University of British Columbia
Vancouver, Canada

FACULTY OF EDUCATION

Department of
Curriculum and Pedagogy

Research in STEM Teacher Education: Examining teachers' knowledge

by Prof. Marina Milner-Bolotin

Science and Mathematics Education Research Group

SyMETRI: Science & Mathematics Education Teaching Inquiry

Faculty of Education Math and Science Research Group

UBC SyMETRI Seminar
April 2022

Teaching as a Transformation

The key to teaching anything is to remember what it was like not to understand that thing. That's a very hard thing to do. Every time you come to understand something you didn't understand before, you are transformed. You become a different person from who you were before. The key to teaching someone else to understand that same thing is to remember your former, untransformed self. If you can do that, I think you can teach anything, even physics.

David Goodstein

(A Creator of the Mechanical Universe)

Dr. Marina Milner-Bolotin

- **Professor** in Science Education, Department of Curriculum & Pedagogy, Faculty of Education, University of British Columbia (UBC), Vancouver, Canada
- **Studies how technology in STEM impacts learning**
- **STEM educator** (K-20) in Canada, US, and Israel
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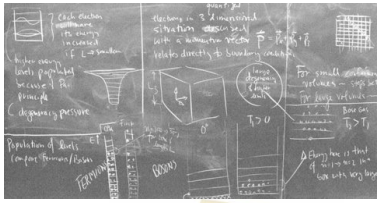
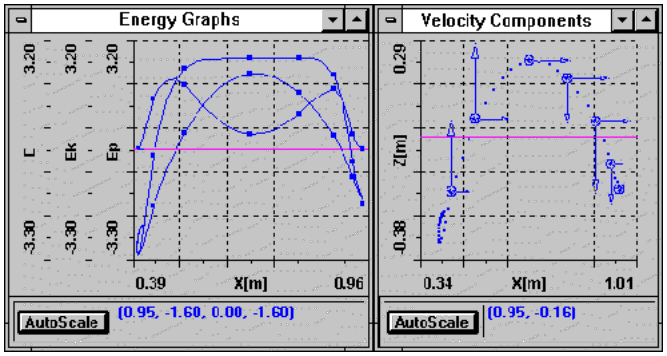
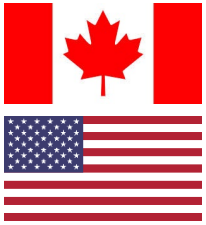
My Teacher Education Journey





V-scope



Dr. M.'s Blog

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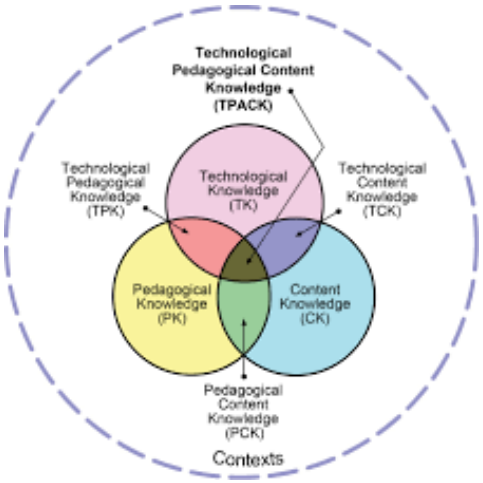
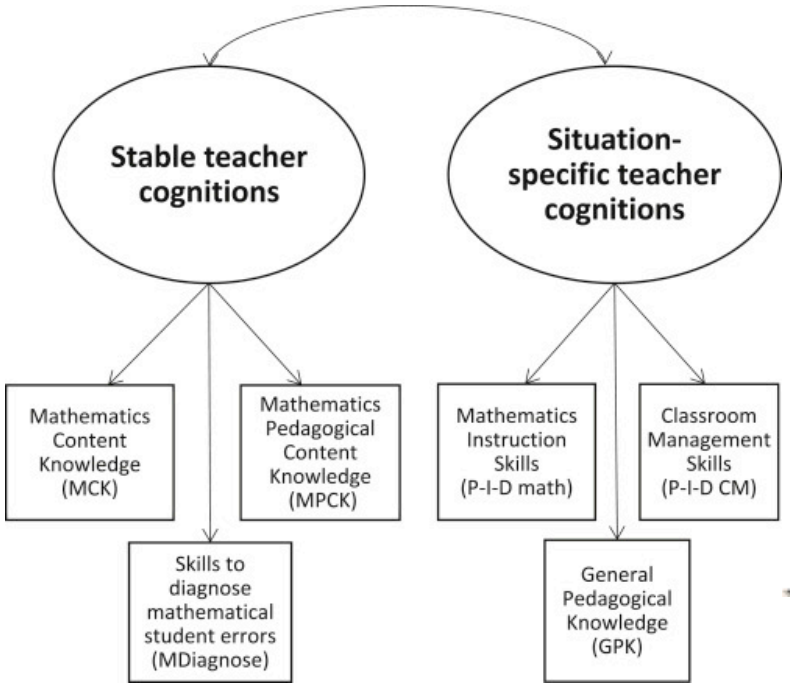
Big questions: Why? How? What?

1. *Why do we study teachers' knowledge?*
2. *How do we study it?*
3. *What do we do with the results?*

1 Why Do We Study Teachers' Knowledge?

Why do we study teachers' knowledge? Your suggestions.

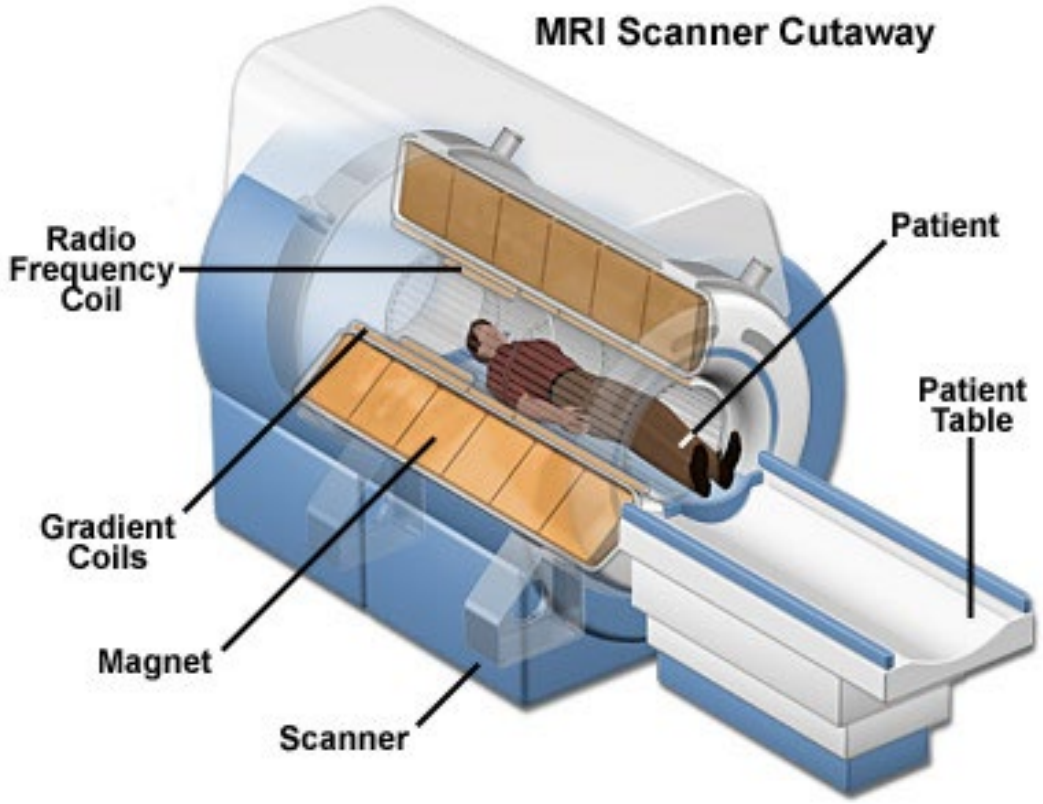




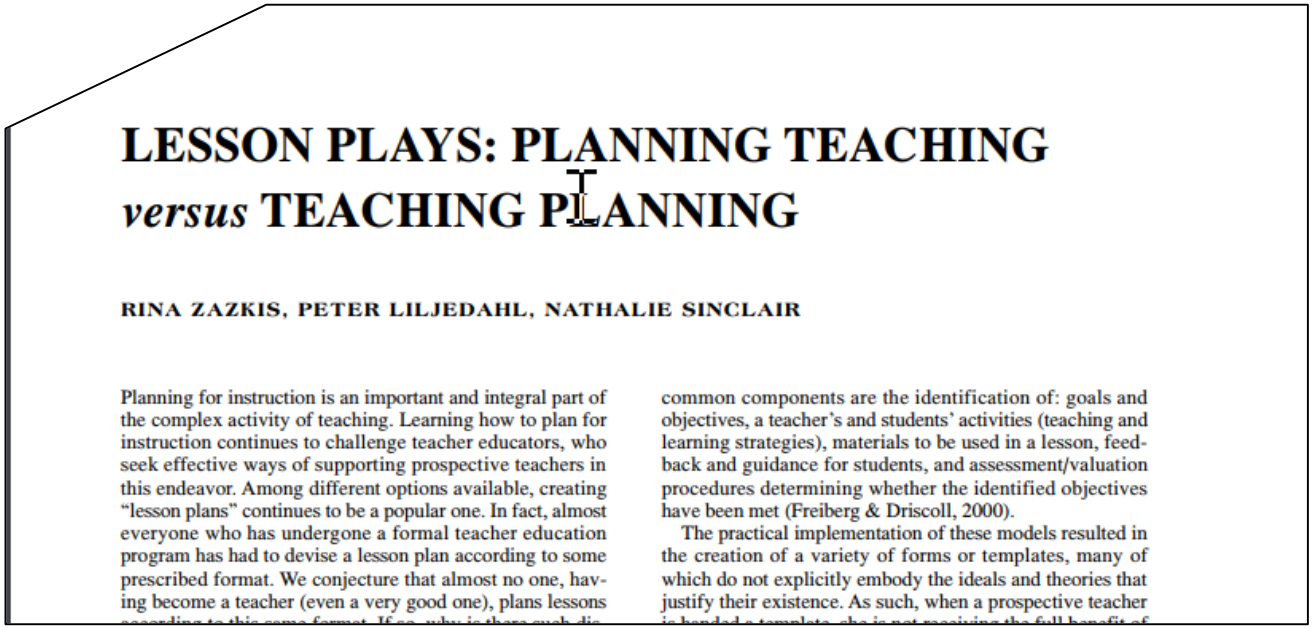
Blömeke, S., Busse, A., Kaiser, G., König, J., & Suhl, U. (2016). The relation between content-specific and general teacher knowledge and skills. *Teaching and Teacher Education*, *56*, 35-46. https://doi.org/https://doi.org/10.1016/j.tate.2016.02.003

2A How Do We Study Teachers' Knowledge?

How can we study teachers' knowledge? Your suggestions.



2A How Do We Study Teachers' Knowledge?



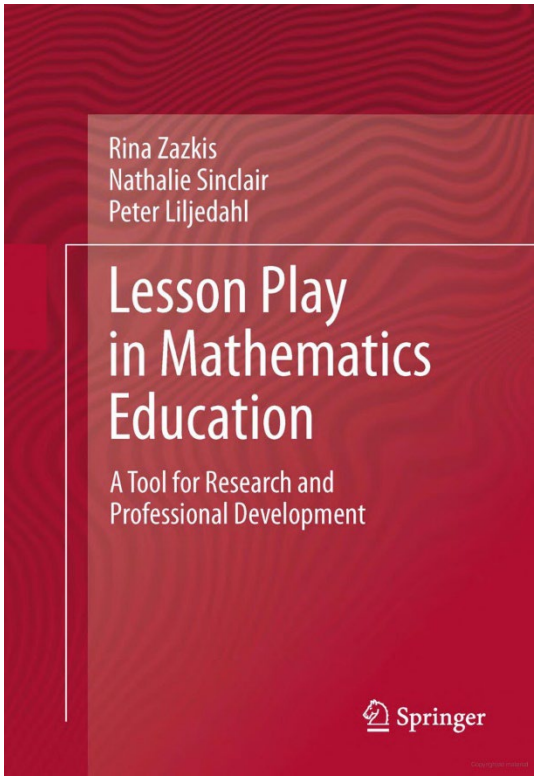
LESSON PLAYS: PLANNING TEACHING *versus* TEACHING PLANNING

RINA ZAZKIS, PETER LILJEDAHL, NATHALIE SINCLAIR

Planning for instruction is an important and integral part of the complex activity of teaching. Learning how to plan for instruction continues to challenge teacher educators, who seek effective ways of supporting prospective teachers in this endeavor. Among different options available, creating "lesson plans" continues to be a popular one. In fact, almost everyone who has undergone a formal teacher education program has had to devise a lesson plan according to some prescribed format. We conjecture that almost no one, having become a teacher (even a very good one), plans lessons

common components are the identification of: goals and objectives, a teacher's and students' activities (teaching and learning strategies), materials to be used in a lesson, feedback and guidance for students, and assessment/valuation procedures determining whether the identified objectives have been met (Freiberg & Driscoll, 2000).

The practical implementation of these models resulted in the creation of a variety of forms or templates, many of which do not explicitly embody the ideals and theories that justify their existence. As such, when a prospective teacher



Zazkis, R., Liljedahl, P., & Sinclair, N. (2009). Lesson plays: Planning teaching versus teaching planning. *For the Learning of Mathematics, 29*(1), 39-46.

Zazkis, R., Sinclair, N., & Liljedahl, P. (2013). *Lesson play in mathematics education: A tool for research and professional development*. Springer.

2B Scriptwriting as a window into teachers' K4T

	Lesson Plan	Lesson Play
Content	**Yes**	**Yes**
Pedagogy in action	Yes to some extent	**Yes**
Real-time T-S and S-S interactions	Maybe	**Yes**
Creative approaches	Maybe	**Yes**
Putting student learning first	Maybe	**Yes**
Zoom on student difficulties	Maybe	**Yes**
Ability to think of student questions	Maybe	**Yes**
Clear research connection	Rarely	**Yes**

Lesson Play takes more time than Lesson Plan, yet it is a "quality over quantity" balance... Sometimes less is more and other times it is much more.

2C Example: Future Physics Teachers' Knowledge of logs

Research Article LUMAT General Issue 2021

A study of future physics teachers' knowledge for teaching: A case of a decibel sound level scale

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[2] Faculty of Education, Simon Fraser University, Burnaby, Canada

This study examines future secondary physics teachers' knowledge related to the teaching of sound waves, and specifically the topics of sound level and sound intensity. The data is comprised of future teachers' responses to a task in which they had to compose a script for an imaginary dialogue between a teacher and a group of students and to provide a commentary elaborating on their instructional choices. The topics selected for the task were chosen intentionally as they provide authentic and rich opportunities to bridge mathematics and science concepts, while challenging future teachers to consider the logarithmic measurement scale and its role in science. The task provided the participants with the beginning of a dialogue that featured student confusion about the measurement of sound level using a decibel scale. Future physics teachers were asked to extend this dialogue through describing envisioned instructional interactions that could have ensued. The instructional interchange related to the relationship between sound intensity and sound level, and particular teachers' responses to the student ideas related to the meaning of a decibel sound level scale were analysed. These responses were categorized as featuring superficial or deep, and conceptual or procedural knowledge for teaching. We describe each category using illustrative excerpts from

ARTICLE DETAILS

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Milner-Bolotin, M., & Zazkis, R. (2021). A study of future physics teachers' knowledge for teaching: A case of a decibel sound level scale. *LUMAT: International Journal on Math, Science and Technology Education*, *9*(1), 336-365. https://doi.org/10.31129/LUMAT.9.1.1519

2C Example: Future Physics Teachers' Knowledge of logs

Physics 11: Exploration of sound and its properties

https://curriculum.gov.bc.ca/curriculum/science/11/physics

https://www.healthlinkbc.ca/health-topics/tf4173

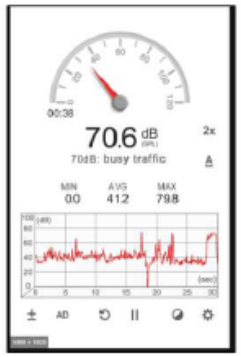
Play Setting: *The play is set in a Physics 11 classroom. The students have just finished the intro unit on waves and already had two introductory lessons on sound. They discussed the properties and behaviour of waves, sound characteristics, the phenomenon of resonance, how waves are generated and how they propagate. When the teacher entered the classroom the following week, she noticed a group of students arguing excitedly in the corner about the sound level at the concert they just attended over the weekend:*

Student 1: I had a huge headache after the last Saturday's concert. I had my smartphone app and it measured the sound level there to be 91 dB. This was hurting my ears and my head for the entire Sunday. I still feel it.

Student 2: I have read that sound levels that are above 85 dB are harmful to humans, so this is understandable, but that harmful? 91 dB is less than 10% higher than the threshold. So 91 dB should not be such a big deal.

Student 3: It doesn't make sense! I am very confused with this dB thing. What is it? I have a Sound level app on my smartphone. But what do these measurements mean? This is so confusing.

Teacher: This is an interesting conversation. This is a great opportunity to discuss the concept of sound level and what it means…



Roles:

Teacher: A very thoughtful and inspiring new physics teacher

Student 1: _____

Student 2: _____

Student 3: _____

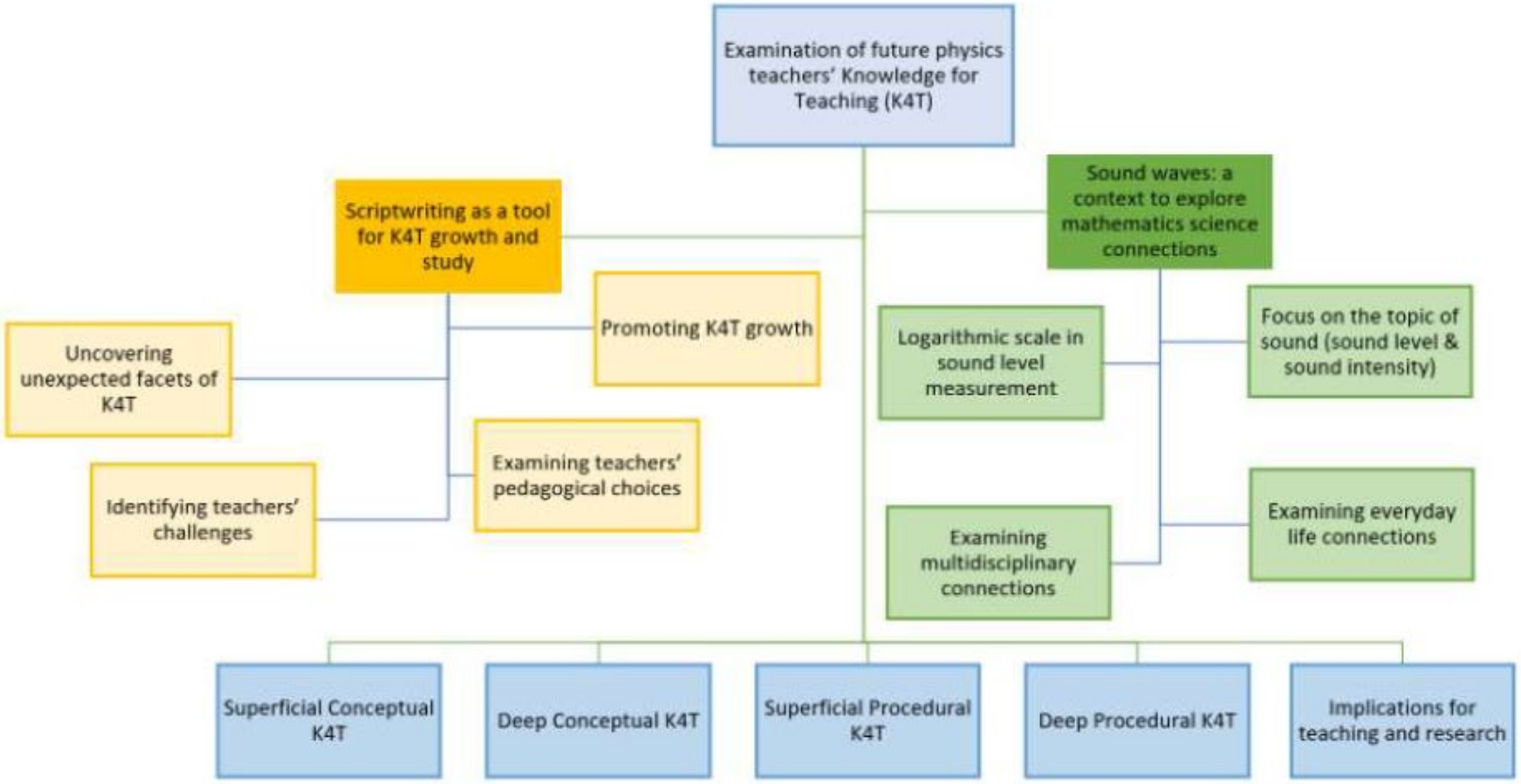
Additional characters: _____

Figure 1. A scripting task on the topic of sound implemented in the study

Assignment for future physics teachers:

1. How do you understand the concept of sound level? The way you understand the idea yourself could be different from the way you explain it to students. If this is the case, please indicate how you could clarify the issue to yourself, or to another physics teacher.
2. What are key physics concepts students need to acquire to understand the concept of sound level and how it is measured?
3. What are potential student difficulties, misconceptions or alternative conceptions?
4. How might a teacher help students understand these concepts? What pedagogical approaches would you recommend and why?
5. What resources did you use to write your Lesson Play that helped you figure it out? (Research papers, pedagogical forums, websites, etc.)

2C Results

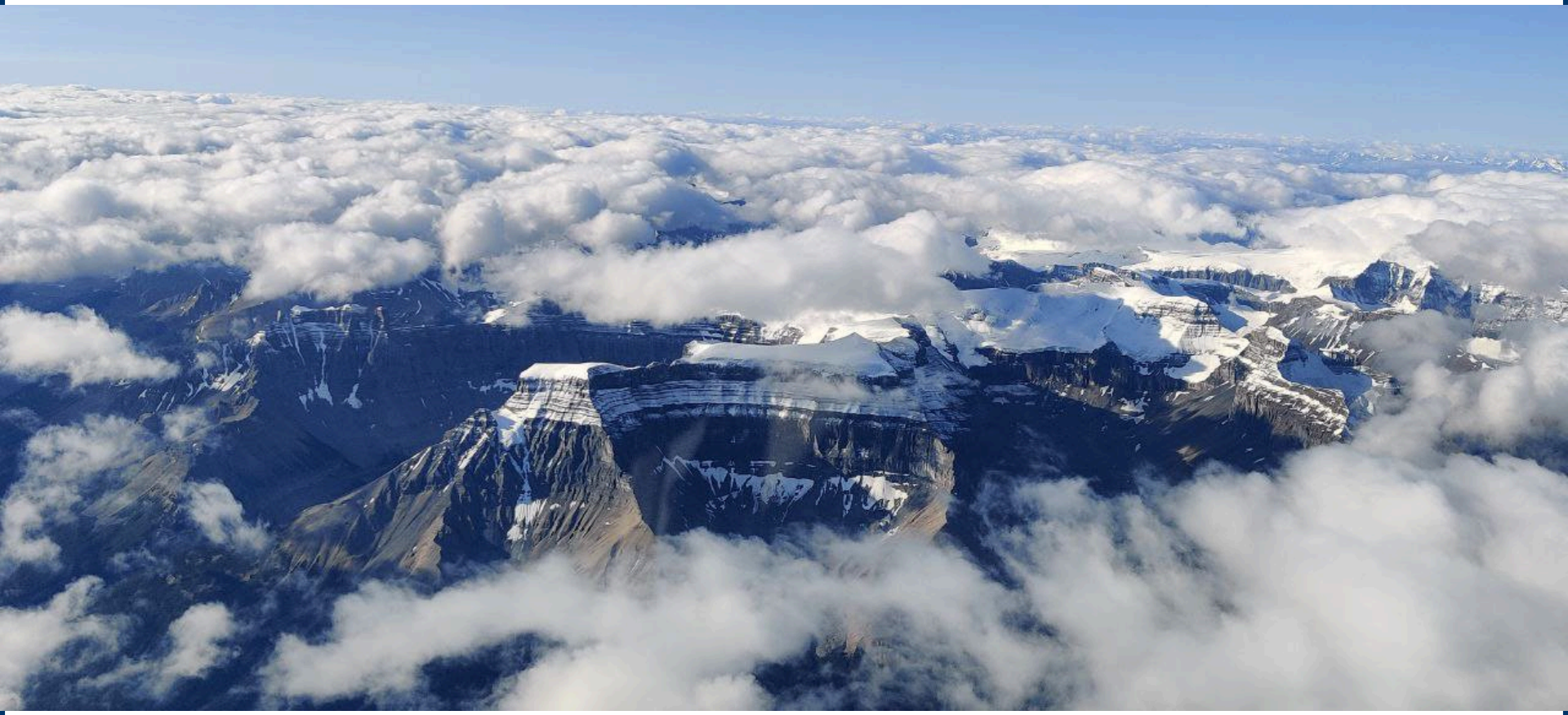

Examination of future physics teachers' Knowledge for Teaching (K4T)
Scriptwriting as a tool for K4T growth and study
Promoting K4T growth
Uncovering unexpected facets of K4T
Examining teachers' pedagogical choices
Identifying teachers' challenges
Sound waves: a context to explore mathematics science connections
Logarithmic scale in sound level measurement
Focus on the topic of sound (sound level & sound intensity)
Examining multidisciplinary connections
Examining everyday life connections
Superficial Conceptual K4T
Deep Conceptual K4T
Superficial Procedural K4T
Deep Procedural K4T
Implications for teaching and research

3 What Do We Do With the Results?

Scriptwriting

1. helps us reveal gaps in teachers' knowledge and develop interventions to address it
2. helps teachers imagine interactions with teachers and appreciate potential difficulties
3. is a powerful tool in STEM teacher education or in teacher professional development
4. encourages teachers to use STEM education research in their practice.
5. encourages researchers to look at the hidden nooks and crannies of teacher knowledge that are rarely visible

Your QUESTIONS



Canadian Rockies

Phyphox is designed by Sebastian Staacks and Physics Educators at the University of Aachen,

I am a physicist with a PhD in solid state physics at the RWTH Aachen University, where I develop the app "phyphox" and come up with strange ways to use smartphone sensors in physics education.

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Physics Phone Experiments
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