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Activity Plans Based On 7E Model Of Constructivist Approach On The Subjects Of "Matter And Heat" In Science And Technology Course*

Assoc. Prof. Dr. Ali Günay BALIM
Dokuz Eylül University
Buca Faculty of Education
agunay.balim@deu.edu.tr

Assist. Prof. Dr. Suat TÜRKOĞUZ
Dokuz Eylül University
Buca Faculty of Education
suat.turkoguz@deu.edu.tr

Dr. Güliz AYDIN
Ministry of National Education
gulizaydin@gmail.com

Research Assistant Ertuğ EVREKLİ
Celal Bayar University
Demirci Faculty of Education
eevrekli@gmail.com

Abstract: The main purpose of this study is to develop some activity plans by 7E model of the constructivist approach on the subjects of "Matter and Heat" in Science and Technology course. 7E model of the constructivist approach consists of stages such as Elicite, Engage, Explore, Explain, Elaborate, Evaluate and Extend. The activities related to subjects about "Matter and Heat" were adapted by each stage in 7E model of constructivist approach. The activity plans were arranged by acquisitions determined for Science and Technology course. So, the application duration of the activities were determined by these acquisitions. This study contains a 4-hour lesson plan on "Matter and Heat" unit in Science and Technology course using the mind mapping technique in 7E learning model and samples of students' activities according to this plan.

Keywords: Constructivist approach, 7E Model, Science and Technology, Science activities

Fen ve Teknoloji Dersinin "Madde ve Isı" Konularında Yapılandırmacı Yaklaşımın 7E Modeline Dayalı Etkinlik Planları

Özet: Bu çalışmanın temel amacı, Fen ve Teknoloji dersinin "Madde ve Isı" konularında yapılandırmacı yaklaşımın 7E modeline göre etkinlik planları geliştirmektir. Yapılandırmacı yaklaşımın 7E modeli, Ön Bilgileri Ortaya Çıkarma, Dikkat Çekme, Keşfetme, Açıklama, Ayrıntıya Girme, Yeni Duruma Uyarlama ve Değerlendirme aşamalarından meydana gelmektedir. "Madde ve Isı" konularına ilişkin etkinlikler, yapılandırmacı yaklaşımın 7E modelindeki her basamağa uyarlanmıştır. Etkinlik planları, Fen ve Teknoloji dersi için belirlenen kazanımlara göre düzenlenmiştir. Bu nedenle, etkinliklerin uygulama süresi bu kazanımlara göre belirlenmiştir. Bu çalışma, Fen ve Teknoloji dersi "Madde ve Isı" ünitesinde zihin haritalama tekniğinin kullanıldığı 4 saatlik ders planını ve bu plana göre düzenlenen öğrencilere yönelik etkinlik örneklerini içermektedir.

Anahtar Sözcükler: Yapılandırmacı yaklaşım, 7E Modeli, Fen ve Teknoloji, Fen etkinlikleri

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1. INTRODUCTION

Constructivism is an approach that explains how learning is realized in a person's mind. According to this approach each person comes to the learning environment with their prior knowledge and they construct their new learning on this knowledge. Depending on Piaget's cognitive theories, Vygotsky's social learning and Bruner's learning by exploring, constructivist learning approach is very important (Herman, 1995). Constructivist approach is a learning process that helps learners to make their knowledge meaningful in their minds (Fardanesh, 2006). This approach is focused on learning environments which gives individuals a chance to construct knowledge by themselves or by discussing with other individuals. In learning by exploring, students construct their new knowledge by basing the knowledge on their environments (Saab et al., 2005). According to constructivist learning approach, the acquisition of knowledge by a learner is more useful than its being transferred by a teacher (Güçlü, 1998). Depending on the idea that all kinds of learning are realised by a process of construction in an individual's mind, constructivism requires individuals to be more responsible and active during learning process (Yaşar, 1998). Constructivist learning applications predict a rich and interactive learning environment which supplies student requires to reach the knowledge, get and analyze it, arrange and use it in order to solve the problems by the way of cooperative learning activities. In the learning process, student is expected to produce his/her own product by searching, doing decisions, collaborating, using high level thinking skills and using his/her own creativeness. In this regard, constructivist learning applications encourage the students "doing about something" instead of "learning about something" (Demirci, 2009). Constructivist learning approach depends on constructivist philosophy. This approach uses 7E learning model (Lawson, 1995 narrated by Kanlı, 2007).

7E learning model consists of elicit, engage, explore, explain, elaborate, evaluate and extend steps. Elicit is the stage in which the prior knowledge of the learner is elicited by questions and scenarios. Engage is the stage in which events are associated with daily activities. Explore is the stage in which students explores knowledge by showing attitudes like scientists. In this stage students are assisted to explore knowledge. Explain is the process in which students are expected to explain about their explorations. In the elaborate stage, learners construct new knowledge. In evaluate stage, learners make comparisons and discuss their findings with other learners in or outside their group. Extend stage is the one in which students adapt their constructed knowledge to another subject (Eisenkraft and et al., 2003; Çepni, 2005; Bybee et al., 2006; Gönen et al., 2006; Kanlı, 2007).

Mind mapping is a technique based on constructivist approach. This technique is one of those stages in 7E learning model and it can be used in eliciting the present knowledge and evaluating what is learnt. The main goal of researchers is to find how to increase the amount of learning (Tas, Apaydin and Cetinkaya, 2011). Mind mapping technique depends on the studies on brain by Roger Sperry et al. in the 1960s. Sperry et al. found out that the two hemispheres of the brain function differently. The left side of the brain is involved with analytic skills. Logic, language and numbers are related to the left side of the brain. The right side of the brain is involved with emotion and creativity; and relations, shapes and colors are the activities of the right side of the brain (Buzan and Buzan, 1995; Smith, 1999). Mind mapping is not involved with only the right or left side of the brain; this is a learning and note taking technique which deals with the operating process of the right and left hemispheres of the brain together and integrating them (Margulies, 1991; Practor 2002). Both the right and left hemispheres of the brain of a student preparing a mind map are active. A few color pencils and a large sheet of paper are needed to prepare a mind map by hand. Basically, making a mind map starts with showing the main point with a picture or image. Then branches are drawn and on each branch memorable key words are written, and those branches which have relationships are associated with each other (Ladge, 2002). Mind maps can be prepared either by hand or by computer using various programs. Computer supported science materials developed for science lessons give students more opportunity to learn from live experience, developing hand skills and use of their mental skills (Chiu, Huang, and Chang, 2000).

Students have a lot of concept difficulty in understanding Matter and Heat in Science and Technology lessons. These are condensation, changing states of matter, chemical change, physical change, dissolution, heterogeneous solution and homogeneous solution (Taşdemir and Demirbaş, 2010).

In this study, an example of lesson plan and mind map on the subject of "Matter and Heat" unit related to 7E model of constructivist approach has been reported.

2. METHOD

This is a descriptive study covering the lesson plan and mind map example on the unit of "Matter and Heat" with technologically-supported mind mapping technique based on the 7E model of the constructivist approach. 6th grade students have prepared the mind map on "Matter and Heat" unit by using Mind Manager Program.

In this study, the activities related to subjects about "Matter and Heat" were adapted by each stage in 7E model of constructivist approach. The activity plans were arranged by

objectives determined for Science and Technology course. So, the application duration of these plans were determined by these objectives. The activity plans have five sections. The first section contains parts as 'the name of the course', 'class', 'name of the unit', 'subject of the unit', 'application duration for the unit'. The second section contains parts as 'acquisitions of subjects of the unit', 'acquisitions toward the scientific process skills being learned in activities', 'acquisitions toward behaviours such as attitude and value', 'teaching and learning strategies on the subjects of the unit', 'educational technologies, tools and materials used in the subjects of the unit', 'activities toward the subjects of the unit' and 'all documented stages of 7E model'. Moreover, the processes related to activities toward the subjects of the unit were not explained in each stage of 7E model. It is advised to explain by seperate titles as 'the name of the activity', 'objectives of the subjects in the activity', 'tools and materials used in the activity' and 'process of the activity' at the end outline of the model. 'Teaching and learning strategies', 'notes toward activity ', 'general points of attention toward unit' and 'security for the activity' were given in each stage of these models. The mind map were used in addition to teaching and learning strategies. The third section contains parts as 'evaluation strategies toward unit' and 'integration with the other courses of subjects in unit'. The fourth section contains 'notes and code numbers toward the applications of the plan'. The code numbers of notes were given in paranthesis at stages of the model. The fifth section contains parts as 'name of activity', 'objectives toward subjects in activity', 'tools and materials used in activity'and 'activity process'.

Below, a lesson plan with 4-hours on "Matter and Heat" unit in Science and Technology course that contains the mind mapping technique in 7E learning model and samples of students' activities according to the plan is given.

LESSON PLAN

SECTION I

Course	Science and Technology
Class	6
Unit	Matter and Heat
Subject	The Particular Structure of Matter and Heat
Duration	40 + 40 + 40 + 40 minutes

SECTION II

Student's Acquisitions	1. The students get the following knowledge related to the particular structure of matter and heat: 1.1. By observing, students conclude that when molecules are heated they move faster (BSB-1, 11, 12, 13, 14, 30, 31; VA-3). 1.2. They associate heat transfer between matters with the crash of atoms/molecules (BSB-6.8, 9; VA-1).
Related Acquisition of Scientific Process Skills	1. They observe matters (object, entity) and events using their sense organs or observation tools. 6. Depending on their observations they make comparisons according to one or more properties. 8. Depending on their observations they make explanations about the reasons of events which have happened before. 9. Depending on observation, evaluation and experiments they put forward ideas about future. 11. They tell the most prominent variable or variables in a given event or relation. 12. They tell the dependent variable in a given event. 13. They tell the independent variable in a given event. 14. They tell the controlled variables in a given event. 30. They comment on the processed data and the constructed model. 31. They reach the relations and designs from their findings.
Related Acquisition of Value and Attitude (VA)	1. Perception ▪ They listen attentively. ▪ They pay attention to events / activities in their environment. ▪ They are willing to learn and understand. ▪ They are open-minded. ▪ They are not biased. 3. Appreciation ▪ They are constantly willing to try (They have intrinsic motivation). ▪ They trust democratic processes. ▪ They trust logic, science and technology. ▪ They appreciate the people and progress that contribute to human welfare. ▪ They try to live clean and healthily and appreciate the people who do so. ▪ They are well-behaved (They do not make a noise, they do not do harm to their environment, they do not violate other people's rights, they are just and honest).
Methods and Techniques of Teaching and Learning	Experiment, discussion, asking and answering, mind mapping
Educational Technologies that are used – Tools, Bibliography Teacher and Students	Mind Manager Program, computers, tools that are used in relevant activities, color pencils, white A4 sheets.

Teaching-Learning Activities	Students have already conceived that heat is a kind of energy and it can change into other kinds of energy in their 4th and 5th year technology courses. Relating the notion of heat to temperature they already know that heat affects matter while studying their subjects of expansion and shrinking and situation change. In their course, they have learned that matter consist of invisible tiny particles and they have classified the changes in the matter as physical and chemical. The teacher asks students to prepare a mind map in their homes to check students' prior knowledge about matter and heat. When he enters the class, the teacher has students discuss their mind maps in their group and asks them to prepare a mind map for their group. Then the teacher and students in each group discuss their maps together and s/he helps them to complete the missing parts if there are. The teacher helps them to remember the matter properties, and then they start their course activities. The teacher takes students to the computer laboratory. Here each student construct their common mind map on the computer again as they want. They compare their mind maps with the one the teacher presents and make any necessary changes. The mind maps prepared on the computer are going to be used at the beginning of the lesson to check students' prior knowledge, in the progress stage to see their level of associating their new knowledge with old knowledge and in the last stage to understand students' construction methods about the subject in question.

Elicit	In order to elicit students' prior knowledge these open-ended questions are asked : "How do humans get warm?" , "Does the inner side of a parked car get warm on a sunny day?", "What can be done to get better warming in homes in winter?", "Give examples of the transfer of heat in your daily life.", "How does a stove or central heating warms a room?" With these questions students' prior knowledge about the subject is tried to be elicited. Students have already learned the notion of heat and temperature (and the effects of heat on matter) in their 4th and 5th year science and technology course. The teacher asks students to prepare a mind map about matter and heat. With this practice the teacher tries to see the level of students' readiness and whether they have the misconception of notion. Students check their mind maps in groups and the individuals of each group prepares a common mind map. The teacher goes round to check students' mind maps that the students prepared together and helps them to correct the misconception of notion if they have.
Engage	The teacher gets the students to practise remembering activities about the particular structure of matter in order to check students' prior knowledge **(Activity 1)**. Later each group presents their findings to the class. Then the teacher emphasizes that the molecules/atoms of gases are independent, and the molecules/atoms of liquids are tied to each other and the space between gas molecules is a lot more than that of liquids. This space is very little in solids. The teacher prepares a diagram on board to show the students that the molecules/atoms of gases and liquids can make pushing movements and the molecules/atoms of solids can make vibrating movements. Besides, it is also emphasised that the molecules/atoms of gases and liquids can also make vibrating movements.

Explore	By asking students the questions "When matter is heated, does this affect the movement of the molecules that the structure of matter has?", students are helped to associate the particular structure of matter with the effect of heat on this structure. Students are asked to make a discussion by asking such questions: "How does heat affect the movement of the particles that comprise the structure of matters?" and "Does the velocity of the particles change?" After the discussion students do the experiment of "How does heat affect the movement molecules?" **(Activity 2)**. After the experiment, students are asked to compare their observations among themselves and they are asked to comment on them. During the experiment students are asked which matters receive and which ones give away heat. Students are asked to deal with how water gets heat from the source of energy. Then students are asked to do a similar experiment with ink instead of cotton **(Activity 3).**
Explain	In activity 3, it is emphasized that the receiving and giving heat partly or directly is due to the touching of two matters, and those rapid molecules in the fire crash air and water molecules and accelerate them. A debate is established on whose movements are the visible ones which are seen in water and air during the heating process. With such questions as "Can we see a molecule?" "What size is a molecule?" "Is the observed movement the movement of only one molecule or the movement of molecule groups?". The students conclude that the visible movement belongs to giant molecule groups and single molecules cannot be seen (Explanation 1.1).
Elaborate	"How does heat affect the movement of the gas molecules?" experiment was done **(Activity 4).** In this experiment, as in the experiment "How does heat affect the movement of liquid molecules?" the students are asked to find out the matter which receives or gives away heat. They are also asked to discuss how this heat is received by air from the heat source. It is emphasized that the heat receiving and giving occurred in the experiment is partly or directly due to touching and rapid molecules in the wires of the stove crash air molecules and then accelerate them. The students are asked to compare the effects of the heat with gas molecules and liquid molecules. And they are told that they should benefit from the observations they have done in order to make these comparisons. The students conclude that heated molecules accelerate. Students are asked to write an experiment report which they discuss and interpret the observations and the results from them in the experiments of "How does the heat affect the movement of the gas molecules?" and "How does heat affect the movement of liquid molecules?" They are asked to write their reports about the matters which receive or give away heat in the experiment and how does the heat transfer happens. By using the brainstorming technique, the teacher starts the debate with the question: "How does the heat transfer happen between the matters?" Opinions are written on the left column of the board for this question. The questions such as "How does the transfer between atoms and molecules happen?" and "Which atoms/molecules move fast which ones slow considering their characteristics?" are discussed by brainstorming one by one. The students are asked to explain the expansion-shrinking events of matters by considering the structure of atom/molecule with examples. The students divided into groups are asked to do a crash experiment of two glass marbles one of which is slow, the other is fast on a smooth surface and then observe the pre and post movements of the marbles. The groups notice which marble accelerates and which one slows down. The teacher asks the students to discuss whether receiving and giving heat of inter atoms-molecules can be associated with the crash of fast and slow marbles. By asking questions such as "Which marble represents hot molecule/atom?", "Which marble represents cold molecule/atom?" the understanding of fast-hot, slow-cold is reached. It is emphasized that with the crash heat is transferred from fast-hot molecules/atoms to slow-cold molecules/atoms (Explanation 1.2).

Evaluate	1. The students are asked to add what they have learned to the mind maps they have prepared at the beginning of the course. Later by observing these mind maps, the relationship built between the new information and the existing one is tried to be understood and the information which is deficient or mistaken is tried to be improved. In the last lesson of the week all the students in the groups are taken to computer labs and are asked to prepare the mind maps about the subject in the Mind Manager Program. In this way, the mind maps that the students prepared by hand are developed individually by reconstructing. 2. The students are divided into three different groups one of which role plays the solid, the other liquid and the last one gas. The students are asked to role play how atom/molecule movements change with the effect of heat. While one group role plays the other students watch them carefully. Each group plays their part in turn. Mistakes are corrected if there are any. With a paragraph, the students present the evaluation of the role play they have watched. 3. The test in "What have we learned?" section in the course book is given to the students. 4. The experiment reports that the students prepare are evaluated.
Extend	By having the students think about the particular structure of matter together with the notion of heat they are asked to observe what these are used for in daily life. As an example, the reasons why other liquids are not used rather than water in central heating systems are discussed.

SECTION III

Testing and evaluation	Filling in the students experiment and observation form. Putting the group experiment reports into the portfolio. Filling in the group evaluation reports.

The Relation of the Course with the other Courses	Computer, Art, Turkish Language Course

SECTION IV

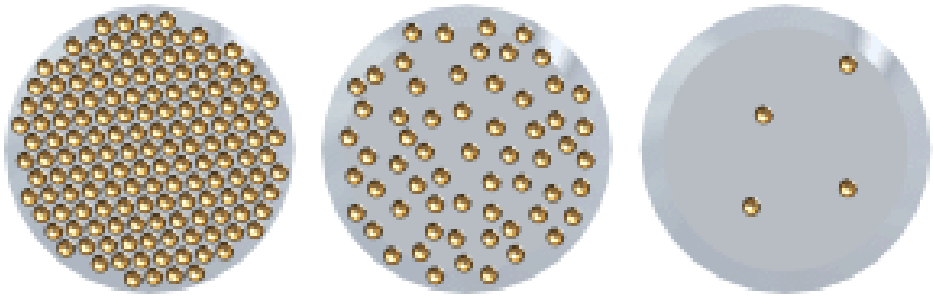
Explanations About Application of the Plan	**[!]1.1.** The heat-movement relation in liquids and gases can be easily made visible. It is not easy to establish the idea that the visible movement is the movement of molecules, but what can be seen are not molecules but the piles of them. During this observation, the teacher should remind the idea that molecules are tiny particles as learnt in unit three; and emphasize that the visible movement belongs to giant groups and it is impossible to see individual molecules. **[!]1.2.** That some of the crashing marbles accelerate and others slow down are directly relevant with receiving and giving away heat, which is an important observation. With this observation, the understanding of fast-hot and slow-cold is expected to be consolidated.

SECTION V- ACTIVITIES

ACTIVITY 1: Which is gas, which is solid, which is liquid?

Tools: Matter models

Doing the Activity and Questions:



I **II** **III**

- Do these structural models belong to solid, liquid or gas?
- How is the form of the particles in solid, liquid and gas?
- What kind of movements do the particles of the matter that are solid, liquid and gas do?
- Which molecules or particles of the model accelerate while getting warm?
- Which model transmits heat better when compared to others?

ACTIVITY 2: How does the heat affect the movements of the liquid molecules?

Tools: Beherglass, cotton, spirit stove, trivet, match

Doing the activity and questions:

1. Fill two thirds of the beherglass with water.
2. Heat water little by little on the spirit stove.
3. Observe the movements in water by throwing little cotton bits in it before water boils.

Did the activities of the cotton bits change during the heating process?

ACTIVITY 3: How does the heat affect the movements of the liquid molecules?

Tools: Beherglass, water, heater, trivet, ink, match

Doing the activity and questions:

1. Fill one of the beherglass with hot water and the other with cold water.

2. Drip a few drops of ink into each tube.

3. Observe the movements of the ink in the water.

What do you observe when you add ink into cold water?

How do you explain the movement of ink in cold and hot water?

What materials which receive and give away heat are used in the experiment you did?

How do the liquid molecules act when getting warm?

ACTIVITY 4: How does the heat affect the movements of the gas molecules?

Tools: An electric stove, uncovered resistance wires, power supply, torch

Doing the Activity and Questions

1. Plug the electric stove.

2. By holding the torch 20-30 cm above the electric stove let the light pass through it. Give the light on a white surface like a wall.

3. Observe the light on the wall.

Below, there is a sample of mind map prepared by 6th grade students by using Mind Manager Program on "Matter and Heat" unit in Science and Technology course.

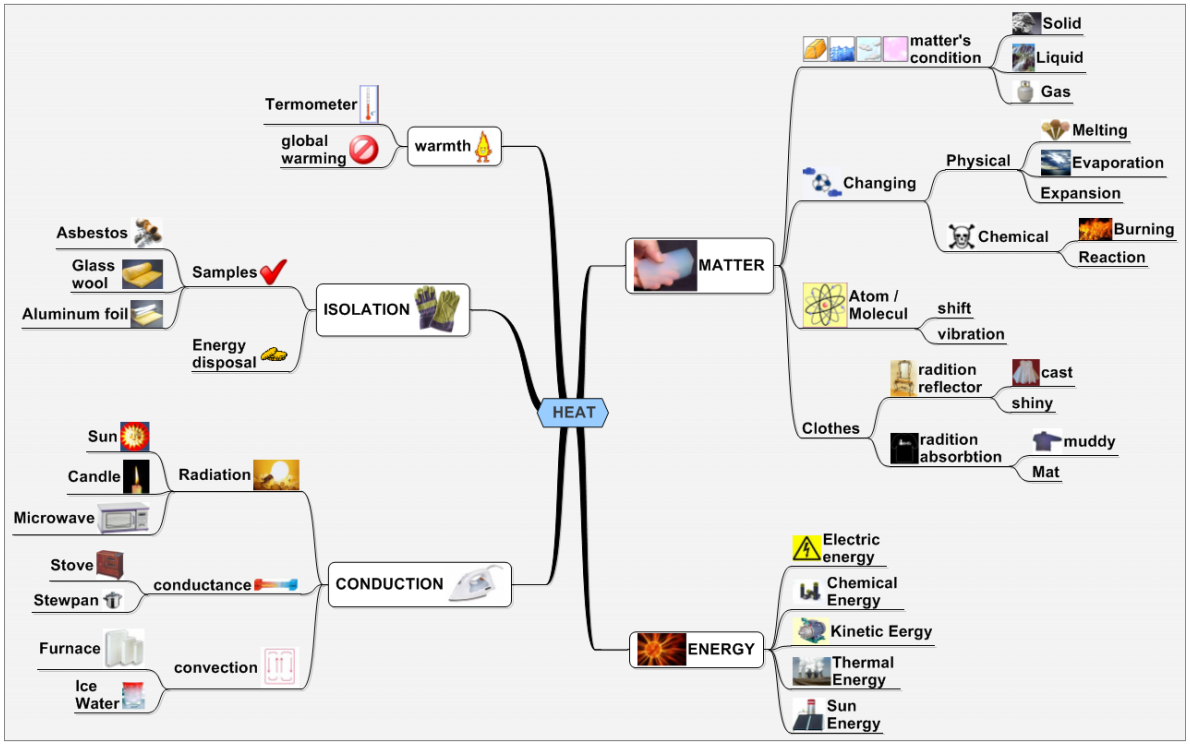


Figure 1. A Sample of Mind Map Prepared by 6th Grade Students related to the Matter and Heat Unit.

3. RESULTS AND SUGGESTIONS

As constructivist approach emphasizes the importance of focusing on background knowledge in learning, it has a special function in every step of 7E learning model. These steps help the teacher understand the education program and have the students gain attitudes, skills, scientific and technological knowledge (Bybee et al., 2006). In this model, the teachers should reveal the background knowledge of the students by asking questions and give them opportunity to associate their knowledge with other subjects at the end of the process and transfer it to other subjects (Eisenkraft et al., 2003). While revealing the learners prior knowledge, the teacher should find out misconceptions and plan the teaching process of the subject to remove these misconceptions, because misconceptions prevent individuals from learning meaningfully. So, background knowledge of the learner should be taken into consideration and research intending to determine such background knowledge should be done (Driver, 1989; Gönen et al., 2006 cited from Grayson et al., 2001). Because of this, the teacher should organise the teaching process by determining the background knowledge and possible misconceptions of the learners. Using mind maps in 7E model enables students not only reveal their background knowledge but also learn cooperatively with their group members by participating actively in the courses; hence it supports their social construction as well. According to the findings obtained in the present study, it is concluded that the mind maps in the 7E model can be used to reveal the background knowledge of the students and evaluate their learning.

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