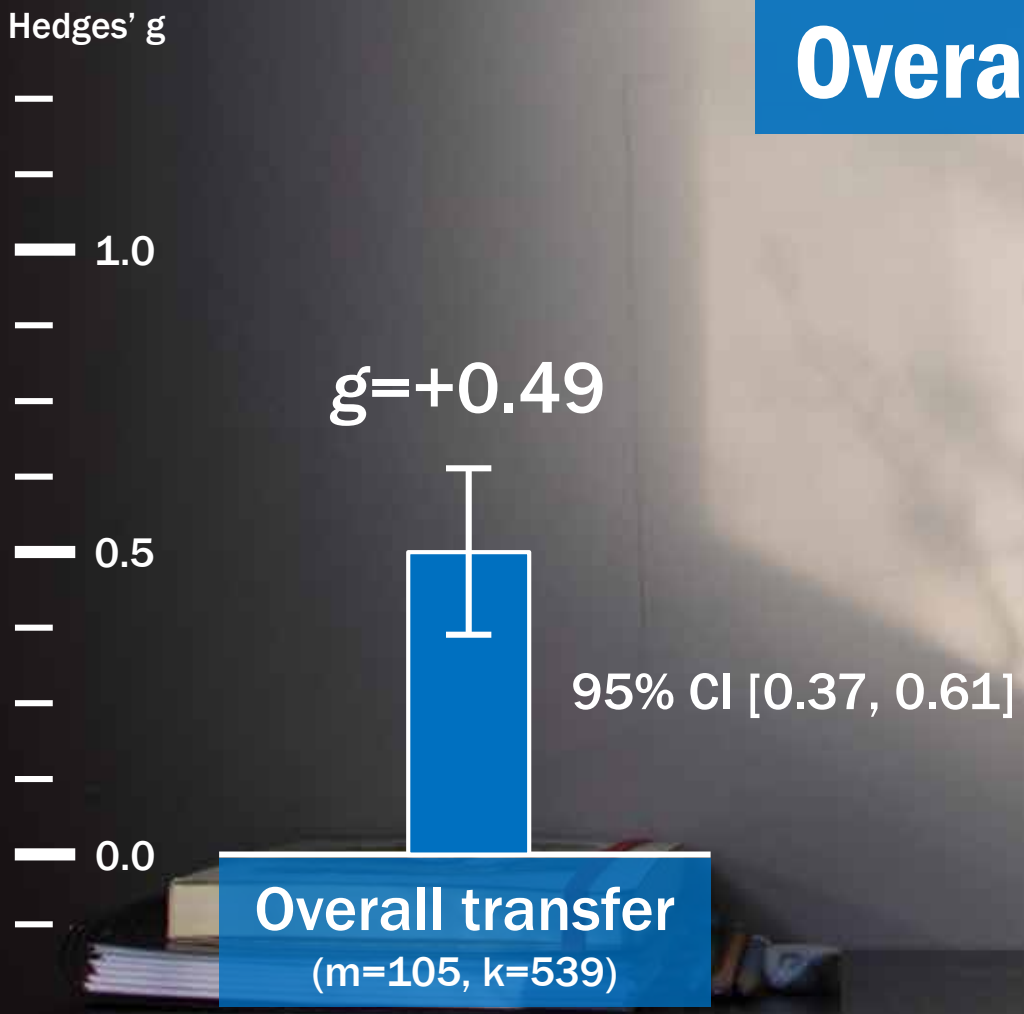
Fine screening
(n=440)

Coding
(n=105)

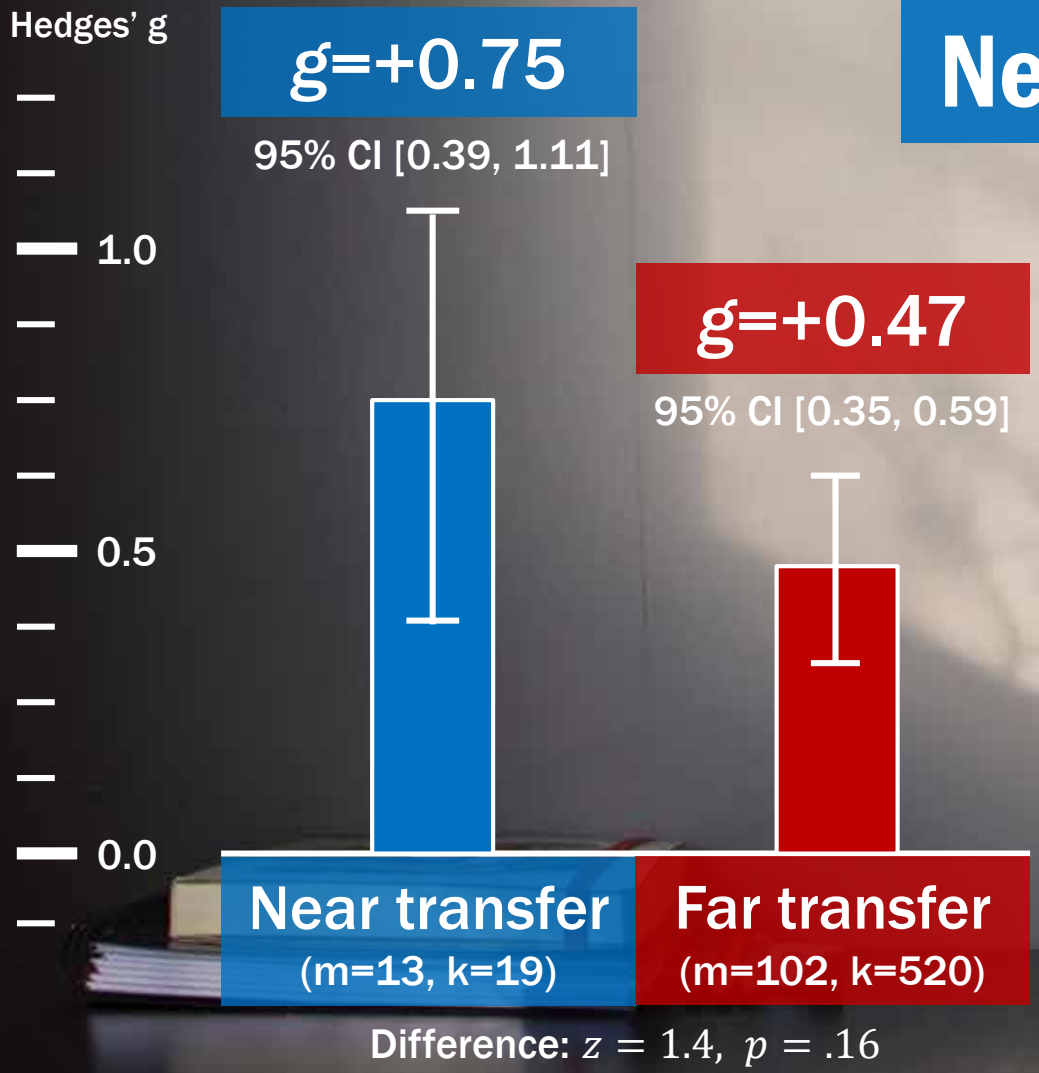
(Quasi-)experimental
Control groups
Cognitive skills

9139 students
539 effect sizes
105 studies
8 cognitive skills

# Overall Transfer Effects



# Near vs. Far Transfer




**Difference:** $z = 1.4,\ p = .16$

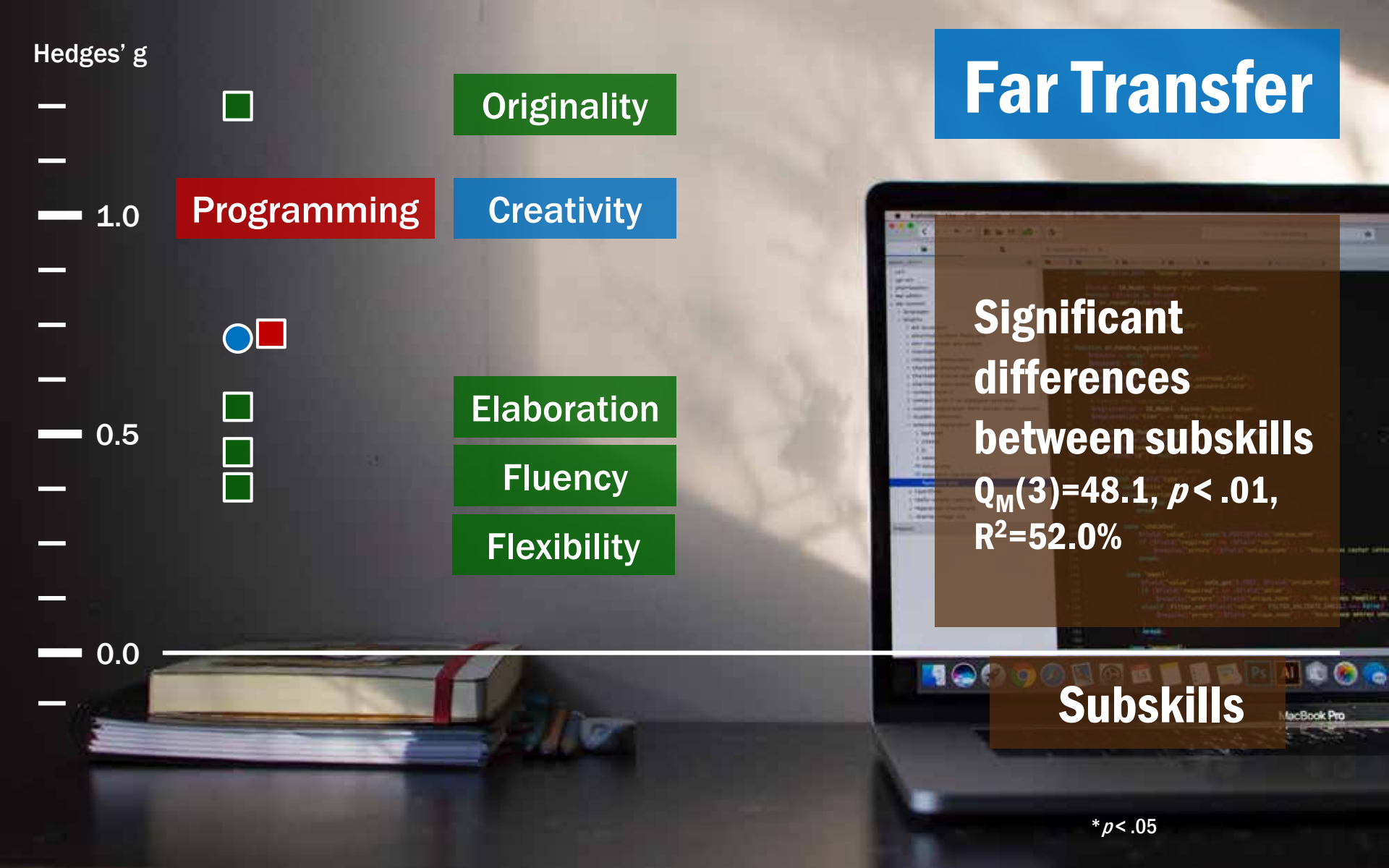
# Far Transfer

**Programming as a creative process producing computational artifacts**

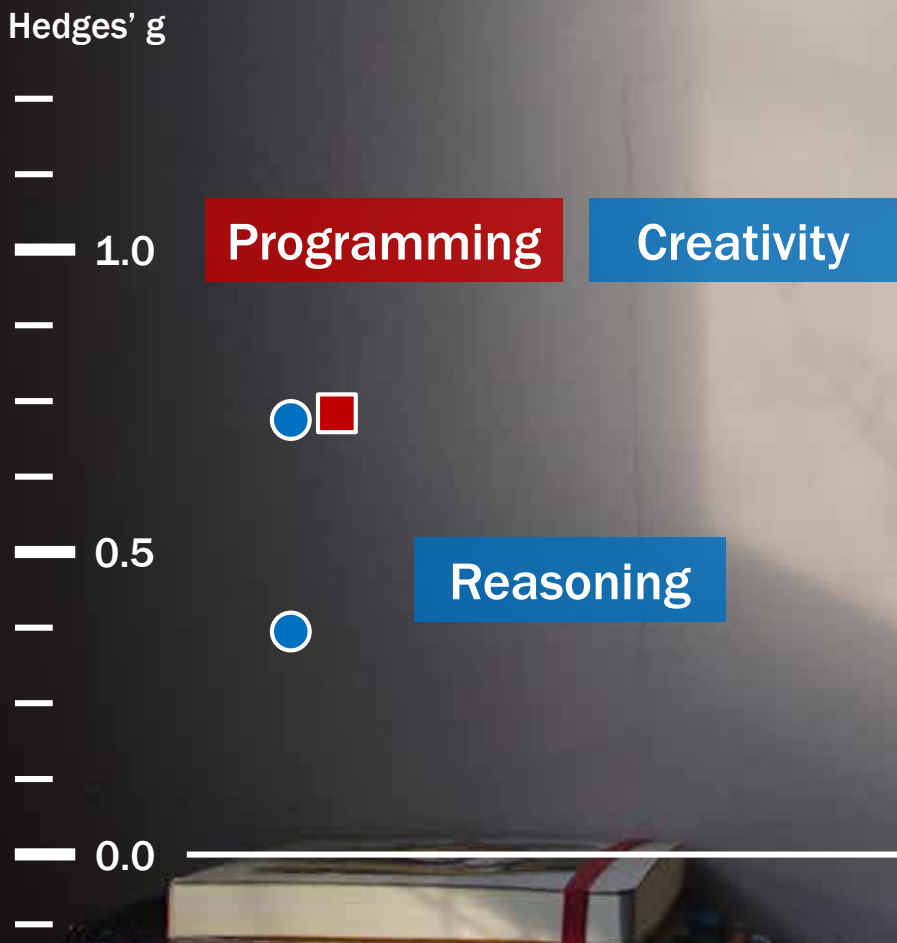
(Grover & Pea, 2013)

**Summary**

$^{*}p < .05$


Hedges' g
1.0
0.5
0.0
Originality
Programming
Creativity
Elaboration
Fluency
Flexibility
Far Transfer
Significant differences between subskills
$Q_M(3)=48.1$, $p < .01$, $R^2=52.0\%$
Subskills
* $p < .05$

# Far Transfer

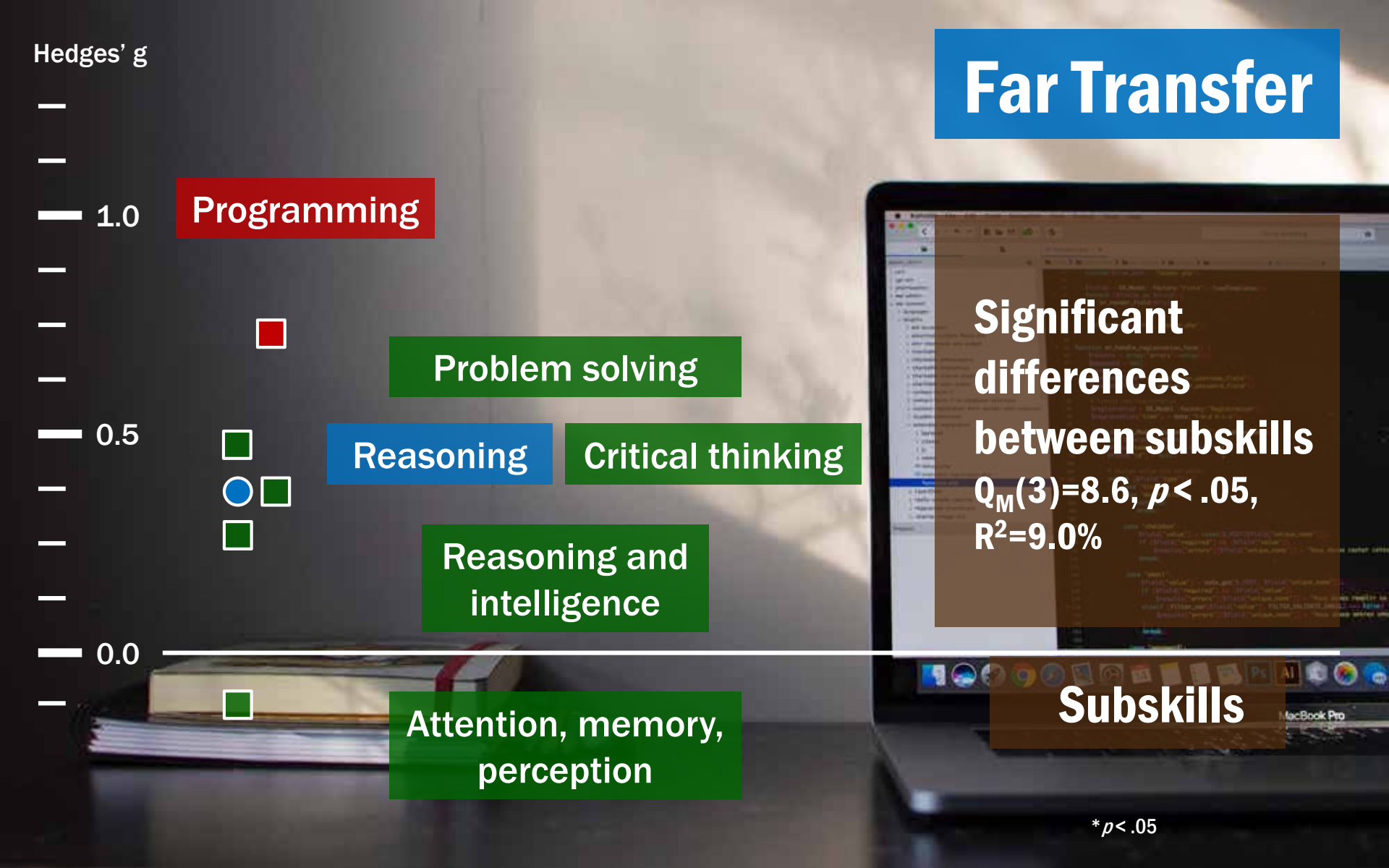



**Programming as a process of problem solving and modeling**

(Shute et al., 2017; Scherer, 2016)

**Summary**

* $p < .05$


Hedges' g
1.0
0.5
0.0
Programming
Problem solving
Reasoning
Critical thinking
Reasoning and intelligence
Attention, memory, perception
Far Transfer
Significant differences between subskills
$Q_M(3)=8.6$, $p < .05$, $R^2=9.0\%$
Subskills
* $p < .05$

# Far Transfer

Programming

Creativity

Mathematical skills

Metacognition

Reasoning

Spatial skills

Achievement

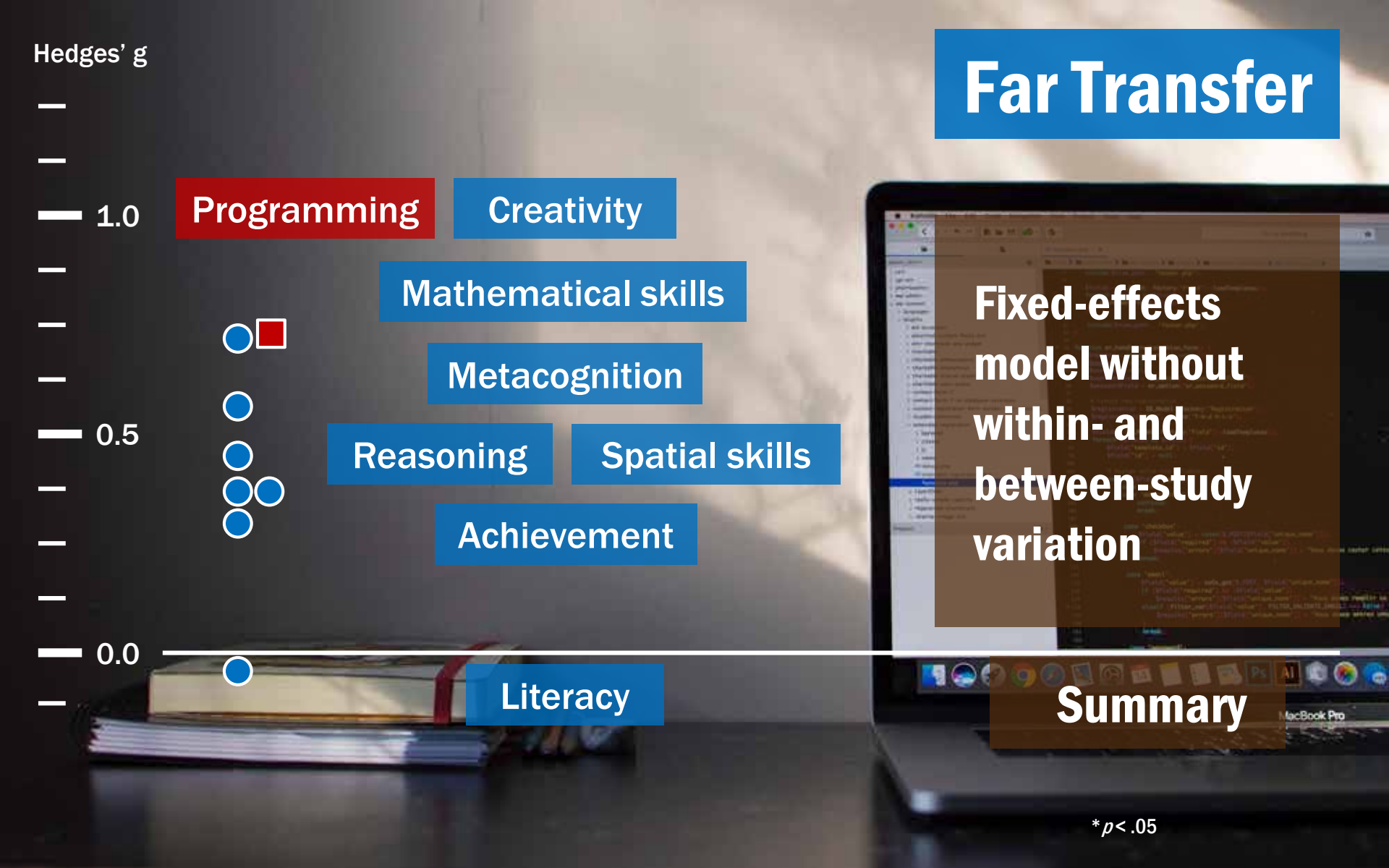
**Programming as a process of problem solving and modeling**

(Shute et al., 2017; Scherer, 2016)

**Summary**

* $p < .05$

# Far Transfer




Fixed-effects model without within- and between-study variation

Summary

* $p < .05$

# Far Transfer

Programming

Creativity

Mathematical skills

Metacognition

Reasoning

Spatial skills

Achievement

Literacy

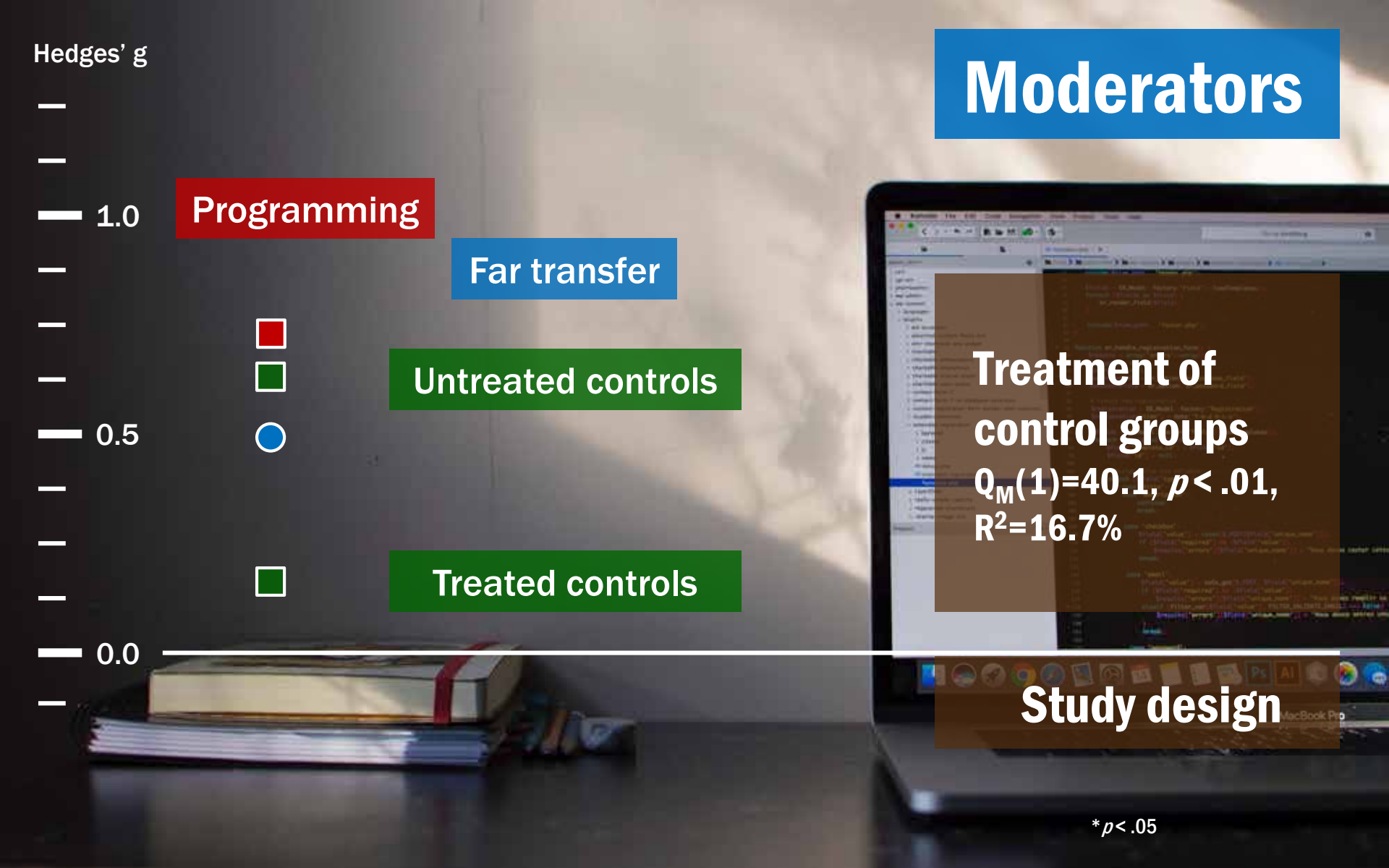
**Significant differences between skills measures**

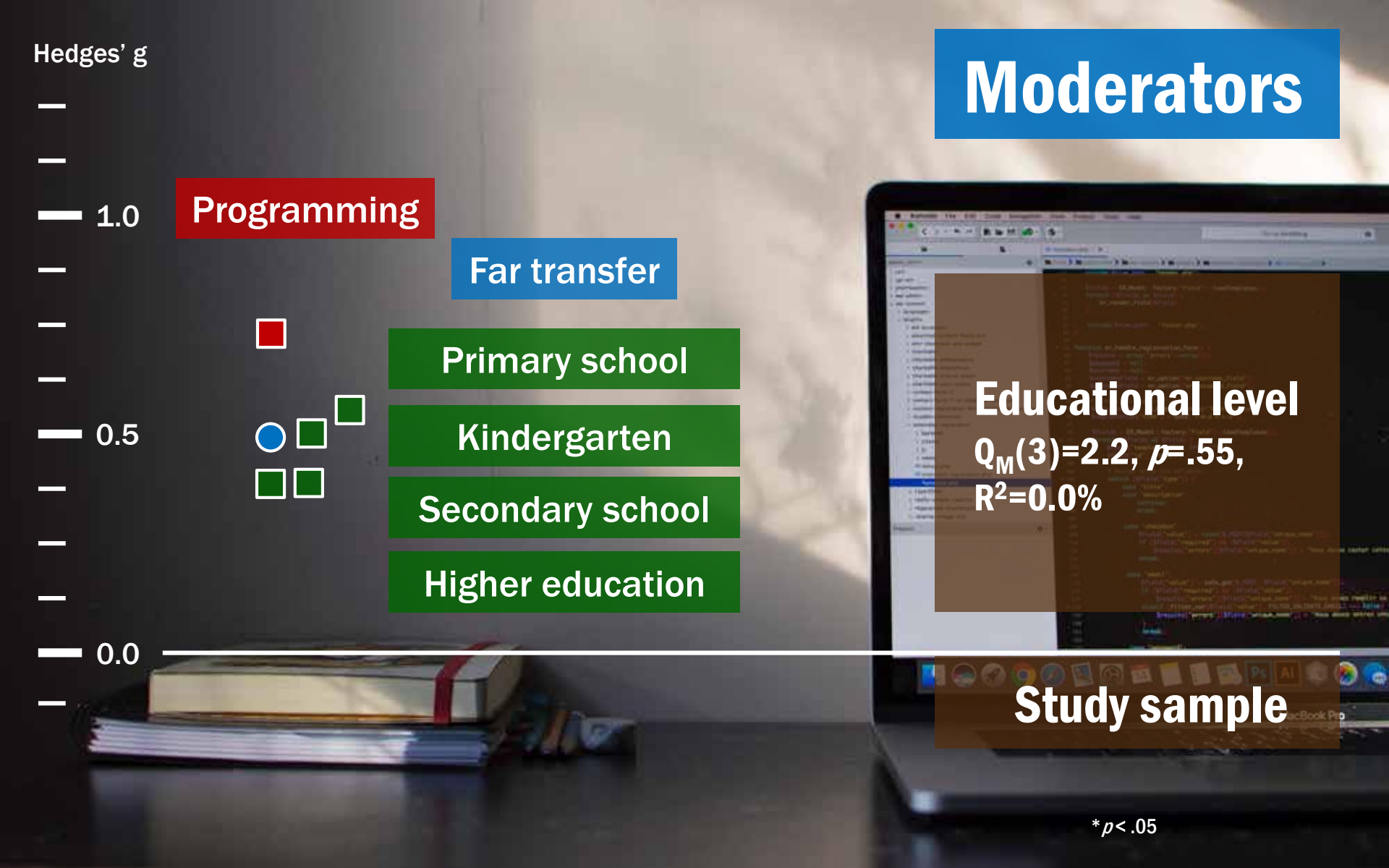
$\chi^2(1) = 13.6^*$

$\sigma_4^2 = 0.045$

**Summary**

$^*p < .05$


Hedges' g
1.0
0.5
0.0
Programming
Far transfer
Untreated controls
Treated controls
Moderators
Treatment of control groups
$Q_M(1)=40.1$, $p < .01$, $R^2=16.7\%$
Study design
* $p < .05$


Hedges' g
1.0
0.5
0.0
Programming
Far transfer
Primary school
Kindergarten
Secondary school
Higher education
Moderators
Educational level
$Q_M(3)=2.2$, $p=.55$,
$R^2=0.0\%$
Study sample
* $p < .05$

# Issues

## Study designs

- Lack of baseline measure
- Treated vs. untreated controls
- Pre- and post-measures
- Measurement issues

So what?
Positive transfer effects
Creativity & problem solving
Need for good studies

# In essence...

- Replicate
- Analyze
- Contextualize
- Explain
- Integrate

- Asking the right questions
- Using appropriate methods
- Linking evidence, practice, and theory

Mayer (2019) Ann Rev Psych

**“Less advocacy and a better linking between claims and evidence”**

**(Mayer, 2015, Educational Psychologist, p. 350)**

Thank you!
PASSION LED US HERE

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# Citation

## Please cite this presentation as follows:

Scherer, R. (2018, October 11-12). Determinants and consequences of technology integration in classrooms: Between technology acceptance and twenty-first century skills. Paper presented at the Fachtagung IWM #Learnmap, Tübingen, Germany [Keynote talk].