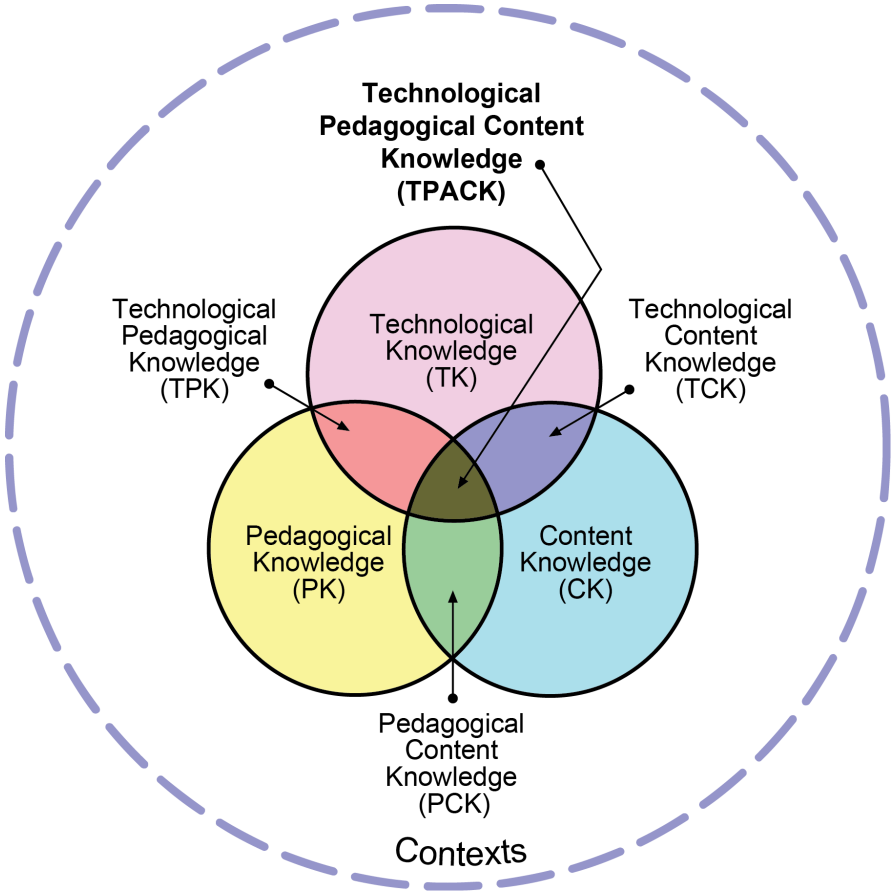
BRIEF RESEARCH OVERVIEW

LECTURE 2 - 27/09/2024

Technology in Mathematics Education

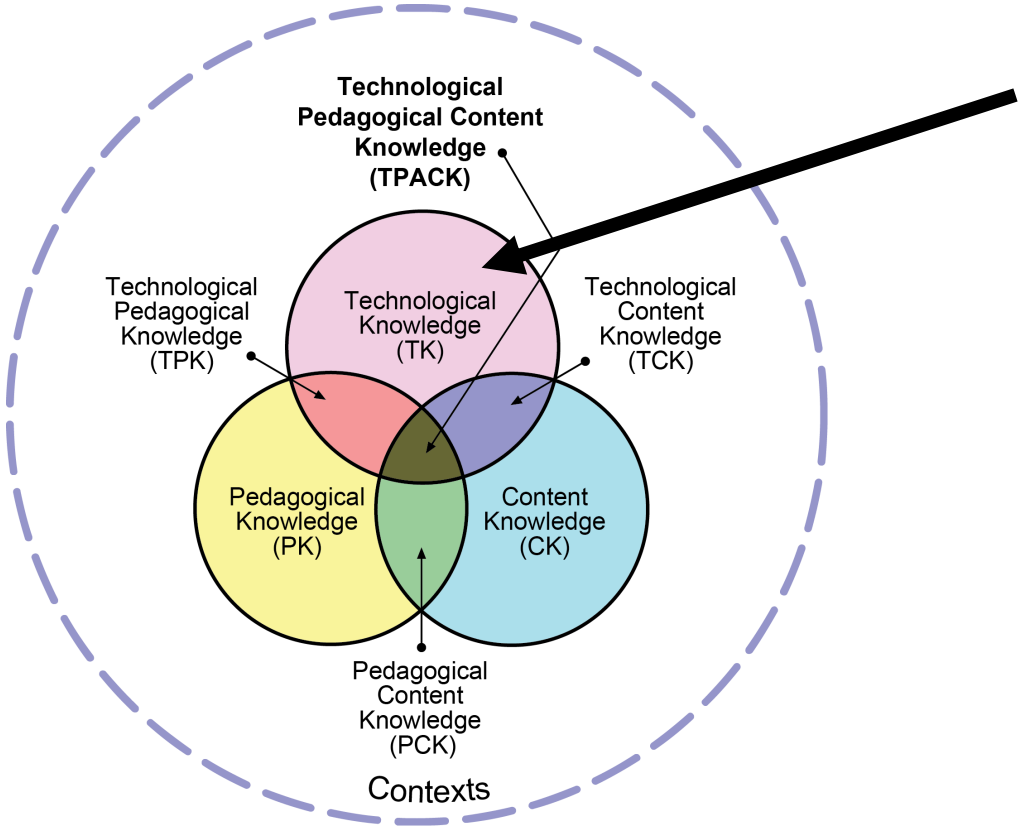
Theoretical framework



http://tpack.org/

At the heart of the TPACK framework, is the complex interplay of three primary forms of knowledge: Content (CK), Pedagogy (PK), and Technology (TK). The TPACK approach goes beyond seeing these three knowledge bases in isolation. The TPACK framework goes further by emphasizing the kinds of knowledge that lie at the intersections between three primary forms: Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK), and Technological Pedagogical And Content Knowledge (TPACK).

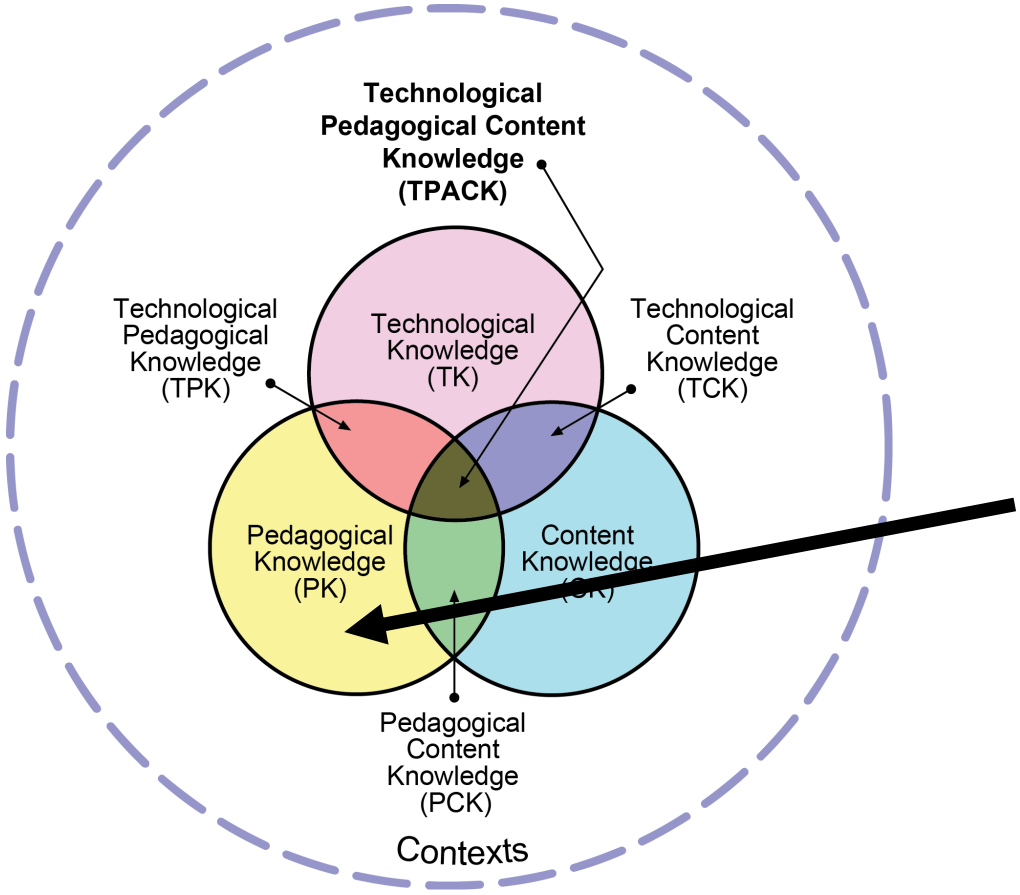
Technological Knowledge (TK)



Knowledge about certain ways of thinking about, and working with technology, tools and resources, and how working with technology can apply to all technology tools and resources. This includes understanding information technology broadly enough to apply it productively at work and in everyday life, being able to recognize when information technology can assist or impede the achievement of a goal, and being able to continually adapt changes in information technology

(Koehler & Mishra, 2009)

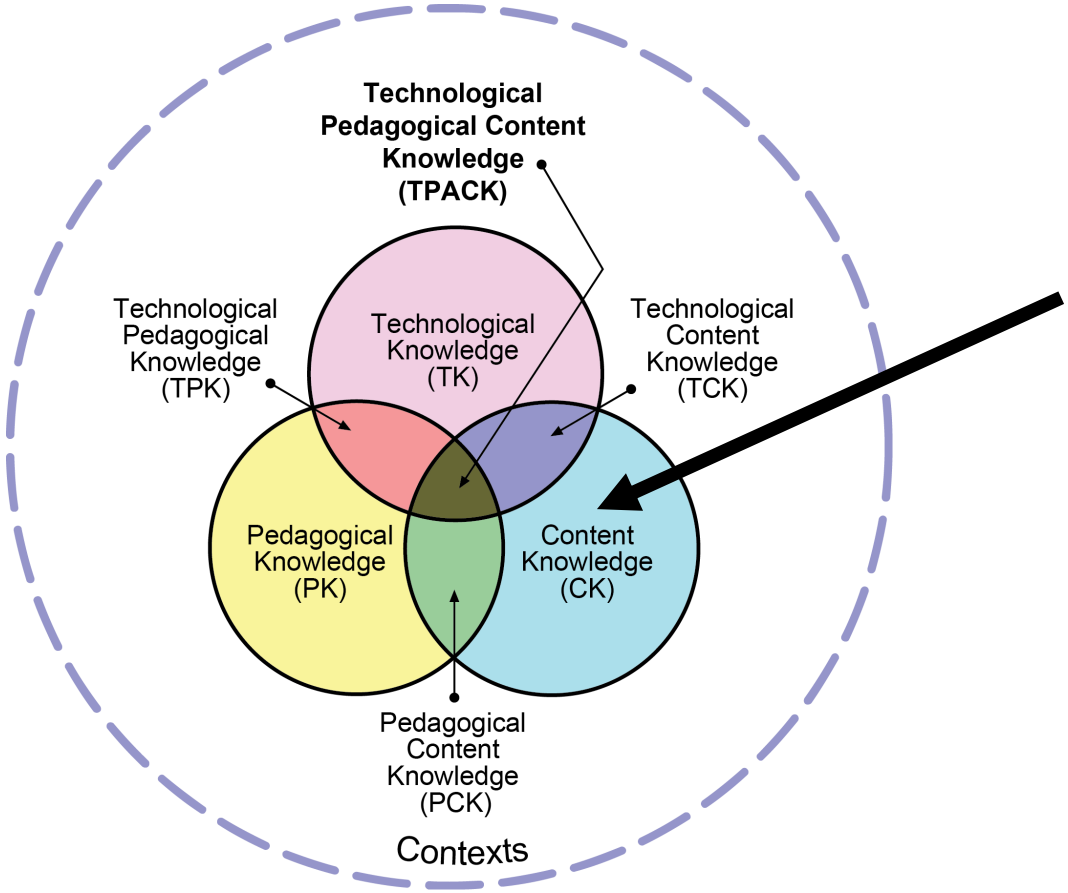
Pedagogical Knowledge (PK)



Teachers' deep knowledge about the processes and practices or teaching and learning methods. They encompass, among other things, overall educational purposes, values, and aims. This generic form of knowledge applies to understanding how students learn, general classroom management skills, lesson planning, and student assessment

(Koehler & Mishra, 2009)

Content Knowledge (CK)



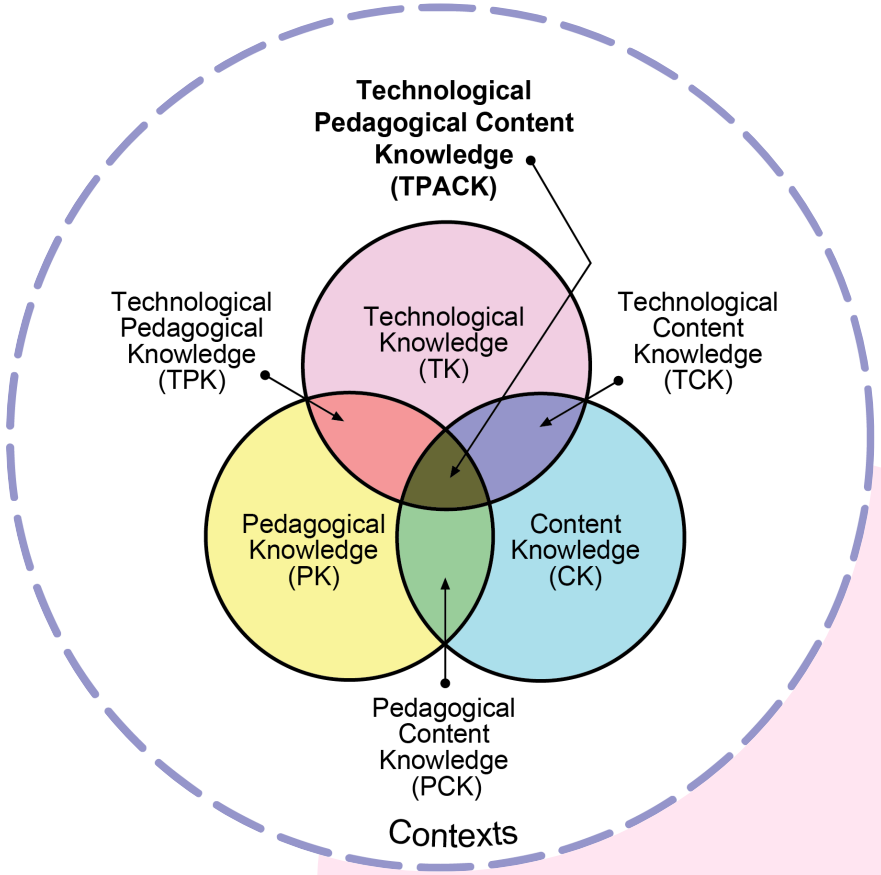
Teachers' knowledge about the subject matter to be learned or taught. The content to be covered in middle school science or history differs from that in an undergraduate course on art appreciation or a graduate seminar on astrophysics... As Shulman (1986) noted, this knowledge would include knowledge of concepts, theories, ideas, organisational frameworks, knowledge of evidence and proof, as well as established practices and approaches toward developing such knowledge

(Koehler & Mishra, 2009)

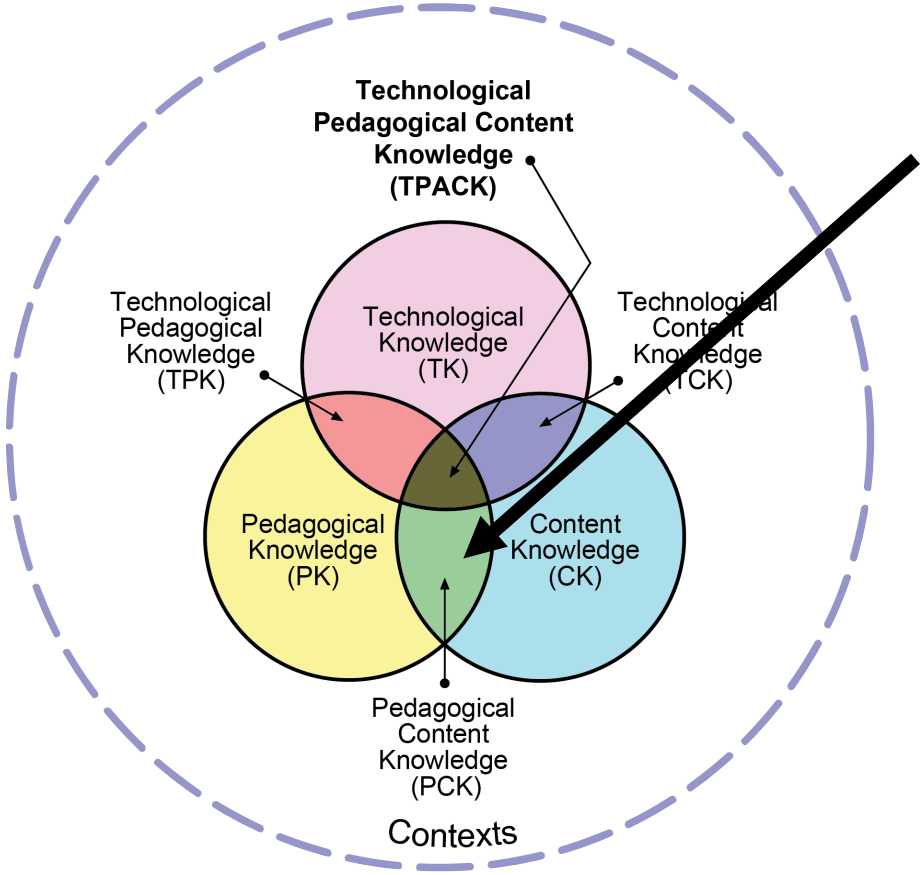
Technological Content Knowledge (TCK)

An understanding of the manner in which technology and content influence and constrain one another. Teachers need to master more than the subject matter they teach; they must also have a deep understanding of how the subject matter (or the kinds of representations that can be constructed) can be changed by applying particular technologies. Teachers need to understand which specific technologies are best suited for addressing subject-matter learning in their domains and how the content dictates or perhaps even changes the technology–or vice versa

(Koehler & Mishra, 2009)



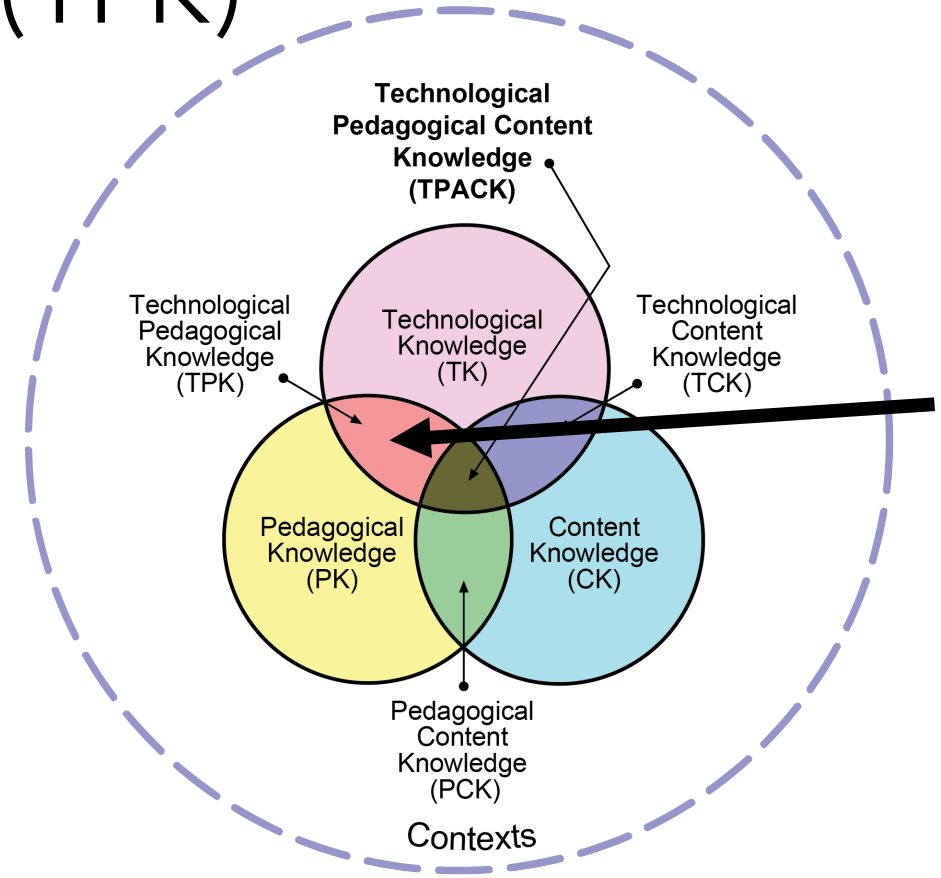
Pedagogical Content Knowledge (PCK)



Consistent with and similar to Shulman's idea of knowledge of pedagogy that is applicable to teaching specific content. Central to Shulman's conceptualization of PCK is the notion of the transformation of the subject matter for teaching. Specifically, according to Shulman (1986), this transformation occurs as the teacher interprets the subject matter, finds multiple ways to represent it, and adapts and tailors the instructional materials to alternative conceptions and students' prior knowledge. PCK covers the core business of teaching, learning, curriculum, assessment and reporting, such as the conditions that promote learning and the links among curriculum, assessment, and pedagogy.

(Koehler & Mishra, 2009)

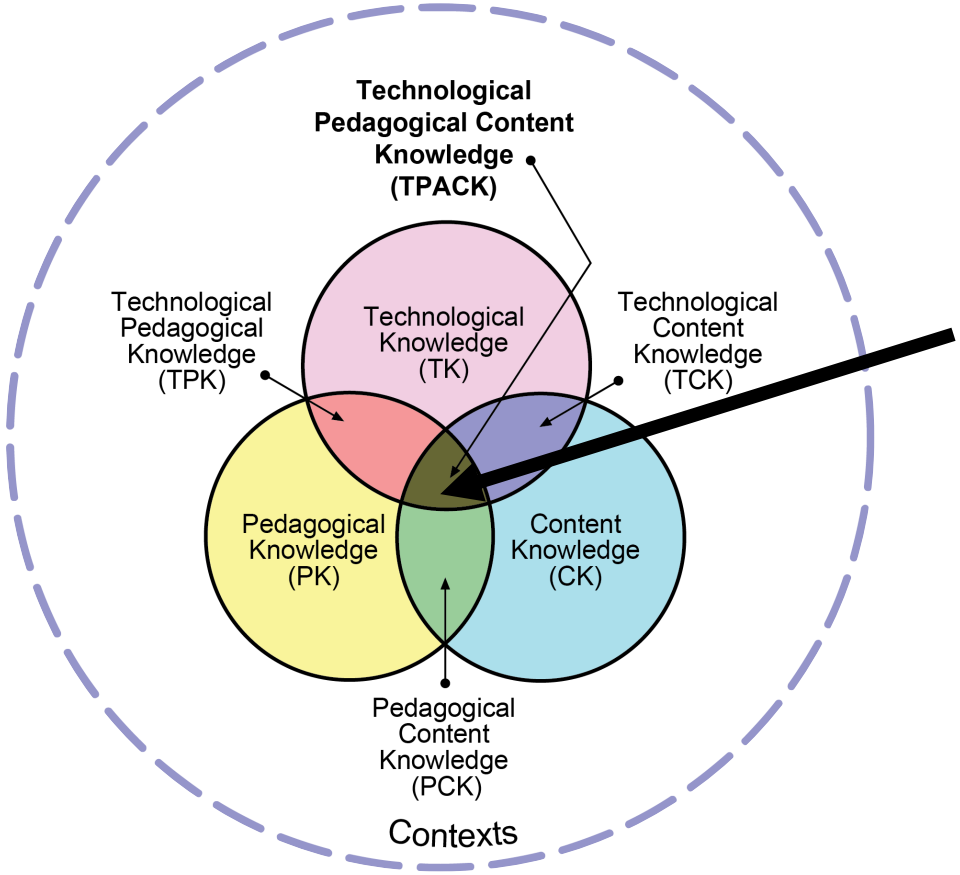
Technological Pedagogical Knowledge (TPK)



An understanding of how teaching and learning can change when particular technologies are used in particular ways. This includes knowing the pedagogical affordances and constraints of a range of technological tools as they relate to disciplinarily and developmentally appropriate pedagogical designs and strategies

(Koehler & Mishra, 2009)

Technological Pedagogical and Content Knowledge (TPACK)



Underlying truly meaningful and deeply skilled teaching with technology, TPACK is different from knowledge of all three concepts individually. Instead, TPACK is the basis of effective teaching with technology, requiring an understanding of the representation of concepts using technologies; pedagogical techniques that use technologies in constructive ways to teach content; knowledge of what makes concepts difficult or easy to learn and how technology can help redress some of the problems that students face; knowledge of students' prior knowledge and theories of epistemology; and knowledge of how technologies can be used to build on existing knowledge to develop new epistemologies or strengthen old ones

(Koehler & Mishra, 2009)

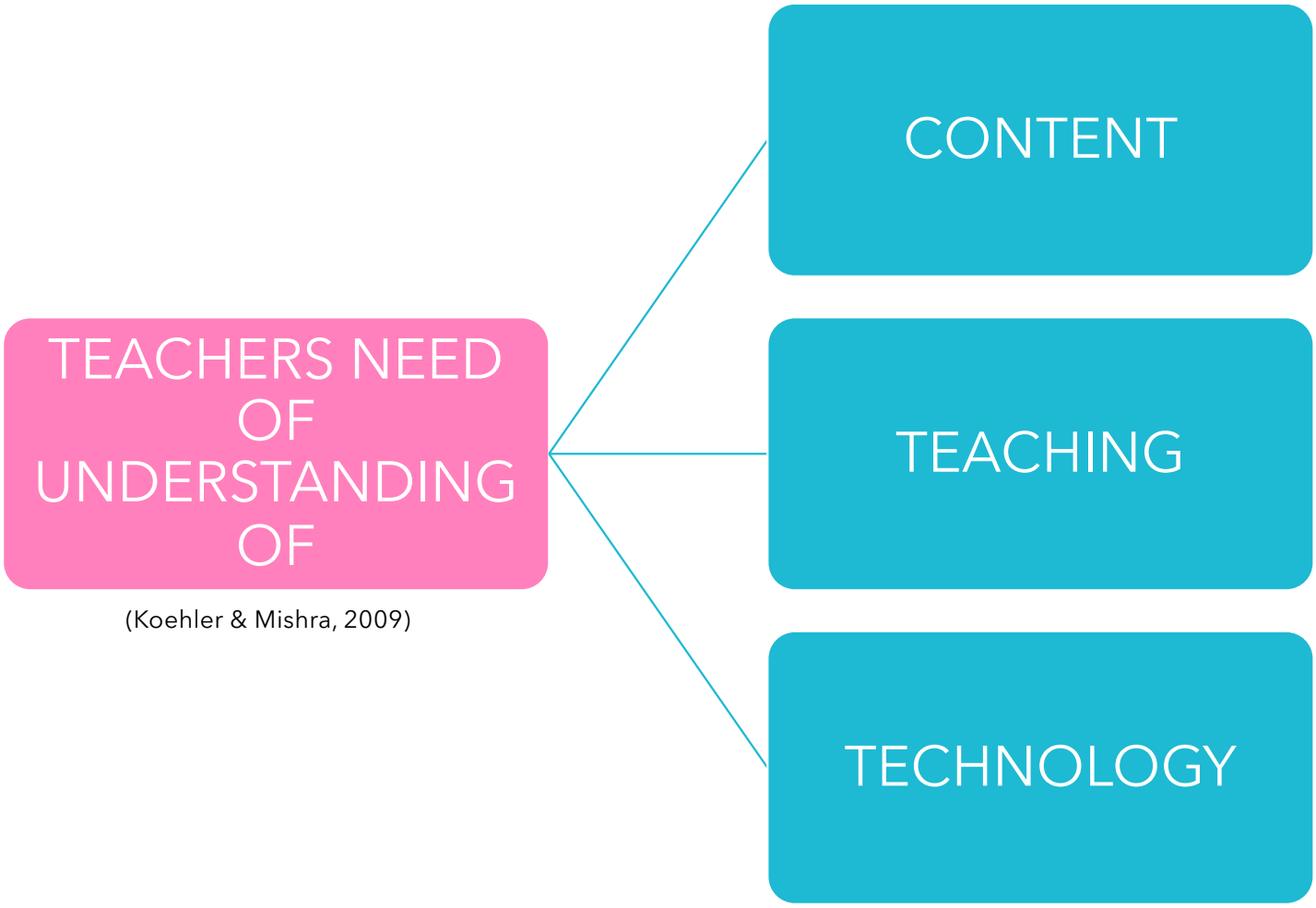
Integration efforts should be creatively designed or structured for particular subject matter ideas in specific classroom contexts.

(Koehler & Mishra, 2009)

TPACK

Each situation presented to teachers is a unique combination of these three factors, and accordingly, there is no single technological solution that applies for every teacher, every course, or every view of teaching. Rather, solutions lie in the ability of a teacher to flexibly navigate the spaces defined by the three elements of content, pedagogy, and technology and the complex interactions among these elements in specific contexts.

(Koehler & Mishra, 2009)

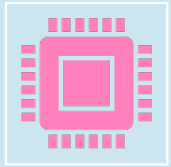


(Koehler & Mishra, 2009)

CONTENT- DRIVEN Knoweldge

use technology to teach a particular mathematical concept or area, such as functions, or algebra

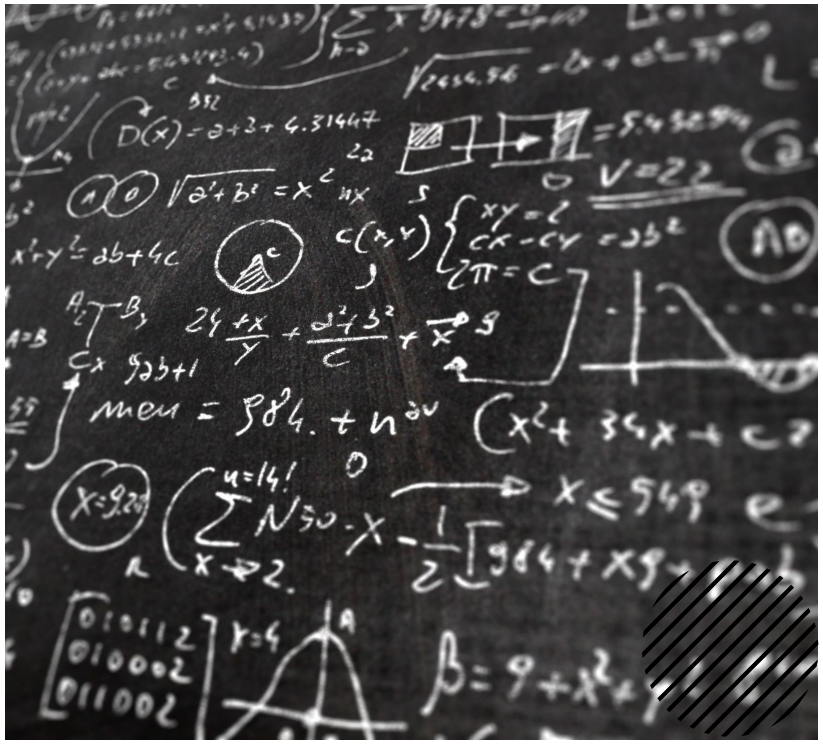
OR BOTH?



TOOL- DRIVEN knowledge

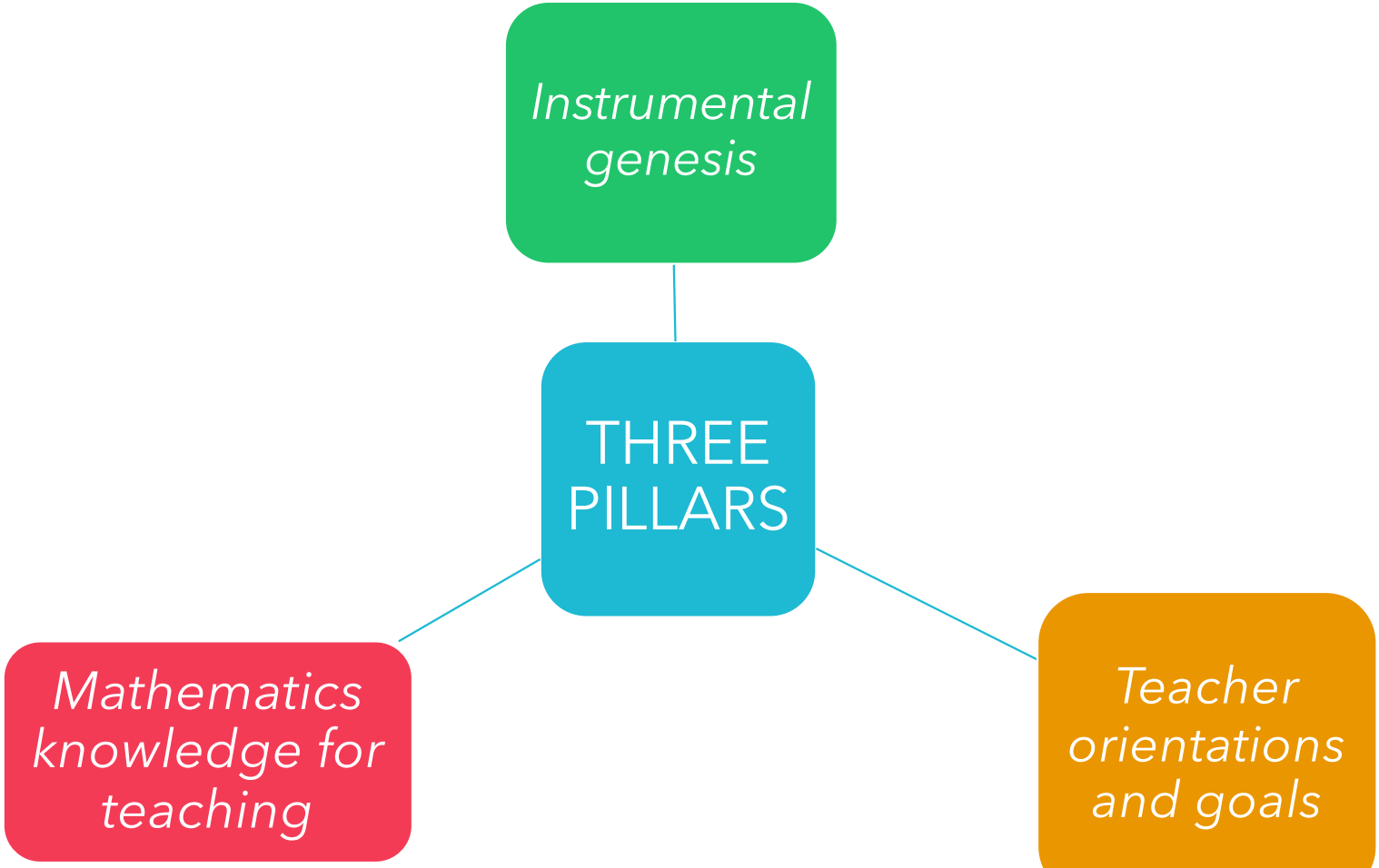
use a particular piece of software, such as the Computer Algebra System (CAS), Dynamic Geometry Environment (DGE) or spreadsheets (such as Excel)

(Tabach, M. & Trgalová, J., 2019)



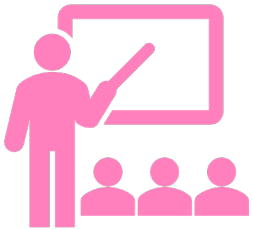
TPACK FRAMEWORK IS NOT CONTENT-SPECIFIC

- DOES **TPACK** FRAMEWORK SATISFY THE REQUIREMENT OF BUILDING MATHS TEACHERS' PREPARATION KNOWLEDGE TOWARDS TECHNOLOGY INTEGRATION?



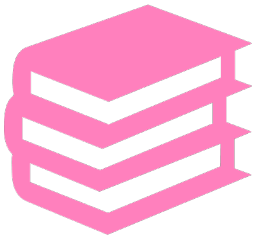
(Tabach, M. & Trgalová, J., 2019)

INSTRUMENTAL GENESIS (Haspekian, 2011)



Personal

Teachers must first acquire basic skills to master the specific technology they intend to use and develop utilization schemes related to this technology



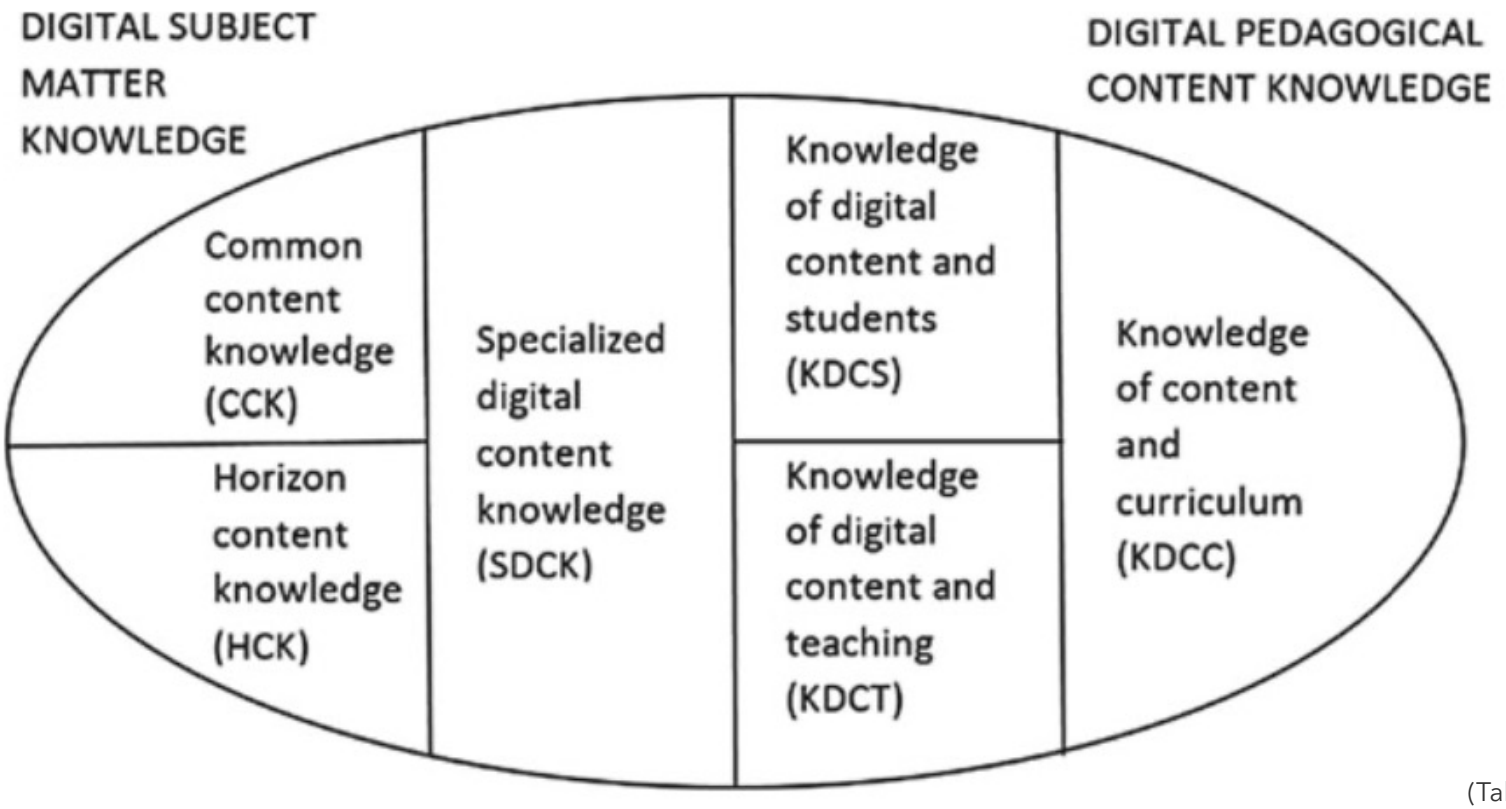
Professional

Teachers must also develop their understanding of how to support students' mathematics learning in a digital environment

ONLY MATHS TEACHERS!

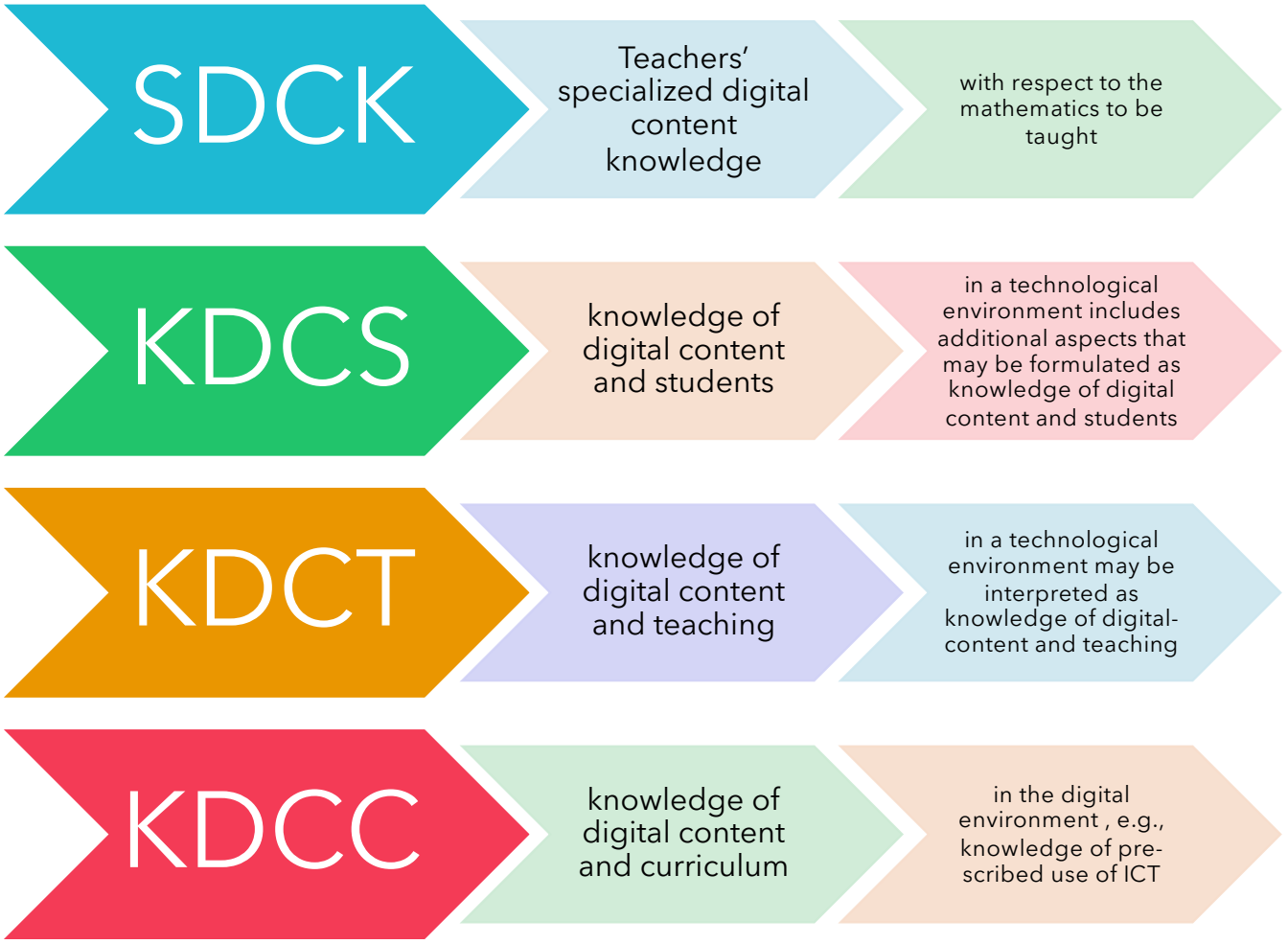
(Tabach, M. & Trgalová, J., 2019)

FROM Mathematical Knowledge for Teaching TO MDigitalKT



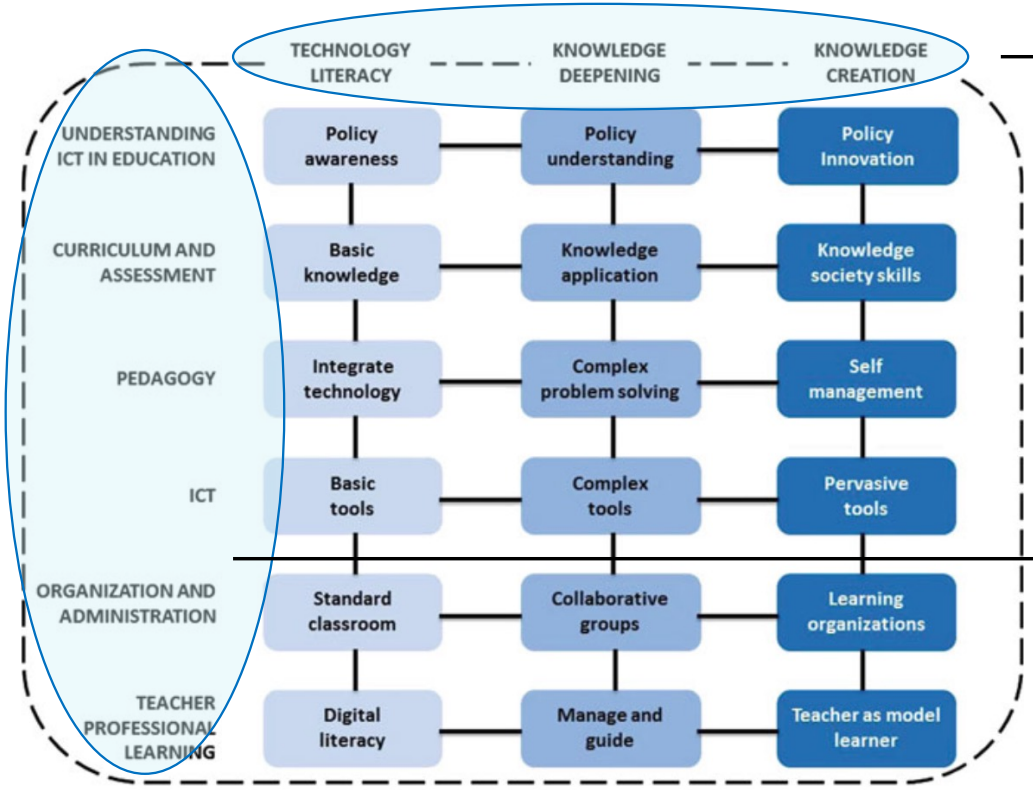
(Ball et al., 2008)

(Tabach, M. & Trgalová, J., 2019)



(Tabach, M. & Trgalová, J., 2019)

Teacher ICT (Information and Communication Technology) Competencies



The UNESCO ICT competency framework for teachers (UNESCO, 2011, p. 13)

Three different approaches to teaching (three successive stages of a teacher's development)

Aspects of a teacher's work

Technology Literacy

Enabling students to use ICT in order to learn more efficiently

Knowledge Deepening

Enabling students to acquire in-depth knowledge of their school subjects and apply it to complex, real-world problems

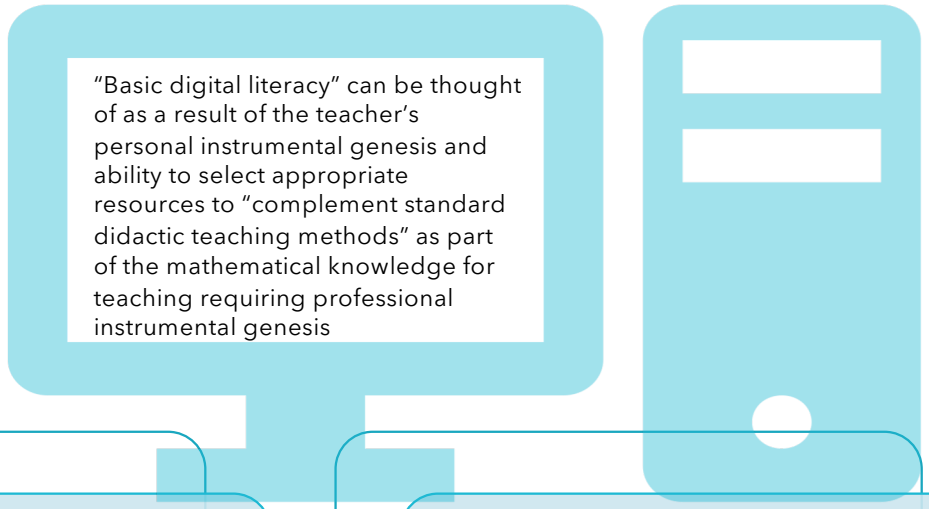
Knowledge Creation

Enabling students, citizens and the workforce they become, to create the new knowledge required for more harmonious, fulfilling and prosperous societies

(UNESCO, 2011-2017)

Technology Literacy

It regards TPK



basic digital literacy skills and digital citizenship

ability to select and use appropriate off-the-shelf educational tutorials, games, drill-and-practice software, and web content in computer laboratories or with limited classroom facilities to complement standard curriculum objectives, assessment approaches, unit plans, and didactic teaching methods.

use ICT to manage classroom data and support their own professional learning

The continuous instrumental genesis of teachers, both personal and professional

(UNESCO, 2011-2017; Tabach, M. & Trgalová, J., 2019)

Knowledge Deepening

Teachers' mathematical knowledge for teaching with technology

> teacher competences… include the ability to manage information, structure problem tasks, and integrate open-ended software tools and subject-specific applications [SDCK] with student-centred teaching methods and collaborative projects in support of students' in-depth understanding of key concepts and their application to complex, real-world problems [KDCS]. To support collaborative projects, teachers should use networked and web-based resources to help students collaborate, access information, and communicate with external experts to analyze and solve their selected problems [KDCS]. Teachers should also be able to use ICT to create and monitor individual and group student project plans [KDCT], as well as to access information and experts and collaborate with other teachers to support their own professional learning (ibid., p. 11).

UNESCO, 2011-2017

(Tabach, M. & Trgalová, J., 2019)

Knowledge Creation Stage

Teachers…

will be able to design ICT-based learning resources and environments [KDCT]; use ICT to support the development of knowledge creation and the critical thinking skills of students [KDCS]; support students' continuous, reflective learning [KDCS]; and create knowledge communities for students and colleagues (ibid., p. 14).

UNESCO, 2011-2017

From TPACK to MDKT

There is a need for "content-specific ideas that address what students or teachers should know about using technology for learning mathematics"

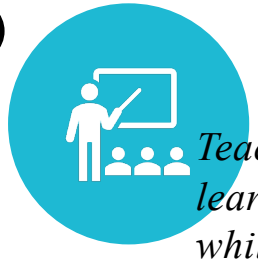
(Niess et al. 2009)

Designing and developing digital-age learning environments and experiences.

Teaching, learning and the mathematics curriculum

Assessment and evaluation

Productivity and professional practice



Teachers design and develop authentic learning environments and experiences while incorporating appropriate digital-age tools and resources to maximize mathematical learning in context.

Teachers implement curriculum plans that include methods and strategies for applying appropriate technologies to maximize student learning and creativity in mathematics.

Teachers apply technology to facilitate a variety of effective assessment and evaluation strategies.

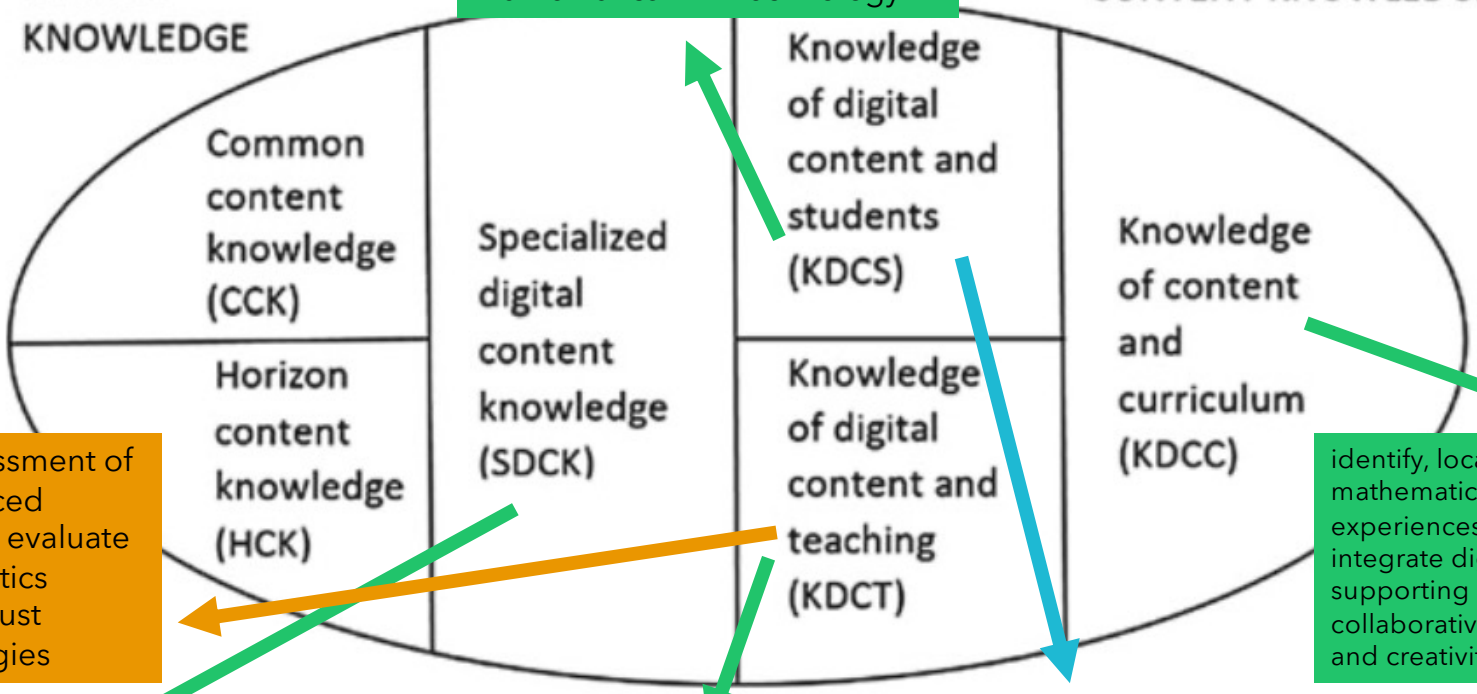
Teachers use technology to enhance their productivity and professional practice.

TEACHERS' TASKS

DIGITAL SUBJECT MATTER KNOWLEDGE

incorporate knowledge of all students' understandings, thinking, and learning of mathematics with technology

DIGITAL PEDAGOGICAL CONTENT KNOWLEDGE



use formative assessment of technology-enhanced student learning to evaluate students' mathematics learning and to adjust instructional strategies

identify, locate, and evaluate mathematical environments, tasks, and experiences in the curriculum to integrate digital technology tools for supporting students' individual and collaborative mathematical learning and creativity

facilitate technology-enhanced mathematical experiences that foster creativity

use technology to support learner-centred strategies that address the diverse needs of all students in learning mathematics, as these strategies help students become responsible for and reflect on their own learning

design appropriate mathematical learning opportunities that incorporate worthwhile mathematical tasks, based on current research and that apply appropriate technologies to support the diverse needs of all students in learning mathematics

Evaluate and reflect on the effective use of existing and emerging technologies to enhance all students' mathematical learning

Development of Habits

teachers are able to use the technology and recognize the alignment of the technology with mathematics content yet do not integrate the technology in teaching and learning of mathematics.

teachers engage in activities that lead to a choice to adopt or reject teaching and learning mathematics with appropriate technology.

teachers evaluate the results of the decision to integrate teaching and learning mathematics with an appropriate technology

teachers form a favourable or unfavourable attitude toward teaching and learning mathematics with appropriate technology.

teachers actively integrate teaching and learning of mathematics with an appropriate technology

# of mind and practices

(Tabach, M. & Trgalová, J., 2019)

- Teachers must first express an interest in using technology for teaching and learning mathematics in order to develop a positive attitude (personal orientation) toward it and use it for personal purposes (personal instrumental genesis leading to the development of SDCK). Only after that can they integrate technology in their professional practice (professional instrumental genesis).

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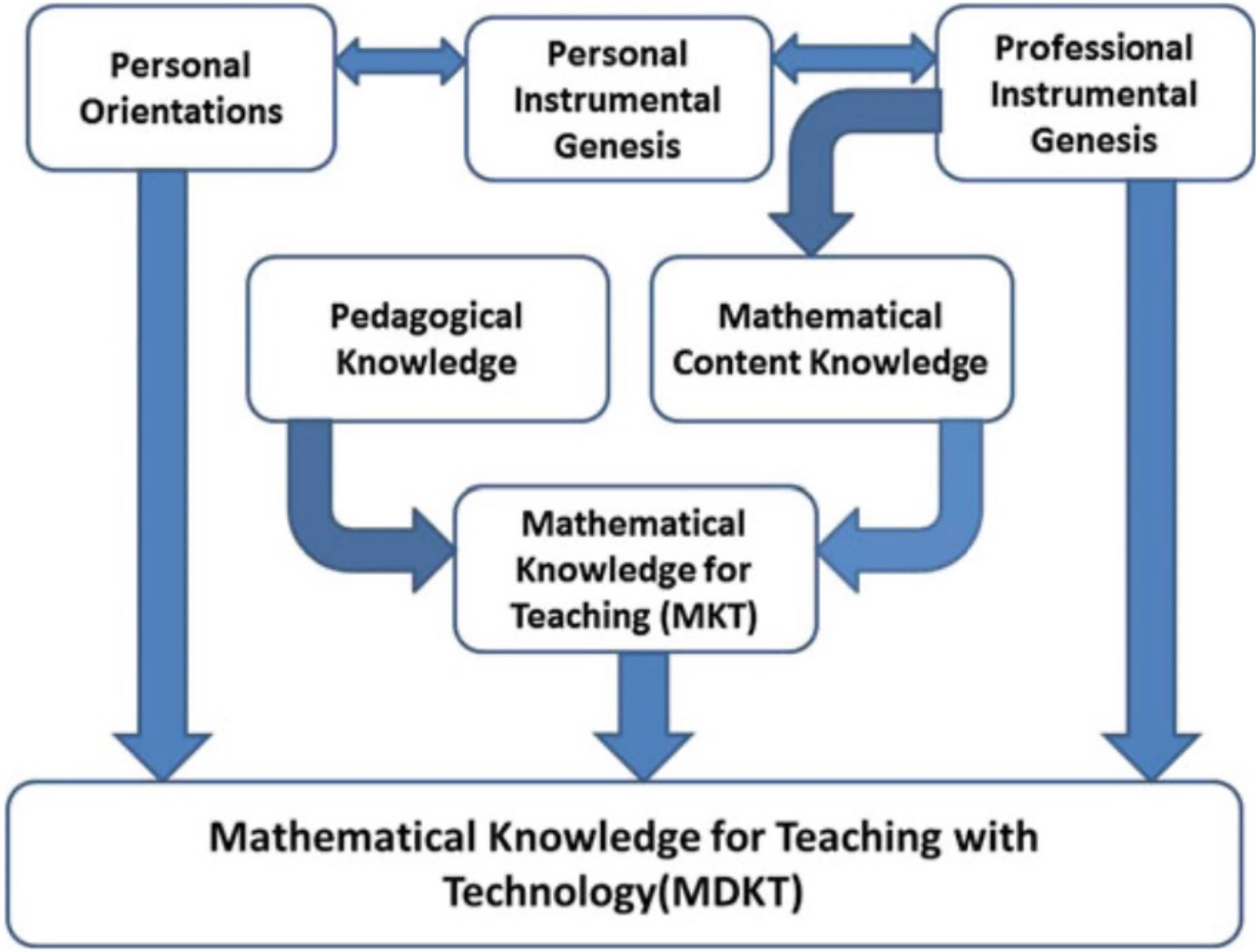

- Mathematical knowledge for teaching with technology (MDKT) framework

(Tabach, M. & Trgalová, J., 2019)