



## RESOURCES USED BY TEACHERS TO TEACH MATH, PHYSICS, CHEMISTRY AND BIOLOGY AT SECONDARY SCHOOL ONLINE

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### Abstract:

This research was meant to find which resources were used by teachers to teach Math, Physics, Chemistry and Biology online during the pandemic, trying to identify the main problems related to the adapting of the available resources, how they were -or not- adapted and the new ones. Besides, student's feedback was considered, for example, if there were online classes, how tasks were sent and how they were checked and evaluated. The notion of the resource proposed by Adler (2012) was adopted by generating a survey to collect data. The survey has 21 items in total, 20 of them with closed answers, 2 of them with a Likert scale and an open question presented in an online format for all the teachers in every province in Argentina. The survey is a tool to analyse the appropriation and use of the resources by teachers of secondary school when teaching online.

**Keywords:** resources, online teaching, COVID-19 pandemic

### 1. Introduction and Framework

The term resource used in this paper is taken from Adler's theory (Adler, 1998, 202). In the educational field as well as common sense, this term refers only to the physical resources, such as textbooks and other materials to learn from. In a broader sense, the

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resources can be physical items or not, for example, language and knowledge. Adler (1998, 2010) thinks of resources as nouns and verbs, trying to focus on their uses and transformations of them in the actual teaching, questioning their general meaning. So, resource is a noun, a verb, an object and an action for the actual professional teaching. Everything (material or symbolic) that gives meaning, supports and projects the teacher's work is a resource. There are human resources (teachers, students, people from the institution), cultural resources, such as language and time, and materials (chalk, board, books, calculators, educational software, web pages, etc.). This also includes exchanges with colleagues and student productions. When they have to teach, teachers look for resources, select and modify them, take them to the classroom and share them with their colleagues (Gueudet, Pepin & Trouche, 2013; Gueudet, Lebaud, Otero & Parra, 2021; Gazzola & Otero, 2022, Rabardel, 1995).

The national educational systems and the school as an institution arise with the creation of modern states in the nineteenth century, together with what has been known as modernity. In its nearly 200-year history, online school education was not part of its operation, even with the dizzying and revolutionary development of information and communication technologies. It is important not to lose sight of the institutional and professional impact of halting the closure of schools due to the pandemic. Thus, from one day to the next and for a very long period in Argentina, teachers go from teaching with chalk and the board in fixed and synchronous classrooms to doing so "virtually classroom", depending exclusively on their physics and symbolic resources, that is, their own strength to face a teaching situation affected by countless variables. While our definition of resource is broad, here and to begin to understand how did teachers teach with the available resources? we restrict ourselves mainly to the modifications that they made to the usual actions, in certain disciplines. While our definition of a resource is broad, here and to begin to understand How did the teachers teach with the available resources? we restrict ourselves mainly to the modifications they made to the habitual actions, in certain disciplines.

Among others, the following questions are formulated: What was the source of the resources? Did they adapt what they already had or did they generate new resources? What changes did they make? How were they selected? How did you evaluate its effectiveness and usefulness? What kind of resources? In what format were they delivered to the students? Did the teachers take into account the repercussions of the proposed resources in the family environment? How did they manage resources such as homework, exercises, experiments, etc.? These questions guide the design of the survey that we designed to collect this information.

## 2. Methods

The survey contains attributive variables about teachers, questions related to the resources, the adaptations made to them and their uses. Closed, Likert type questions and one open question are proposed (López-Roldán & Fachelli, 2015).

Closed questions have predetermined answer possibilities and are of different types: dichotomous for cases where it is important to identify the affirmation or negation of an affirmation, categorized for answers where various possibilities are offered whose nuances are fixed and it is appropriate to select one or more options; and Likert-type questions, or scale questions where a gradation is established in the response of acceptance or rejection between very high, high, medium, low or not at all (Ibid.). In the case of the open question, the teacher surveyed must freely and concisely write his opinion regarding online teaching versus face-to-face teaching.

The construction of the instrument consisted of the design of a preliminary version of the survey, the realization of a pilot test whose results were discarded, the evaluation of the items by expert evaluators in the research area, the redesign of the instrument and finally the implementation of the final version. The representativeness of the survey is based on the use of the strata used in the official surveys that include professors from all the provinces of Argentina in the disciplines involved. The survey is administered in digital format (<https://forms.gle/V3XE1T4fApvYqTk8>) allowing access to all places and ensuring anonymity.

### 3. The Survey Design

The survey contains 21 items, is anonymous and has as its main objective to know the explicit opinion of teachers on the development of online teaching and the resources used. The items are distributed in four parts corresponding to: the attributive variables (questions 1 to 7), the resources (questions 8 to 17), the accreditation and correction of tasks (questions 18 to 20) and 21 is the open question.

Table 1 presents the items corresponding to the attributive variables of the survey, the type of question, the possible answers, the type of variable and the type of response that will make up the analysis.

**Table 1:** Survey attribute variables

Attributive variables		
Question	Possible answers	Type of question, variable to conform and type of answer
1. Age	<ul style="list-style-type: none"> <li>○ 20 to 30 years old</li> <li>○ 31 to 40 years old</li> <li>○ 41 to 50 years old</li> <li>○ More than 50 years old</li> </ul>	Closed question, ordinal qualitative variable from an interval segmentation ( <i>age range</i> ). Only option answer.
2. Province where you work as a teacher	<ul style="list-style-type: none"> <li>○ Buenos Aires</li> <li>○ Ciudad Autónoma de Buenos Aires</li> <li>○ Catamarca</li> <li>○ Chaco</li> <li>○ Chubut</li> <li>○ Córdoba</li> <li>○ Corrientes</li> <li>○ Entre Ríos</li> </ul>	Closed question, which forms the qualitative <i>jurisdiction</i> variable. The possible answers are the 23 provinces and the Autonomous City of Buenos Aires (CABA). Only option answer.

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	<ul style="list-style-type: none"> <li>○ Formosa</li> <li>○ Jujuy</li> <li>○ La Pampa</li> <li>○ La Rioja</li> <li>○ Mendoza</li> <li>○ Misiones</li> <li>○ Neuquén</li> <li>○ Río Negro</li> <li>○ Salta</li> <li>○ San Juan</li> <li>○ San Luis</li> <li>○ Santa Cruz</li> <li>○ Santa Fe</li> <li>○ Santiago del Estero</li> <li>○ Tierra del Fuego, Antártida e Islas del Atlántico Sur</li> <li>○ Tucumán</li> </ul>	
<b>3. Teaching career</b>	<ul style="list-style-type: none"> <li>○ Between 0 and 10 years.</li> <li>○ Between 11 and 20 years.</li> <li>○ Between 21 and 30 years.</li> <li>○ More than 30 years.</li> </ul>	Closed question, ordinal qualitative variable from an interval segmentation ( <i>career range</i> ). Only option answer
<b>4. Hours dedicated to teaching</b>	<ul style="list-style-type: none"> <li>○ Between 0 and 20 hours.</li> <li>○ Between 20 and 40 hours.</li> <li>○ More than 40 hours.</li> </ul>	Closed question, ordinal qualitative variable from an interval segmentation ( <i>dedication</i> ). Only option answer.
<b>5. Number of institutions where he works as a professor</b>	<ul style="list-style-type: none"> <li>○ 1</li> <li>○ 2</li> <li>○ 3</li> <li>○ 4</li> <li>○ More than 4</li> </ul>	Closed question, ordinal qualitative <i>number of institutions</i> variable. Only option answer.
<b>6. Type of Institution</b>	<ul style="list-style-type: none"> <li>○ Public</li> <li>○ Private</li> <li>○ Public of management private</li> </ul>	Closed question, nominal qualitative <i>type of institution</i> variable. Multiple-choice answer.
<b>7. Discipline</b>	<ul style="list-style-type: none"> <li>○ Mathematics</li> <li>○ Physic</li> <li>○ Chemistry</li> <li>○ Biology</li> </ul>	Closed question, nominal qualitative <i>discipline</i> variable (Only select the one with the highest workload)

Questions 1 to 7 define the set of qualities and characteristics of the surveyed population. This group of questions is important since the age of the professor linked to his experience as a teacher, the number of hours dedicated to teaching, the number of institutions in which he works and the type of institution, that affect the use and selection of the resources, as well as the possibilities and availability of access to them. The same way,

knowing the province in which the teacher works allows a better interpretation of the resources.

Table 2 presents the questions linked to the resources. The type of question, the possible answers, the type of variable and also the type of answers that will make up the analysis are summarized as follows.

**Table 2:** Questions related to resources and their uses

Resources		
Question	Possible answers	Type of question, variable to conform and type of answer
<b>8. Equipment available for classes</b>	<ul style="list-style-type: none"> <li>○ Internet connection.</li> <li>○ Computer.</li> <li>○ Cell phone.</li> <li>○ WhatsApp chat.</li> <li>○ Platforms with a paid license (Zoom, Google Workspace, others).</li> <li>○ Digital board.</li> <li>○ Board.</li> </ul>	Closed question, nominal qualitative <i>equipment</i> variable. Multiple-choice answer.
<b>9. Did you use any technical support and/or any technical tutoring for online format?</b>	<ul style="list-style-type: none"> <li>○ Yes</li> <li>○ No</li> </ul>	Closed question, nominal qualitative <i>technical support</i> variable. Multiple-choice answer.
<b>10. What were the different possibilities students had to contact the professors?</b>	<ul style="list-style-type: none"> <li>○ Internet connection.</li> <li>○ Computer</li> <li>○ Cell phone</li> <li>○ Material in photocopier</li> </ul>	Closed question, nominal qualitative <i>student technical support</i> variable. Multiple-choice answer.
<b>11. Where did you get the resources to teach?</b>	<ul style="list-style-type: none"> <li>○ Web pages</li> <li>○ Teacher blogs</li> <li>○ YouTube videos</li> <li>○ Textbooks</li> <li>○ Digital textbooks</li> <li>○ Educational platforms</li> <li>○ Teachers' productions</li> </ul>	Statement with 5 degrees of agreement on a Likert scale: very high, high, medium, low or not at all. Form a nominal qualitative <i>source</i> variable.
<b>12. Which are the resources you mainly used for teaching online?</b>	<ul style="list-style-type: none"> <li>○ Educational platforms (Google Classroom or similar ones).</li> <li>○ Video calls (WhatsApp, Zoom, Meet or others).</li> <li>○ YouTube videos.</li> <li>○ Personal videos.</li> <li>○ Simulation softwares.</li> <li>○ Spreadsheets.</li> <li>○ Digital books.</li> <li>○ Teacher notes.</li> <li>○ Assignments.</li> </ul>	Statement with 5 degrees of agreement on a Likert scale: very high, high, medium, low or not at all. Form a nominal qualitative <i>resource used to teach</i> variable.

<p><b>13. Which criteria did you use when choosing the different resources?</b></p>	<ul style="list-style-type: none"> <li>○ Choosing resources from the internet, already digitalized.</li> <li>○ Digitalizing resources used for face-to-face classes for the online teaching.</li> <li>○ Creating new resources better adapted for online classes.</li> </ul>	<p>Closed question, nominal qualitative student technical <i>criteria to choosing resources</i> variable.                  Only-option answer.</p>
<p><b>14. Which are the changes needed in the resources to use them online?</b></p>	<ul style="list-style-type: none"> <li>○ The resources are the same, only digitalized.</li> <li>○ The resources are the same adding explanation to them.</li> <li>○ The resources were completely replaced by more appropriate ones.</li> </ul>	<p>Close question. Conforming the nominal qualitative variable: <i>resource transformations</i>.                  Only-option answer.</p>
<p><b>15. How did you organized your online classes?</b></p>	<ul style="list-style-type: none"> <li>○ Teacher only sent tasks.</li> <li>○ Teacher sent tasks and checked students' answers.</li> <li>○ Teacher gave the online class, sent tasks and students answered.</li> <li>○ Teacher gave the online class, sent tasks and checked students' answers.</li> </ul>	<p>Close question. Conforming the nominal qualitative variable: <i>class organization</i>.                  Only-option answer.</p>
<p><b>16. How did you do experiments in online teaching?</b></p>	<ul style="list-style-type: none"> <li>○ They were replaced by YouTube videos.</li> <li>○ The teacher recorded him/herself and showed the experiment.</li> <li>○ The teacher used simulating software for the different experiences.</li> <li>○ The students performed the different experiments with elements available at home.</li> <li>○ No experiments were done.</li> </ul>	<p>Close question. Conforming the nominal qualitative variable: <i>experimental classes</i>.                  Only-option answer.</p>
<p><b>17. Up to what extent are the resources used online part of your face-to-face teaching?</b></p>	<ul style="list-style-type: none"> <li>○ A lot</li> <li>○ Some</li> <li>○ None.</li> </ul>	<p>Close question. Conforming the nominal qualitative variable: <i>permanence of resources</i>.                  Only-option answer.</p>

Questions 8 to 17 mainly collect information on material resources, be they technological or those traditionally and naively described as school resources (board, books, etc.) that

teachers used, created, adapted or simply put into operation in online teaching. Questions 8 to 10 allow us to survey what technological resources teachers and students had for online teaching and also if they received technical-pedagogical advice. Questions 11 to 13 allow information to be collected on the source of the resources and among those available, which ones were used and to what extent. Questions 14 and 15 refer to the transformations carried out in the resources for online teaching and student feedback. Question 16 refers to whether experiments were carried out, with what resources and how. Question 17 inquiries about the continuity or rupture between online and face-to-face teaching.

Table 3 presents the items linked to accreditation in online teaching. The type of question, the possible answers, the type of variable and also the type of answers that will make up the analysis are summarized as follows.

**Table 3:** Questions related to corrections and forms of accreditation

Corrections and accreditation		
Question	Possible answers	Type of question, variable to conform and type of answer
18. How many of the suggested tasks were checked by you?	<ul style="list-style-type: none"> <li>○ All.</li> <li>○ Only the most important ones.</li> <li>○ None.</li> </ul>	Close question. Conforming the nominal qualitative variable: <i>correction</i> . Only-option answer.
19. How did you send corrections to students?	<ul style="list-style-type: none"> <li>○ You sent corrections to each student.</li> <li>○ You sent corrections to the group so that each student would check.</li> <li>○ You suggested a class to solve activities together.</li> <li>○ There was no checking.</li> </ul>	Close question. Conforming the nominal qualitative variable: <i>feedback corrections</i> . Only-option answer.
20. As regards grading, which activities do you consider to be most appropriate for online teaching?	<ul style="list-style-type: none"> <li>○ Assessing is the same face-to-face or online.</li> <li>○ Assessing changes drastically but it is still necessary.</li> <li>○ Assessing cannot be done.</li> </ul>	Close question. Conforming the nominal qualitative variable: <i>assessing</i> . Only-option answer.

The purpose of these questions is to find out about the resources used to evaluate and accredit, the activities that were corrected, and the way to establish the feedback of the corrections if any. It is interesting to know if the teachers “corrected”, if it was possible to take the evaluation in some way, or if it was not possible directly or if it was decided not to evaluate.

The last question corresponds to an open opinion question: **21. What is your opinion about online teaching compared to face-to-face teaching?** and teachers are expected to express their feelings, their main problems, the benefits, or what they consider important regarding online teaching. The only condition is to express your opinion in a maximum of 200 words.

#### 4. Final Reflections

For this paper, we propose a survey designed to collect the opinion of teachers in secondary school about the resources used for teaching online as a result of the pandemic. The notion of resource adopted is advantageous since considers as such any item -be it physical or not- to support and aid teachers' activities, so the resources are questioned in terms of how they facilitate teaching actions. Considering the development of online teaching in the circumstances mentioned above was affected by different variables, it is important to make visible and focus on the resources that in general are transparent both for pedagogy as well as the political instance, in fact, the decisions taken show that the resources were not considered. Teachers used them, as was proposed in this paper, reflecting the characteristics and the quality of teaching developed in practice. This survey could be very helpful to evidence the resources used by teachers and the difficulties that they had to face without preparation nor technical-pedagogical assistance required. Moreover, it is obvious that the analysis and development of the resources to teach, and the awareness of teaching as an instrumented activity in constant evolution should be part of the initial and ongoing teaching training.

#### Conflict of Interest Statement

The authors declare no conflicts of interest.

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