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Supplement of

Understanding groundwater – students’ pre-conceptions and conceptual change by means of a theory-guided multimedia learning program

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Pretest & posttest: questionnaire for pupils (T1 and T3)

The original version of this questionnaire was developed in German. The study was performed exclusively with German speaking pupils and students. This is the translated version. The differences between the pre- and posttest as well as the versions for students and children are restricted to the wording of the introductions. All questions about geology and groundwater are identical in all versions of the questionnaire.

Dear students!

Many thanks for joining our research project. It deals with a topic you might not be very familiar with. No matter how much you already know about it, please fill out the following questionnaire as you can!

It is not a normal test. If you do not know the answer to a question, do not copy your neighbour's answer!

Many Thanks!

Your codename:

1.+2. letter of your mother's first name : e.g. Gerti →

1.+2. letter of your father's first name: e.g. Bernd →

Age:

male

female

1. First, we would like to know your opinion about three topics. We'll start with geology – the structure of the earth, stones, mineral resources, volcanoes, earthquakes.... Please mark your answer with a cross!

In my opinion, geology is...		
interesting	○ ○ ○ ○ ○	boring
unimportant	○ ○ ○ ○ ○	important
modern	○ ○ ○ ○ ○	old-fashioned
useful	○ ○ ○ ○ ○	useless
unlikeable	○ ○ ○ ○ ○	likeable

Have you ever concerned yourself with geology? Mark where you heard about it with a cross!

I	... read about it in newspapers or journals	... saw reports about it on the TV	... did research on the internet	... read about it in books	... learned about it in school	... have never heard anything about it
	○	○	○	○	○	○

What would be interesting for you to learn about geology?

In my opinion, groundwater is ...		
interesting	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>	boring
unimportant	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>	important
modern	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>	old-fashioned
useful	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>	useless
unlikeable	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>	likeable

Have you ever concerned yourself with groundwater? Mark with a cross where you heard about it!

I...	... read about it in newspapers or journals	... saw reports about it on the TV	... did research on the internet	... read about it in books	... learned about it in school	... have never heard anything about it
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

What would be interesting for you to learn about groundwater?

In my opinion, wells are....		
interesting	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>	boring
unimportant	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>	important
modern	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>	old-fashioned
useful	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>	useless
unlikeable	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>	likeable

Have you ever concerned yourself with wells? Mark with a cross where you heard about it!

I...	... read about it in newspapers or journals	... saw reports about it on the TV	... did research on the internet	... read about it in books	... learned about it in school	..have not heard anything about it so far
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

What would be interesting for you to learn about wells?

2. How would you define **groundwater**? Please explain!

.....

.....

.....

.....

.....

.....

3. Draw what you think groundwater looks like!

The drawing does not need to be an artistic masterpiece! 😊

You just have to draw how you imagine groundwater. Please label your drawing!

4. What is groundwater needed for?

.....
.....
.....

5. What are sediments? Please mark you answer(s) with a cross! (several answers are correct)

- sand
- gravel
- granite
- water
- clay
- limestone

How sure are you about your given answer? Place a mark on the line!
 (very uncertain= 0, completely convinced = 10)
 0 ----- 10

6.

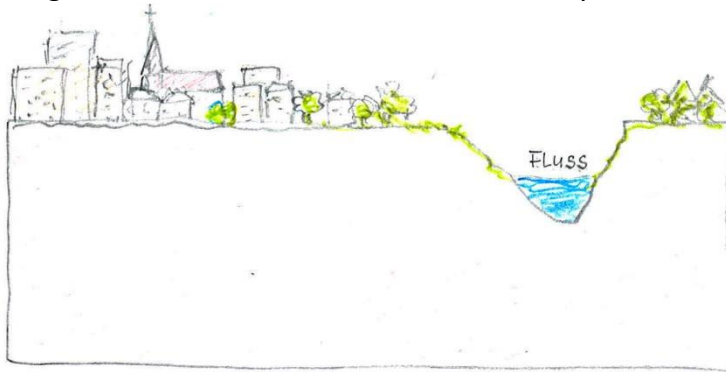


Here you can see gravel as it is below the surface. Geologists say that fine grained gravel has also small pore spaces. Do you know what is meant by the term **pore space**?

Describe what you imagine pore space means!

.....
.....
.....
.....

7. This drawing shows the ground under a city. Do you have any idea about where the groundwater level is? Draw a line where you think it is!



How sure are you about your given answer? Place a mark on the line!
 (very uncertain= 0, completely convinced = 10)
 0 ----- 10

In the following questions gravel, sand and clay are the centre of attention.



8. Where does water filter through the fastest? What do you think? Please mark your answer with a cross!

- sand
- gravel
- clay

How sure are you about your given answer? Place a mark on the line!
 (very uncertain= 0, completely convinced = 10)

0 ----- 10

9. What is an aquiclude? Please mark your answer with a cross!

- sand
- gravel
- clay
- I do not know

10. Gravel, sand and clay are components of the ground below the earth's surface. Where do these components come from?

- They were always there where they are now.
- They developed in the time of dinosaurs in certain places.
- They come from the mountains and were transported over many kilometres in rivers.
- They come from regions with volcanoes and earthquake.

How sure are you about your given answer? Place a mark on the line!
 (very uncertain= 0, completely convinced = 10)

0 ----- 10

11. Please read the following statements and tick if they are right or wrong!

	right	wrong	I do not know
Groundwater flows downwards and towards a river.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Groundwater flows like blood flows in veins in our body.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Rain and rivers influence the groundwater.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Groundwater is rainwater that flows slowly between the grains of sand and gravel.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Groundwater does not flow. It just collects somewhere below the surface.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Aquifers are layers underground in which the groundwater flows.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The groundwater level is the upper boundary of soil filled with groundwater. Above this level pores between the grains are filled with air; beneath this level the pores are filled with water.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The groundwater level is not stable. Depending on the amount of rain it can rise or fall.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Groundwater is a lake under the earth's surface.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

12. This is a scene that could occur anywhere:

Anja opens the window: *"It stinks out there! The farmers are spreading manure on the fields."*

Markus: *"Oh, don't be so sensitive! It will rain very soon and afterwards you won't smell it anymore, the air will be clean again and everything is all right."*

Anja: *"No, it is not all right! The manure will seep into the ground, so the problem is not solved. I read that manure has already poisoned drinking water wells."*

Markus: *"Do you really believe that? I can't imagine that is possible. The manure may filtrate half of a meter into the ground but the wells are normally much deeper. My grandfather had a well and it was 10 m deep"*

Anja: *"I'm not convinced. Why shouldn't the manure seep much deeper into the ground with the rainwater?"*

What do you think about this conversation? Who is right?

I think, is right. Here is my explanation:

.....

.....

.....

.....

Many thanks!

Questionnaire for the formative evaluation (T2)

Dear students!

Now we ask you to evaluate the learning program.

Your codename:

1.+2. Letter of your mother's first name:

e.g. Gerti →

1.+2. Letter of your father's first name:

e.g. Bernd →



How many points did you get?
Please write the score in the box!

Please grade the learning program with the following common scale!

→ very good → good → satisfactory → adequate → not adequate

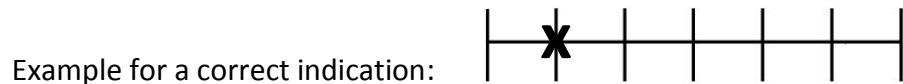
Your reason:

Please answer the following questions! Please mark all questions with a cross!

	I strongly agree	I agree	I do not agree	I strongly disagree
The topic "groundwater" was presented in an interesting way.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The content of the learning program was understandable.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Working on the chapter "Wasser im Boden" (water in the ground) was fun.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am convinced that I have learned a lot about groundwater.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

	I strongly agree	I agree	I do not agree	I strongly disagree
The <u>spoken text</u> was easy to understand.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I think the <u>written text</u> was understandable.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I understood the <u>test questions</u> without any problems.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The <u>visualisations</u> (e.g. elevator ride or the water droplet moving in the ground) were helpful for understanding.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The instructions for various activities (e.g. to use the magnifier or to find information with the cursor) were worded clearly so I knew what to do.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The <u>test questions</u> were clearly formulated so I always knew what to do.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The mixture of information, instruction and questions was interesting.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The navigation within the program was clear (e.g. using the arrow to switch to the next page) and easy to use.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I read or listened to <u>all</u> information provided in this chapter of the learning program.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am convinced that I found all important information provided in the chapter.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I deliberately skipped some pages.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The scientific model was interesting.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The scientific model was helpful in understanding groundwater.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The program improved my idea about the ground under the earth's surface.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

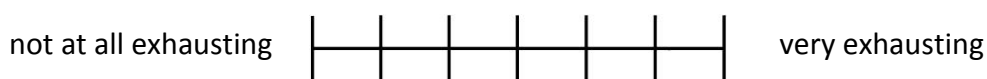
Now we ask you to inform us if working with the program was exhausting or challenging for you. Please answer the following questions with a cross on the scale bar. Please mark directly on the line!



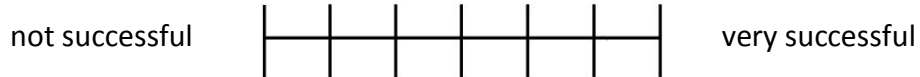
Was the handling of the learning program easy or challenging?



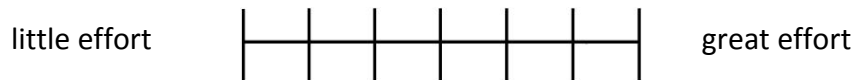
Was it exhausting to understand the contents of the learning program?



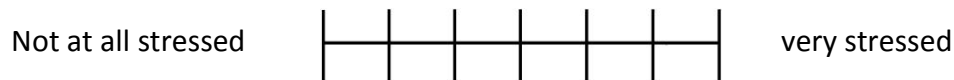
How would you evaluate your personal success in understanding the program's content?



How much effort was needed to find your way through the learning program?
(e.g. arrow to switch to the next page, using the cursor for information, etc.)



Did you feel stressed (uncertain, demoralised, confused or annoyed) while working with the learning program?



Do you have any more feedback, ideas or suggestions to improve the learning program?

Many thanks for your cooperation!