Paired teaching approach to earthquake education: A cross-country comparison between Dushanbe, Tajikistan and London, United Kingdom

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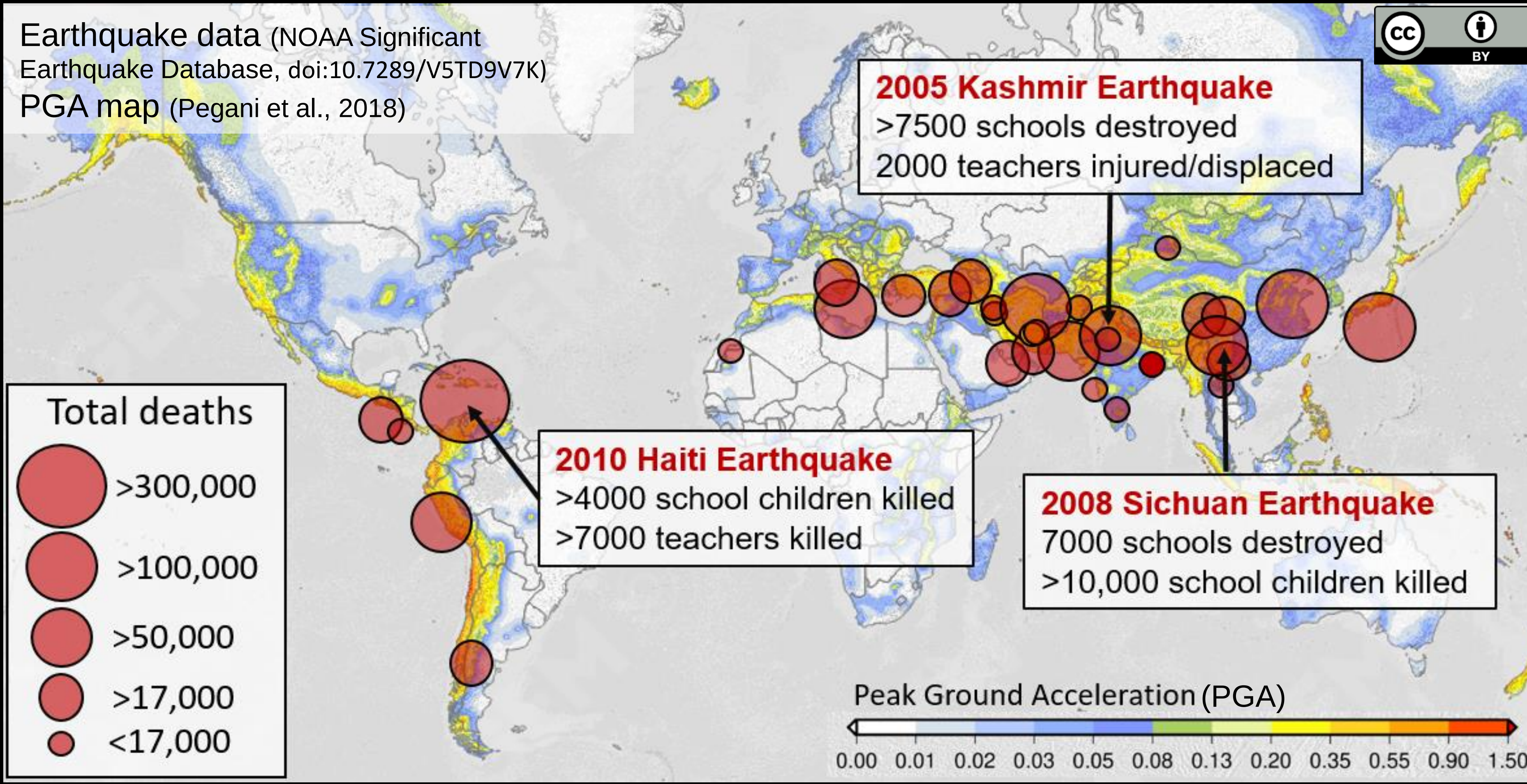


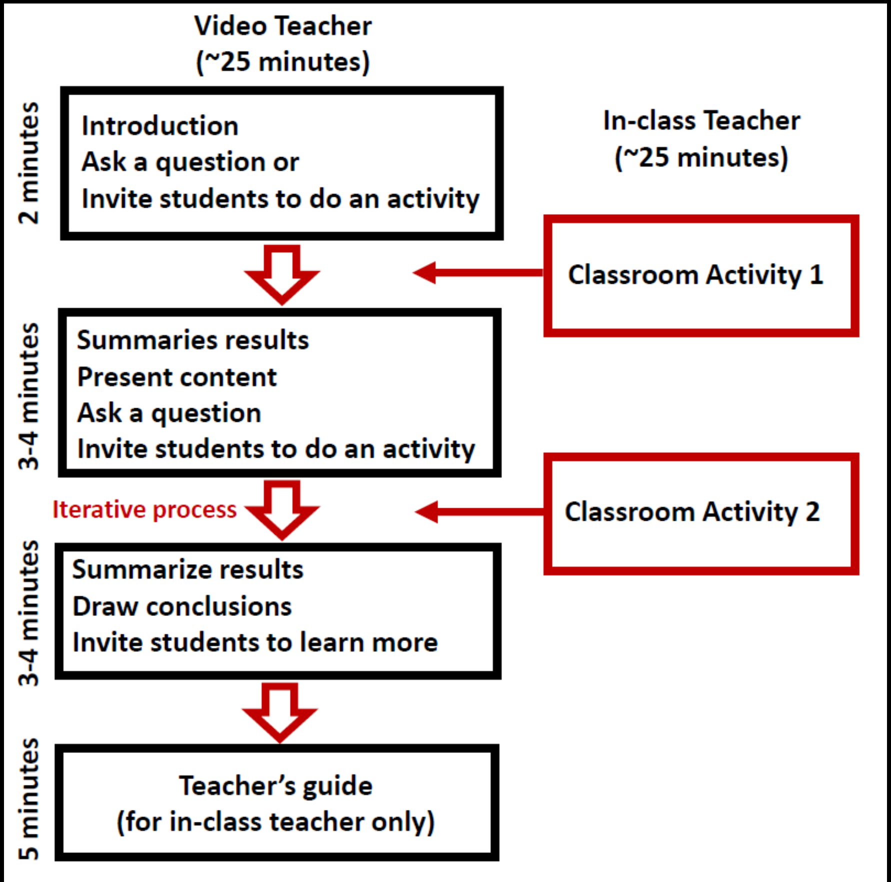
Mohadjer et al., 2020 (in prep)

1. Motivation – Recent earthquakes demonstrate how vulnerable school communities are to earthquake disasters. Lack of knowledge, awareness, and education about earthquake hazards and safety contribute to overall low levels of seismic cultures of prevention. For earthquake education to be effective, the curriculum must be science-based. Unfortunately, most teachers lack the resources and expertise required for teaching a science-based earthquake curriculum. Our **paired teaching videos** (introduced in the next slides) are designed to address this issue by connecting school teachers with scientists through virtual and live classroom teaching.

Dushanbe, Tajikistan (2018)

2. Paired Teaching Method – We used a pedagogical model known as paired teaching (or teaching duet) developed by the MIT BLOSSOMS (Blended Learning Open Source Science or Math Studies). This approach enables scientists and educators (**video teachers**) from around the world to create and teach virtual lessons and activities that are carried out under the guidance of **in-class teachers** in school classrooms. In this study, we adapted and applied the paired teaching technique to earthquake education lesson plans of Mohadjer et al. (2010)*. More details about the paired teaching method are given in the next slide.

*Mohadjer et al. (2010): Earthquake Emergency Education in Dushanbe, Tajikistan, Journal of Geoscience Education, v. 58, n. 2, p. 86-94.



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3. Paired Teaching Method (con't) – A typical video lesson contains 4-6 video segments (black rectangles) taught by the video-teacher. Each segment is followed by a **live active-learning** segment (red rectangles) in the classroom, guided by the in-class teacher. For example, the class starts with segment 1 of a learning video (top black rectangle). At the end of this segment, the video-teacher gives a challenge to the class. The in-class teacher pauses the video and guides the students in an active learning activity (red rectangle). After the exercise is concluded, the in-class teacher resumes the video, allowing the video-teacher to continue with teaching. The passing of teaching between the in-class and video-teachers is an iterative process and a type of blended learning referred to as paired teaching (Larson and Murray, 2017)*.

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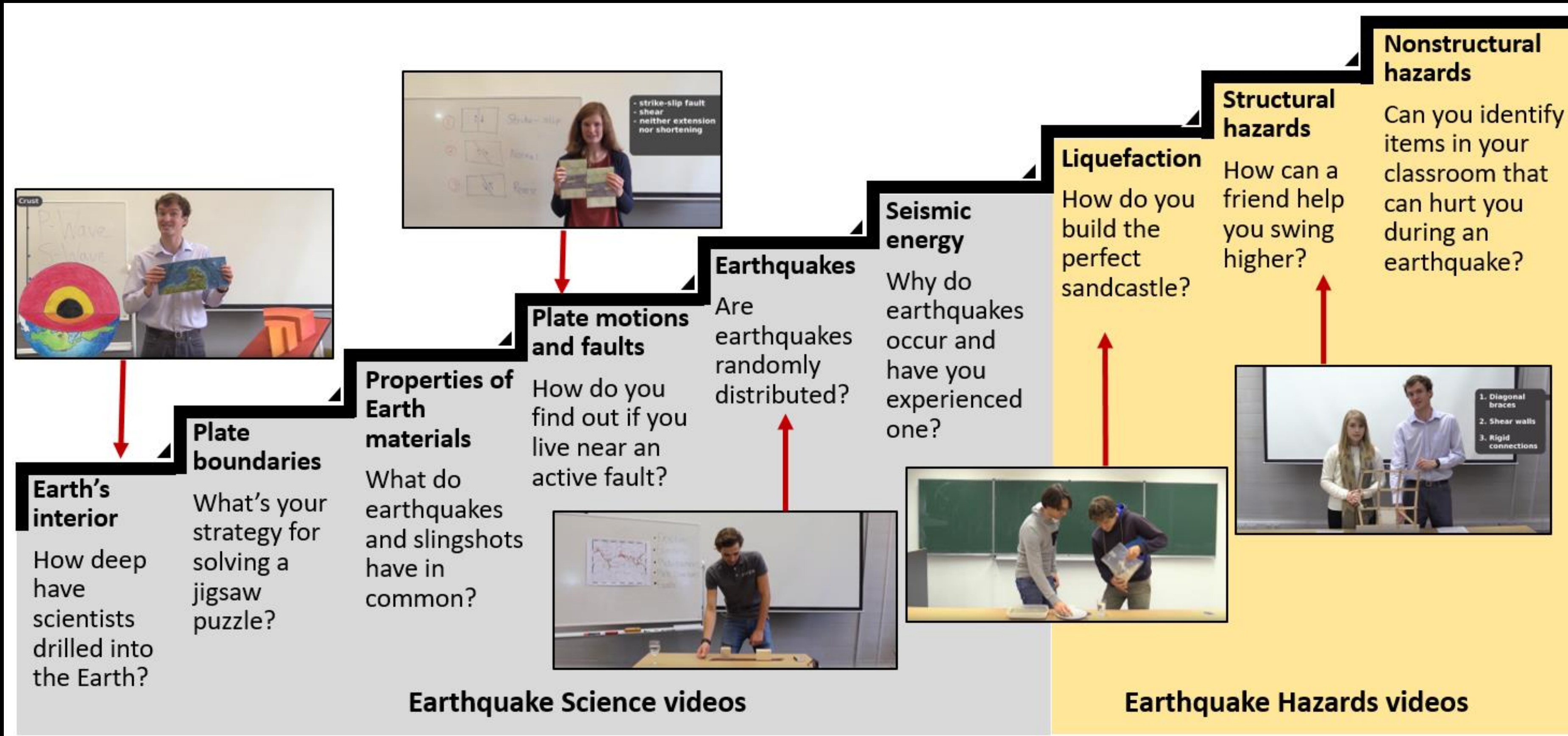
*Larson and Murray (2017): STEM Education: Inferring Promising Systems Changes from Experiences with MIT BLOSSOMS. System Research and Behavioral Science, 34(3), pp.289-303.

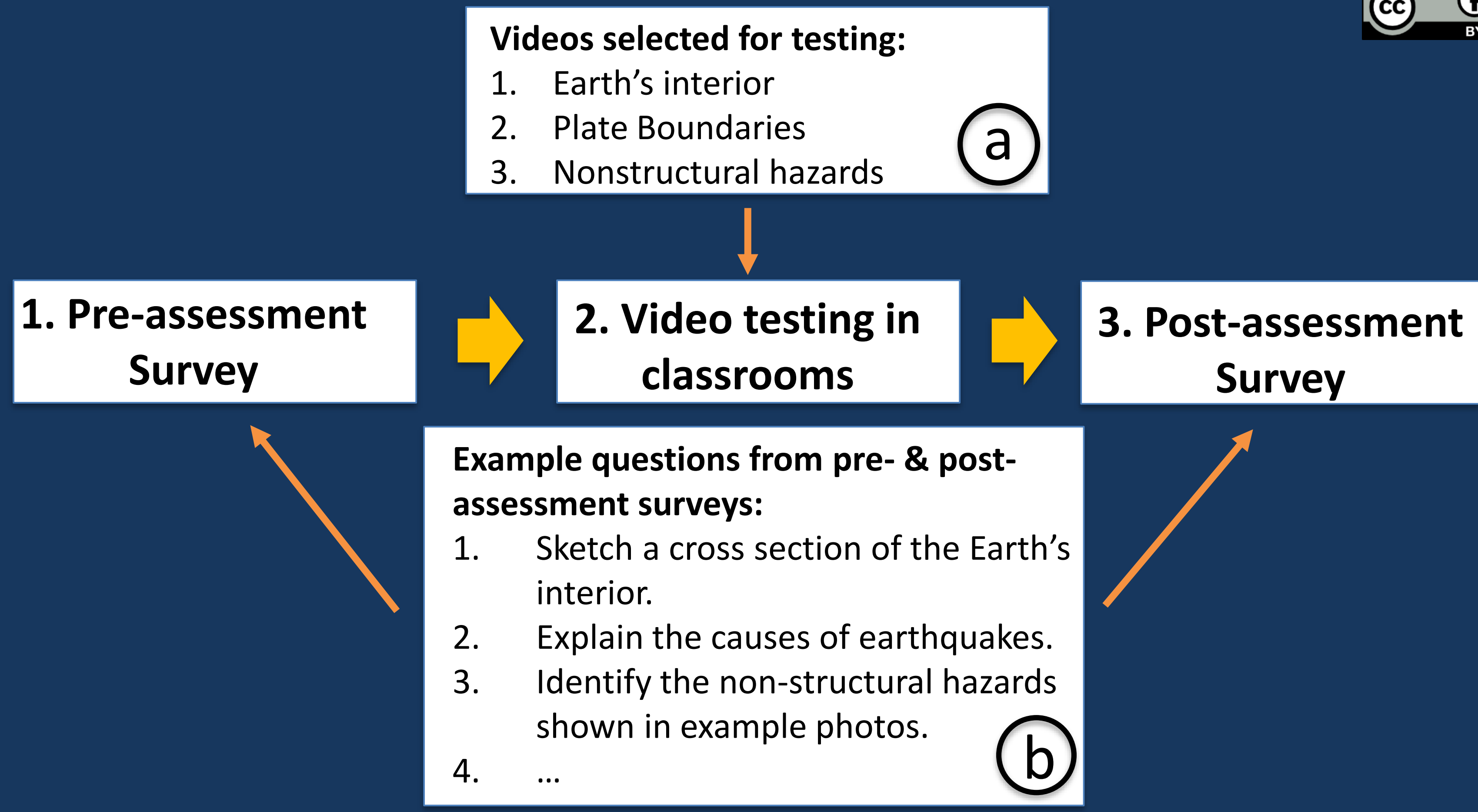


Mohadjer et al., 2020 (in prep)

4. Curriculum structure – The curriculum structure follows a **stepwise approach** (where later videos build on topics covered in earlier videos). The first five video lessons (grey background) introduce students to fundamental scientific concepts describing earthquakes including Earth's interior, plate motions, faults and seismic energy. The last three videos (yellow background) cover topics related to earthquake hazards and safety (e.g., liquefaction, structural and nonstructural hazards). Video lessons are taught by Earth scientists from academic institutions in the United Kingdom and Germany.

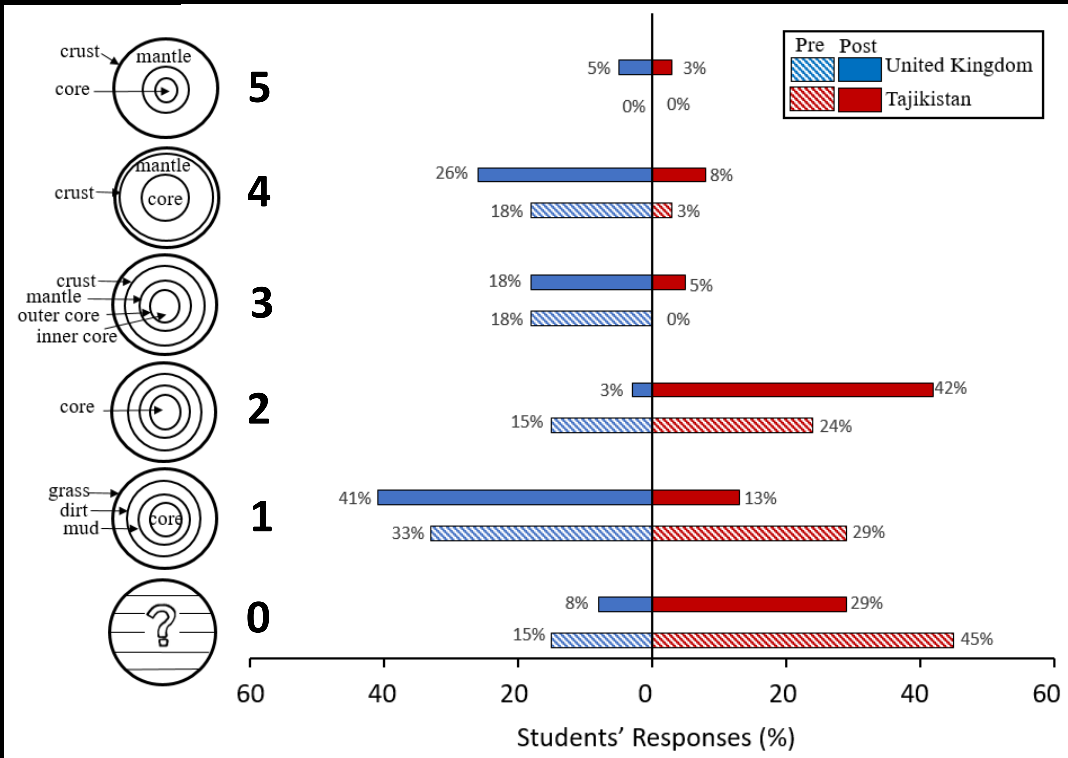
Access videos: https://www.youtube.com/user/EuroGeosciencesUnion

5. Curriculum testing sites – Selected videos were tested with 38 sixth grade students (12 years of age) and 39 ninth grade students (12-14 years of age) from two school classes in Dushanbe (Tajikistan) and London (United Kingdom), respectively. The school in Dushanbe is a typical public school located in the city center, and was selected for this study by the Tajik Institute of Earthquake Engineering and Seismology because of its previous collaboration with Mohadjer et al. (2010). Due to unavailability of school teachers in Dushanbe, the videos were tested by the lead author in school classrooms. The school in London is a foundation trust school located in the heart of London, whose trustees include several higher education institutions. The London school was selected through our existing teachers network in the UK. The videos were tested by two geography teachers in the London school.



6. Curriculum evaluation – The curriculum assessment included three phases: (1) completion of a pre-assessment survey by students, (2) classroom testing of three videos (panel a) and (3) completion of a post-assessment survey by students. We assessed the effectiveness of each video lesson by comparison of pre- and post-assessment survey data. This comparison was possible because students answered the same questions in both surveys. The three survey questions shown in panel (b) are discussed further in the next slides.

Question 1: Sketch a cross section of the Earth.



Evaluation Rubric

a

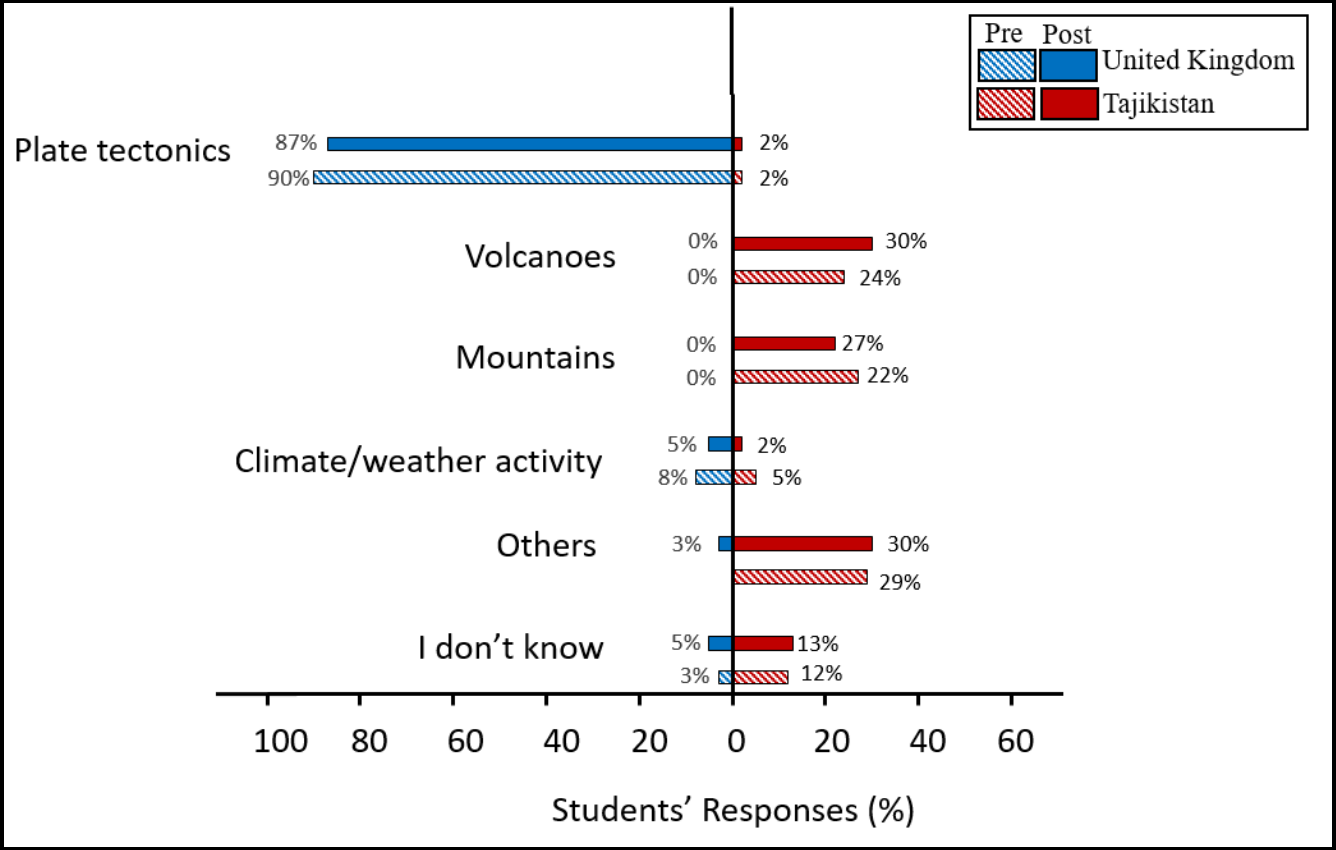
After Steer et al. (2005)*

Points	Description
5	Advanced understanding
4	Concentric layers + correct scale
3	Labeled concentric layers
2	Multiple concentric layers
1	Naïve view
0	No conceptual framework

*Steer et al. (2005): Challenging students ideas about Earth's interior structure using a model-based, conceptual change approach in a large class setting. Journal of Geoscience Education, 53(4), pp.415-421

7. Understanding Earth's Interior – The evaluation rubric of Steer et al. (2005) (panel a) was used to assess students' understanding of the Earth's interior. A significant percentage of students from Tajikistan (74%) and from the UK (48%) demonstrated having a naïve/no conceptual framework about the Earth's interior (scored 0-1) before video testing. After video testing, a notable percentage of Tajik and UK students (58% and 52%, respectively) demonstrated an increased level of understanding of the Earth's interior (scored 3 or higher). The difference between Tajik students' responses before and after video testing was statistically significant above 95% level (D-stat: 0.31, D-crit: 0.30). In addition, the difference between UK and Tajik students' responses before and after video testing was significant above 95%, using the Kolmogorov-Smirnov (KS) test (D-stat: 0.33 and D-crit: 0.30).

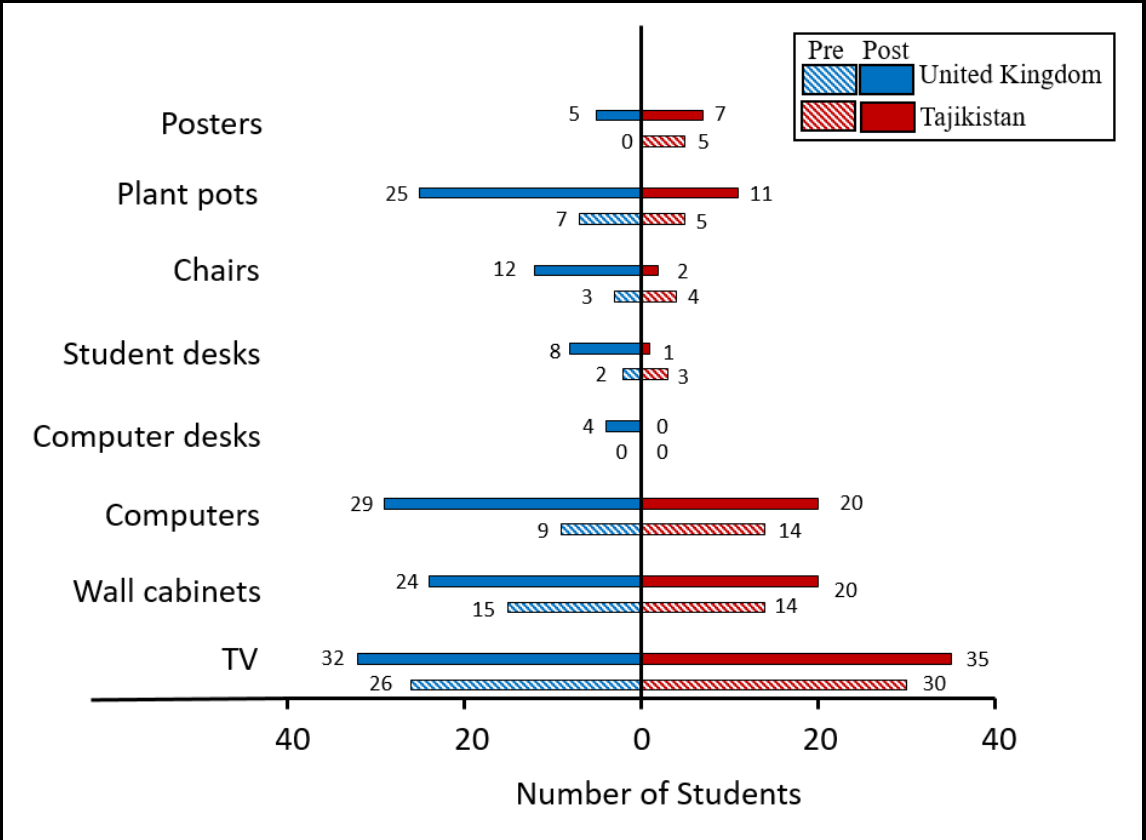
Question 2: Explain the causes of earthquakes.



Mohadjer et al., 2020 (in prep)

8. Causes of Earthquakes – In their responses to Question 2, 90% of UK students mentioned plate tectonics while 46% of Tajik students made references to mountains and volcanoes (with only 2% mentioning plate tectonics) before video testing. After video testing, Tajik students showed little improvement in their understanding of the causes of earthquakes. The difference between UK and Tajik students' responses prior to video testing, as well as their responses afterwards was significant above 95%, using the KS test (D-stat = 0.84, 0.79 and D-crit = 0.30, 0.30, respectively).

Question 3: Identify non-structural hazards.



Example photo used in the assessment survey for nonstructural hazards identification.

Mohadjer et al., 2020 (in prep)

9. Curriculum evaluation – For nonstructural hazard identification, students were asked to identify non-structural hazards in three example photographs (panel (a) shows one example). Both groups demonstrated some knowledge of nonstructural hazards found in typical school classrooms prior to video testing, and showed some improvement after video testing. However, only the difference between pre- and post-assessment responses by the UK students was significant above 95% as indicated by the KS test (D-stat = 0.43, D-crit = 0.30).

Statistically significant differences in students' responses

	Question 1*	Question 2**	Question 3 ***
Pre- vs. Post-assessment (Tajikistan)	95%		
Pre- vs. Post-assessment (UK)			95%
Pre-assessment (Tajikistan vs. UK)	95%	95%	
Post-assessment (Tajikistan vs. UK)	95%	95%	

	not significant
95%	significant (at 95% significance level)

* Question 1: Sketch a cross section of the Earth.
** Question 2: Explain the causes of earthquakes.
*** Question 3: Identify non-structural hazards.

10. Significant differences in results – While Tajik and UK students appear to respond similarly to Question 3 (nonstructural hazards) in pre- and post-assessment surveys, the difference in their responses to Question 1 and 2 are significant at 95% level. Comparison of pre- and post-assessment data by students from Tajikistan and UK reveals significant differences (indication of an increased in their understanding of lesson topics) in their responses to Questions 1 and 3, respectively.

Discussion & Summary

Videos tested:	Tajikistan	UK
Earth's Interior	✓	✗
Plate Boundaries	✗	✗
Non-structural Hazards	✗	✓

Curriculum effectiveness – Green check mark indicates an increase in students' understanding of topics covered by the video; red cross mark indicates no or little knowledge gain.

Possible factors affecting students' learning

Suitable classroom culture

- Tajik students were unfamiliar with non-lecture based teaching

Levels of pre-knowledge

- Almost all UK students were informed about the causes of earthquakes prior to video testing

Past hazard experience

- UK teachers reported low levels of student engagement with classroom hazard identification attributed to lack of hazard experience

Some practical advice

If you are a school teacher:

- Integrate videos into your existing curriculum
- Plan ahead. Watch the “teacher segment” before class
- Skip video segments unsuited for your classroom
- Cultivate a collaborative learning environment in your class
- Contextualize activities during active-learning segments
- Ensure adequate technological support for video watching

For curriculum developers:

- Familiarize yourself with your classroom culture
- Test your content with school classrooms
- Incorporate feedback from students and teachers
- Publish your results in open-access journals