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Critical Issues in STEM Education: Research on Effective STEM Teachers and Teaching

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RUSMP Spring Networking Conference

The Rice School/La Escuela Rice

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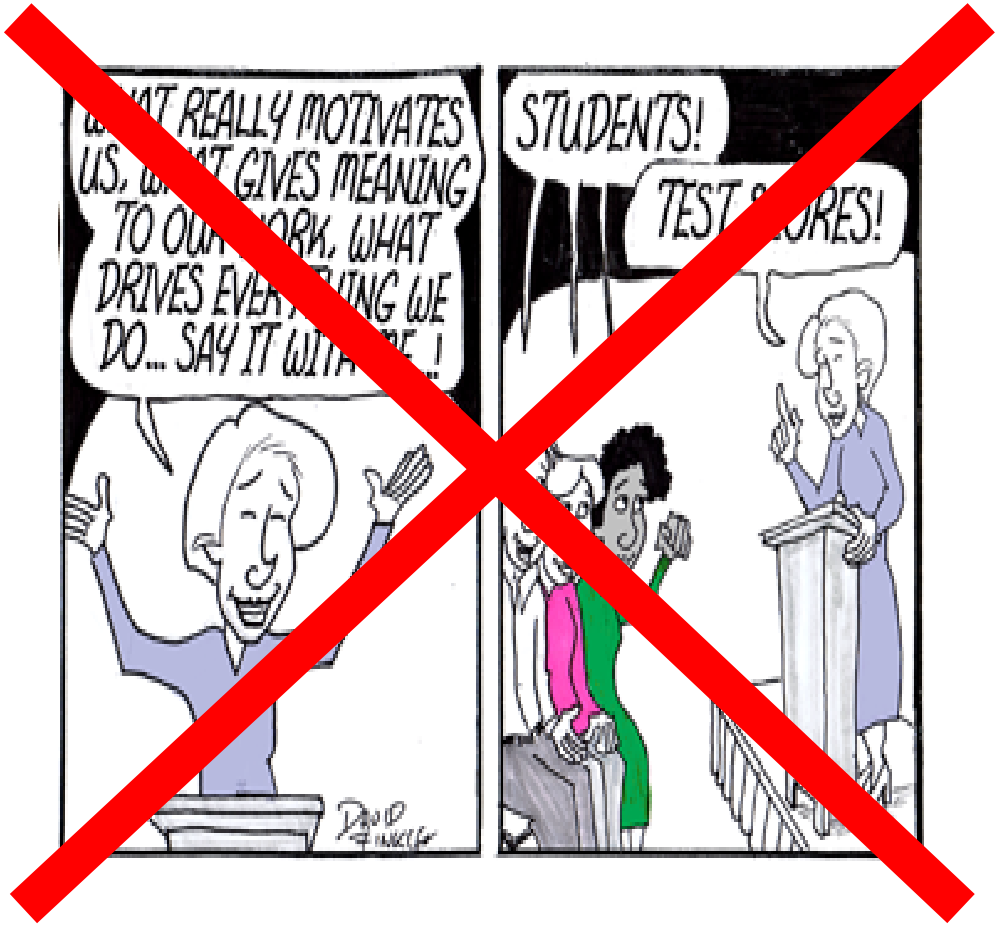
What Matters the Most in Education???



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What Matters the Most in Education???

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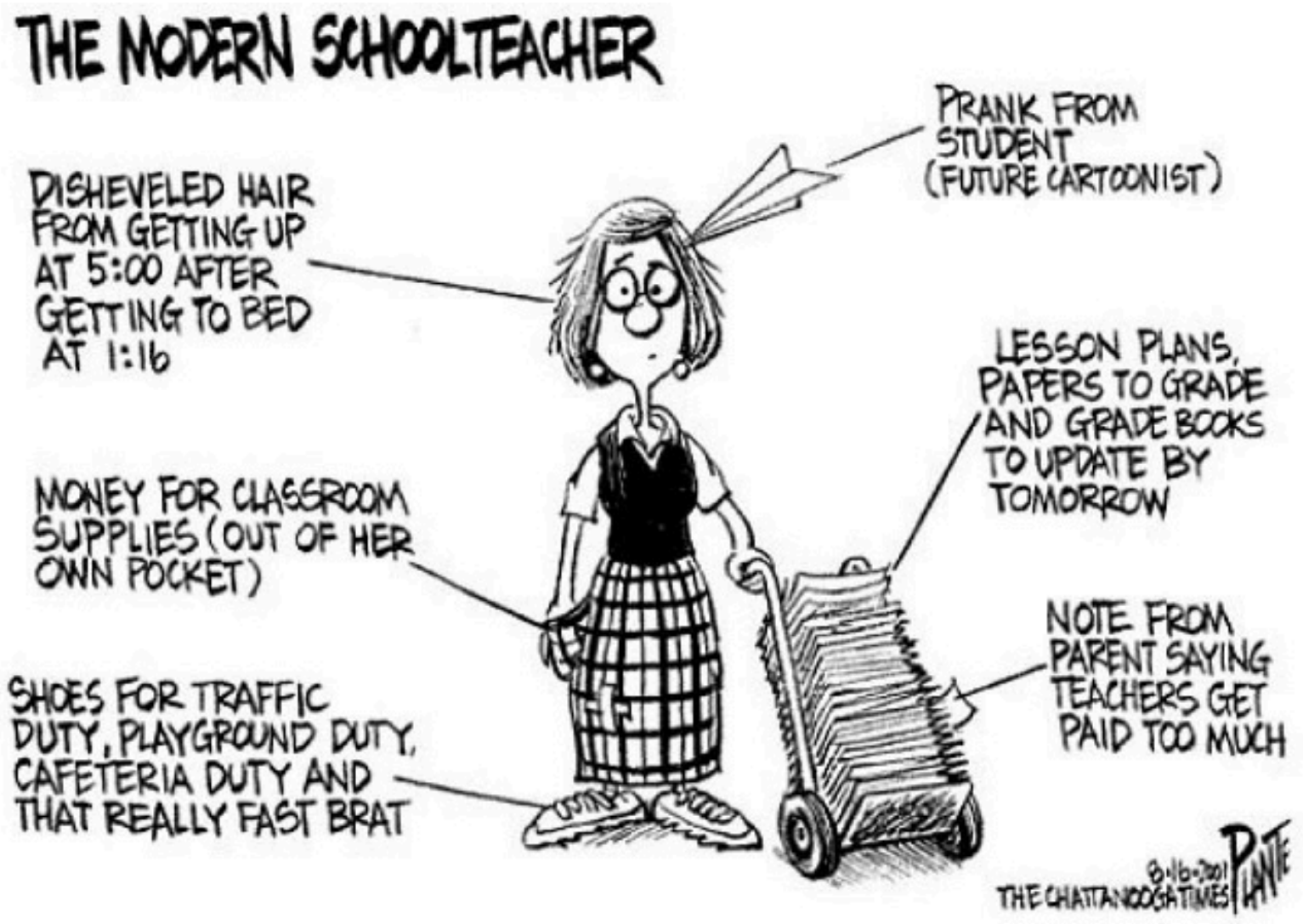
What is the Most Important Key Player in Education???


THE MODERN SCHOOLTEACHER
PRANK FROM STUDENT (FUTURE CARTOONIST)
DISHEVELED HAIR FROM GETTING UP AT 5:00 AFTER GETTING TO BED AT 1:16
LESSON PLANS, PAPERS TO GRADE AND GRADE BOOKS TO UPDATE BY TOMORROW
MONEY FOR CLASSROOM SUPPLIES (OUT OF HER OWN POCKET)
NOTE FROM PARENT SAYING TEACHERS GET PAID TOO MUCH
SHOES FOR TRAFFIC DUTY, PLAYGROUND DUTY, CAFETERIA DUTY AND THAT REALLY FAST BRAT
8-16-2001
THE CHATTANOOGA TIMES
PLANTE

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"It doesn't matter how long you've been teaching or how much you care about children.

This job is hard."

- Justin Minkel

(2007 Arkansas Teacher of the Year)

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Need for Teachers

- Severe teacher shortages in math and science across the country (Cross, 2017)
- Eight percent of public school teachers leave and another eight percent change schools (Learning Policy Institute, 2019)
- Reasons: dissatisfaction, lack of support, autonomy, lack of collaboration opportunities
- High-poverty, high-minority, urban public schools are the most hurting (Ingersoll, May, & Collins, 2019)

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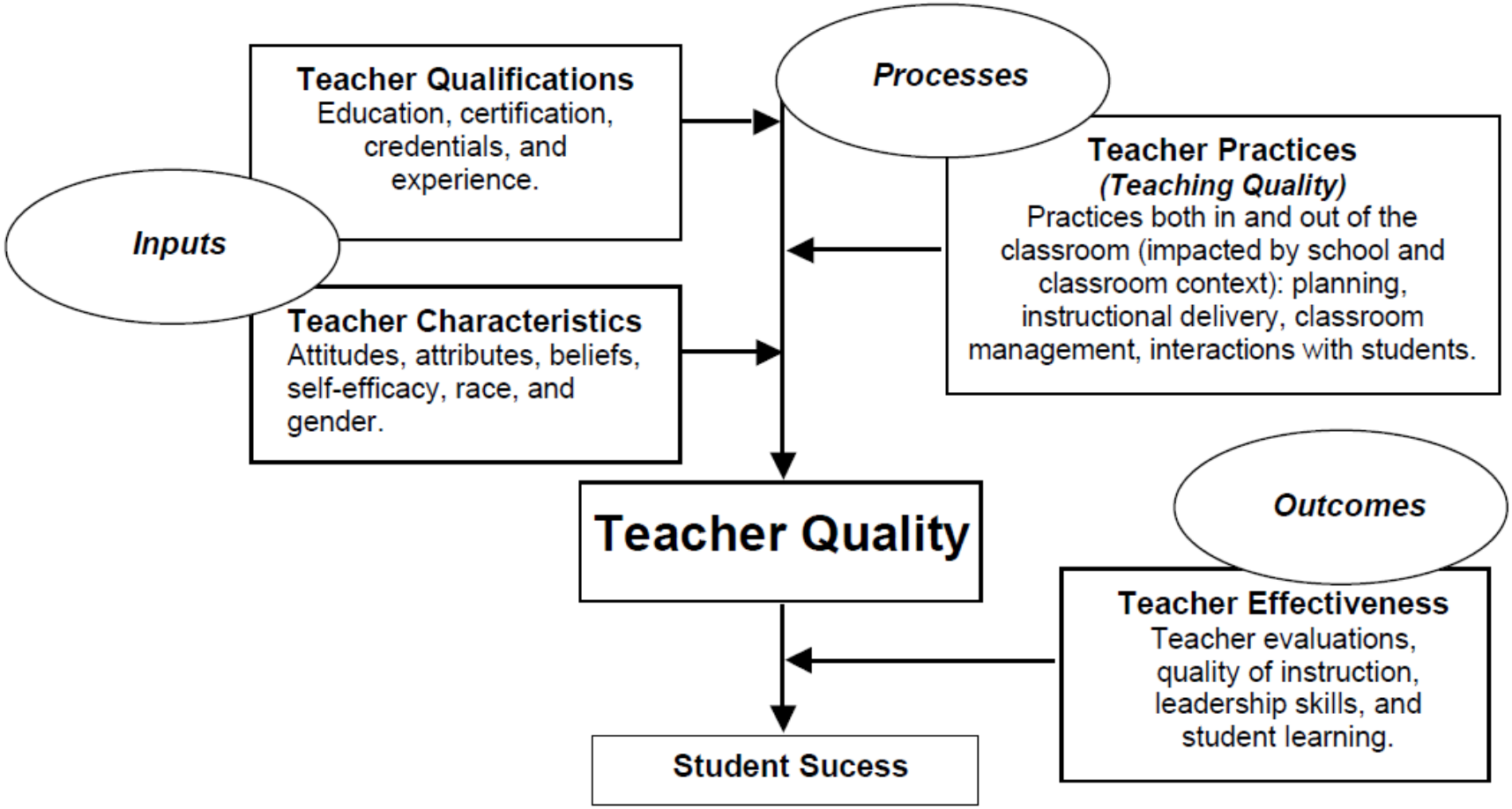
A Framework for Effective Teaching



Adapted from Goe (2007); supported by Darling-Hammond (2000), Hill et al. (2012), National Council on Teacher Quality (2004), and Rice (2003, 2010)

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Teacher Qualifications and Algebra I Achievement

Teacher performance on math certification exams and years of experience teaching math are the qualifications most strongly associated with middle school students' Algebra I achievement.

Institute of Education Sciences (2019)

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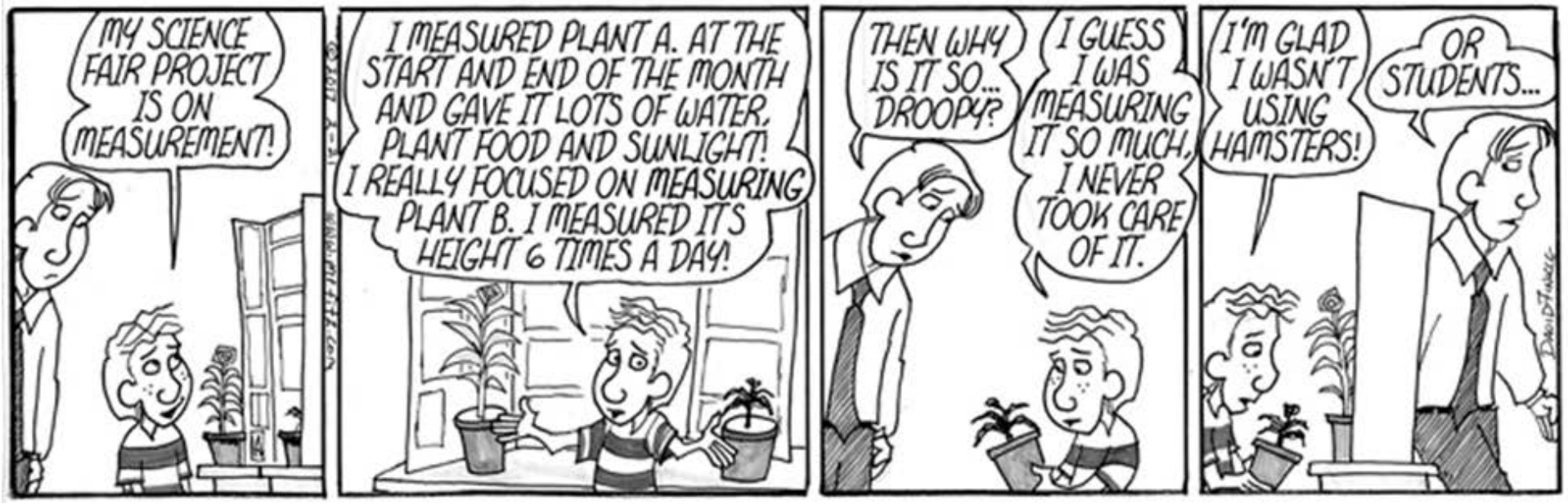
What is Student Success?



Note from the presentation: We discussed student outcomes other than test performance including education attainment and life and career expectations/outcomes (as included in the next slide with SCCT) and 21st Century Skills including communication, collaboration, creativity, and critical thinking.

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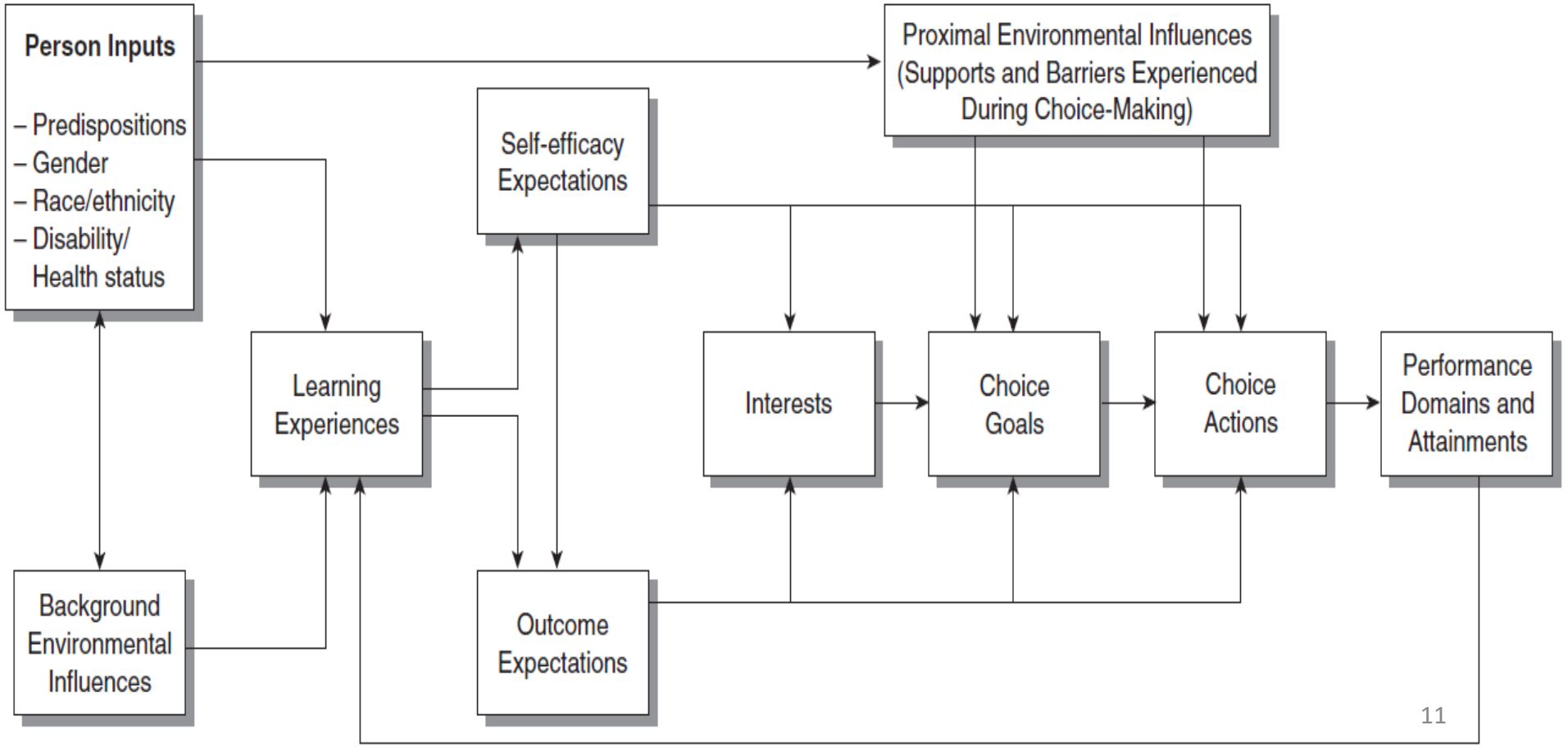
Social Cognitive Career Theory (SCCT)



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SCCT (cont'd)

- Individual (background, demographics etc.)
- Motivational and behavioral (self-efficacy, identity, utility, interest, course-taking, course effort, achievement)
- Contextual (school, teacher, family, etc.)

Lent, Brown, & Hackett (1994)

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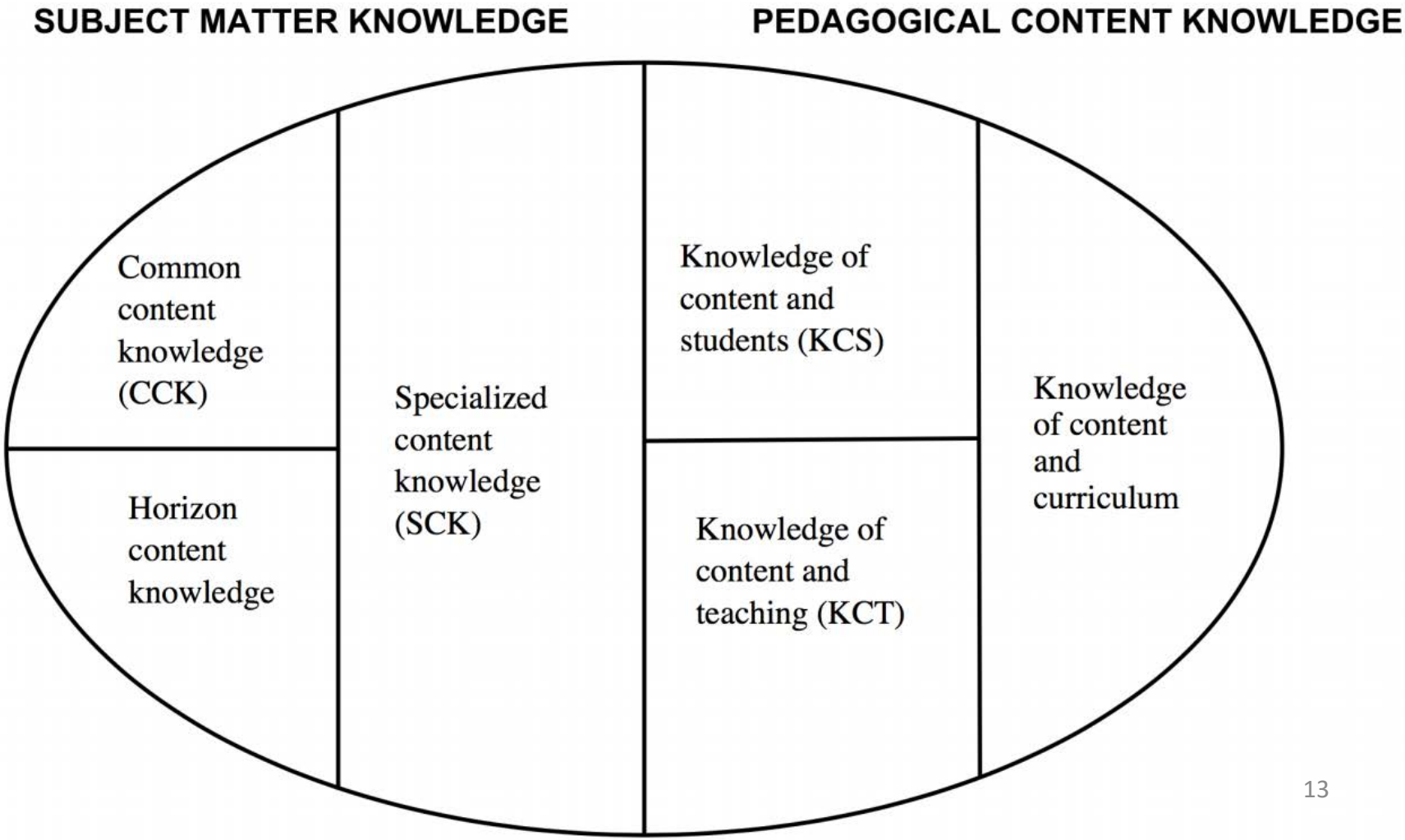
Effective Teaching: Key Ingredients



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Effective Teaching: Key Ingredients – MKT

Mathematical Knowledge for Teaching (MKT)—transcends the pure content knowledge and includes knowledge about students' ideas, knowledge, and conceptual understanding of material.

Hill, Ball, & Schilling (2008)

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Effective Teaching: Key Ingredients – MKT (cont'd)

Strong positive association with mathematical knowledge for teaching and student performance

Hill & Chin (2018); Hill, Rowan, & Ball (2005)

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Effective Teaching: Key Ingredients – Motivational Beliefs

- Self-efficacy in the content area
- Self-efficacy for teaching
- Intrinsic value for teaching
- Epistemic beliefs

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RUSMP Research Results - 1

- A bachelor's degree in mathematics,
- Mathematical Knowledge for Teaching, and
- Epistemic Beliefs

had significant positive effects on students' math achievement.

Ekmekci, Corkin, & Fan (*in press*)

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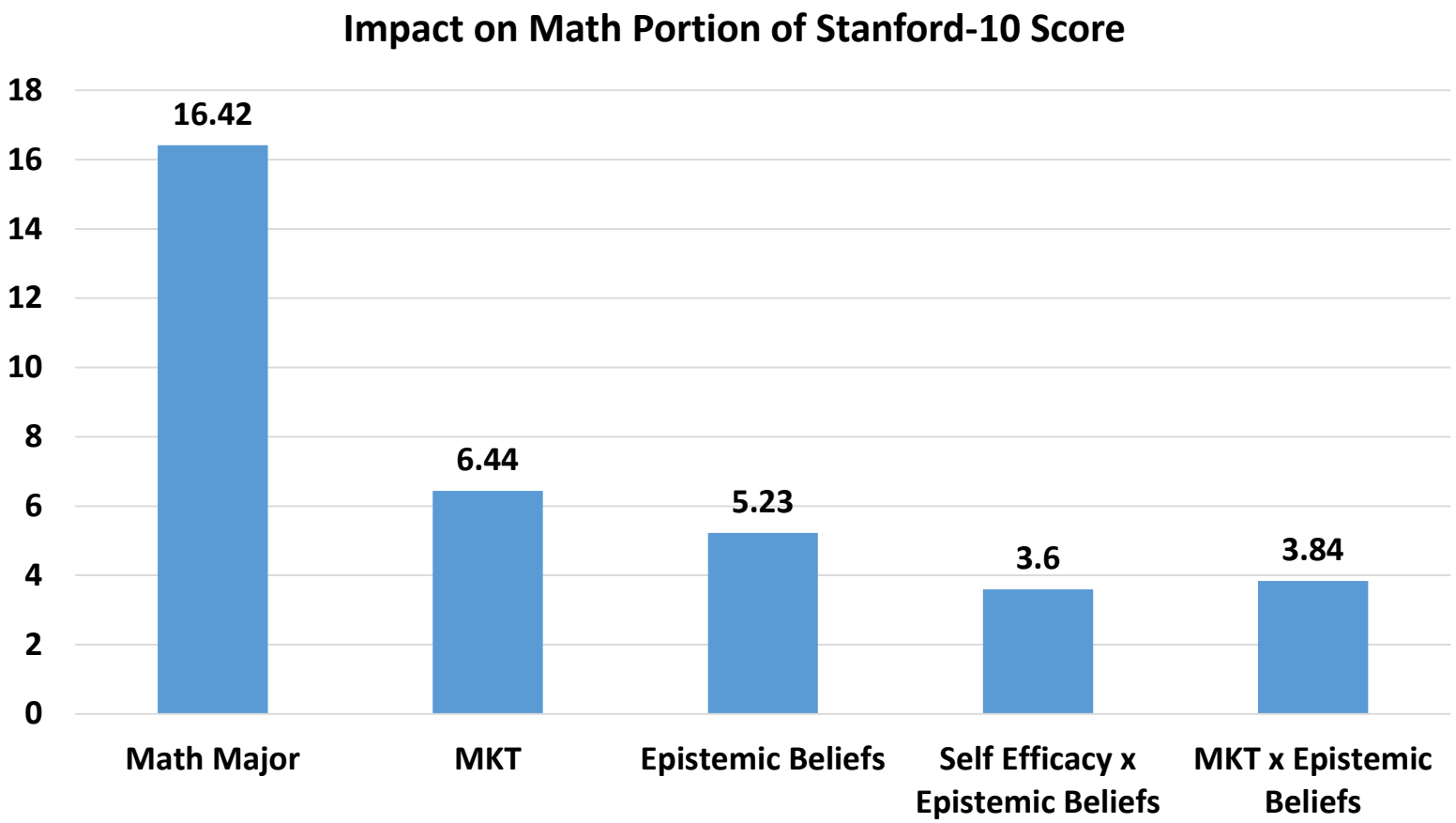
RUSMP Research Results – 1 (cont'd)



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Effective Teaching: Key Ingredients – TPACK

Technological Pedagogical Content Knowledge (TPACK)—effective utilization of technology for teaching particular topics; knowledge of students' understanding, thinking, and learning with technology in a particular subject; and knowledge of curriculum materials that integrate technology with learning in the subject area

Mishra & Koehler (2006)

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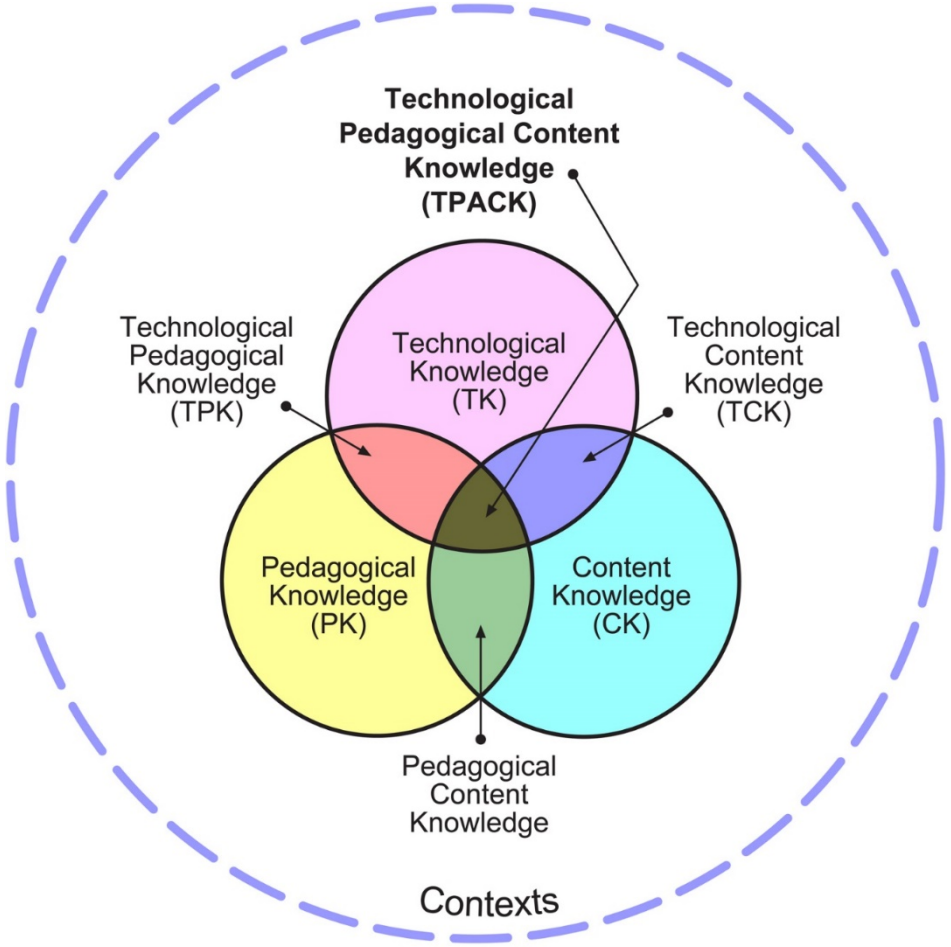
Effective Teaching: Key Ingredients – TPACK (cont'd)



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Effective Teaching: Key Ingredients – TPACK (cont'd)

Its significance is widely-agreed upon; however, TPACK's relation to student outcomes and instructional quality has yet to be studied.

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RUSMP Research Results – 2

Motivational beliefs, professional background, and MKT are strongly and positively associated with teachers' TPACK.

Ekmekci et al. (2019)

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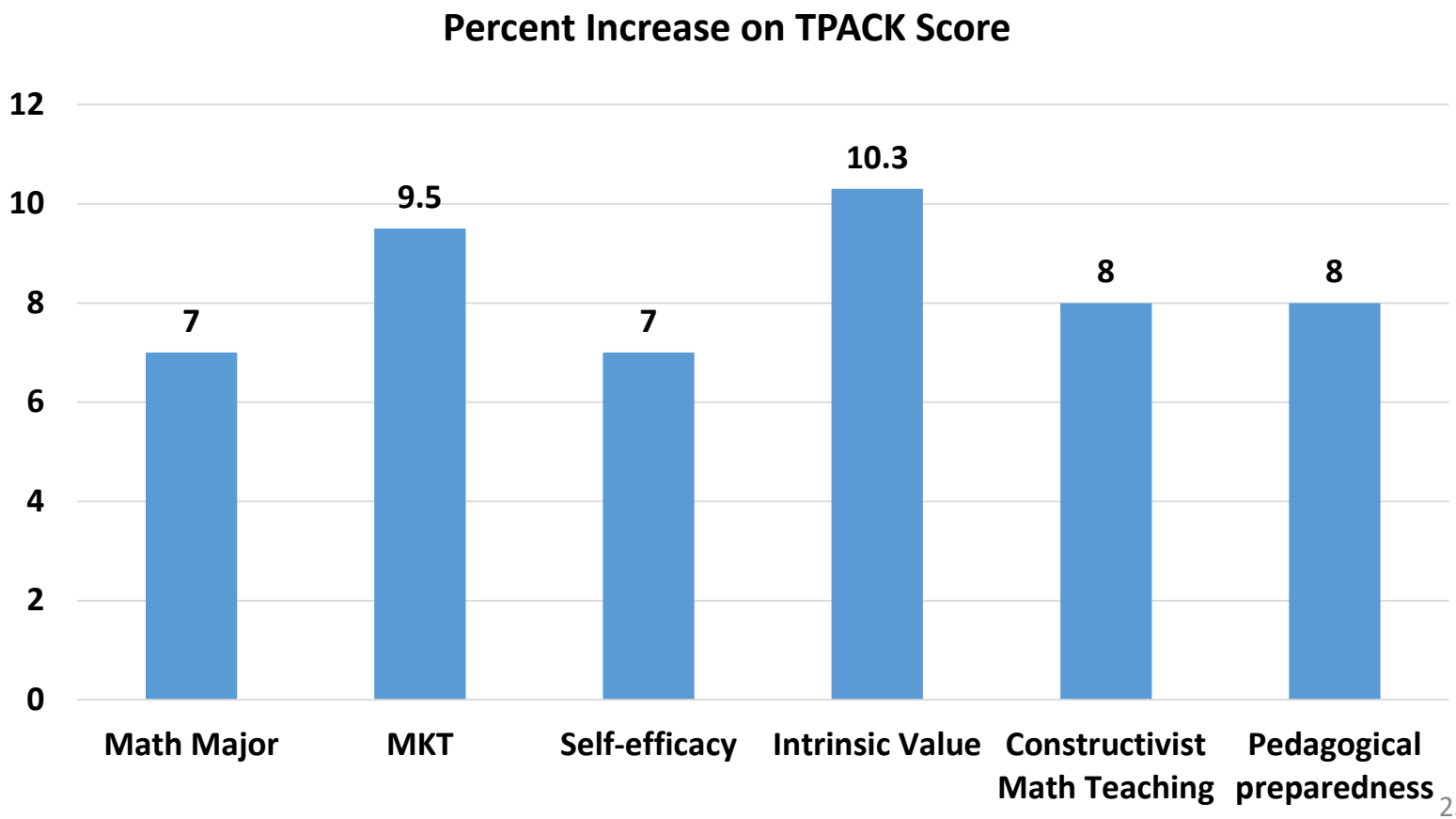
RUSMP Research Results – 2 (cont'd)



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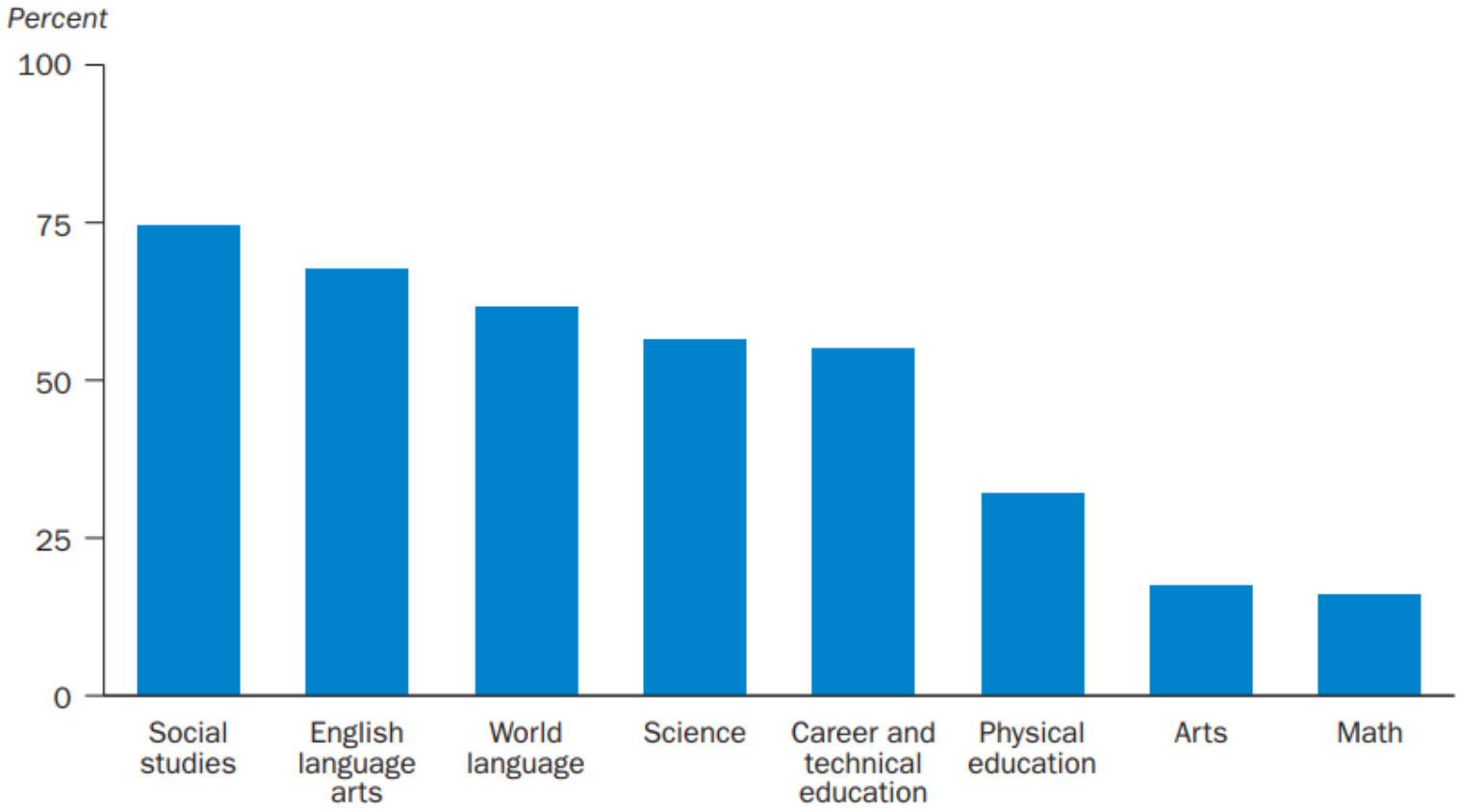
Teachers Asking Students to Use Technology for Collaboration



Institute of Education Sciences (2019)

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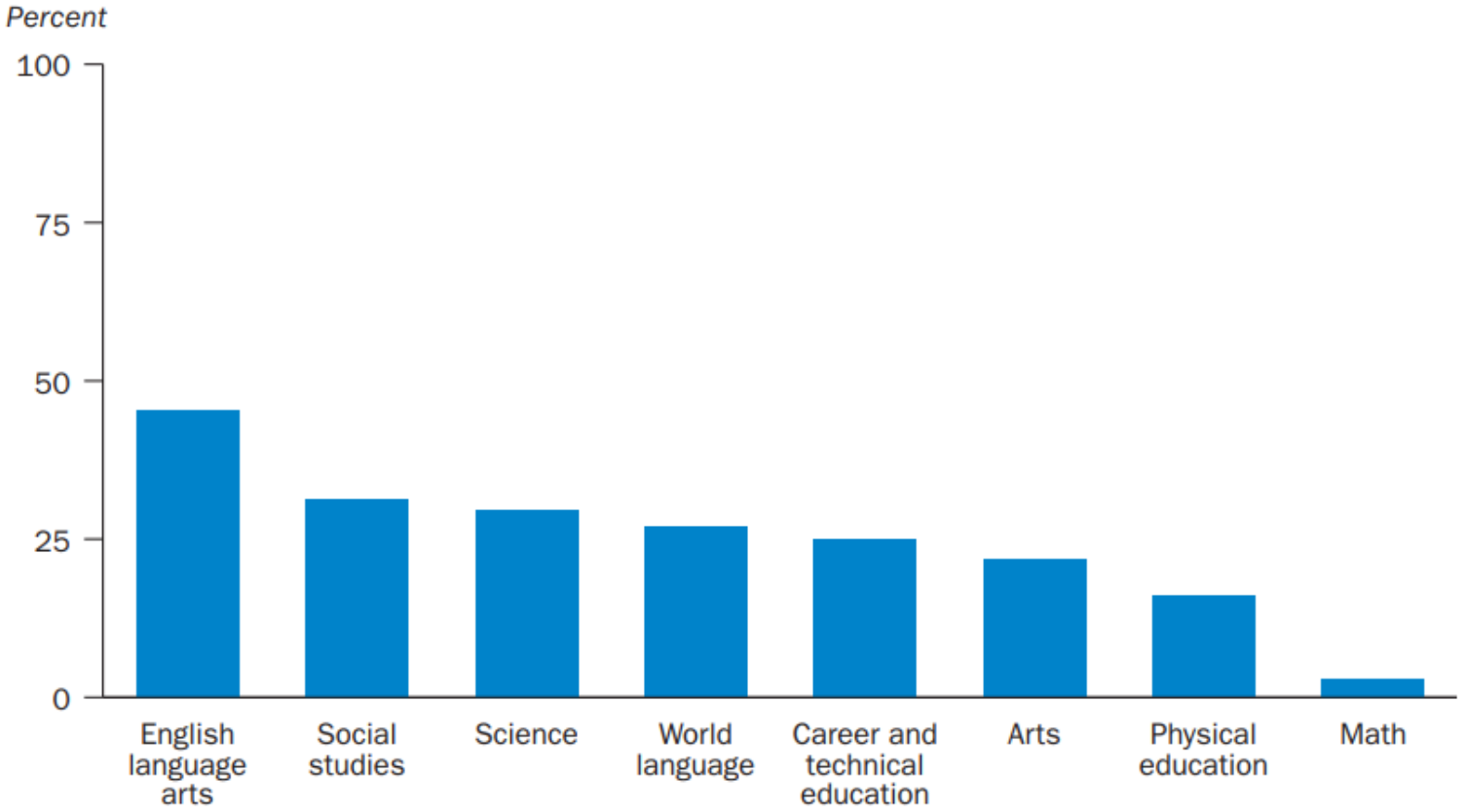
Teachers Asking Students to Use Technology for Communication



Institute of Education Sciences (2019)

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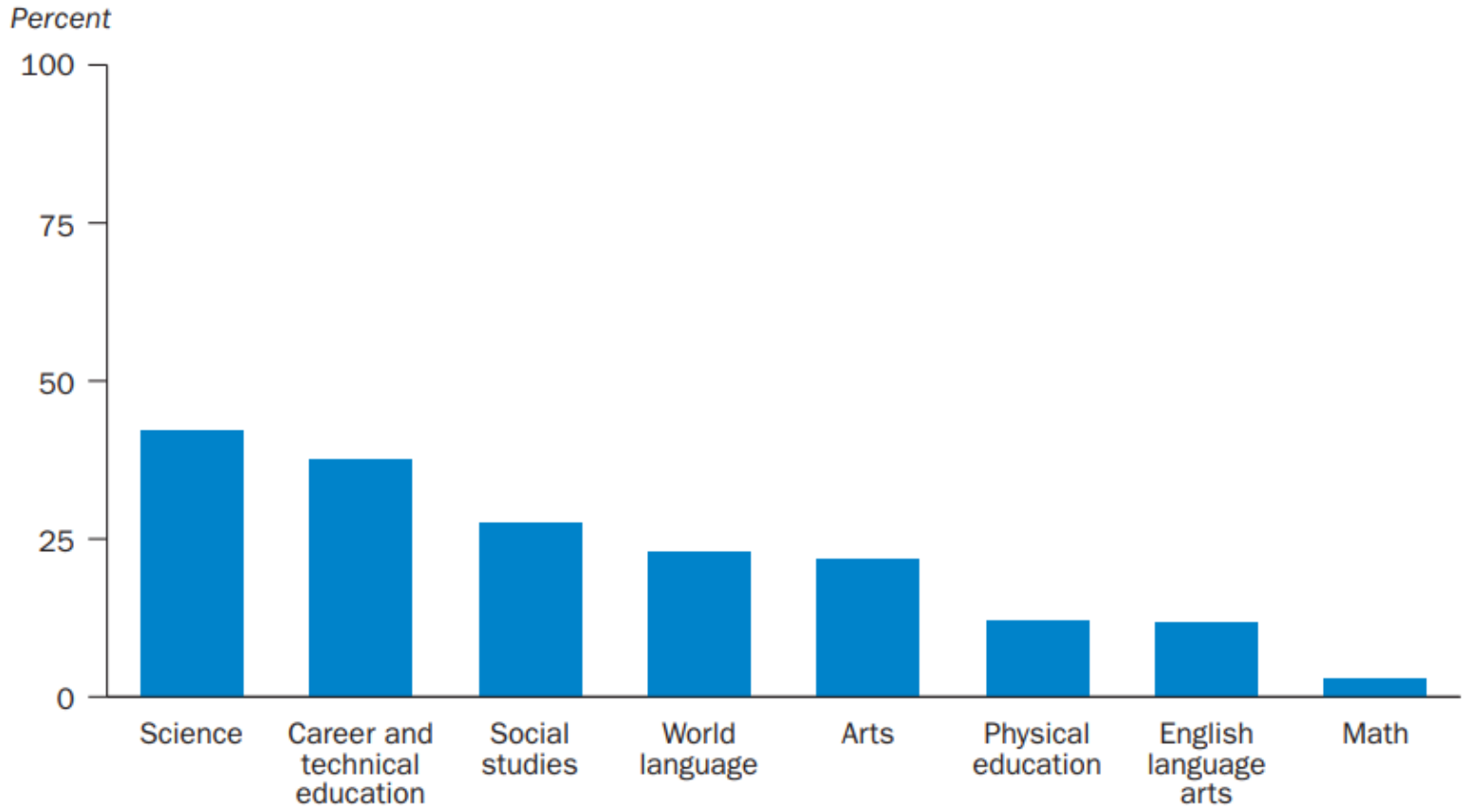
Teachers' Use of Technology to Prompt Student Creativity



Institute of Education Sciences (2019)

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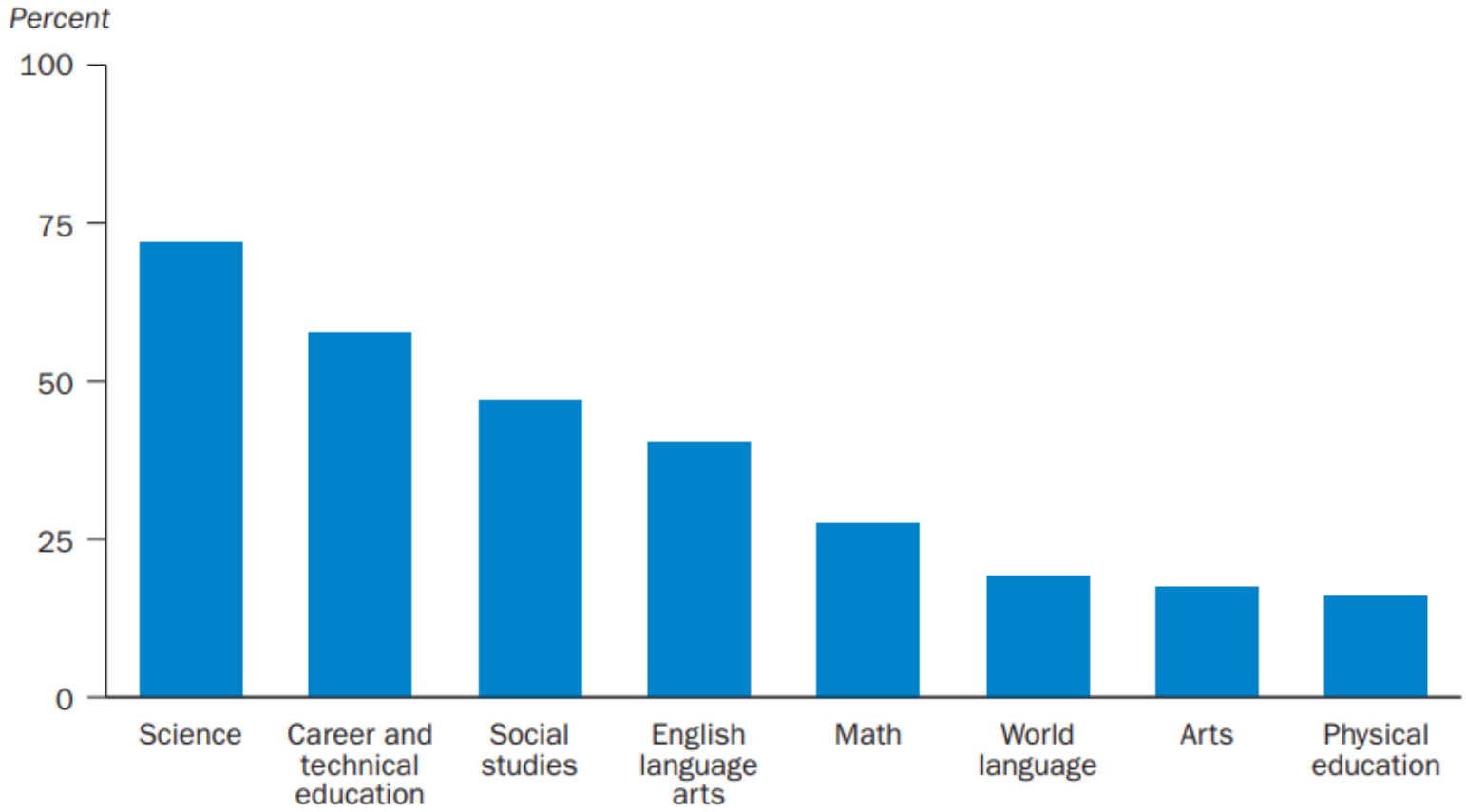
Teachers' Use of Technology to Prompt Student Critical Thinking



Institute of Education Sciences (2019)

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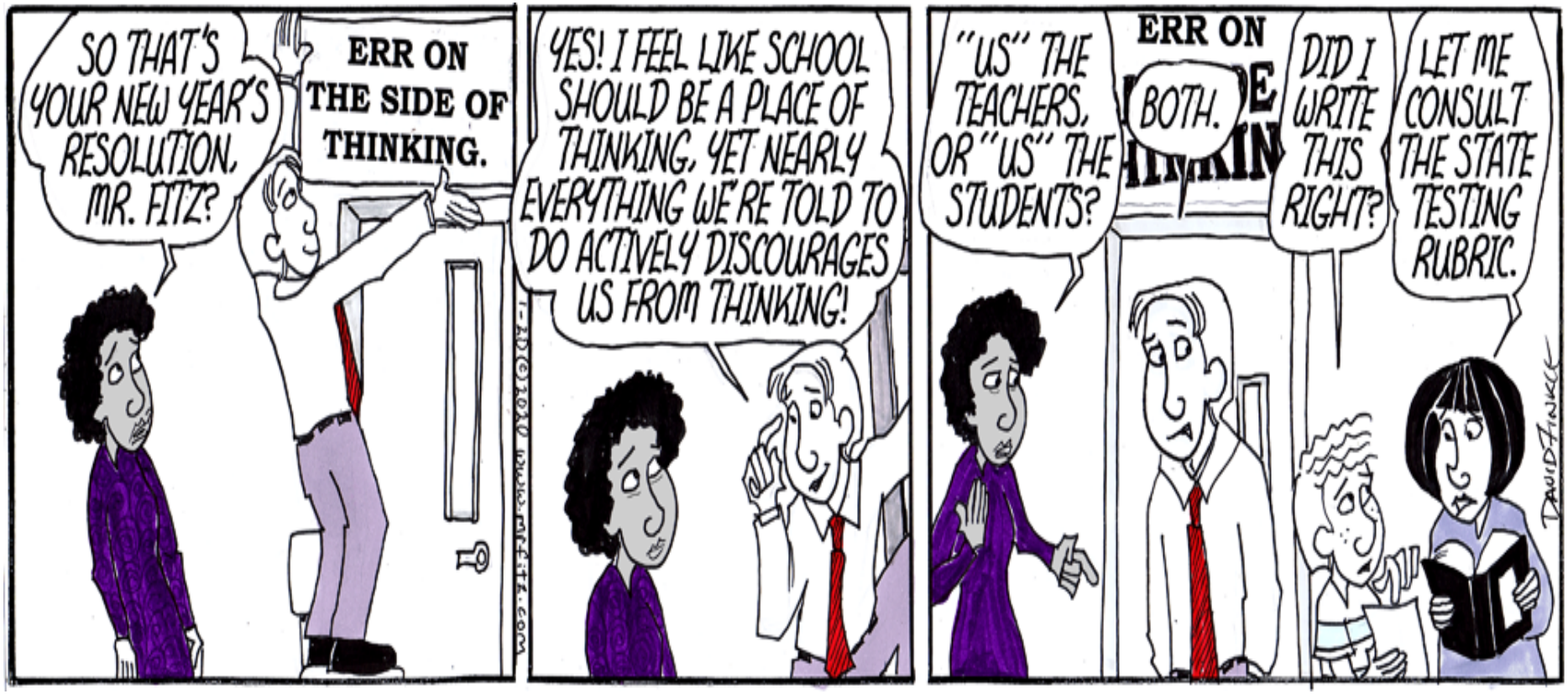

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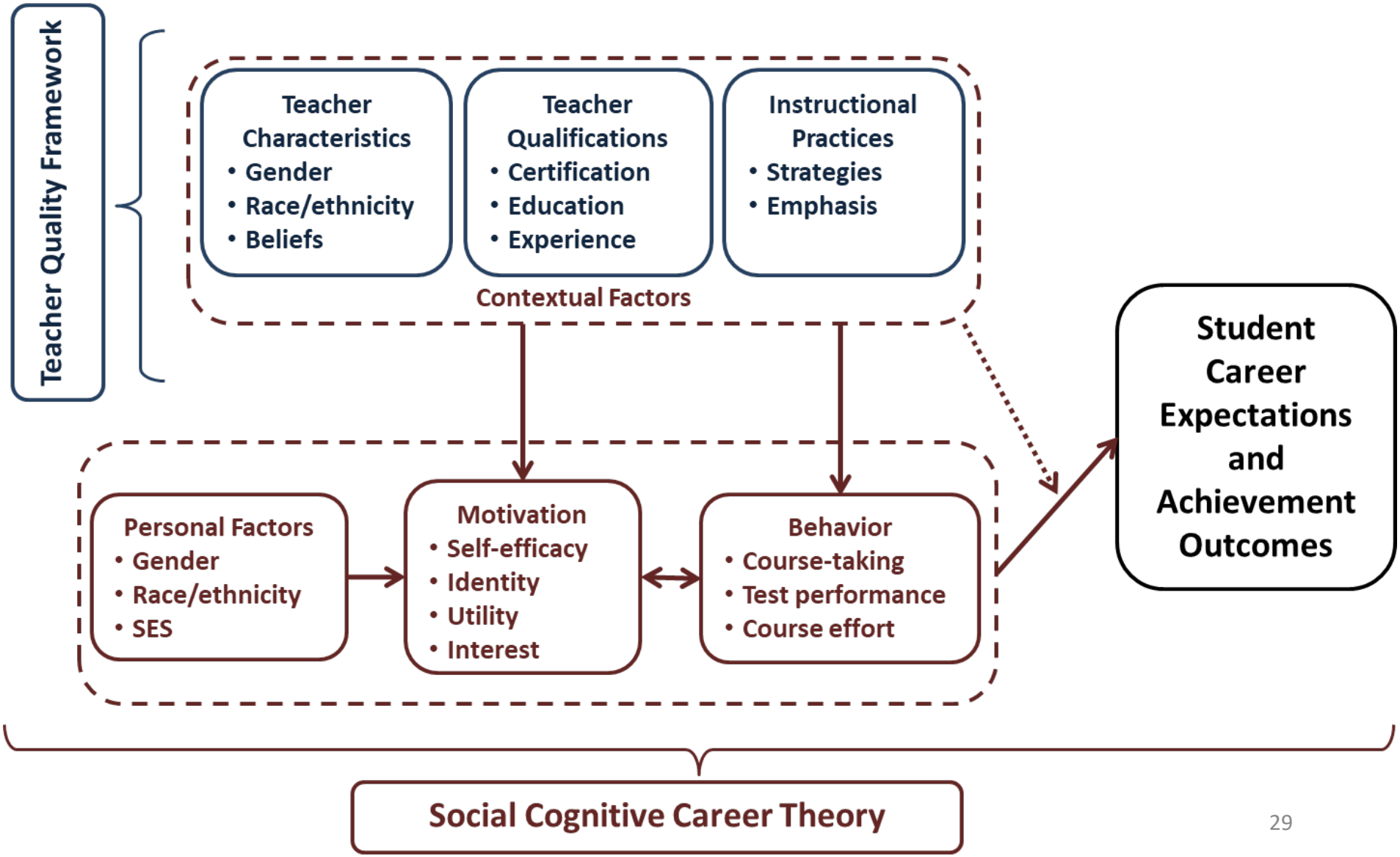

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RUSMP Research Results - 3

Science teachers' constructivist teaching practices (inquiry-based and connections to real life and history of science), self-efficacy, degree in science had significant impact on students' science motivation and achievement outcomes.

Ekmekci & Corkin (2019)

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RUSMP Research Results – 3 (cont'd)

Math teachers' constructivist teaching practices (focusing on conceptual understanding), self-efficacy, traditional certification, and degree in math had significant impact on students' math motivation and achievement outcomes.

Corkin & Ekmekci (2019)

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RUSMP Research Results – 3 (cont'd)

Both math and science teachers' constructivist teaching practices and self-efficacy in teaching the content had a positive impact on high school students' career expectations in STEM at age 30.

Ekmekci & Corkin (*in preparation*)

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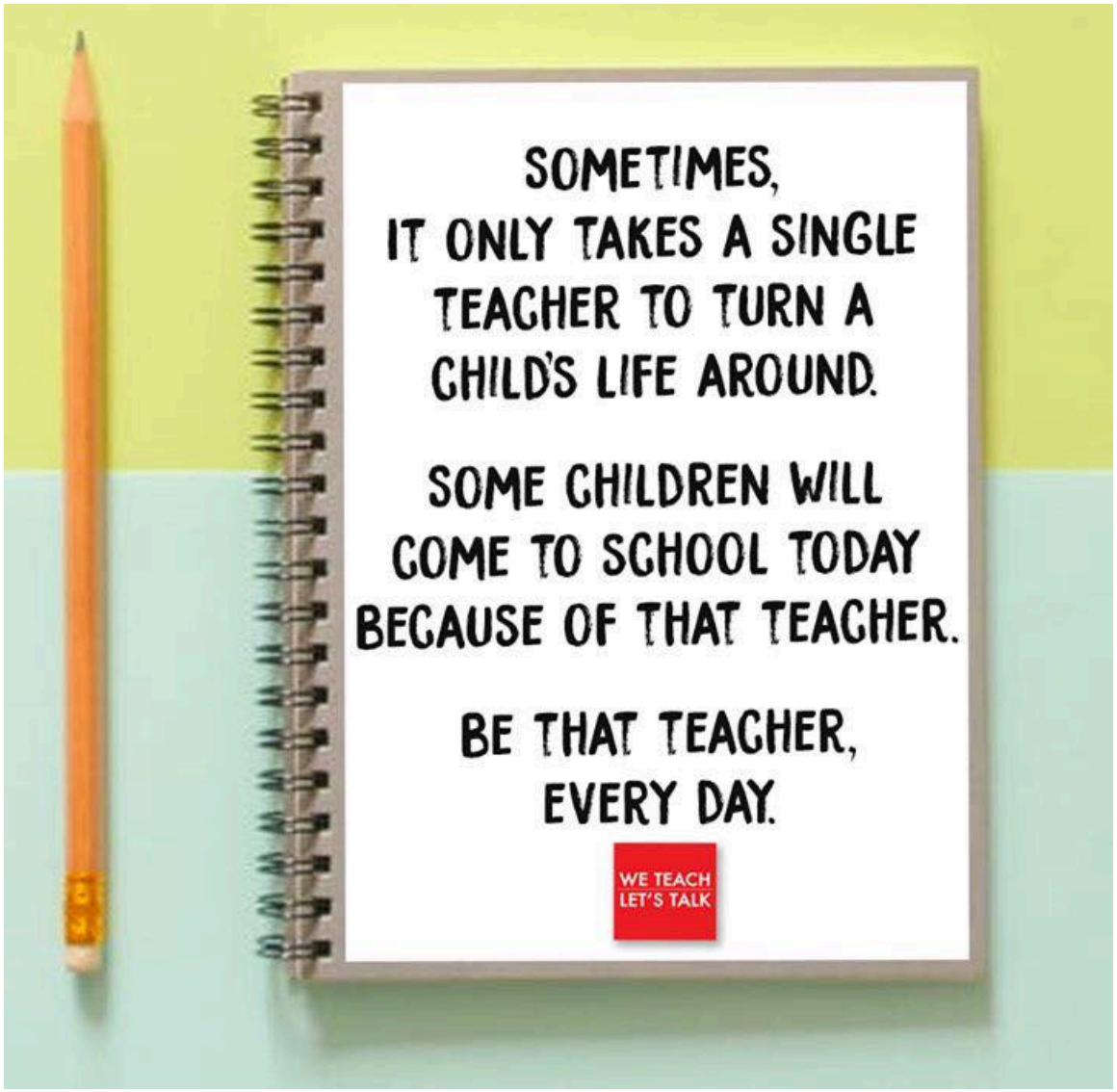

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Professional Development

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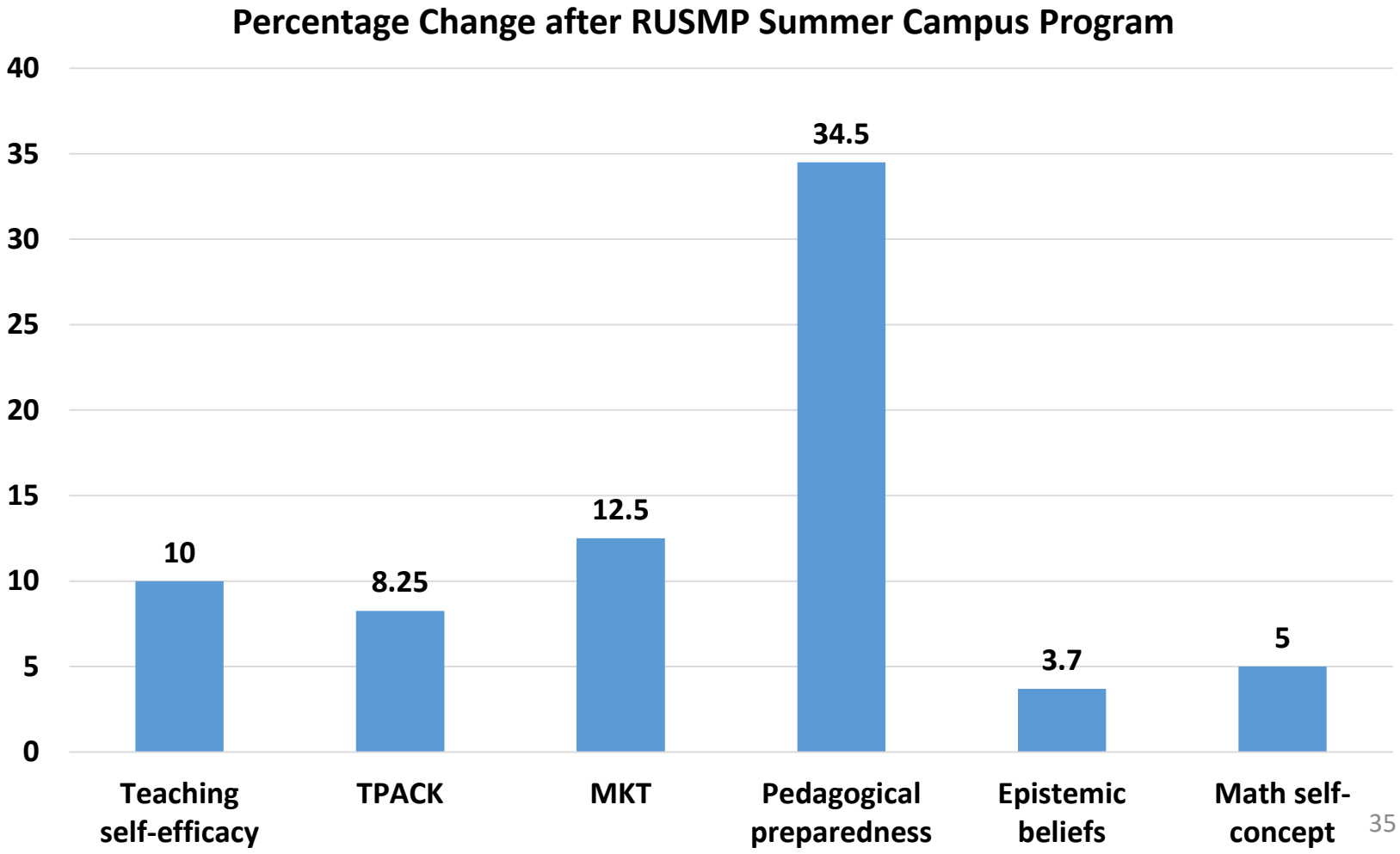
RUSMP Research Results – 4



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RUSMP Research Results – 5 Barriers

- Cultural
  - Student motivation and knowledge background
  - Student mindset for learning
  - Lack of collaboration among teachers
  - Attitude of other teachers
- Political
  - Lack of autonomy support from administrators
  - Lack of instructional resources
  - Testing culture

Corkin, Ekmekci, & Coleman (2018)

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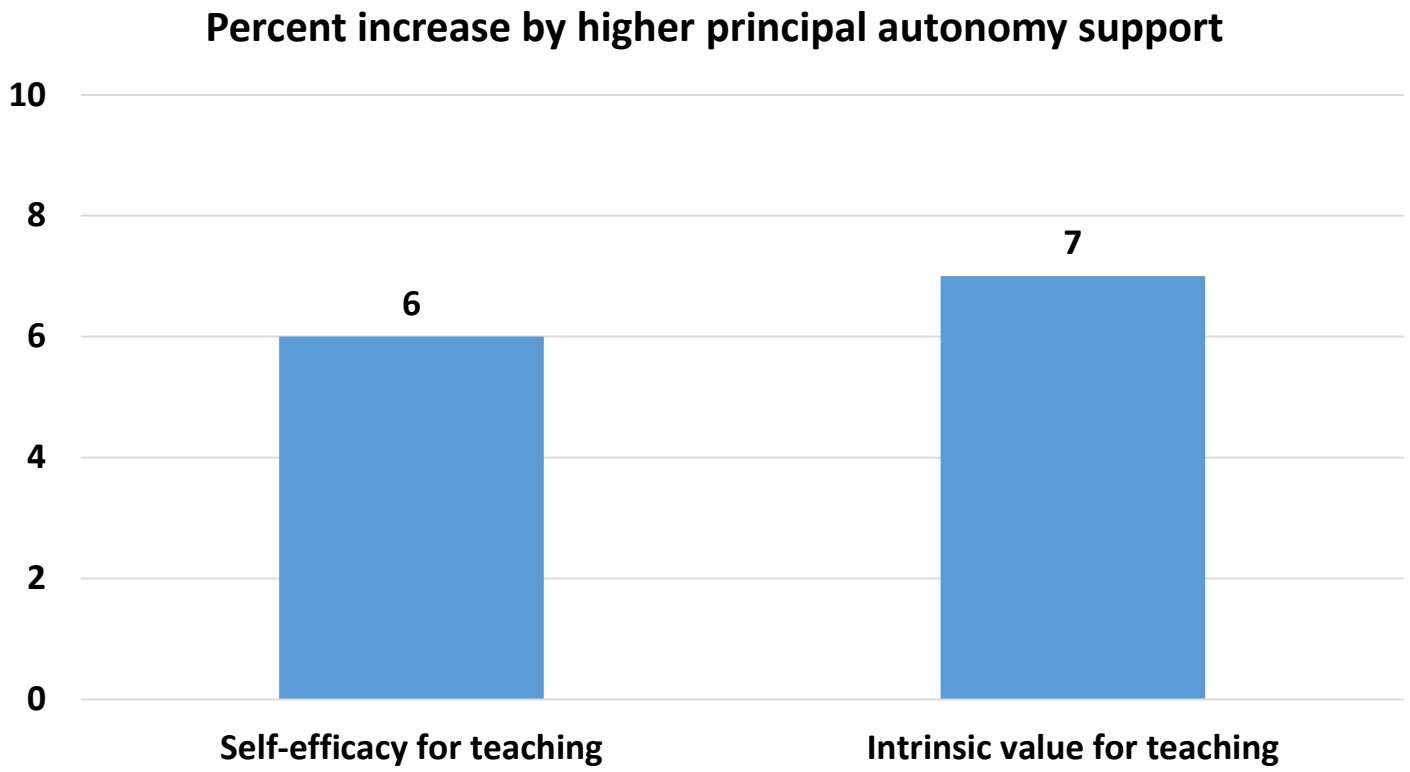
RUSMP Research Results – 6 Principal Autonomy Support



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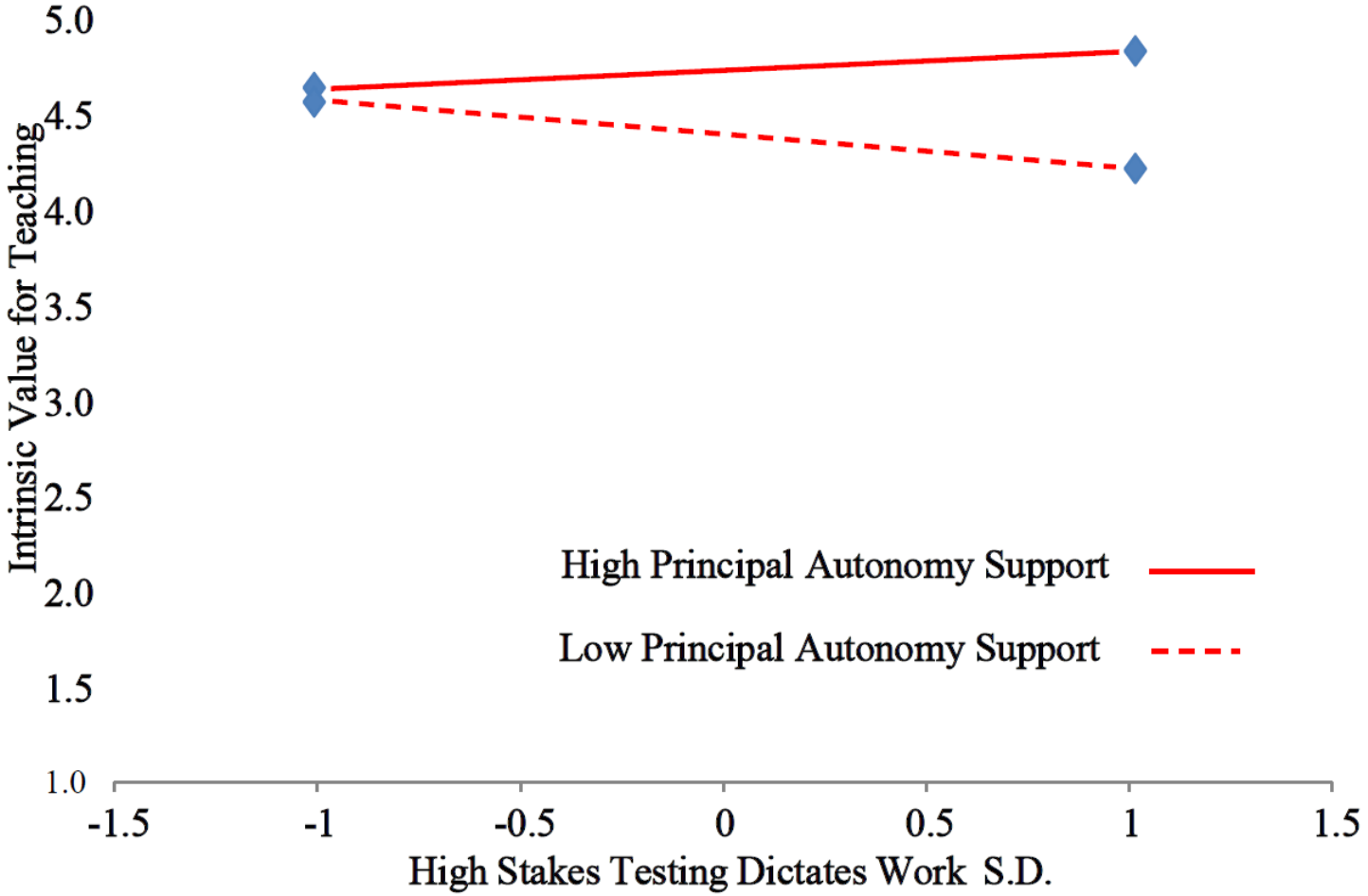
RUSMP Research Results – 6 Principal Autonomy Support (cont'd)



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"Real teachers hear the heartbeats of crisis; always have time to listen; know they teach students, not subjects; and they are absolutely ***non-expendable****."*

(Source unknown)

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Other points discussed at the end of presentation in Q&A portion:

- Culturally relevant instruction and family/parent visits by teachers to motivate and engage diverse group of students, especially from minoritized and underserved populations
- Integration of computer science in algebra/geometry courses
- Desmos.com and its plethora of activities that can be used in school math instruction as an example of effective use of technology
- We need school and district administrators' support for teacher autonomy and promoting effective professional development of teachers
- TEACHERS need to continue growing and developing professionally and take action to impact colleagues (leadership—not just a position but actions, for example, presenting at a conference serving in task forces at school/district)