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## **Inquiry-based learning in science classes: challenges and benefits**

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### **Abstract**

This article aims to investigate the way sciences are taught in Romanian schools and to find out whether inquiry-based learning is frequently used. For this purpose, TIMSS data collected in 2019 has been used. The participants were 610 science teachers, from 194 schools, situated in different regions of the country. The research demonstrated that most teachers (422 respondents) involve their students in scientific experiments occasionally. Considering such findings, we also conducted a qualitative research in our attempt to identify the possible reasons why teachers are reluctant to use the investigative method. This interview-based study was held at a school where students are annually involved in inquiry-based science projects. The participants were science and primary school teachers who implemented such learning activities. The aim was to identify the perceived challenges teachers deal with in inquiry-based science activities and the way such activities benefit their students. The main challenge teachers face is that inquiry-based learning is time consuming. The lack of practical skills and the students' inability to identify laboratory equipment also prove problematic. Teachers also refer to issues related to the unpredictability of learning through inquiry and class management challenges associated with this type of learning.

**Keywords:** benefits, inquiry-based learning, challenges

### **Introduction**

Research has shown that active, collaborative learning is the type of instruction schools should provide, considering its numerous benefits. However, teaching is still mostly about transmission of information from an expert, the teacher, to the students, who are perceived as passive recipients of content.

This represents the premise of this article which seeks to analyze the way natural sciences are taught in Romanian schools and to reveal the importance teachers place on learning through investigations and experiments.

Research conducted by experts demonstrated the benefits of this science teaching method. Hence, involving students in inquiry-based learning experiences makes them ask questions and solve problems. Through such activities involving research and scientific experimentation, students find their own answers to the questions they raise and identify the solutions to the problems they set to solve.

It is during such exploration processes that learners also develop their social skills, being involved in meaningful interactions with their peers with whom they devise action plans meant to help them find the right answers to the questions they start from.

Inquiry-based learning is also promoted by international institutions such as The Organization for Economic Co-operation and Development (OECD) which cites The National Research Council.

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This states that “instructional approaches focusing on investigations and first-hand experiences (e.g. conducting investigations and using data to build models and explanations), integrated with content learning, are more effective and stimulate greater student interest in science compared to when students follow predefined procedures (e.g. memorization and demonstration activities)”. (OCED, 2025)

OECD also mentions a metaanalysis of a experimental and quasi-experimental studies, suggesting that “inquiry activities which combine procedural, epistemic, and social elements, can have a significant positive impact on student learning (Furtak et al., 2012[48])”.

First-hand learning experiences go beyond observation of the studied phenomena, contributing to their deep understanding. Through such activities, learners make sense of the things they investigate while also acquiring the scientific content material they study. In addition, they develop on a holistic level, becoming more creative, cognitively flexible, enhancing their critical thinking skills and their ability to solve complex problems. Their socio-emotional skills are also developed, as they cooperate with their peers. As part of their teams, they learn to negotiate their roles and manage to build their resilience while struggling to manage their frustrations caused by the challenges they face.

In light of the above considerations and the lack of specific research on this topic conducted in Romanian schools, the TIMSS data base has been accessed. We analyzed the natural science teachers’ answers to the questions given in the context questionnaires related to the teaching methods and approaches they use in class. The aim was to highlight the way natural sciences are taught in our educational institutions.

The research questions this article attempts to answer are: How much emphasis do teachers place on inquiry-based teaching in Romanian secondary schools?; How often do they involve their students in experiments?; Which factors influence the usage of this method?; Do schools facilities and teachers’ training courses impact the teaching methods?

The findings of the above mentioned quantitative study are accompanied by those of a qualitative research, conducted to probe the teachers’ views on the difficulties they face when implementing inquiry-based activities. Also, the latter study reveals teachers’ perceptions related to the benefits of this teaching method.

### **Inquiry-Based Learning. Theoretical Framework**

Inquiry-based learning falls within the scope of active learning. It is based on the constructivist learning approach, whose purpose is to create meaning, promoting the idea that each individual follows their own pathway for personal construction and management of knowledge.

Inquiry is “the process that encourages skills development and holistic knowledge acquisition.” (Ai, Bhatt, Chevrier, Ciccarelli, Grady, Kumari, 2008)

The inquiry method “cultivates lifelong learning and promotes a multi-faceted approach toward pursuing life’s opportunities.” (Ai et al., 2008)

Virginia S. Lee states that it “promotes the acquisition of new knowledge, abilities, and attitudes through increasingly independent investigation of questions, problems, and issues, for which there often is no single answer.” (Lee, 2012)

Inquiry-based learning is grounded on John Dewey’s principles and his learning-by-doing and stems from the model proposed by David Kolb. It is the latter who has imposed in the literature

the concept of “experiential learning” defined as “the process whereby knowledge is created through the transformation of experience.” (Kolb, 1984)

The four-stage experiential learning model implies having first a concrete experience (doing), followed by the reflective observation of what has been done (reflecting on experience) and the abstract conceptualization (reading upon it), the process ending with the planning of the next step and, of course, the actual experience.

Kolb’s model shares certain elements with inquiry-based learning. The inquiry-based learning process, IREC (Inquire, Research and Reflect, Evaluate, Construct), involves in its first stage the formulation, discussion, and reformulation of questions. The second stage consists of research and reflection, through which resources are identified and information is accessed. The third stage, the evaluation, focuses on finding out if the resources are suitable for the questions and if they raise other questions. The “Construction”, the stage that completes the process, involves reformulation, reevaluation and synthesis.

In the study of science, there are four essential elements from an inquiry-based learning perspective:

- formulating questions and hypothesis;
- getting evidence to answer the questions and test the hypothesis;
- understanding and explaining the evidence resulted;
- formulating arguments and communicating the outcomes of learning.

The relevant literature proposes several inquiry-based learning methods. One of the most important is the “case for dialogic inquiry” developed by Gordon Wells at the University of California. He argues that it is the “dialogue” between the participants that stays at the core of each of the 3 steps (research, interpretation of data and their presentation). Hence, we are dealing with a form of cooperative learning, which is highly collaborative in nature.

Starting from this case, the authors of the paper „From design to narrative: the development of inquiry-based learning models”, build “the peer, collaborative inquiry learning” model. Fostering dialogue and discussions on the inquiry process represents the essence of this model, where students work together to answer a research question. Synthesising the results and reflecting on them and on the process are also collaborative endeavors.

“Hypothesis driven inquiry learning”, “multiple forms of representation” and ”modelling” are three other existing models.

In inquiry-based learning, the teacher becomes a facilitator, a mentor who “assesses the skills students use in the inquiry process.” (Sutman F.X et al., 2008) He channels students’ attention to the procedures to be followed and provides them with the techniques meant to help them accomplish the task. The social component is essential in this type of learning because it involves collaborative tasks, where students work in teams, negotiating and assuming various roles within them, based on the skills they already have or intend to develop.

## Method

### **Inquiry-based learning in science classes. Quantitative Study**

Following the TIMSS (Trends in International Mathematics and Science Study) 2019 tests, given to 8<sup>th</sup> grade students, Romania ranked below the international average (500). In science, our country achieved a score as low as 470 points.

The tests were accompanied by a context analysis aimed at collecting data about the family and school environment of the students. The study used context questionnaires that were completed by the tested students, their natural science teachers and school principals.

The biology, chemistry and physics teachers who participated in the study were asked to provide details on the teaching methods and techniques used in the classroom. Thus, given the experimental nature of the four disciplines, they also spoke about the frequency with which they involved their students in learning tasks that were based on scientific experiments.

All this data helps us to outline an overview of how science teaching and learning happen in schools in our country and to find out if experiential learning plays a central part.

The sample volume consists of **610 validated respondents, coming from 194 schools (on average 3 teachers/school), from different regions of Romania**. The amplitude of the number of respondent teachers per school is equal to 5: The minimum value = 1 person and the maximum value = 6 persons.

**Table 1. The respondents' distribution**

No. of respondents in a school	No. of schools	Percentage%
0 person	1	0,5%
2 persons	2	1,0%
3 persons	172	89,6%
4 persons	9	4,7%
5 persons	7	3,6%
6 persons	3	1,6%
<b>Total</b>	<b>194</b>	<b>0,5%</b>

The distribution of seniority shows a balance between experienced and unexperienced teachers, but with a higher share of teachers with years of relevant practice.

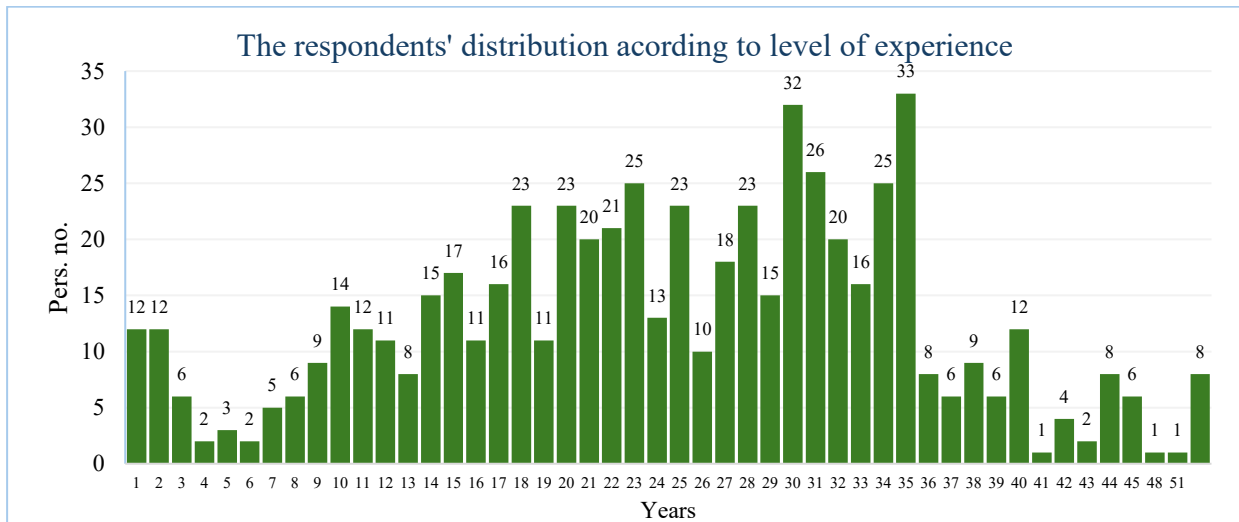


Figure 1. The respondents' distribution according to level of experience

**Beginners** (less than 5 years of experience) account for only 5.2% of the total, reflecting a low rate of entry in the profession; 13.9% are **teachers with 5-14 years of experience**, while the largest category (208 teachers, accounting for 29.5%) consists of teachers with **25-34 years of teaching experience**, which suggest a high level of experience and career stability.

**Gender distribution** shows an overwhelming share of women among teachers. As such, 82% of the study participants are female. This trend can be seen in many educational systems, where educator's or teacher's profession is more commonly associated with women. However, such a gender imbalance can lead to certain challenges, in particular in terms of diversity of educational process insights and of balanced distribution of human resources.

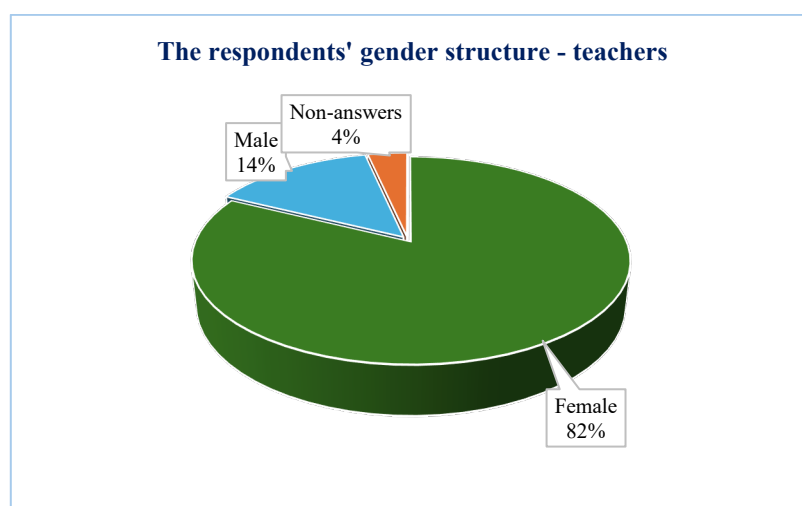


Figure 2. The respondents' gender distribution

## Findings and discussion

Respondents were asked about the teaching methods used in the classroom. Hence, by answering the question “**In teaching science to the students in this class how often do you ask them to do the following?**”, they provided data on how frequent they use these practices, as shown in the figures below:

**Table 2. Science teaching methods and techniques**

Statements		1. Every or almost every lesson	2. About half the lessons	3. Some lessons	4. Never	Non answers
BTBS15A	Listen to me explain new content	452	75	72	6	5
BTBS15B	Observe natural phenomena and describe what they see	342	140	120	2	6
BTBS15C	Watch me demonstrate an experiment or investigation	120	150	311	21	8
BTBS15D	<b>Design or plan experiments or investigations</b>	<b>43</b>	<b>124</b>	<b>384</b>	<b>49</b>	<b>10</b>
BTBS15E	<b>Conduct experiments or investigations</b>	<b>37</b>	<b>116</b>	<b>422</b>	<b>28</b>	<b>7</b>
BTBS15F	<b>Present data from experiments or investigations</b>	<b>38</b>	<b>108</b>	<b>424</b>	<b>32</b>	<b>8</b>
BTBS15G	<b>Interpret data from experiments or investigations</b>	<b>52</b>	<b>110</b>	<b>413</b>	<b>26</b>	<b>9</b>
BTBS15H	<b>Use evidence from experiments or investigations to support conclusions</b>	<b>66</b>	<b>130</b>	<b>373</b>	<b>33</b>	<b>8</b>
BTBS15I	Read their textbooks or other resource materials	246	132	214	11	7
BTBS15J	Have students memorize facts and principles	160	151	245	43	11
BTBS15K	Use scientific formulas and laws to solve routine problems	344	124	117	16	9
BTBS15L	Do field work outside of class	112	131	322	36	9
BTBS15M	Work in mixed ability groups	82	168	330	22	8
BTBS15N	Work in same ability groups	83	149	347	22	9

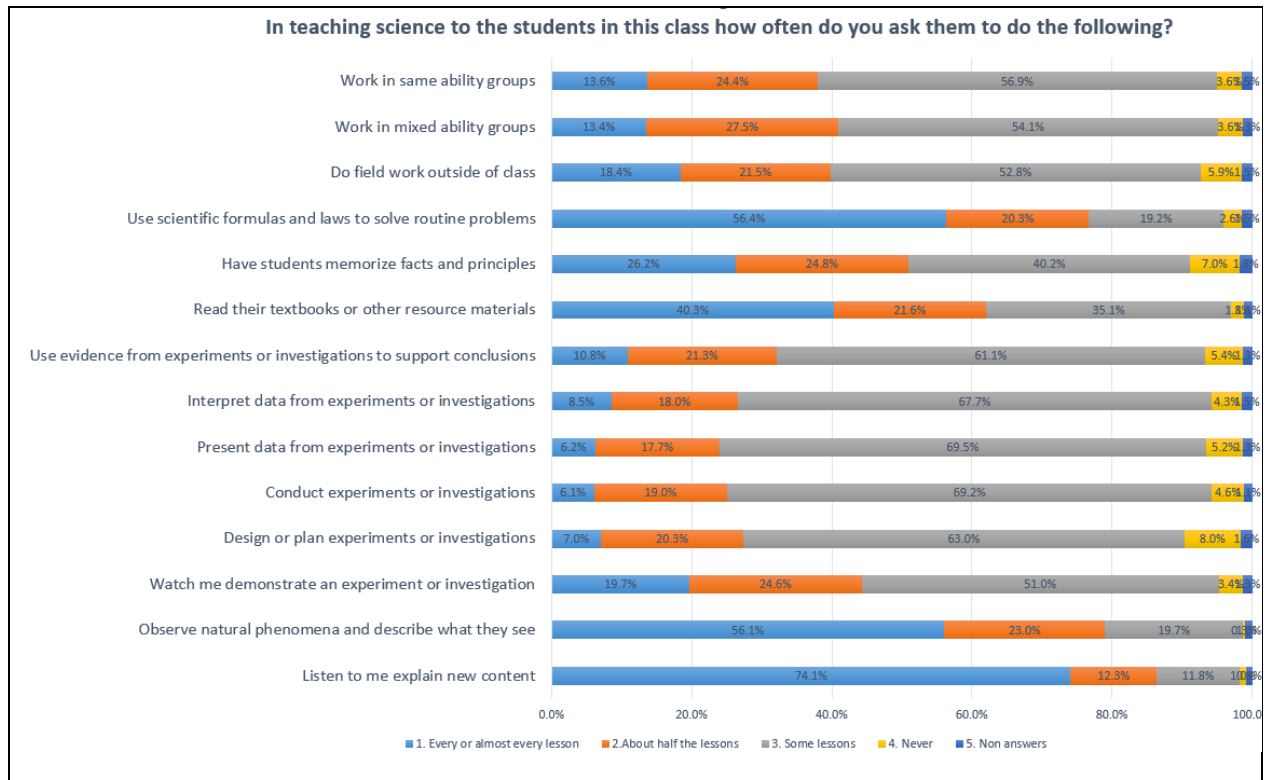


Figure 3. Science teaching methods and techniques in percentages

The above data reveals that teaching through verbal exposition is the prevailing method in science classes. As such, **452 teachers (74.1%)** request their students to listen to their explanations of new scientific content in every or nearly every lesson. This suggests a **strong dependence on the expository method of teaching** and reflects a traditional style of teaching based on the teacher’s direct communication of knowledge.

**The observation and description of natural phenomena by students are used by 342 of the teachers surveyed (56.1%)** in every or nearly every lesson. This is the second most commonly used teaching method, which underlines the importance of students’ direct interaction with nature’s observable phenomena.

In terms of “**designing and planning scientific experiments**”, only **43 teachers (7.1%)** propose to students’ activities involving the design/planning of experiments in every lesson, and only **37 (6.1%) ask them to conduct experiments on a regular basis**. In most cases (**69.2%, representing 422 respondents**), teachers involve their students in experiments occasionally, in a few lessons.

It suggests that practical activities are less commonly used and are not a central component in science teaching and learning.

The situation is similar when it comes to involving students in activities such as presenting and interpreting data from experiments and using experimental evidence to formulate their conclusions. Hence, **only 38 of the teachers (6.2%)** ask students to present data from experiments in every lesson, while **424 of them (69.5%)** do so occasionally (a few lessons). Only **52 teachers (9%)** involve students in activities aimed at interpreting data from scientific investigations in every class, while the majority (**413 teachers, namely 68%**) do so in just a few lessons.

Only **66 (11%)** of the teachers involve their students in activities implying the use of evidence from experiments to formulate and support conclusions, while **373 (61%)** do so sporadically, in just a few classes.

Using textbooks/resources and memorizing facts and principles are still among the top assignments imposed by respondents, with **246 (40.3%)** teachers asking students to refer to textbooks or other resources in every class. Students are requested to memorize scientific content in every class by **160 teachers (26.2%)**.

The table above shows that the traditional methods of science teaching and learning are prevailing. There is a strong dependence on verbal and explanatory teaching in most science lessons, with a focus on memorizing facts and using scientific formulas. Hence, traditional methods continue to be the pillar of science teaching, at the expense of experimental and interactive ones.

Although there is a clear presence of experimental activities among teaching practices, they are used occasionally without being an essential component. This may suggest a need for additional resources or difficulties in frequently implementing practical activities.

### Resources Required for Conducting Experiments and Training of Teachers

The analysis of responses provided by the school principals participating in TIMSS 2019 helps us draw certain conclusions on the access of science teachers to the **resources required** in order to engage the students in experimental learning activities in science classes. Thus, of the **196 schools participating** in the research, **only 119** have a science laboratory in which students could carry out investigative activities. In the remaining **77** educational institutions this essential resource is missing, being most likely one of the reasons why the students cannot benefit from this type of learning. As a percentage, **39% of lower secondary** schools fail to provide eighth-grade students with an adequate space to carry out experiments in natural sciences, which would allow them to benefit from inductive teaching.

In terms of assistance provided to teachers when implementing experimental activities in the classroom, in **64% of schools**, this does not happen. More specifically, **in 126 of the 196** educational units, science teachers do not receive assistance when conducting experimental activities with students.

The situation described above is illustrated in the following figure, where we relate the presence of a science laboratory in schools to the assistance provided to teachers when conducting experimental activities in the classroom:

**Table 3. Association between laboratory availability and teachers' assistance in experimental classes**

ScQ-08A BCBG08A: Does your school have a science laboratory that can be used by 8th grade students?	BCBG08B: Do teachers usually have assistance available when students are conducting science experiments?		Total
	Da	Nu	
YES	59 (a)	60(b)	119
NO	11 (c)	66 (d)	77
<b>Total</b>	<b>70</b>	<b>126</b>	<b>196</b>

Of the 119 schools that are provided with a science lab, in nearly half (59 of them), teachers also benefit from assistance during the experiments with students.

It's important to mention that in 11 of the 77 schools that do not have a laboratory, teachers receive assistance when they ask students to conduct experiments. From such data, two possible conclusions are to be drawn: either teachers in these schools involve their students in experiments, in spite of not having the necessary facilities, and conduct them in the classrooms, or the question in the context questionnaire was not fully understood by the study respondents.

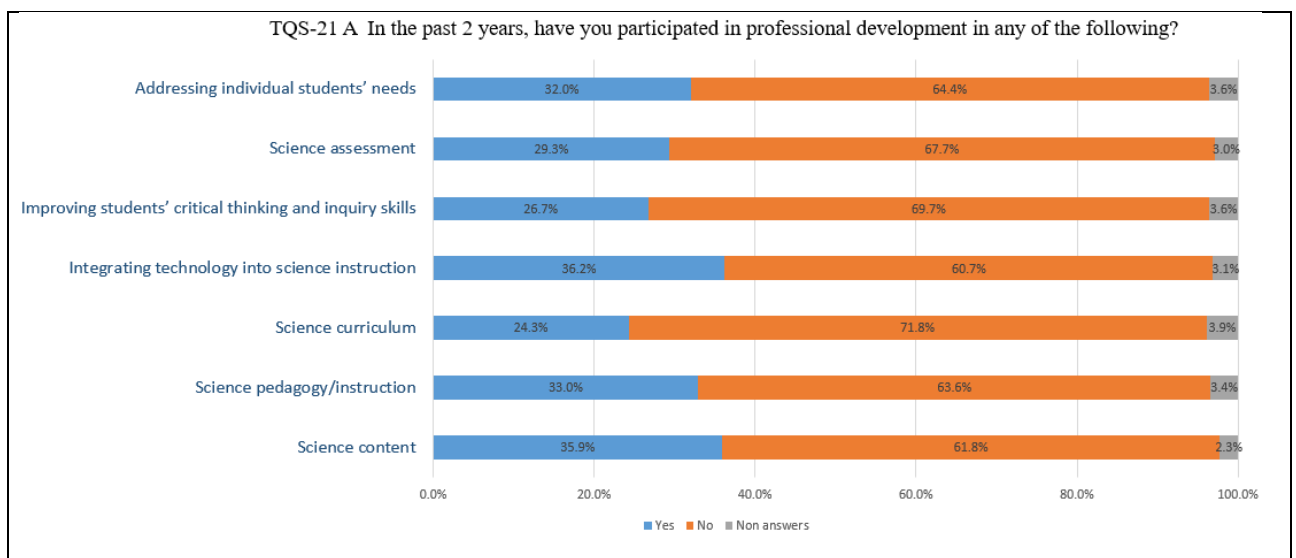
From the statistical analysis of the data stated above, more precisely, from Yule's coefficient of association (also referred to as Yule's coefficient of skewness) calculation, it becomes apparent that there is a strong positive association between the two variables.

The calculated Yule's coefficient ( $C_{as} = 0.710$ ) approaches +1, being hence close to the value that indicates a perfect association. This means that overall, the schools with a science laboratory in place also provide assistance to teachers when students conduct scientific experiments.

With regard to **the training of science teachers**, the situation is as follows:

**Table 4. Teachers' professional development domains**

Professional development domains		Yes	No	Non answers
BTBS21AA	Science content	219	377	14
BTBS21AB	Science pedagogy/instruction	201	388	21
BTBS21AC	Science curriculum	148	438	24
BTBS21AD	Integrating technology into science instruction	221	370	19
<b>BTBS21AE</b>	<b>Improving students' critical thinking and inquiry skills</b>	<b>163</b>	<b>425</b>	<b>22</b>
BTBS21AF	Science assessment	179	413	18
BTBS21AG	Addressing individual students' needs	195	393	22



**Figure 4. Teachers' professional development domains in percentages**

The figures above show that between 2017 and 2019 only **26.7% of the teachers surveyed (163 of the 588 who answered this question)** attended training courses aimed at **improving critical thinking or research skills of the students.**

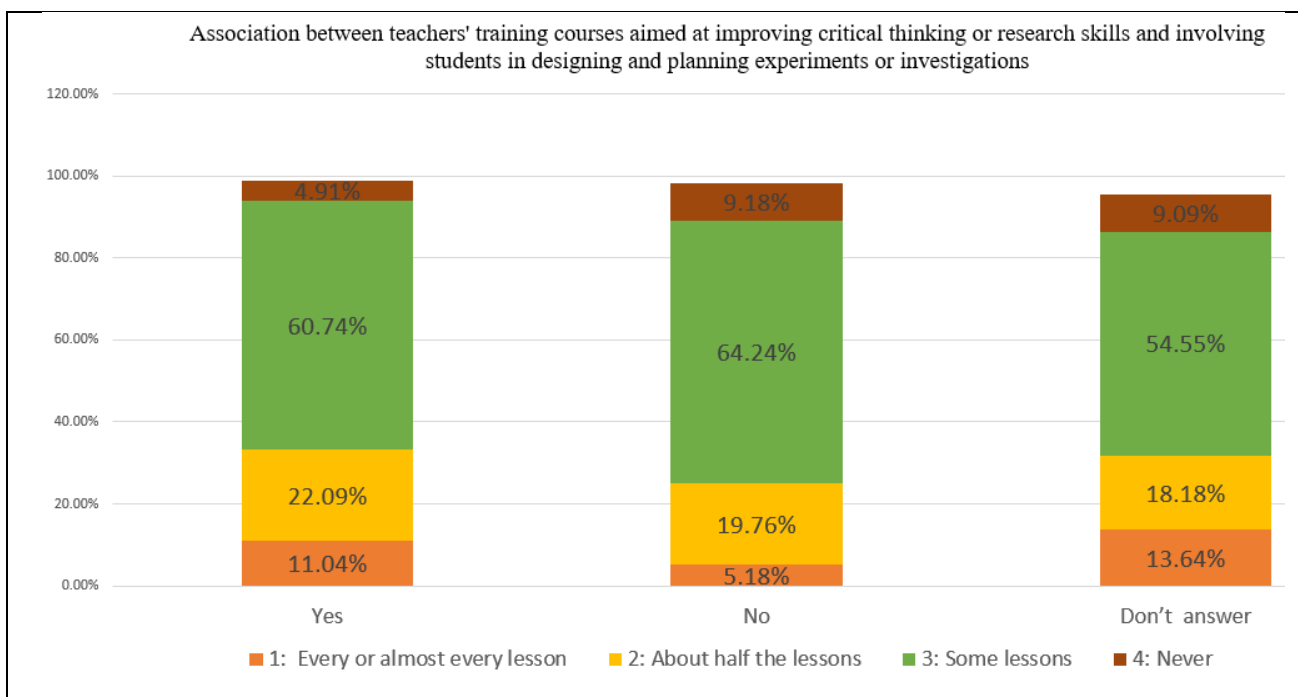
The most commonly addressed aspects of professional development are the integration of technology in science instruction (36.2%) and science content (35.9%), showing a relatively high interest in updating technological skills and science knowledge.

Over the last two years, the teachers surveyed failed to participate in any professional development courses covering the investigated domains, in a significant percentage (more than 60%), which may suggest either a lack of access to these opportunities or a low interest in them.

In order to determine whether teacher training aimed at improving critical thinking or student research skills has an impact on the teaching methods used in class, we used the association of variables.

**Table 5. Association between teachers’ training courses aimed at improving critical thinking or student research skills and involving students in designing and planning experiments or investigations**

BTBS21AE Teachers’ training courses aimed at improving critical thinking or student research skills	BTBS15D Asking students to design and plan experiments and investigations					Total
	1: Every or almost every lesson	2: About half the lessons	3: Some lessons	4: Never	5: Non answers	
Yes	18	36	99	8	2	163
No	22	84	273	39	7	425
Don’t answer	3	4	12	2	1	22
<b>Total</b>	<b>43</b>	<b>124</b>	<b>384</b>	<b>49</b>	<b>10</b>	<b>610</b>

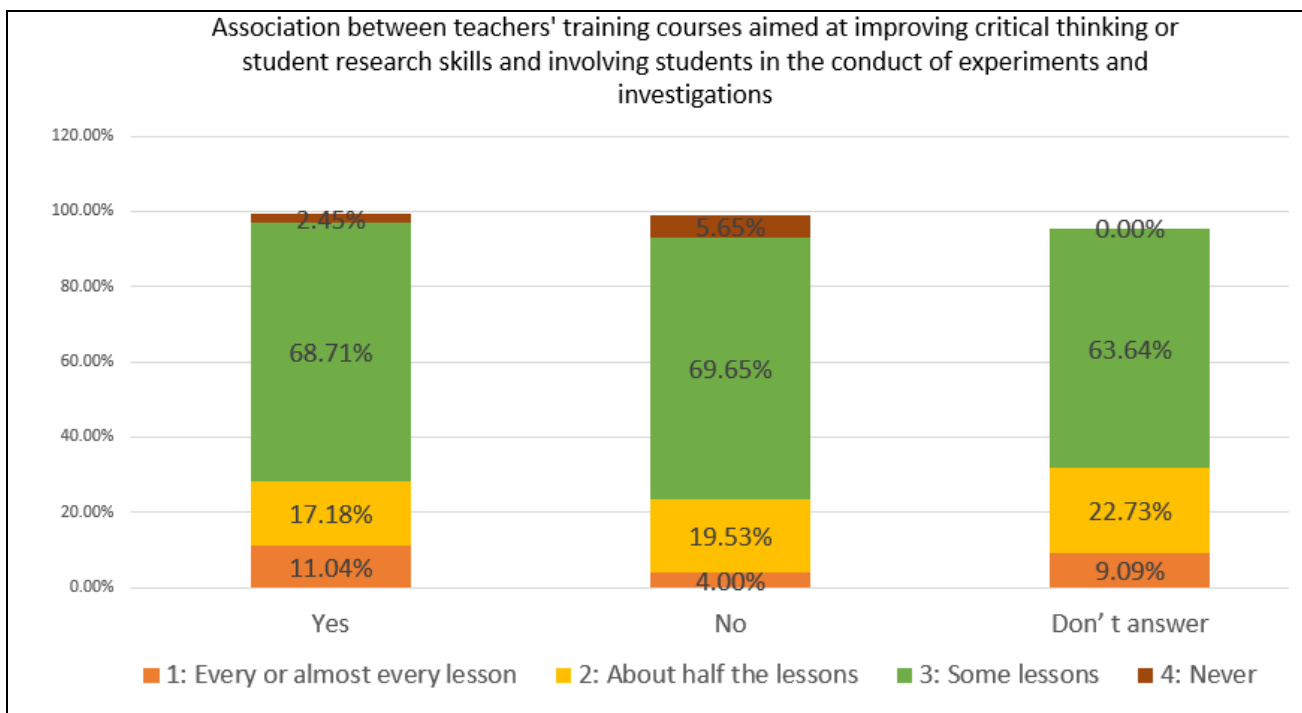


**Figure 5. Association between teachers’ training courses aimed at improving critical thinking or student research skills and involving students in designing and planning experiments or investigations in percentages**

The analysis detailed above highlights that **11.04% of the teachers** who participated in training focused on improving students’ critical thinking or research skills engage their students in activities that imply the design and planning of experiments/investigations in every or nearly every class. The percentage of those who do this, but who did not participate in such training is **only 5.18%**. Also, teachers who have recently specialised in this domain involve their students in the design and planning of experiments in approximately half of their classes, representing **22.09%** – a percentage higher than that of teachers who did not attend these courses (**19.76%**).

**Table 6. Association between teachers’ training courses aimed at improving critical thinking or student research skills and involving students in the conduct of experiments or investigations**

BTBS21AE Teachers’ training courses aimed at improving students’ critical thinking or research skills	BTBS15E Asking students to conduct experiments or investigations					Total
	1: Every or almost every lesson	2: About half the lessons	3: Some lessons	4: Never	Non answers	
Yes	18	28	112	4	1	163
No	17	83	296	24	5	425
Don’ t answer	2	5	14		1	22
<b>Total</b>	<b>37</b>	<b>116</b>	<b>422</b>	<b>28</b>	<b>7</b>	<b>610</b>



**Figure 6. Association between teachers’ training courses aimed at improving critical thinking or student research skills and involving students in the conduct of experiments or investigations in percentages**

With regard to involving students in the conduct of experiments/investigations, **11.04% of teachers** who have recently completed training in this domain do so in every or nearly every lesson. Of those who did not attend these courses, **only 4%** require students to conduct experiments in every lesson. As to the involvement of students in experiments in about half of the

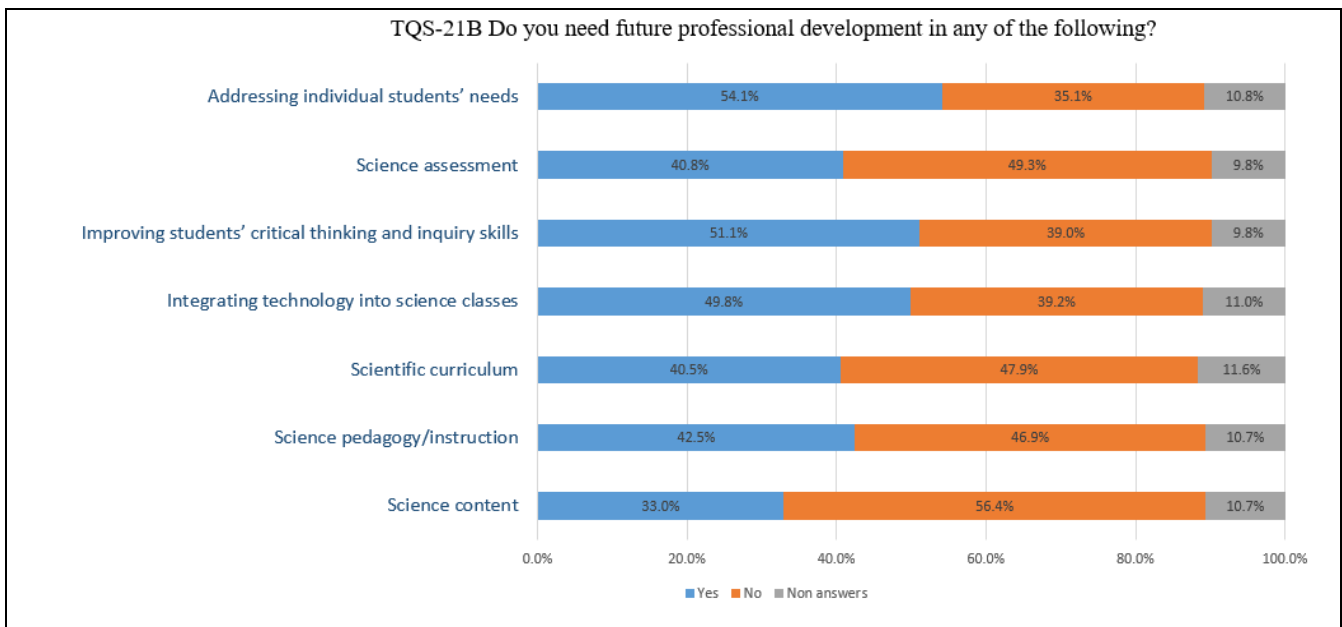
lessons, we note that teachers who have attended these training courses involve their students in such activities in a relatively lower percentage. Only **17.18%** of teachers participating in training in this field in the last two years require students to perform experiments in half or nearly half of the lessons, compared to **19.53%** who do the same, although they have not recently attended such training sessions.

These analyses help us infer that teachers’ training influences the choice and adjustment of teaching methods to students’ needs and to the specifics of subjects taught. Still, this is not the only condition.

Also regarding teachers’ training, we analyzed the needs reported by them. The following data were obtained from the study:

**Table 7. Teachers’ reported needs for professional development**

Teachers’ reported needs for the following professional development domains		Yes	No	Non answers
BTBS21BA	Science content	201	344	65
BTBS21BB	Science pedagogy/instruction	259	286	65
BTBS21BC	Scientific curriculum	247	292	71
BTBS21BD	Integrating technology into science classes	304	239	67
BTBS21BE	<b>Improving students’ critical thinking and inquiry skills</b>	<b>312</b>	<b>238</b>	<b>60</b>
BTBS21BF	Science assessment	249	301	60
BTBS21BG	Addressing individual students’ needs	330	214	66



**Figure 7. Teachers’ reported needs for professional development in percentages**

Hence, the most demanded domains for future professional development are **addressing individual student needs (54.1%)**, **improving students’ critical thinking or research skills (51.1%)**, and **integrating technology into science instruction (49.8%)**. Science

**content** and **science assessment** are the domains in which teachers reported the least a need for development (33% and 40.8% respectively).

The general perception shows a significant need for training in pedagogical and technological domains, suggesting that teachers feel the need to develop professionally in order to adjust their teaching to the students' various and dynamic needs and to better integrate technology into teaching.

As regards teachers' professional development meant to help them meet students' needs with a view to improving their critical thinking and research skills, we note that this is an area of great interest for **312** of those surveyed. Therefore, this is an aspect that Romanian policy-makers and mentors should take into account when making the offer for the initial and continuing training of science teachers.

### **Inquiry-based learning in science classes. Qualitative Study**

In order to identify why experiential learning is not an essential element in science teaching, we have initiated a qualitative study to collect data on the challenges teachers face when facilitating such learning activities. This research also aimed to outline the benefits offered to students who are involved in this type of learning processes, so as to emphasize the usefulness of inquiry-based learning in natural sciences. To this end, we found a school that organizes an annual science fair, consisting of presentations of students' scientific works in front of an audience and subject-matter experts. After obtaining the consent of the school principal, we conducted interviews with primary school teachers who facilitated such learning experiences and with science teachers (biology, physics and chemistry) who gave their informed consent on the participation in the study.

In total, 7 interviews have been recorded, transcribed and analyzed thematically. The respondents' profile is detailed below:

**Table 8. The respondents' profile**

<b>Respondent</b>	<b>Level taught</b>	<b>Subject taught</b>	<b>Gender</b>	<b>Teaching Degree</b>
Respondent 1	Primary School	Primary education teacher	Female	Def.
Respondent 2	Primary School	Primary education teacher	Female	2nd Degree
Respondent 3	Primary School	Primary education teacher	Female	1st Degree
Respondent 4	Lower and upper secondary school	Biology	Female	1st Degree
Respondent 5	Lower and upper secondary school	Physics	Female	1st Degree
Respondent 6	Lower and upper secondary school	Chemistry	Female	1st Degree
Respondent 7	Lower secondary school	Biology	Male	1st Degree

### ***Challenges Perceived by the Teachers in Facilitating Inquiry-Based Learning***

Reflecting on the challenges they faced in implementing these activities, respondents identify *the time*, highlighting **the time consuming nature** of this type of learning:

*“The main challenge is the time, because a project of this kind takes dozens of hours. It involves hours of planning, hours of discussing the theoretical part with the children.”* (teacher 1)

*“The time to complete the project is the biggest challenge.”* (teacher 2)

*“The teacher is facing a lack of time...”* (teacher 3)

*“The first challenge was that some children proceeded very quickly, while others did not. (...) And it took quite a while, I mean, this stage of exploration. While we expected it to take a week or two, it took about a month and a half.”* (teacher 5)

**The identification of instruments** in the laboratory, **the manual handling skills** and **the handiness** of the students, or better said the absence thereof, are other challenges perceived by the teachers, especially when they work with young students:

*“The challenges are also related to the handling skills that students have, to the manual handling skills, because they have actually constructed everything from scratch. For the ship floating experiment, they had to build some boats using aluminium foil. They struggled quite a lot.”* (teacher 1)

*“When children are younger, they are not very handy and have no experience in the lab. They must first become familiar with the laboratory instruments before I can work with them.”* (teacher 4)

*“Especially the little ones, they don’t have any manual handling skills, they don’t quite realise what they need to carry out an experiment.”* (teacher 5)

Another challenges included **the unpredictable nature of learning** through experiments and the special conditions imposed by it. The unpredictability of scientific experiments raises big issues when the work is to be presented at a scientific event before an audience.

*“The experiment is part of the lesson. And it’s a part that gives teachers headaches, isn’t it? Because it needs to be prepared and there is still a risk that it will not work then. In other words, you can set it up to work, and yet it may still fail. It’s just like using a computer.”* (teacher 3)

*“We saw how that experiment didn’t work, how we had realised we hadn’t had much time, how, at the eleventh hour, we had to find something that could be done quickly.”* (teacher 4)

*“There have also been challenges while conducting the experiment, crystals are naturally formed, but it takes time. In order to reduce time, certain conditions must be created.”* (teacher 6)

**The existing conditions of school science laboratories** are not always the most adequate for conducting authentic scientific experiments:

*“Experiments were limited due to the conditions, and not all proposed experiments could be carried out in school, as the laboratory is a closed, unventilated space.”* (teacher 6)

For the teacher, **monitoring students** to ensure their safety and physical integrity is a challenging matter, as one respondent states:

*“The teacher has to make sure that the students are safe, that there are no accidents, their safety is very important. This practice class is much more challenging from the teacher’s point of view because he/she has to keep students connected and attentive to the operating materials, since scalpels, scissors and other similar objects that can hurt them are often used.” (teacher 7)*

The challenges of lower secondary school teachers are also of a different nature. Thus, **getting students acquainted with the language of science** raises problems:

*“Another challenge is the language of science. They are not familiar with it.” (teacher 4)*

Students’ tendency to **focus on the product rather than the process** is another challenge that teachers have to face. This is accompanied by **a lack of reflective practice** which prevents students from reflecting on the process of learning by discovery and is an area where the student requires constant teacher’s guidance:

*“There are times when some of them lack patience; that is, I achieved something, but I have to organise my work further. When the task concerned only a foreseen outcome, they were more enthusiastic compared to when they were asked to put on paper, step by step, what they did, to describe the stages.” (teacher 6)*

**The lack of perseverance and consistency** in learning leads some students to give up such science projects, as follows from the observations of another teacher:

*“We had children who gave up toward the end, either because they did not participate and were consequently removed from the team, or because they avoided participation.” (teacher 5)*

Therefore, **the time consuming nature** of experimental learning of science is the challenge identified by all interviewed teachers. Also, **the unpredictability of the experiments** is another difficulty, along with **the conditions of school laboratories**, which limit the range of experiments that can be performed with the students, especially in chemistry. The students’ lack of manual handling skills and learning reflexivity, and the safety-related issues inquiry-based projects involve are also aspects teachers must deal with.

### ***Benefits of Science Inquiry-Based Learning Perceived by the Teachers***

The interviewed teachers claim that students involved in scientific investigations benefit from **“deep learning”**, described as *“the kind of authentic learning that remains”*: *“(Students) are learning things for real.” (teacher 1)*

*“They learned by doing and understood much better... we are talking about a much deeper type of learning, and the students have actually understood what was happening.” (teacher 2)*

By engaging in experiments, students learn in an authentic way and remember for a long time what they observe or practice: *“It is also a more durable type of learning. In the lower secondary school, there are fewer measurement experiments, but there are many aimed at demonstrating the*

*theoretical notions taught. Then, they remember much better the notions, much faster what we have done, making associations with the experiments we carry out.” (teacher 5)*

There is also a contrary standpoint, as sustained by a primary school teacher, who argues that the young student *“is more of an observer, a spectator, because whatever he/she does must be done with adult support”* in these experiential learning activities. This type of learning is useful starting from the sixth grade, when the study of physics is introduced, for, he says, *“in primary school classes, information is reduced.”*

However, all respondents talk about a method of **learning which is motivating** for the students:

*“So, for them it was fun, it was entertaining.” (teacher 3)*

*“They learned with more pleasure. That is, they had higher motivation than when they were learning at other times, which is the main benefit, as I see it.” (teacher 2)*

*“(The students) liked it very much. I consider it the greatest benefit. They proved themselves that it could be done, and I sensed their pleasure in speaking before others and being acknowledged by a large group.” (teacher 6)*

It is also worth mentioning the **social-emotional side of inquiry-based learning**, which is noted by respondents and also reported in relevant literature. We are referring to key skills that students develop, such as **collaboration** with their peers within the work teams. **Teamwork** has been identified by the teachers as one of its main advantages, as the inquiry-based learning *“also brings about self-awareness and interpersonal awareness within the group”* (teacher 1)

*“Basically, when we are referring to benefits, we have to consider **teamwork, and the practical part**, as they constructed, deconstructed and reconstructed.” (teacher 5)*

*“Firstly, **it is the teamwork**, because they worked as a team. Secondly, this learning by discovery seems to me the most important thing, at least in science, because you actually see the process and understand it. And it seems to me that it is **a long-term learning**, because (the student) sees the phenomenon and those observed remain throughout his life.” (teacher 4)*

**The long-term retention** of the concepts assimilated is therefore considered another positive aspect to be taken into account:

*“One of my colleagues asked me to give her the information from the last year’s fair, and they (the students) remembered perfectly: What they did, how they did it, why they did it, how they wrote, where they glued, how we presented, and so on. I suspect this is also related to the emotional charge. So, it is an authentic **emotionally charged learning**.” (teacher 1)*

*“They retain these notions acquired through experiment much better and will not forget them. When they encounter them in real life, everything will come back to them, and they will recall having done or seen that or something similar.” (teacher 7)*

**The practical side of learning and skills development** are also included in the list of benefits:

*“They also develop some work skills. At their age, they need to work, create, build, not just sit in a classroom, write and be attentive.” (teacher 7)*

**The authentic nature of experiential learning and its connection to the student's real life** are brought to the fore by one of the subjects of this study, who points out that in this way, *“child learn much easier to assess things in their life. The experiment helps them discover, demonstrate, observe, and there is also the part of value reading and interpretation that they perform within an experiment.”*

Investigative learning develops **students' critical thinking skills and reflexivity**.

*“It is more important to draw the conclusion, what we have tried to do through this experiment and finally to detect the sources of errors: why the experiment failed or, if it succeeded, why it succeeded. These are the discussions with which we always end an experiment.”* (teacher 5)

In conclusion, except for the primary school teacher who does not believe that this type of learning is extremely beneficial to students in the lower primary cycle, the other 6 subjects outline a comprehensive picture of the advantages of inquiry-based learning, confirming those reported in the relevant literature. As such, we are referring to **the deep, authentic nature** of inquiry-based learning, **the motivational boost** shown by the students, **the development of their practical skills** and, last but not least, the **long-term retention** of science concepts acquired through investigation and experiment. **The social-emotional side** of learning is also reported by respondents, strengthening the idea that inquiry-based learning promotes collaboration among students, having thus a strong social and emotional nature. No less important are **students' reflexivity enhancement and development of critical thinking** that are gained when students ask questions, test hypotheses and reflect on the processes and products resulting from their scientific projects.

## Conclusion

This article highlighted the way sciences are taught in lower secondary schools in Romania. The analysis of TIMSS 2019 data has outlined that traditional methods prevail in science teaching, at the expense of modern approaches. Hence, verbal exposition and memorization of science content by the students are still the most common teaching practices encountered in schools. Consequently, engaging students in tasks that involve planning science investigations, scientific experiments and the presentation of resulting data plays a secondary role, thereby depriving students of genuine learning experiences that would contribute to their holistic development.

The data provided by school principals with respect to educational institution equipment showed us that a significant percentage of schools do not possess any science laboratory, which may explain the absence or the low frequency of experimental activities. The study also revealed that a low number of teachers participated in professional development courses aimed at improving students' critical thinking and research skills in the years preceding the research, but that a large number of teachers felt this need.

The qualitative research conducted made it possible to identify certain possible causes of the low frequency of investigative learning in science. These range from its time consuming nature to the lack of student manual handling skills. Moreover, students' knowledge of science language, their inability to identify the laboratory instruments and the school laboratory conditions are other areas that science teachers need to focus on. Data on the advantages of inquiry-based learning were also collected, including the deep nature of learning, the long-term retention of science notions, the development of students' practical skills, the improvement of their ability to

work as a team, the motivational boost brought to science learning and the development of students' reflexivity and critical thinking.

### **Limitations of the Research**

The use of TIMSS 2019 database is a strength of this research. Considering the representativeness of the sample, the findings of the analysis can be generalized. Nevertheless, the qualitative study conducted may represent a limitation of the research, given that it involved a convenience sample and was carried out in a single educational institution. However, the resulting data should not be disregarded and can be generalized by expanding the research to other schools.

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