APPENDIX

TASKS AND TAXONOMIC SCORES

For each activity's data collection, the students were given a brief text that provided context for the questions. A glossary of terms that might be difficult to understand was also provided.

Activity	Tasks	Criteria
Global Trade	Examine the first statistical indicator (set of data processed to provide information on variations over time and space) on imported cotton, using the various display options available to you and answer the questions below: • What is the temporal evolution of cotton imports worldwide from 1960 to 2020? • And the locations of cotton imports worldwide from 1960 to 2020?	C1, C2
	Carry out the same operations for the second indicator, per capita income. Then describe the evolution and distribution of this indicator on a global scale from 1960 to 2020. • What is the temporal evolution of per capita income in the world from 1960 to 2020? • And what are the locations of per capita income in the world from 1960 to 2020?	C1, C2
	Formulate explanatory hypotheses on the links between locations and the temporal evolution of these two indicators, particularly in terms of factor endowment (type of production factors) and your economic knowledge.	C3, C4
Silicon Valley	Select from the lists below the five counties . . . . . . with the highest average household incomes in 2019 (q11). . . . with the largest proportions of individuals with a Bachelor's degree or higher in 2019 (q12). . . .having the highest share of information-related jobs in 2019 (q13).	C1, C2
	Compare your answers to q11, q12, and q13 with the perimeter of Silicon Valley counties. Describe the factor endowment (HOS) of this area.	C3
	Using the Four Ts (barriers to trade) and your economic notions, write hypotheses on the factorial endowment (question 2) of this area (Silicon Valley) and its specialization. Explain why Silicon Valley is such an innovative and essential territory for new technology companies. Do not hesitate to consult again the various graphic information at your disposal.	C4
Commodity Trading	Identify the districts in French-speaking Switzerland where the concentration of productive organizations active in commodities trading is greatest by selecting districts from the list below (2 districts). In which territory is the concentration of productive organizations active in commodities trading located? Select the title that best describes this concentration (5 suggestions).	C1, C2
	Following on from the study of the Silicon Valley cluster in our last assessment, could you say that the concentration of productive organizations active in commodities trading would also be a cluster? Write your answer, giving at least two reasons, based on your economic knowledge and the map indicators available on the website.	C3
	Picture the economic development (jobs, sales, income, etc.) of the region (where there is a high concentration of productive organizations active in commodities trading) and its influence on a global and regional scale over the next 20 years. Once again, use the map indicators and your economic knowledge. What are your hypotheses? Write down at least one hypothesis on the economic development and at least one on the future influence of this territory.	C4

In the analysis of student productions, points were awarded separately according to criteria. For statistical analysis purposes and to avoid bias, points were scaled between 0 and 1.

METACOGNITION SURVEY & SCORE

After each activity, students answered a survey. Following the last activity, additional questions were added to produce a written feedback report. As not all students were able to take part in the focus groups, it was important that they all had the opportunity to express themselves at least in writing.

Global Trade	Write a text about: • Your difficulties in completing tasks using the web map. Don't forget to explain the reasons for these difficulties. • How easy it was for you to complete the tasks using the online map. Don't forget to explain why it was so easy. • Also mention what you liked and didn't like, and why.
Silicon Valley	
Commodity Trading	• Following these three activities around web mapping and the economy, do you feel you've made any progress? If so, in what area do you feel you have made progress? In each case, explain what enabled you to do so. • Do you feel you were unable to overcome certain difficulties? If so, which ones and why? Don't forget to explain the reason(s). • As a result of these three activities, do you feel you've strengthened one or more of your skills (map reading, graphic analysis, etc.)? If so, which ones? For what reasons? • Do you feel that these three activities have provided you with useful knowledge for your everyday life, or even for the future (academic, civic and professional)? If so, which ones? • Do you have any other comments on these activities? Any suggestions?

FOCUS GROUP

As mentioned in the article, not all students took part in the focus groups. The questions below were used to guide the interviews, while taking care to allow the students to express themselves.

Questions
Which representations/visualizations (chart/map) helped you most in completing the tasks? For which reasons?
On the contrary, which representations/visualizations did you find difficult? Why?
Which visualization features (i.e., the different types of interactive display) helped you most in completing the tasks? Why?
On the contrary, which visualization features didn't help you get the job done? For which reasons?
What difficulties did you encounter when using web maps? Why?
Which questions did you find most difficult? Why?
How would the activities have been carried out with paper maps? What would be the advantages and disadvantages based on your experience?

Do you think these web maps helped you to understand certain things about the themes studied?

To what extent are web maps a good way of understanding economic and geographical phenomena?

Do you work in the same way in other classes (e.g., online tools, web maps, criteria grid)?

What do you recall from these three activities? What conclusions do you spontaneously draw? What did you learn?

MAP INTERPRETATION TAXONOMY[1]

Given its use in research and teaching fields (Favier and van der Schee 2014; De Miguel González and De Lázaro Torres 2020; Saint-Marc et al. 2017), Bloom's renewed taxonomy was selected to describe the intellectual operations and knowledge mobilized for map interpretation. It provides us with a tool for analyzing the contribution of online maps to learning. Within the cartographic interpretation process, it enables us to assess not only simple learning operations, such as localization, but also more complex learning operations requiring intellectual activity of high cognitive intensity, such as the evaluation and creation of hypotheses to explain the occurrence and distribution of a spatial phenomenon. Our taxonomy was developed based on possible uses of maps in schools by students aged 12 to 15. This selection is based on uses proposed by geography education researchers (Fontanabona 2002; Mérenne-Schoumaker 2014; Wiegand 2006). After grouping these different uses into different ability categories, we proceeded to identify the cognitive processes and levels of knowledge mobilized when exercising these abilities. The result of this work is presented below.

The first component of map interpretation skill, mastering map language, focuses on the ability to use cartographic language. Cartographic language is based on the articulation of two sub-components: the verbal language and the graphic language of the map.[2] Learning these languages requires the acquisition of factual and conceptual knowledge (CN1, CN2).[3] Cognitive operations of memorization and comprehension are used to achieve this, notably through comparisons (CG1, CG2). As an example, these operations are carried out when reading the map legend. The reader assimilates the meaning of the symbols on the map to interpret the discourse conveyed by the map. The articulation of these languages is based on procedural knowledge (CN3) and metacognitive knowledge (CN4). It involves using reading procedures for geographic information to articulate verbal and graphic language to be able to interpret the map. This may prove difficult for students since each of these languages has its own semiotic logic. To achieve this articulation, the individual must not only have knowledge of their own learning processes, but must also be able to recognize, through their ability to manage learning, what they have learned and what they lack. Of course, this ability is also required in the other components of map interpretation.

The ability to use these two sub-components together allows us to reach a first level of map interpretation, enabling us to obtain information from the map. To this end, the cognitive dimension CG3 is mobilized. It consists in employing a reading method to extract factual geographic information. Connecting features of geographic phenomena and their interactions with space requires the cognitive dimension of analysis (CG4). It aims to highlight the links that enable us to account for spatial interactions. The last component, problematization, involves both evaluation (CG5) and creation (CG6). Problematizing includes exercising judgment and critical thinking—i.e., defining the geographic problem(s) depicted, developing, and assessing related hypotheses, and then synthesizing using geographic thinking.

Performing these map-interpretation skills involves a combination of the various intellectual operations listed in the map-interpretation taxonomy. However, particularly

1. Adapted and traduced from Bachmann (2020).

2. Graphic language is essentially iconic, relying as it does on a resemblance between the sign and its referent. Verbal language, found notably in place names, spatial markers, and legends, follows a sequential logic (Fontanabona 2002). Mastering graphic language requires learning the rules of graphic semiology. It offers a synoptic overview, even though the interpretation and learning of these rules takes place sequentially.

3. To lighten the text, we have chosen to refer to cognitive processes and levels of knowledge using abbreviations (see Figure 2).

in classroom map use, these intellectual operations are not necessarily carried out in a linear order, although some of them are required (notably mastery of cartographic language). The reader's thinking may lead them to follow paths that alternate the use of different levels of knowledge and cognitive processes, depending on the task at hand. In this way, cartographic interpretation and elaboration processes are characterized by a certain iterativity.