Learning through Discovery in the Online Environment. Examples, Principles, Advantages, and Difficulties. A Case Study on Renewable Energy

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Abstract

The aim of this research is to investigate how learning through discovery can be achieved by Z generationpupils using the textbook and the online available sources. We have analyzed a lesson from the textbook Mathematics and Environment Exploration and an animated film from the point of view of learning through discovery, an activity performed into the virtual classroom based on these materials.Weidentified the difficulties and the problems both pupils and teachers cope with, and wehighlighted certain principles and advantages of learning through discovery performed by accessing web sources. We concluded that the film proposed by the teacher for viewing on YouTube represented a valuable information source that corresponded to the pupils' level of knowledge and, more than that, satisfied their curiosity. However, the success of the educational activities depended much on parents' supervision and support.

Keywords: Digital natives, Virtual classroom, Digital skill, Primary education, COVID-19

1. Introduction and Theoretical Background

With the decision of the Romanian Ministry of Education and Research, beginning with March 11, 2020, face-to-face classes were suspended and the communication and cooperation methods in the educational system changed in order to ensure the continuity of the learning process (Botnariuc et al., 2020, p. 8). In this regard, impediments of technical, logistical, pedagogical, and content nature appeared on many school subjects, these being barriers or challenges for teachers, pupils, parents, and education decision-makers (Botnariuc et al., 2020, p. 9).Teachers were forced to a rapid change from face-to-face teaching with blackboard and chalk, from the classroom to the "virtual classroom", to the "online" method of delivering the education (Botnariuc et al., 2020) and to find, for themselves, the best strategies by which to carry out their teaching activities, so that the educational goals to be fulfilled as much as possible.However, previous research proves that Romanian teachers were familiar with online education (Adăscăliței et al., 2019; Magdaș and Pop, 2015; Magdaș and

Răduţ-Taciu, 2016; Manea and Stan, 2016, 2018; Vlada et al., 2010; Vlada, Jugureanu and Albeanu, 2011; Vlada, Jugureanu and Istrate, 2009).

Many teachers have digital skills developed at a certain level (Dulamă, Ilovan andMagdaş, 2017; Magdaş et al., 2017; Magdaş et al., 2018) which allow them to use technology on didactic activities (Magdaş, Ilovan andUrsu, 2018; Magdaş, VereşandDulamă, 2019). Studies referring to "digital manuals" in .pdf format for *Mathematics and Environment Exploration* indicate their features, including their weaknesses (Buzilă et al., 2017; Dulamă et al., 2017; Magdaş, et al., 2017; Ilovan et al., 2018a).

Regarding learning through discovery, in pedagogical literature, there is much information about its specificity, types of discoveries, stages, examples, importance (Bocoş, 2004; Cristea, 2005; Dulamă, 2008). The strategy of learning through discovery is considered an effective way of performing pragmatic learning (Petrovschi, 2009, p. 1).This strategy implies personal investigation performed by the pupil within an independent directed activity in order to acquire new knowledge from variousinformation sources (Petrovschi, 2009, p. 1). The study material is not presented in a final form to the person who learns, but it is to be discovered through a mental activity and then included into his or her cognitive structure (Petrovschi, 2009, pp. 1-2). Learning through discovery includes several stages: establishing contents to be discovered by the pupils; presenting the learning project and tasks; establishing the time resources given for solving tasks; distributing information sources; performing activities under the guidance and the consultancy offered by the teacher on request; acquired knowledge assessment; integration of the new knowledge acquired into the lesson (Iutiş, 2008, p. 66).

Research related to learning through discovery focused mainly on didactic activities performed in nature (Ilovan et al., 2018b; Deacet al.,2019), for which are used also Online Apps, Web Sources and Electronic Devices (Rus et al., 2019). At primary education level, in order to know the environment, during studies there were used educational films (Ilie and Cristea, 2020; Ilie et al., 2020) and animation films (Vereş andMagdaş, 2020; Vereş, Dulamă andMagdaş, 2020).

The purpose of this study is to investigate the way in which learning through discovery can be performed by pupils using the school textbook and the available online sources, while considering the topic of energy, relevant also for raising awareness about renewable energy sources (cf. Bălan et al., 2019) and understanding the resilience of territorial systems (Petrişor, Meitaand Petre, 2016). The research questions are: How much does the method of presenting a lesson from a textbook and the animation films favour learning through discovery performed by pupils? How can learning through discovery be organized in the virtual classroom? What are the principles, advantages, and difficulties teachersconsider when applying these strategies?

2. Material and Method

*Procedure.*The research took place in March 2020, a few days after the closing down of schools. In the documentation stage, we searched for and selected visual materials suitable for the topic, weanalyzedthe Google Classroom application, the text and illustrations from the textbook, and we designed the didactic activity. During the activity with the pupils, we sent them tasks and support materials on the account created on the Classroom application. We asked them to read the information from inside the textbook, to watch an animation film, to solve the tasks from the textbook, to photocopy/scan the pages from the textbook or their notebooks with solved tasks and to post them on their personal account.

The research material consists of: the text and illustrations from the lesson "Forms and Sources of Energy" from the *Mathematics and Environmental Exploration* textbook for the 1st grade, EdituraDidacticăşiPedagogică(Bălanet al., 2018); the animation film "Let's Learn what Energy

Means" (AgenţiapentruEficienţaEnergetică, 2018), the solutions to the pupils' tasks from the textbook posted on the Classroom application.

Data collecting and processing. We collected the data about the activities performed with pupils using the method of observation, and wecollected their solutions to the tasks by means of posting them on the account created on the Classroom application. Weanalyzed the information and the tasks from the textbook, the Classroom application, and the content analysis method for the pupils' solving of the tasks. Weanalyzed the animation film and the Classroom application with the aid of visual methods. We performed data processing using statistical methods.

Participants.In this research, 24 pupils, 7-8 years old, from a 1ˢᵗ grade of "Avram Iancu" Theoretical High School of Cluj-Napoca were benevolently involved. All pupils had internet access at home and laptops/tablets to use on their online activity. The first author, a primary school teacher was actively involved in the online activity, being perceived by the pupils as their teacher and not as a researcher. Knowing the class very well, she chose and analyzed materials, established tasks, communicated with herpupils using the Classroom application and analyzedeachpupil's activity.

3. Results and Discussions
3.1. Analyzing the content of a lesson from the "digital" textbook, considering the perspective of learning through discovery
Weanalyzed the lesson "Forms and Sources of Energy" which takes two pages from the 1ˢᵗ grade textbook*Mathematics and Environmental Exploration* (Bălan et al., 2018), posted on the website of the Ministry of National Education, at digital textbooks, https://www.manuale.edu.ro/

Form of the material to learn. The written information is presented in several forms: keywords (5), riddle (1), assertions (*"I remember!", "I recorded!", "Did you know that…?"*), structured list (an enumeration and a classification), questions (4), tasks or exercises (5). Visual material consists of a painting, a photography and 12 schematic drawings (Bălan et al., 2018, pp.84-85). The fact that only the structured list and the assertions present information apparently "ready" to memorize induces the perception that this material "to learn" corresponds to the request mentioned in literature regarding the process of learning through discovery because "it is not presented in a final form" (Petrovschi, 2009, p. 1).

Information volume designed for discovery. Information that should be learned results and is indicated mainly in the title of the lesson ("Forms and Sources of Energy"), through keywords ("forms of energy, sources of energy, electricity, exhaustible, inexhaustible, mine"), in structured lists which also include other concepts (light, heat, Sun, water, wind, coal, petrol/oil), in assertions (*"I remember!", "I recorded!", "Did you know that…?"*) (Bălan et al., 2018, pp. 84-85).

In literature, it is specified that "a certain volume of planned discovery" should be established (Cristea, 2005, p. 116). In this case, at a first analysis, we identified 13 concepts, but we noticed the fact that pupils already had some knowledge about the Sun, about water, wind, and heat. The volume designed for discovery is suggested or recommended by the questions in the textbook and tasks proposed for solving. In this lesson, the essential keyword is missing: energy. This concept is defined as being "the capacity of a system to perform a mechanical work or another equivalent action" (MDN '00, 2000) and can be understood with great difficulty by pupils.

Tasks proposed for performing the discovery.*Riddle.* Pupils are challenged to "guess" the concept (hydroelectric power plant) that has the attributes shown in the following riddle: "*Water stirs in*

the turbine/And from it, it makes light;/I am looking and keep wondering/How does it start running through the wire." (Bălanet al., 2018, p. 84). Above the riddle, there is a picture of a hydroelectric power plant dam, but without specifying what it represents. When we search on Google for the keyword "hydroelectric power plant" (in Romanian), we find the definition: "Power plant in which electrical energy is obtained by converting hydraulic energy" (Marcu andManeca, 1986). Comparing the content of the riddle with the dictionary definition and taking into account the pupils' level of knowledge, we consider that these pupils have little chances to "discover" the concept of a hydroelectric power plant and to solve the "problem-situation."

If it were for another picture, in which the dam and the lake were visible, then chances the pupils found the answer were bigger, provided that they made the connection between the riddle and the picture. In this case, perceptual learning would be mainly favoured (through observation and intuition) (Dulamă, 2004, p. 75) if the teacher presented the picture and specified that it represented a hydroelectric power plant, thus helping the concept formation according to the ostensible model (Dulamă, 2004, p. 158) or visible model, "that can be shown or can be seen" (DEX, 2009). Applying this concept formation model, the children memorize ("label") the term without being able to characterize the object (Dulamă, 2004, p. 158).

Questions (1ˢᵗ task) (Bălan et al., 2018, p. 84). Pupils are asked to look at an image (a painting) (Figure 1) and to answer questions. Trying to discover "Who enjoys the light and the warmth of the Sun", we consider that nature and people could be the beneficiaries. For the second question, we consider that the home is lighted up and heated during wintertime with the aid of solar panels, but also using electricity. The third question is subject to interpretation or is badly worded. If it means the sources from which electric energy is produced, then the correct answer is: water, the Sun, wind and, possibly, coal. The last question creates problems to the respondent, too. The Sun, car, solar panels produce heat. Even if some questions are inappropriately worded, still, solving this task determines a mental activity (Petrovschi, 2009, p. 1), a discovering process, when pupilscan answer questions correctly. In order to give a correct answer, they should have previous knowledge or representations to be able to identify the objects from the painting: the correspondence term-image for the hydroelectric power plant, solar panel, wind turbine, mine entrance, wagon with coal, electricity transmission grid pillar.

1. Look at this picture and answer the questions:
a) Who enjoys the light and the warmth of the Sun?
b) How do people light up and heat their houses during wintertime?
c) Which are the sources for electrical energy production illustrated in this drawing?
d) What sources for heat production do you recognize in this drawing?

Figure 1. Image from the textbook (Bălan et al., 2018, p. 84)

Tasks. For the second task,pupils are asked to find energy forms into their classroom and their house and to name the energy sources used. Starting from the information given in the textbook, pupils should discover in the classroom and in their house all forms of energy mentioned. If this is a learning through discovery activity, then, they should be able to determine for themselves, based on previous knowledge, the connection source of energy - form of energy, in this case the correspondence Sun - source of light and heat (correct Sun - solar energy). Referring to electricity, it is more difficult for children to discover for themselves the sources from which electricity is produced, they need information from other sources then the textbook.

For the third task, pupils are challenged to present to an imaginary character (Pogo) the importance of electrical energy in a human's life. Based upon observations made at home and upon previous knowledge and experiences, pupils can discover certain aspects of the importance of electrical energy for humans. In order to solve the problem-situation, pupilsmay talk to their family members. For the fourth task, the association drawing-form of energy is being requested. Regarding the identification of the significance of the drawn elements, it will be easy for pupils to recognize the Sun and the tree, it will be a little bit more difficult to establish that the drawing represents a running water or a waterfall and we donot think that they will be able to identify the oil well unless with the aid of an adult who possesses this representation or knowledge. The associations pupils can make, according to the information presented into the textbook, are empirical (Table 1).

Table 1. Associations made using the information in the textbook

Empirical associations	Correct associationssource - form of energy
Sun - light, heat, electricity	*Sun - solar energy*
Running water - electricity	*Running water - hydraulic energy*
Tree - wind energy	*Wind - Aeolian energy*
Oil well - light, heat, electricity	*Oil/Petrol – fuel*

For the fifth task, pupils are asked to match the source of energy with the object it sets in motion. We identified: car, airplane, boat, wagon, and locomotive. Two sources of energy are offered: oil and coal. Pupils may associate petrol/oil with the car, airplane and the boat, and coal with the wagon and locomotive. Pupils may be confused because, nowadays, the sources of energy that set cars in motion are gasoline, diesel, electricity, and other sources, and not petrol/oil or crude oil. For the sixth task, pupils are asked to identify actions that can cause energy saving or, instead, actions that can prevent the waste of energy. By solving this task, pupils can be aware of the need for certain behaviours regarding natural sources.

3.2. Analyzing the animation film considering learning through discovery

Using the Google search engine and using keywords "energy sources video" (in Romanian), weidentified the animation film „Să învăţăm ce înseamnă energie"["Let's Learn What Energy Means"] posted by the Energetic Efficiency Agency (AgenţiapentruEficienţaEnergetică, 2018)on July 3, 2018. YouTube offers several films for this topic but not all of them are suitable for pupils' age and knowledge level and do not have the necessary information for the studied topic. The animation film has several strengths: short duration (3 minutes and 52 seconds); starts form a child's questions while observing the objects around him and wanting to know what their uses are, what their importance is (*"What are these mirrors on the roof of our house?", "What are they for?"*) and introduces a character (the grandfather) with much knowledge, who answers his questions in an accessible manner; the information volume about energy sources and their use is great, but reasonable as difficulty degree for children in primary school.

From a didactic point of view, the dialogue from the film is built using a progressive cognitive approach: closed question, question that needs explanation, assumption, or hypothesis. For the first stage, the child asks a question and receives the information (*"photo-voltaic panels"*), and for the second question he receives an explanation (how these panels are used). At the second stage, the child starts from an assumption (*"this pinwheel…is also used to heat the water?"*) and he receives the correct explanation. Another assumption follows (*"Like this, big cities are also illuminated, with the aid of wind turbines," "In water there is also energy?"*).The child, who has the age-specific curiosity, formulates questions and answers applying the method of trials and errors at cognitive and not practical level. At the third stage, his grandfather asks him questions: *"Why do you think we*

gather all this hay, the scrap wood from around the lathe, these dry twigs and leaves, every year?"
The child offers several answers (hypotheses), and the grandfather offers him the right answer, the answer the child did not discover. At the end of the film, the child formulates a series of questions, which represent the start point for future discoveries.

In the film, there are used 17 concepts regarding this topic: photo-voltaic panels, sunlight, photo-voltaic cells, solar collectors, wind energy, wind turbines, generator, electricity, bio-mass, bio-fuel, bio-gas, geothermal energy, geothermal pumps, heat pumps, soil, and ground-water. It is of great value that the logical route is followed between the source of energy (for example, wind), form of energy generated (wind energy), the way of collecting and processing this form of energy (wind turbines), the way of using the final form of energy (electrical). The weakness is represented by some errors regarding the use of heat pumps for extracting the heat "from the soil", when, in fact, it is from underground. To sum up, we consider that this film meets all requirements in order tosupport a learning through discovery activity.

3.3. Analyzingthe Google Classroom application
During theactivity, we noticed that this application offers several facilities or advantages: the teacher can send information, messages, tasks in front of all pupils, but also, he/she can communicate individually, privately with each pupil; tasks solved by a single pupil can be viewed only by the teacher, the others not having access to their colleagues' account; tasks solved and sent as a photograph can be corrected directly on the photo with a distinctive colour, and thus, the pupilcan see exactly the place where he/she did wrong and correct by himself/herself into his/her textbook/auxiliary/notebook; after correcting the solutions to the tasks, pupils can receive individual, private/particular feedback; points from 0 to 100 can be assigned to evaluate these solutions.

3.4. Analyzing learning through the discovery activity performed in the virtual classroom
Because this activity took place several days since theinterruption of face-to-face classes, teachers searched for solutions in order to carry on with their didactic process. For this lesson, pupils received an hour before the scheduled time, their tasks and indications regarding sources of information (textbook, animation film and such) and were asked to solve them and post solutions on their Classroom account. Each child chose his/her optimum time to solve tasks and could ask and benefit from the help of his/her family. The teacher did not supervise pupils' activity, but she assessed the solutions put done on their textbooks and handbooks and provided individual written feedback.

Table 2. Pupils' results regarding the solved tasks

Item	Answers					
	Correct		Partly correct		Incorrect/ Missing	
	No.	%	No.	%	No.	%
1. Look at the picture below and answer the questions.	21	87.5	2	8.33	1	4.16
2. Find forms of energy into your classroom and into your house.	20	83.33	1	4.16	3	12.49
3. Tell Pogo about the importance of electricity in human's life.	18	75	2	8.33	4	16.66
4.Look at the drawings below and write into the boxes the form of identified energy.	24	100	-	-	-	-
5. Match the source of energy with the object	24	100	-	-	-	-

it sets in motion.						
6. What do you have to do in order to save energy? Mark with an X the boxes.	24	100	-	-	-	-

In Table 2, it is noted that the tasks which pupils were asked to fill in, to make matches and to select correct information from a list of built answers, were correctly solved by all pupils (100%). Pupils had difficulties concerning the tasks, where they had to phrase written solutions (answers to questions, examples of energy sources, reasoning the importance of energy sources in human life) because, as they are still in the alphabet period, they do not have the skill to write well yet.

3.5. Principles, Advantages, and Difficulties
Based on the analysis of the didactic activity, the process performed by pupils based on the strategy of learning through discovery using the online environment, we deduced several principles, and we identified some advantages and difficulties.
Principles. In order to produce learning through discovery when children use online sources, several principles should be mainly complied with: the list of keywords or questions to be short; the concepts or topics proposed for discovery to be suitable for children's level of knowledge and understanding; children should be given the necessary time sources; the adult should demonstrate to them the application of some strategies and procedures for information searching and should explain how to evaluate information in the virtual environment.
Advantages. All children from this class have computers and almost all of them (except fortwo or three) receive support from their parents (supervision, communication, support for solving tasks). Under these circumstances, pupils can practice learning through discovery using the Ethernet as source, without being exposed to great risks.Using the strategy of learning through discovery under the teacher's (and parents') guidance and supervision, children benefit from the advantages of this strategy: they learn to search for information designed for learning and not for other recreational purposes; they learn to assess information (i.e. critical thinking) and to select the one that is suitable for them; they learn to process the information presented in various forms (documentary films, animation films, drawings, pictures, text, etc.); they learn how to formulate questions and how to search for answers to questions; they learn strategies to search for information (they formulate the question, use Google find and give the page where the answer is); they notice that there are different opinions about certain topics, contradictions, false and incomplete information and thus, they learn to be suspicious regarding the information; they learn how to make a selection from the diversity and variety of sources.
Difficulties. The children of this class had some difficulties during the investigation process in the online environment because their skill of written communication (reading and writing) was not developed at a superior level, they did not have the necessary ability to correctly evaluate the information, their abilities to search for information were not well-developed, they did not know how to make the difference between correct and wrong or false information and to choose relevant information.

4. Conclusions
Pupils from the 1st grade, "digital natives", involved in the didactic activity in which they applied the strategy of learning through discovery using sources from the online environment, had in their homes the necessary devices (i.e. computers) and had the digital skills developed at a level that allowed them to use those devices successfully, under their parents' supervision and support.
    The lesson in the textbook, designed as a curricular auxiliary, proposes a series of tasks but without offering the necessary information for solving them and for this reason the pupils need to discover other sources of information, in this case, online and even to ask for their parents' support. The animation film proposed by the teacher for viewing on YouTube represented a

valuable source of information that corresponded to the pupils' level of knowledge and, more than that, satisfied their curiosity.

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