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The main features of the application of the “Case study” method in chemistry lessons

One of the priorities of the modern education system of the Republic of Kazakhstan in recent years is the formation of functional literacy of students and finding new methods of teaching subjects of the natural and mathematical cycle. Along with traditional teaching approaches, new pedagogical technologies such as collaborative learning, interactive teaching methods, the project method, online learning, and the situational analysis method known as Case-study (case study method) are gaining popularity. The essence of this method is the division of the trainees' educational material into tasks of various types, and information is learned as a result of their active investigation and creative activity in producing answers. In this paper, the main features of the use of the Case-study method are identified and described, which contribute to increasing the activity of students and the effectiveness of the learning process in secondary school, the main advantages and types of the method of concrete situations (Case-study), as well as examples of various chemistry cases for 9th-grade students are developed. The study was limited by a small sample size, but the findings provide valuable information for teacher professional development and the development of current chemistry curricula. The results of the survey of students indicate that the use of the method of specific situations (Case-study) when studying individual topics in chemistry increases the success of the assimilation of educational material by students.

Keywords: Case-study, problem-solving, science literacy, chemistry, lower-secondary school, questionnaire, 9th grade.

Introduction

The main methodological innovations today are the use of modern learning technologies, involving each student in the learning process, i.e. in the process of cognition. As a result, there is a need to increase the quality of training sessions as well as chemistry teaching techniques by introducing current modern teaching methods [1]. The case-study technique is frequently used in economics classrooms across the world. It was employed in the educational process for the first time at Harvard University's Law Faculty. The first versions of the cases were published in 1926 in the Harvard University Business Reports. In the United States, the technique was the most closely connected with The University of Chicago Department of Sociology. From around 1925 to 1935, The Chicago School was the dominant institution in the discipline and the source of much of the literature [2; 22]. Campbell (1975) identified the “case-study approach” as an effective method for connecting evidence to ideas. According to Campbell (1975), pattern-matching is a circumstance in which numerous bits of information from the same instance may be connected to some theoretical concept [3].

According to Yin (1994), a case study investigator must be competent to function as a senior investigator throughout data collection. There should be a training phase that begins with an analysis of the problem definition and construction of the case study design. This may not be essential if there is only one investigator. The training would address topics that the investigator should be aware of such the purpose of the research, the sort of evidence sought, and what variances could be expected [2; 58].

There are now two case-study schools: Harvard (American) and Manchester (European). Harvard University is now at the forefront of scientific and practical breakthroughs in case-oriented techniques. Harvard's purpose is to teach the approach of discovering only one correct solution; their examples are 15–20 pages long, with 5–7 pages of drawings. Manchester's purpose is to find a multivariate solution to the problem; their cases are 5–10 pages long [4].

The method of specific situations (case-study method) is a type of active problem-situational analysis that involves tackling specific difficulties (solving cases). The primary goal of this strategy is to study numerous circumstances in groups and then suggest and select the best algorithm to solve the problem. The case technique or method of specific scenarios should be attributed to active problem-based, heuristic learning

approaches [5]. It is essential that students are urged to analyse and solve a situation that is relevant to real-life challenges and whose description represents a practical assignment. The construction of a crisis situation based on real-life facts is a distinguishing element of this strategy. At the same time, there are no unequivocal answers to the problem. To deal with such a circumstance, the educational task must be carefully specified, and to accomplish it, a "case" containing various information items must be prepared (articles, literary stories, Internet sites, statistical reports, etc.) [6].

The case method has the following advantages:

- a strong focus on gaining knowledge in the disciplines, the lack of an unambiguous answer to the question posed (multiple possible answers);
- concentration is not on ready-made knowledge, but on their development;
- democracy in the process of acquiring knowledge (student and teacher are equal in the process of discussing the problem);
- formation of practical skills, development of students' value system (professional positions, life attitudes);
- overcoming the problem of traditional instruction, since a well-organized case discussion resembles a theatrical performance [7].

Types of Case study

1. The practical case depicts incidents from numerous life situations in detail. The primary goal of this case is to teach students and help them solidify their information, abilities, and decision-making in specific scenarios. Typically, such scenarios are detailed in-depth, and the goal of learning life events and obtaining the skills to engage in genuine professional action is assigned.

2. The educational case first and foremost handles educational tasks. The setting, problem, and narrative in this story are not true, but they may be in real life. They are distinguished by artificiality, the "assembly" of the most crucial components.

3. The research case serves as a model for gaining new knowledge about the circumstances and its participants' behaviour. The solution to such a problem is to improve scientific research skills through the use of modelling. As a result, it is better to utilise it not as a general education technique, but as a means of professional growth, i.e. as a method of specialty training and retraining [8–10].

To summarize the above material can be in the form of Table 1 [11; 200].

Table 1

Types of Case study

	Content	Purpose	Educational task of the case
Practical case	Situations in life	Cognition and life knowledge	Behaviour training
Case study	Situations for (conditional) training	Recognizing common situational qualities	Analysis, comprehension
Research case	Situations for investigation	Developing Situation Models	Research, design

General recommendations for the development of a case task

At first impression, the technology of the case preparation approach for students appears to be extremely easy, but it takes some preparation. A model of a certain situation (Case study) is constructed following a specified style, which can occur in real life and illustrates the complex information, abilities, and connections that students must acquire. Other sources of information are related to the case, including news articles, papers, images, video applications, and so on. Participants do preliminary research on the case, gathering material from several sources. Following that, the material is thoroughly discussed. Simultaneously, the teacher produces questions, records responses, and facilitates the conversation [12; 100].

Before beginning to design tasks for a training case, a teacher or methodologist should usually answer the following questions [13]:

- Who will be the participants of the events? (full name, age, description of the role of the participants of the case).
- What will occur? That is, who says what and writes what.
- Why do pupils require this? Establish a goal for the case's participants, describing the outcome they should achieve.

- When should the solution be prepared? This is a matter of virtual time. By attempting the case, you may calculate how much time should be allocated to solve it. If we want to create engaging answers to real-world problems, we should devote as much time as possible to the case, so that creativity is not stifled.
- How should the issue be resolved? This is frequently incorporated in the case's task, i.e. discovering the solution is part of the case's assignment for the participant/participants. But it is critical that you, as a compiler, take care of the technique for executing the case. Your query is, "How?" — A description of the method or regulations for dealing with the situation [14].

Methods and materials

Case study evaluation criteria

In the literature, you can find various criteria for evaluating ready-made case-study tasks. We created our own case assignment system based on Yin's scientific work [15], which is presented in Table 2.

Table 2

Case task evaluation criteria

Criteria	Advanced	Medium	Basic	Not Attempted
Identification of main issues / problems	*3 points* – identifies and displays a deep knowledge	*2 points* – identifies and displays an appropriate comprehension	*1 point* – identifies and displays a lack of grasp	*0 points*
Analysis and evaluation of issues / problems	*3 points*– provides a detailed and insightful analysis of all identified issues / problems	*2 points* – provides a cursory examination of some of the highlighted difficulties	*1 point* – provides an insufficient examination of several of the identified difficulties	*0 points*
Recommendations on effective Solutions / strategies	*4 points* – strong reasoning and well-documented data support diagnoses and conclusions; gives a balanced and critical viewpoint; interpretation is both rational and objective. *3 points* – arguments and facts are used to support the diagnosis and opinions; average interest in the concepts given	*2 points* – the case study's challenges were addressed with little action and/or incorrect remedies.	*1 point* – no action was advised, and incorrect solutions to the challenges in the case study were given.	*0 points*

Examples of developed case study chemistry tasks for 9th grade

1. Alkali metals

Case type: practical case.

The contents of the case: On June 4, 2020, a tragedy involving an 18-year-old Karaganda resident occurred on the 40th bus. The man sat down on the bus seat as if nothing had occurred, yet it was soaked. He sprang up right away, but it was too late. The strange substance was quickly absorbed by the pants and began to burn the flesh to a crisp. The man got off the bus with a third-degree chemical burn (Fig. 1).

Figure 1. Case study task on the topic: "Alkali metals (chemistry)"

An unknown individual spilt a mysterious liquid on the seat, which functioned like acid. The fabric of the pants and knickers quickly became saturated with a caustic chemical and adhered to the skin. The man felt a

severe burning feeling followed by pain. The patient was taken to the hospital with the following diagnosis: the chemical burn of both buttocks, 3 A, B degrees, with a 4% area. The situation is currently steady, with no negative dynamics. The vehicle fleets administration maintains that if it was acid, it would destroy the seat fabric.

Questions to the case*:*

- What was the material that produced the burns?
- What is your opinion on the effect of alkalis on living tissues? What about weaved materials?
- Why should acids and alkalis in glass containers be transported in vehicles designed for this purpose from the point of unloading to the warehouse and from the warehouse to the point of use?
- What first-aid procedures should be available in the event of an alkali burn?

2. Chlorine in human life

Case type: research

Case contents: The National Institute of Health and Shizuoka Prefectural University collaborated on a research in Japan. Natural organic molecules react with chlorinated tap water, generating hazardous chemicals that might cause cancer, according to scientists. Such chemicals are referred to as MX, which stands for "Mutagen x" or "Unknown mutagen" (Fig. 2).

Figure 2. Case study task on the topic: "Chlorine in human life (chemistry)"

Questions to the case:

• Investigate several home chemical goods. Create a list of chlorine-containing substances and identify safety precautions while handling them.

• Calculate how much-chlorinated water you consume during the day and for what uses based on your daily habits.

• Which human organs are the most vulnerable to chlorine exposure?

• How does bathing in chlorinated water effect a person?

3. Properties of benzene

Case type: practical.

Case contents: A chemical factory in the city of Atyrau disposed of industrial waste in the Caspian Sea. According to the government, benzene compounds can be found in industrial waste (Fig. 3).

Figure 3. Case study task on the topic: "Chlorine in human life (chemistry)"

The polluted area is currently roughly five kilometres long. So far, the report states that the pollution was kept under control owing to emergency measures implemented by local authorities, and no particular pollution occurred in general. The immediate construction of a specific barrier dam was initiated in particular, and

activated carbon is utilised as an adsorbent for water filtration. According to media accounts, the pollution was found by local people who reported the red colour of the water and froth in the sea to local officials. Environmentalists feel that if the first data on the scale of discharges is credible and the area of the spot does not exceed 5 kilometres, the contamination zone may be obscured.

Questions to the case:

• Can you identify the major issue from the text?

• What is the structure, formula, and physical characteristics of benzene?

• What are the dangers of benzene poisoning?

• Consider if this is an environmental disaster, and what repercussions the residents of the region will endure.

• Is it possible to protect residents from the harmful effects of benzene compounds?

4. Natural gas

Case type: practical.

The contents of the case: An explosion of a gas cylinder (volume of 5 litres) without burning occurred in a 2-story residential building, resulting in the collapse of the wooden floor and partitions in apartment No. 6 (on the 2nd floor) and partially in apartments No. 4, 5 (on the 2nd floor), and 3 (on the 1st floor) on a preliminary area of 36 sq. m.", according to the press service of the Emergency Department Karaganda region (Fig. 4).

Figure 4. Case study task on the topic: "Natural gas (chemistry)"

A man born in 1970 and a woman born in 1971 were injured in the explosion and hospitalized with burns in Karaganda's Regional Medical Center. The incident's circumstances are being investigated.

Questions to the case:

• What is the composition of natural gas?

• What caused the explosion in the apartment building?

• What should you do if there is a smell of gas at the entrance or the apartment?

• The use of natural gas and its constituent marginal hydrocarbons?

• Offer residents of apartment buildings their own ways to prevent such tragedies?

Result and discussion

The experiment was carried out on the specialized school of Specialized school-internat "Murager" (Karaganda), in the period from 27.02.2023 to 22.04.2023. Students of the 9th grade took part in the approbation of the developed case-study chemistry tasks, there are a total of 24 students (11 girls and 13 boys).

Lessons in the 9 "A" class (control group) were provided in a traditional style. Traditional instruction entails passively obtaining information that the teacher possesses. Lessons in the 9 "B" class (experimental group) were provided using case-study tasks in chemistry.

The same final test was designed for all classes, taking into account the students' ages and desired knowledge. The exams were given out on A4 pieces of paper. Students in ninth grade had 30 minutes to complete the final test, which consisted of 15 questions. That is, every task took around 2 minutes to complete. Topics included in testing: Alkali metals, Chlorine, Properties of benzene, and Hydrocarbons. Diagrams 1-2 show the average score and grades for the final test in grades 9 "A" (control group) and 9 "B" (experimental group).

Final test results

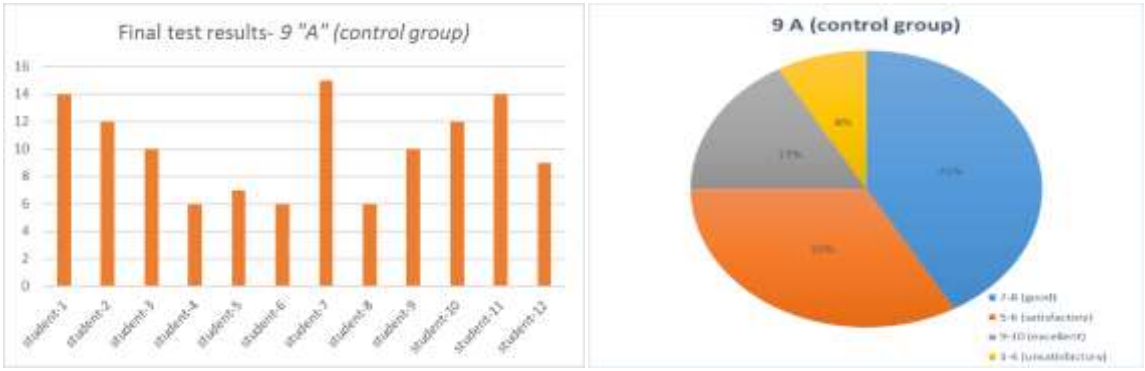

Diagram 1. Results of final testing in grade 9 “A” (control group)

1 student – unsatisfactory (8%);
4 students – satisfactory (33 %);
5 students – good (42%);
2 students – excellent (17%).

Based on the final testing data, the quality of knowledge was 58,33%. The average score was 10.08 points.

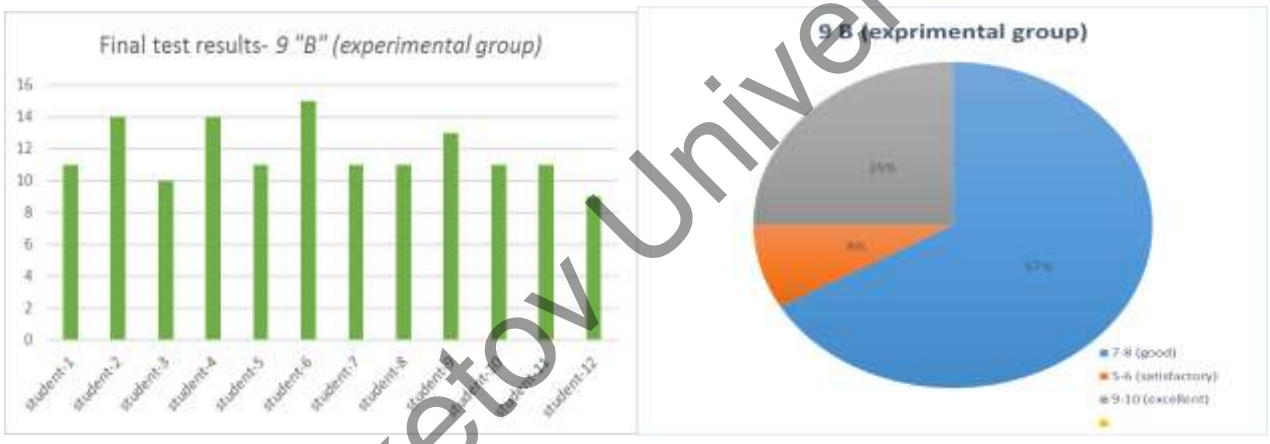

Diagram 2. Results of final testing in grade 9 “B” (Group 2 – experimental)

1 student – satisfactory (8,3 %);
8 students – good (66,7%);
3 students – excellent (25 %).

Based on the final testing data, the quality of knowledge was 91,7%. The average score was 11.75 points. There was only a slight difference in the degree of knowledge, skills, and abilities between the two groups 9 “A” (control group) and 9 “B” (experimental group). 9 “B” (experimental group) scored 1.67 more points than the second 9 “A” (control group).

Survey results

We have developed our questionnaire to study the students’ opinions based on application case-study tasks during eight chemistry lessons. The questionnaire used in this research consisted of ten closed-ended questions:

1. Do you like lessons using case-study tasks?
2. Do you think that lessons with case-study tasks are more interesting than traditional ones?
3. Was the explanation in the lesson clear enough to understand the topic well?
4. Do you think that the knowledge gained in case-study tasks will be useful to you in life?
5. Have the knowledge gained in case-study tasks been applied in real life?
6. Would you like such lessons to be held more often?
7. Were you interested in solving problems using a mobile phone or tablet?

8. Do you think that solving problems in this way is more interesting than the traditional method?
9. Would you like such case-study tasks in chemistry and biology to be solved more often?
10. Do you feel that case-study tasks help to memorize and assimilate new concepts?

A three-level rating scale from 1 to 3 (1 – Agree, 2 – Neutral, 3 – Disagree) was chosen as the most appropriate for measuring participants' opinions (Diagram 3).

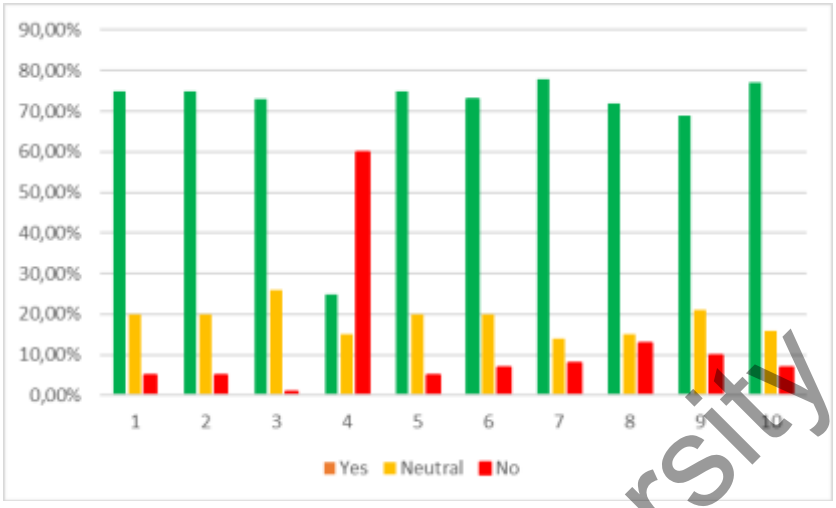

Diagram 3. The results of the survey (9 "B" – experimental group)

As can be seen in Diagram 3, the majority of respondents 72 % rated positively and think that case-study lessons are more interesting than the traditional ones, only 9 % prefer the traditional form of the lessons (questions 1-2). 75% of students answered "agree", 20% — "neutral" and 5% — "disagree" the question 5 "Do you think that the knowledge that was obtained in a case-study task can be applied in real life?". Questions 7 and 8 were asked to find out whether students like to solve case-study tasks using a mobile phone and tablet. The respondents rated this method of learning mostly positively (73%), and only 10% of respondents believe that it is not suitable for learning.

In questions 6 and 9, respondents were asked if they would like solving tasks with the case-study method carried out more often, 66% of respondents answered positively.

Conclusion

In summary, case study methodology serves to provide a framework for the evaluation and analysis of complex issues. Although case studies offer some advantages, like the capacity to provide data from real-life circumstances and provide greater insights into the precise actions of the subjects of interest, they are often condemned for their inability to generalise their findings.

The use of the case-study method not only stimulated students' learning activities and increased basic professional competencies, but it also reduced the gap between their theoretical understanding of environmental issues and the application of environmentally friendly behaviour principles in the lives of both groups of students.

We observed that students are performing better after analysing the experiment's data. Twelve students responded positively to a survey administered as part of this study when asked how they felt about case method classes and whether they would like to take them more frequently. Students' mental capacities improved after using the case technique, and autonomous activity was also stimulated. The case method, a technology of interactive learning, inspires a favourable attitude on the part of students who see in it an opportunity to demonstrate and improve analytical and evaluative skills, learn to work in a team, put theoretical knowledge into practice, see the ambiguity of solving problems in real life, find the most logical solution, and more.

The introduction of up-to-date teaching methods is anticipated to heighten the urgency of this educational system reform. However, it is difficult to predict how these changes will affect established institutions that were created to bring together researchers, students, and teachers.

It would be advantageous to do studies with students from different populations. Additionally, in most instructional design studies, participants are only exposed to a few bits of instruction over a short period. It is

also necessary to study the link between performance during instruction and performance on criteria assessments. It is unknown if performance during teaching can be generalised to performance on criteria tests.

Further research on the subject might focus on improving the use of the case study technique in the context of natural education. This line of inquiry will help eliminate the gap between students' theoretical and activity-practical attitudes towards their professional and general education, under environmental trends that are now in the spotlight in scientific and journalistic discourse.

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Химия сабақтарында «Case-study» әдісін қолданудың негізгі ерекшеліктері

Қазақстан Республикасының қазіргі білім беру жүйесінің соңғы жылдардағы басым міндеттерінің бірі — оқушылардың функционалдық сауаттылығын қалыптастыру және жаратылыстану-математикалық пәндерді оқытудың жаңа әдістерін табу. Оқытудың дәстүрлі әдістерімен бірге жаңа педагогикалық технологиялар танымал бола бастады, олардың арасында ынтымақтастықта оқыту, оқытудың интерактивті әдістері, жобалау әдісі, онлайн оқыту, сондай-ақ Case-study (кейстер әдісі) деп аталатын жағдаяттық талдау әдісі бар. Бұл әдістің мәні оқушылардың оқу материалын әртүрлі типтегі тапсырмаларға бөлу болып табылады, ал білім олардың шешімдерді әзірлеу бойынша белсенді зерттеу және шығармашылық қызметі нәтижесінде алынады. Мақалада оқушылардың белсенділігі мен орта мектептегі оқу процесінің тиімділігін арттыруға ықпал ететін Sase-study әдісін қолданудың негізгі ерекшеліктері, нақты жағдаяттық әдістің негізгі артықшылықтары мен түрлері (Case-study) анықталған және сипатталған, сондай-ақ 9-сынып оқушыларына арналған химия бойынша әртүрлі жағдаяттық мысалдар әзірленген. Бұл зерттеу

салыстырмалы түрде шағын іріктеу көлемімен шектелді, дегенмен нәтижелер мұғалімдердің кәсіби дамуы және қазіргі химия сабақтарын дамыту үшін маңызды деректерге ие. Оқушылардың сауалнамасының нәтижелері химия бойынша жекелеген тақырыптарды зерделеу кезінде нақты жағдаяттық әдісті (Case-study) қолдану оқушылардың оқу материалын игерудегі табыстылығын арттыратынын көрсетеді.

Кілт сөздер: Case-study, есептерді шешу, жаратылыстану сауаттылығы, химия, орта мектеп, сауалнама, 9-сынып.

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Основные особенности применения метода «Case-study» на уроках химии

Одной из приоритетных задач современной системы образования Республики Казахстан в последние годы является формирование функциональной грамотности учащихся и нахождение новых методов обучения предметов естественно-математического цикла. Совместно с традиционными методами обучения всё большую популярность приобретают новые педагогические технологии, среди которых обучение в сотрудничестве, интерактивные методы обучения, метод проектов, онлайн обучение, а также метод ситуационного анализа, получивший название «Case-study» (метод кейсов). Сущность данного метода заключается в разделении учебного материала обучаемых на задания различного типа, а знания приобретаются в результате их активной исследовательской и творческой деятельности по разработке решений. В данной работе определены и описаны основные особенности применения метода «Case-study», способствующие повышению активности учащихся и эффективности процесса обучения в средней школе, основные преимущества и типы метода конкретных ситуаций, а также разработаны примеры различных кейсов по химии для учащихся 9-х классов. Это исследование было ограничено относительно небольшим размером выборки, однако полученные результаты имеют важные данные для профессионального развития учителей и разработки современных уроков по химии. Результаты анкетирования учащихся говорят о том, что применение метода конкретных ситуаций («Case-study») при изучении отдельных тем по химии способствует повышению успешности усвоения учебного материала учащимися.

Ключевые слова: Case-study, решение задач, естественнонаучная грамотность, химия, средняя школа, анкетирование, 9 класс.

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