EXAM CS-411 Digital Education NAME:
January 2024 SCIPER:

Short answers are expected but, if you need more space, please write on the back of the page.

Question 1 8 points

Question 1.1. To implement a PS-I approach, with problem solving followed by a lecture followed by exercises, what would be relevant digital tool(s) for each phase: *(0 or 1 choice per line, you may add comments if you want)*

	Problem Solving	Lecture	Exercises	Comments (optional)
MOOC				
Microworld				
Simulation				
A Drill & Practice app				

Question 1.2. Which feature(s) would be more relevant for each phase? *(0 or 1 choice per line, you may add comments if you want)*

	Problem Solving	Lecture	Exercises	Comments (optional)
Individual adaptation				
Gamification				
Immediate feedback				
Collaboration tools				

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Question 2 8 points

Student may encounter various difficulties in a lesson on computing correlations. Complete the following sentences for illustrating each difficulty:

a. Metacognition difficulty

A student is computing a correlation coefficient and obtains a value of 1.34 but …. *(complete the sentence…)*   *Why is this a metacognitive difficulty?*

b. Transfer difficulty

A student has learned to compute correlations between homogeneous data sets (e.g., cost of X and cost of Y) but…*(complete the sentence…)*   *Why is this a transfer difficulty?*

c. Cognitive overload

A student has learned to compute correlations on numerical data and (s)he has also learned to convert data (e.g., changing miles into kilometers or changing Euros into dollars), but…*(complete the sentence…)*   *Why is this cognitive overload?*

d. Misconception

A student obtains a correlation of 0.82 between the amount of chocolate consumed in a country and the number of patents produced in the same country, and she concludes ….*(complete the sentence…)*   *What is the misconception?*

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Question 3 6 points

When students do collaborative problem solving, what are the benefits of designing the collaborative task as described here:

Task features	*Benefit(s) – use proper terms*
To form pairs of students with different backgrounds (e.g., computer science and chemistry).	
To assign a specific role to each team member.	

To ask the team to produce not only one solution but to propose 3 solutions and to rank them.	

Question 4 4 points

Connect education the activities listed in the left column to learning processes listed in the right column.

Refreshing pre-requisites	o	o	Conceptual change
Providing an advance organizer	o	o	Hypothetico-deductive reasoning
Trapping misconceptions	o	o	Mastery learning
Running experiments in a Simulation	o	o	Guided discovery

Question 5 4 points

Connect education the activities listed in the left column to types of knowledge to be acquired listed in the right column.

Induction	o	o	Scientific laws
Compilation & practice	o	o	Facts
Prediction of results	o	o	Procedural skills
Spaced repetition	o	o	Concepts

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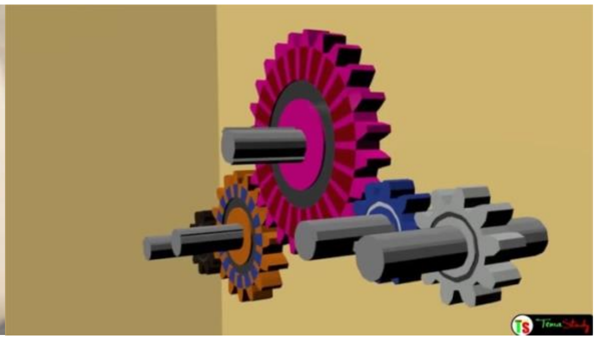
Question 6 6 points

In a maker space, teams of students are invited to build a physical gear box system ("système d'engrenages") such as the one illustrated below by the left picture. They receive physical gears from different diameters that they can connect to each other on a 2D plane. They are expected to acquire some basic notion of mechanics, namely how the rotation of a gear affects the speed and sense of rotation of the connected gear.



Question 6.1. A first teacher follows a mastery learning approach. Describe briefly how this lesson could unfold?

Question 6.2. A second teacher follows a project-based approach, claiming that the understanding of a gear system is less important than the opportunity to practice other skills, Which kind of skills could that be?

Question 6.3. A third teacher decides that, after having played with the physical gear toolkit, the students should play with a virtual system as the one illustrated above in the right picture. What could be the advantages of using a virtual system after the physical one (not as a replacement)?

Question 7 4 points

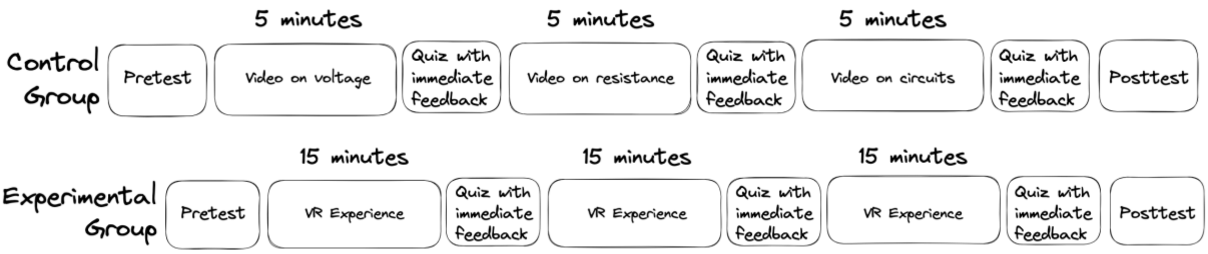
Imagine that you are a TA for CS-411 in 2024. One of the groups come to you with a problem. After running their PS-I vs. I-PS experiment, they analyzed their data and failed to find a difference between conditions. They've asked you to look over your pre-test and post-test to see if they notice any problems.

Question 7.1: You notice that a few of their questions may be invalid because of *construct irrelevance*. Please explain the idea of construct irrelevance, then provide an example of a question in maths that suffers from this issue.

Question 7.2: You also notice that their exam suffers from *construct underrepresentation*. Especially, in the PS-I condition, construct underrepresentation would fail to reveal the differences between I-PS and PS-I. Please explain how an assessment for this experiment might suffer from construct underrepresentation.

Question 8 10 points

An experiment has been conducted where two groups of 15-years old learned the basic concepts of electricity. The control group watched 3 5-miute videos on voltage, resistance and circuits, each followed by a quiz with immediate feedback. The experimental group explored a virtual reality environment (VR) in which they could build circuits, place batteries, engines and lights. The VR experience paused every 15 minutes and provided a quiz with immediate feedback, so that participants in the experimental group also took 3 quizzes. All participants took 3 quizzes, a pre-test, and a post-test. The average age of participants was respectively 15.4 and 15.6 years in the two groups; the number of girls and boys was 2/3 in each group. The experimenters also collected the grades of participants in their last test on sciences.



Their results show that the learning gain was significantly higher in the experimental group (using VR) than in the control group. They also noticed that members of the control group made more mistakes during the first quizz than those in the experimental condition and that, across both conditions, the number of mistakes in the first quiz correlated to the learning gains. The authors explain this result by the fact that the frustration of failing the first quiz would lead participants to pay more attention to the next activities. Moreover, the authors note that the benefit for VR over videos was significantly higher for students with lower grades at previous science test. They conclude that using VR is more effective than watching video for science lessons, especially for weaker students.

Question 6.1. What is/are

- the main independent variable
- the dependent variable(s)
- the controlled variable(s)
- a simple effect
- an interaction effect
- a mediating or intermediate variable

Question 6.2. What methodological bias (co-found variable) makes their results questionable?

Question 6.3. Even if this methodological bias had been avoided, would you agree with their conclusion that "VR is more effective than watching video for science lessons"? You may continue you answer on the back of this page.