ICSE Academy

Diversity and inclusion in STEM
Session 3
Analysing Inclusive Classroom Practices
30-04-2024

Designing team: Katerina Bogiatzi, Despina Potari, Babis Sakonidis, Vassiliki Spiliotopoulou

ICSE Academy
Co-funded by the European Union
(Place for another logo)
Pädagogische Hochschule Freiburg
Université des Sciences de l'Education · University of Education
ICSE International Centre for STEM Education

Recall Session 2

- Diversity in cognitive ability, multiculturality & gender related STEM
- Designing STEM tasks to promote inclusion
- Classroom context and possible interventions

AIM

- To promote awareness of
  - theoretical ideas and practices while **implementing** and **evaluating** inclusive STEM lessons
  - the affordances, constraints and challenges of such lessons

Plenary lecture

PROGRAM OF THE SESSION

Introduction (5 minutes)

Plenary sharing (40 minutes)

- Reflecting and reporting on your designs
- Emerging issues

Break (15 minutes)

Plenary lecture: (10 minutes)

- Research informed pedagogical practices

Working Groups (20 minutes)

- Collective work based on a reflective tool

Plenary closure (10 minutes)

- Summing up emerging issues from WG and take home messages.

Homework – Plenary (5 minutes)

Reflecting on your experiences (40 minutes)

- Which aspects of diversity (cognitive ability, multiculturality & gender) related to STEM have you chosen? Give reason for your choice.
- What kind of tasks have you organized for your classroom to address diversity?
- What difficulties have you met in designing the lesson or in enacting it?

The collaborative groups will prepare a 4-5 minutes presentation around these three points (2-3 slides)

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BREAK
15 minutes

Plenary Lecture – Working groups – Summing up

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Example 1. An idea for diverse classrooms: the Photovoice (Harper, 2017)

- Photovoice is an arts-based participatory action research methodology (Chinn, & Balota, 2023)
- The use of photovoice allows participants to express their ideas, experiences, and emotions about a topic through photographic language (Gaboardi, 2022)

Engaging Karen refugee students in science learning through cross-cultural learning community

- Students were given the following prompt: Take photos of your culture and science at home.
- The following questions were asked in the focus group:
  - Pick out your favourite photo. What do you see? Why is this one your favourite?
  - Pick out your best science photo. What do you see? Why is this photo important?
  - Pick out your best culture photo. What do you see? Why is this important?

Sharing Cultural experiences related to STEM

- The visual language for sharing students' culture and science at home

Lucy and Hannah were always in a small group with Lily unless you separated them. Lily's social fearlessness gave them courage, I believe, at the beginning of the program. Unlike Lily, Lucy and Hannah were shy, almost withdrawn. With Lucy, this developed into a quiet confidence. For Hannah, the shyness lingered until the end. Although at the Karen Christmas celebration, Hannah was racing around in flip flops in the freezing rain, and plainly having a great time! I will always remember her bright wet face smiling up at Mark and myself as we trekked along from the church to the wide field where Karen children were running everywhere in groups, laughing and trying to climb a greased pole to claim the $20 prize at the top. Lucy was our teachers' surprise at the end of the program; she blossomed as a science learner who could focus on the problem at hand and try different approaches until she was satisfied with the result. She was the teachers' helper, distributing snack for us so that all of the students, even the late-comers in Fit Club, could have something. She watched James to make sure he didn't put handfuls of the pineapple candies away in his pockets. During game time and group learning, Lucy and Hannah were not the first to call out answers or volunteer for responsibility, but when they focused on a project, like the aquifer project, they gave it their full attention and expected to discover something amazing!

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Example 2: Connecting multiple representations

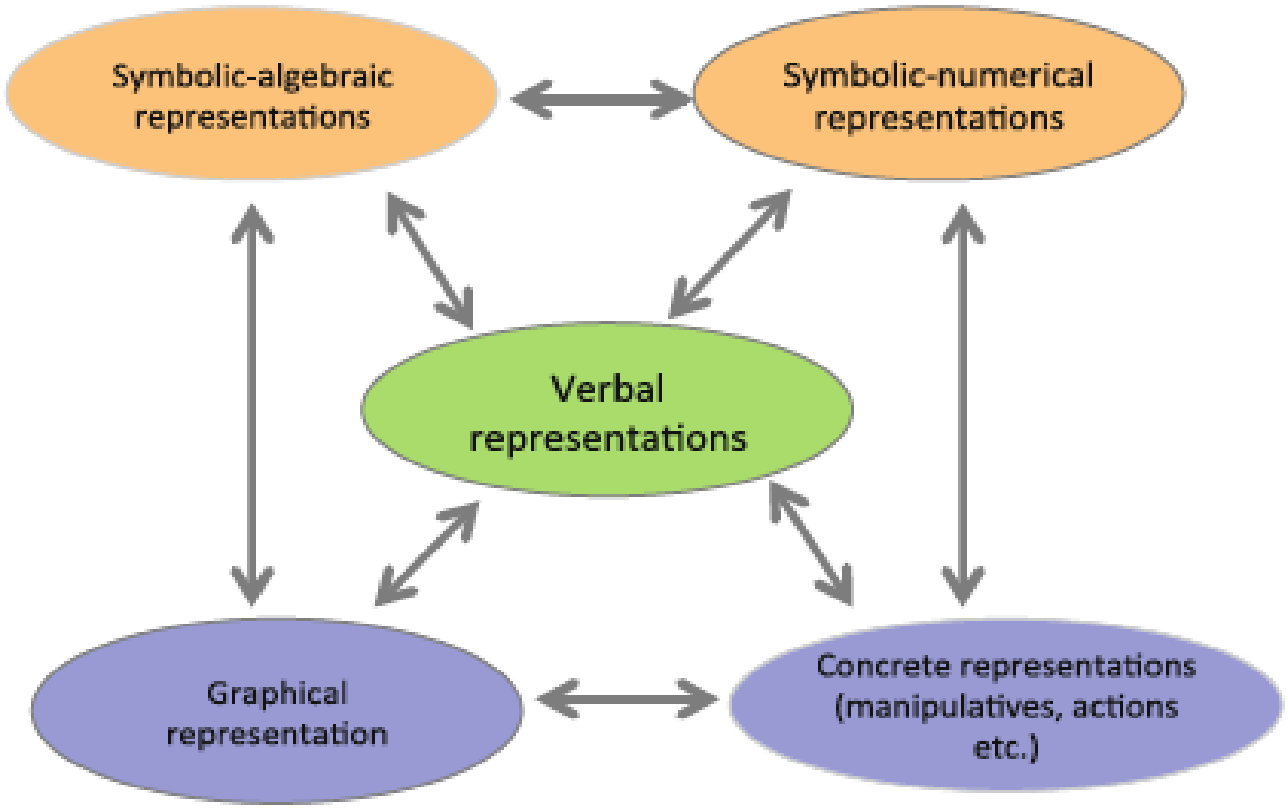
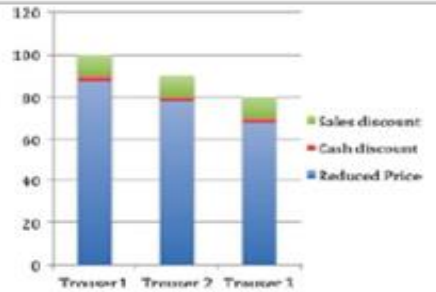
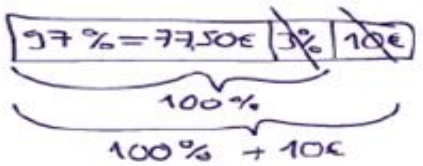


Fig. 2.1 Different forms of representation (Prediger, Clarkson, & Bose, 2015)

Example 2: Transitions among mathematical representations and linguistic registers for a word problem involving the use of percentages

<table>
<tr><th></th><th>Everyday register</th><th colspan="5">School register</th><th colspan="4">Technical register</th></tr>
<tr><td>Representation in words</td><td>Yesterday I was at a sale, in my favourite shop. The sale meant I received a 10 € discount for the trousers. Since I paid in cash, the sales clerk gave me another discount of 3 %. In all I only paid 77.50 €. How much was the original price?</td><td colspan="5">In a sale, a pair of trousers was reduced by 10 €, and further 3 % discount was offered if you paid in cash. Hence, the final price was 77.50 €. What was the original price of the trousers?</td><td colspan="4">If the original value is reduced by 10 € and then by 3 %, the new value is 77.50 €. What was the original value?</td></tr>
<tr><td>Graphical representation</td><td> 
</td><td colspan="5"> 
</td><td colspan="4"> 
</td></tr>
<tr><td>Symbolic-numerical representation</td><td>–</td><td></td><td>Original price (€)</td><td>Price with sales discount (€)</td><td>Price with 2nd discount (€)</td><td></td><td>Base value</td><td>First reduction</td><td>Second reduction</td></tr>
<tr><td></td><td></td><td>Trouser 1</td><td>100</td><td>90</td><td>87.30</td><td>Trial 1</td><td>100</td><td>90</td><td>87.3</td></tr>
<tr><td></td><td></td><td>Trouser 2</td><td>90</td><td>81</td><td>78.57</td><td>Trial 2</td><td>90</td><td>82</td><td>78.57</td></tr>
<tr><td></td><td></td><td>Trouser 3</td><td>80</td><td>72</td><td>69.84</td><td>Trial 3</td><td>80</td><td>72</td><td>69.84</td></tr>
<tr><td>Symbolic- algebraic representation</td><td>–</td><td colspan="5">–</td><td colspan="4">$(G-10€)\times 0.97=77.50€$</td></tr>
</table>

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Example 3: Girls' involvement in a community collaboration authentic project (Burrows, Lockwood, Borowczak, Janak, & Barber, 2018)

- **The context**
  - STEM as an interdisciplinary field in which the disciplines strengthen and support each other (not as separate science, technology, engineering, and mathematics disciplines)
  - Middle school female students (aged 9–15 years),
  - Informal educational setting (i.e., Girl Scouts)
  - A research project, an open-ended & complex problem: investigating water quality following the river's restoration.

The scenery

- The Girl Scout group, led by university educators and involving community members, created a research project investigating the success of the Laramie River Restoration that was completed in 2012.
- The restoration site is located within the city limits of Laramie, and a primary goal of the project was to allow the scouts the ability to “be” scientists, and to have a voice
- With guidance, the scouts posed a research question and generated testable alternatives and null hypotheses.
- To test these hypotheses, the scouts decided to compare macro-invertebrates’ diversity, riparian height, canopy cover, particle size, and river velocity between a control site and restored site.

Adopting engineering practices

- The Girl Scouts studied during this project by learning STEM through eight science and engineering practices (NRC)
    - Asking Questions and Defining Problems
    - Developing and Using Models
    - Planning and Implementing Investigations
    - Analyzing and Interpreting Data
    - Using Mathematics and Computational Thinking
    - Constructing Explanations and Designing Solutions
    - Engaging in Evidence-Based Arguments
    - Obtaining, Evaluating, and Communicating Information

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The phases of the project

Girl Scouts in Science Discovering
WYOMING WATER

The impact of stream restoration on the Laramie River: A research project by Laramie Girl Scouts

OVERVIEW:
- We examined the impact of stream restoration on the Laramie River
- Our research project followed the process of science
- Each poster will cover different stages of the scientific process and our research

Scientific Process
Define question
Gather information
Generate hypotheses
Design study
Collect data
Analyze
Interpret data
Draw conclusions
Disseminate results
Ask new questions

Define question:
Was the Laramie River Restoration successful?

Gather Information:
Tony Hoch from the Laramie Rivers Conservation District told us about the Laramie River and the Restoration Project.


Before

After

Generate testable hypotheses:
- Null Hypothesis: The River Restoration had **no impact** on the quality of the river
- Alternative Hypothesis$_1$: The River Restoration **reduced the quality** of the river
- Alternative Hypothesis$_2$: The River Restoration **improved the quality** of the river

(a)

Girl Scouts in Science Discovering
WYOMING WATER

The impact of stream restoration on the Laramie River: A research project by Laramie Girl Scouts

Design study:
In addition to the restoration section of the river we examined a section that had not been changed.
This site served as our Control Site.


Control


Restored

We selected several types of data to compare sites:

General data:
- Water velocity
- Stream depth
- % canopy cover
- Mean particle size
- Mass of algae
- Mass of terrestrial organic matter

Invertebrate data:
- Density of invertebrates
- Density of EPT
- Family richness
- EPT richness

EPT: Most mayflies (Ephemeroptera), stoneflies (Plecoptera) & caddisflies (Trichoptera) are sensitive to ecosystem quality making them great indicators of stream health

Collect data:
We collected these data from both our Control and Restored site

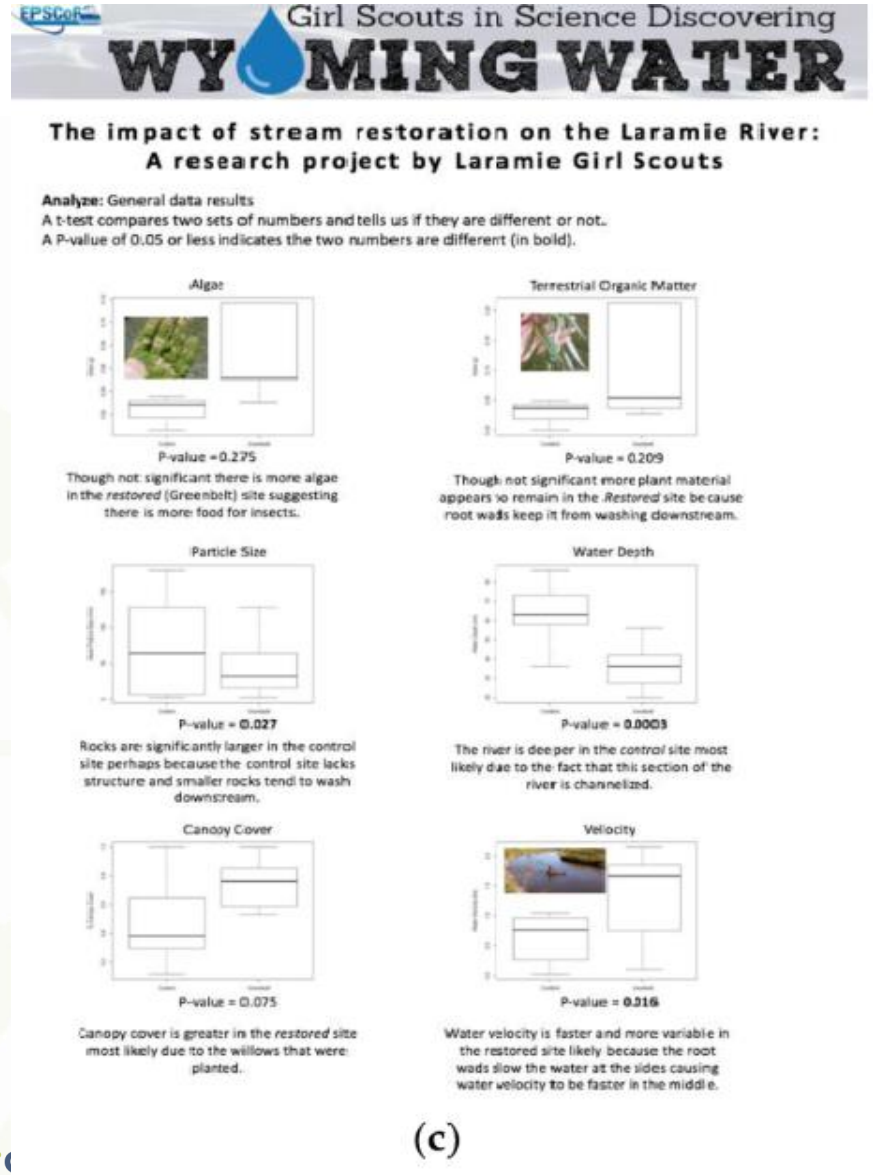

Measuring rocks (Mean particle size)

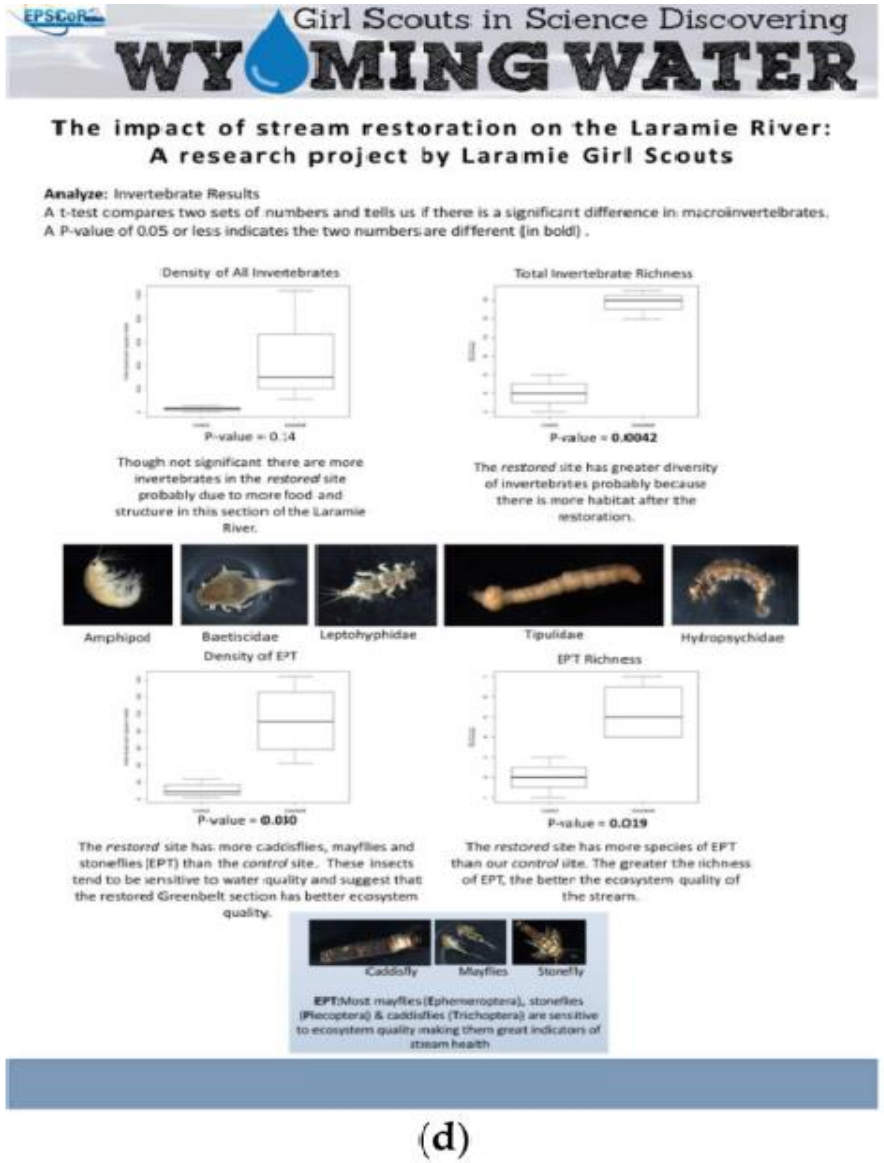

This is fun!


Using the Hess sampler to collect invertebrates

(b)

The phases of the project





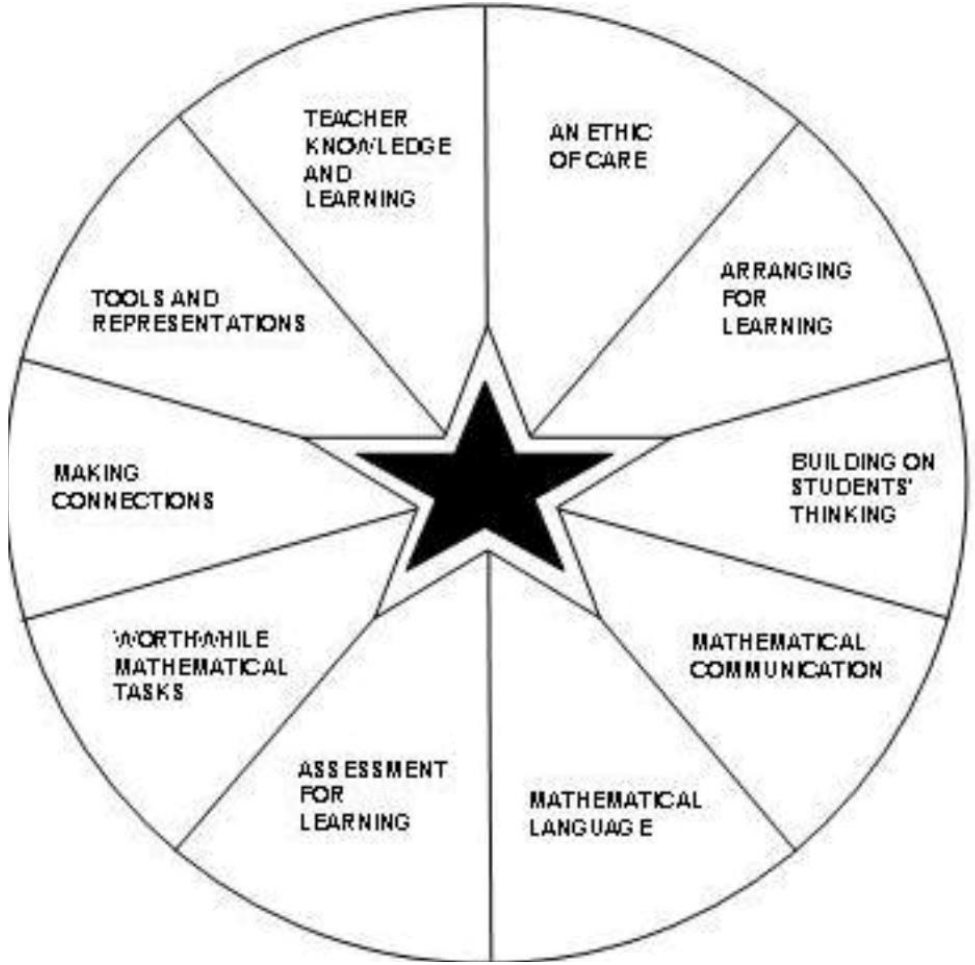
Effective Teaching Practices from Anthony and Walshaw (2009)

Teaching is an evolving network involving the school, the wider education system, and the home and local community.

All students can become powerful mathematical learners

Teachers aim to develop students' mathematical (STEM) and cultural identities (ethic of care). They

- provide students opportunities to work individually and collaboratively (arranging for learning)
- facilitate classroom dialogue supporting mathematical argumentation (building on students' thinking – mathematical communication)
- model appropriate terms and communicate their meaning to promote students' understanding (mathematical language)
- select appropriate tasks (worthwhile mathematical tasks)
- **support students to make connections among different topics, contexts, representations (making connections, tools and representations)**
- develop appropriate knowledge



Scheme for reflection (complete the table)

Plenary lecture

Questions	Comments
What aspects of diversity have been addressed? (culture, gender, disadvantaged, other)	
How has the STEM perspective been expressed? (Mathematics-Science, Mathematics-Engineering, workplace, Design/construction)	
What pedagogical practices have been adopted? (Students' background/prior experiences, multiple forms of assessment, classroom dialogue)	

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Scheme for reflection

Plenary lecture

Which resources have been used? (videos, glossaries, examples, problem/ project- based materials, cultural elements/values)	
What specific teaching ideas have been employed to promote diversity in STEM learning ? (Underrepresented/diverse scientists, discussion with scientists, women, people of colour, engineering design process, building a prototype, hands-on materials, multiple representations, take into account local community)	

Collective Reflection in break out rooms (20 minutes)

- Use the suggested scheme to discuss about the following questions
  - To what extent have you adopted one of the ideas in your designs?
  - What changes would you consider to adopt in your designs and why?

Report on the Google document link

https://docs.google.com/spreadsheets/d/1ZbNWDD8_9Xd631Qzd7oVdYi2RSUgxigVdRJ4oI9RjxI/edit#gid=0

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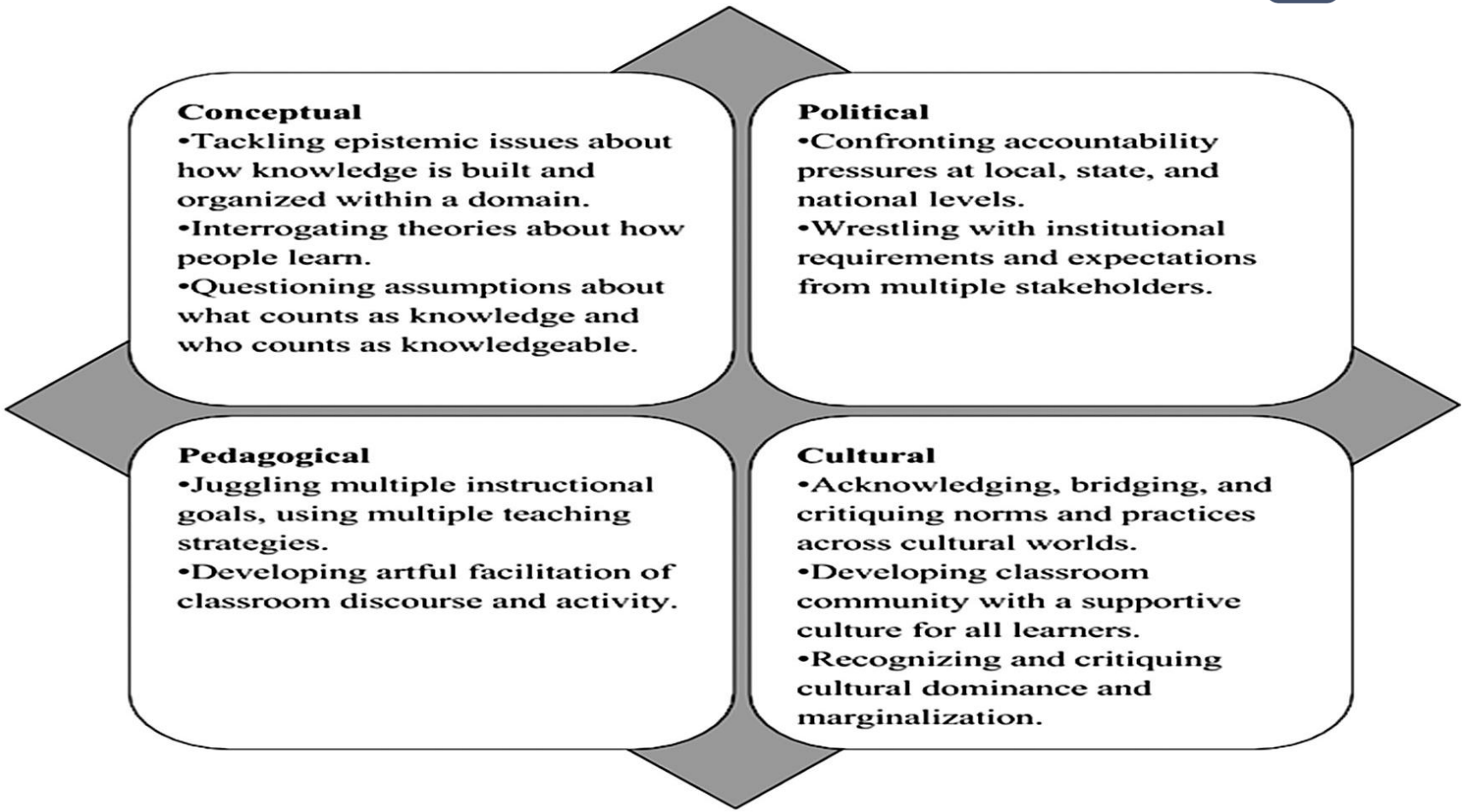
Plenary Closure (10 minutes)

Identify constraints and affordances of implementing these practices in relation to the following dimensions:



What the teacher needs to take in to account in diverse classrooms (Braaten & Sheth, 2017; Windschitl, 2002)

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HOMEWORK

- Write a short reflection on your learning experience (up to 200 words)
  - Indicate two messages from cluster 2 that you would like to keep practising in your classroom.
  - Explain in what ways these messages will meet students' diverse needs.
- Share your reflection on the Moodle platform .

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