EXAM CS-411 Digital Education NAME:

January 2023 SCIPER:

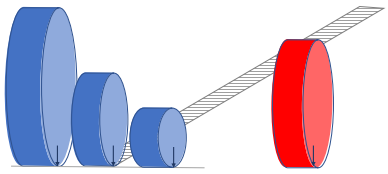
Short answers are expected but, if you need more space, please use addition paper sheets and add your name and Sciper number

Question 1

Anna and Robert are two teachers who share the same pedagogical objectives: to make their 10-year-old pupils learn that the ratio between the circumference of a circle and its diameter is a constant, and to be able to compute the circumference of a circle form its diameter and vice-versa.

Anna gives each pupil team 3 blue wooden disks, a paper strip and a ruler. She asks them to come up with a procedure that they could use to predict where any disk would stop one complete turn (i.e., when the arrow on the disk points down). For 10 minutes they are allowed to roll the blue disks on the paper strip but they cannot roll the red disk.

Pupils are informed that the diameter of the red disk is 7 centimeters. Anna asks every team to write their prediction of the stopping point of the red disk and to explain their prediction. Then, she rolls the red disk to show where it actually stops and follows up with a short lecture during which she introduces the value of π. Finally, pupils have to do simple exercises.



Robert has a different style. During the first 10 minutes he manipulates the 3 blue disks and, for each of them, he writes on the blackboard the value of the diameter, the distance travelled on the strip, and shows them that the ratio between the two is always a bit more than 3. Then he asks where the red disk would stop. He finishes by giving a short lecture with the value on π and, finally, pupils have to do simple exercises.

At the end of the lesson, pupils in both classes have to answer two questions:

A. Since the length of the equator is 40'000 km, what is the approximate diameter of the earth?
B. A carousel rotates at 5 revolutions per minute. A child sits in a small rocket connected to the carousel. He is travelling at the speed of 120 meters per minute. How long is the arm between the rotation center and the rocket?

Question 1.1. During the first 10 minutes of activity, how would the pupils in Robert and Anna's classes differ in terms of intrinsic cognitive load and in terms of germane cognitive load? Explain what intrinsic and germane load are and why they differ in both situations.

Question 1.2. Would the pupils in Robert and Anna's classes perform differently on questions A and B? Explain your hypotheses.

Question 1.3. What would be the pros and cons of using a VR to replace the wooden disks or using an AR system to augment them? Justify your answer in the table below (empty cells are acceptable).

	Virtual Reality	Augmented Reality
PROS		
CONS		

Question 1.4. During the first 10 minutes, Anna divided the class in teams but she noticed that some teams did not collaborate well, for instance there were some free riders in some of the groups. Next year, how could she create interdependence inside teams?

Question 2

You are hired by a professor to develop simulations in physics for bachelor students. He informed you that many students come with strong misconceptions, for instance they believe that an object with a higher mass will fall faster than an object with a low mass.

Question 2.1. How are misconceptions formed by learners?

Question 2.2. Describe a learning activity that could repair these misconceptions.

Question 2.3. You downloaded a simulation (implemented with Unity, a game engine) where students can modify multiple parameters such as the mass of the objects, their shape, the air friction, and the gravity. You know that studies show that not all students are able to conduct a proper hypothetico-deductive cycle. Describe two pitfalls that you might expect from using this simulation, and what the teacher could do to avoid these pitfalls.

Question 2.4. The professor asks you what would be the pros and cons of re-implementing the simulation with Jupyter notebooks instead using the simulation as it stands (i.e., implemented with Unity). What would you reply to the professor?

Question 3

You are hired as learning scientist by an EdTech company. They have developed an online course for training their salespersons which is composed of 5 case studies. For each case study, participants follow the same a sequence of activities: (1) they watch a video presenting a sales situation, i.e., how it started, which sales strategy has been used, including some unproductive strategies; (2) they analyze a spreadsheet with the actual sales performed in this case; (3) they watch a video about the lessons learned from this case; (4) they answer a multiple-choice questionnaire (MCQs) about the case. At the beginning and at the end of the course, the participants' knowledge is measured by a test where situations are presented and, for each of them, they must choose among 5 potential sales strategies the one that would generate highest sales.

Question 3.1. You propose to the company to add an activity between (1) and (2) where participants are asked to predict whether the sales strategy presented in (1) will be productive or not. How would you explain or justify your suggestion to the company?

Question 3.2. In a second time, you propose to the company to design an experiment to find out which method is the more effective. Let's call A the method as initially designed and B the modified method that you suggested. They would like to know if one method would work with novices versus participants with some sales experience. Describe the experiment:

- What would be the independent, dependent, controlled, and mediator variables?
- Describe the experiment. Would it be within-subjects or between-subjects?
- Describe a potential interaction effect and draw what the final results might look like?

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Question 3.3. After the experiment, you wonder whether a difference of learning gains could result from a difference in the time spent on the learning activities. How could check this?

Question *4 (bonus)*

A journalist asks you if learning fractions is more effective on a tablet than on paper-based activities. What would you answer?