Epistemological and educational study of the time's concept and how do the university students understand it? Case of Algerian students

Rabah Ladj[1, 2], Mohamed Khadraoui[2]
[1]Laboratory of N Corps and Matter structure, School of Physics E. N. S., Kouba, Algiers,
[2]Laboratory of Education of Science and Mathematics, School of Physics E. N. S., Kouba, Algiers, Algeria.

E-mail: r.ladj@hotmail.com

(Received 5 June 2018, accepted 29 November 2018)

Abstract

The importance of the time's concept in Physics has been emerged since the appearance of relativity´s study, which has changed in an important way in human thought, contrary what it was known and beloved about it. We mean the following concepts: The relative duration of time (Δt) and the relative length (Δl) in the deferent inertial frame, and their implications or their consequences for other physics magnitudes. Thus, the time is considered as the fourth dimension of our space. In addition to previous new concepts −which are the aim subject of our research−, the light's speed postulate in all inertial frames**.** In teaching relativity course, to the third year Physics students (Algerian students), we noticed that they to face difficulties in understanding the interpretation of physics' magnitudes being calculated in using "Lorentz transformation". For our experience of teaching this field of physics (relativity restraint), we always face a great quandary to convince students, to believe in the results calculated, especially, the reality of time dilation and length contraction. *i.e*., whether those dilation and contraction, are real facts or just manifestations due to the observer, on the frame chosen. In this work, we wanted to focus on the time concept only, because of its role, as an intermediary in all kinds of motions, and its indispensability in all physics states' evolution, whatever the physics fields. Our work is divided in two parts: the first study was related to an epistemological study, while the second study was concerned to pure educational questions. The results obtained from the educational part showed that, the concept of time needs to be seriously reviewed in the all educational systems.

Keywords: Epistemology, education, time, time dilation, relativity.

Resumen

La importancia del concepto del tiempo en la física ha surgido desde la aparición del estudio de la relatividad, el cual ha cambiado de manera importante en el pensamiento humano, en contra de lo que se le conocía y quería. Nos referimos a los siguientes conceptos: La duración relativa del tiempo (Δt) y la longitud relativa (Δl) en el sistema de referencia inercial, y sus implicaciones o sus consecuencias, para otras magnitudes físicas. Así, el tiempo se considera como la cuarta dimensión de nuestro espacio. Además de los nuevos conceptos anteriores −que son el objetivo de nuestra investigación−, el postulado de la velocidad de la luz en todos los marcos inerciales. En el curso de enseñanza de la relatividad, a los estudiantes de física de tercer año (estudiantes argelinos), notamos que ellos enfrentan dificultades para comprender la interpretación de las magnitudes de la física, que se calculan al usar la "transformadas de Lorentz". Por nuestra experiencia en la enseñanza, de este campo de la física (restricción de la relatividad), siempre nos enfrentamos a un gran dilema para convencer a los estudiantes, de creer en los resultados calculados. Especialmente, la realidad de la dilatación del tiempo, y la contracción de la longitud. Es decir, si esas dilataciones y contracciones, son hechos reales o simplemente manifestaciones debidas al observador, en el marco elegido. En este trabajo, queríamos centrarnos únicamente en el concepto de tiempo, debido a su papel, como intermediario en todos los tipos de movimientos, y su indispensabilidad en la evolución de todos los estados físicos, independientemente de los campos de la física. Nuestro trabajo se divide en dos partes: el primer estudio se relacionó con un estudio epistemológico, mientras que el segundo estudio se ocupó de cuestiones educativas puras. Los resultados obtenidos de la parte educativa demostraron que, el concepto de tiempo debe ser seriamente revisado en todos los sistemas educativos.

Palabras clave: Epistemología, educación, tiempo, dilatación del tiempo, relatividad.

PACS: 01.40.–d, 45.20.D **ISSN 1870-9095**

I. INTRODUCTION

A. Epistemological study

Before starting our work, we would like to mention that, we focused just on the time in physics, which has the same measurement results for all the observers who are in same conditions (frames). By other word, the time in physics is the time in which, its duration be measured by an objective device "Clock", because there is a so-called: psychological time (depends to the feeling) which is relative, from one to another observer, even, thought the observers are in the same condition (frame). First, in order to legitimate our work, let us start with the following sentence: "Time is one of the great mysteries of the universe .We are all swept up in the river of time against our will" [1]. Also, Nobel laureate Ahmed Zewail, said: "The wonders of the time and its impact in our lives is that, we still looking for its meaning, this is not surprising, because the time is one of the most mysterious, ambiguous and incomprehensible in the universe, although it is woven in it" [2]. As it mentioned above, the concept of time is one of the most ambiguous concepts, and is considered in physics as an intermediary factor in description all types of matter's transformation, either matter's internal transformation or in matter's surface transformation (variation), and also, in the description of objects motion in space. Nevertheless, its nature and its concept have had many definitions, were defined by both scientists and philosophers through the history: "Time enters deeply into all the laws of the universe that represent the solid base of concrete physical reality" [3, 4]. It is obvious that, there is no change, no mutation and no motion without the time. In addition, there is no time without any mutation, or without any motion. It is clear that, time is neither a motion, nor is with no motion. Until now, we do not know exactly what the time is? This concept has known many different interpretations since the beginning of mankind.

Several questions, some remain so far being asked by physicists interested in epistemology of time, for examples, is it cyclical?, or is it linear? Is it quantified or continuous?

Is it everlasting (have no onset or have no beginning)? Is it separated from space, or is it a dimension of space dimensions? Has it a real existence? In other words, is it objective or it exist just in mind? In other words, it has only a mental existence.

B. Educational study

Notice 1: The motivation that led us to this study, is the total ignorance of most students of time concept, so that we have noticed incidentally many times that, most students questioned about the time or sense of time, they refer to their watches.

Notice 2: We wrote intentionally the following questions, closer in the meaning to each other, in order to determine exactly how far the student's knowledge of the time's concept.

According to the understanding's difficulties of the time's concepts above mentioned, as a special case of special relativity and as an important concept in all physics fields, we provided a questionnaire sheet related to its concept. The questionnaire was presented to homogeneous sample of 33 Physics students, of third year's university. Our aim was to study the problematic of the students' misunderstanding, of the time concept. Students believe or conceder, that the time is an obvious concept, however, as it was mentioned above is not. Also, we aimed to enrich and discuss its physics' meaning; and to legitimate some proposals hopping that, the time concept will be incorporated as separated subject with the other physics subject of the first undergraduate year courses, in order to improve the Physics students' assimilations.

II. QUESTIONNAIRE DESCRIPTION

Answer: (yes) (no) (no idea) for each of the following queries:

A. Time's Nature (epistemological questions)

Set A_1

-The time's presence is everlasting (hasn't a beginning of existence).
-The time has outset of presence (has a beginning of existence).
-It exist only in our mind (has a mental presence only)
-Time is an objective (has a real presence).

Set B_1

-Time is reversible in its nature.
-The time isn't reversible (spreads in only one direction).
-The time's alteration is a linear concept.
-The time's alteration is circular concept.
-

B. Concept of the time in physics

(Important reminder: when we say about grandeur is physical that means it is measurable).

Set A_2

-Time is either a magnitude of motion between two different locations or a magnitude of motion (or variation) in the same location.
-Time's alteration is continuous concept.
-Time is absolute (measurement of its magnitude is independent to the observe frame).
-The time a dimension of space (the fourth one of the space).
-

Set B_2

-The time's alteration is quantified concept.
-The time's alteration is relative (measurement of its magnitude depends on the observe frame).

-Time is independent of space dimensions.

-Time is only a magnitude of motion between two different locations.

III. QUESTIONNAIRE RESULTS

Questionnaire Results "Time's Nature" in the next table and figures:

TABLE I. Answers of students.

Questions Set	Yes	No	No idea
A_1	11	15	7
	14	12	7
	14	10	9
	13	13	7
B_1	2	29	2
	30	2	1
	17	8	8
	16	11	6

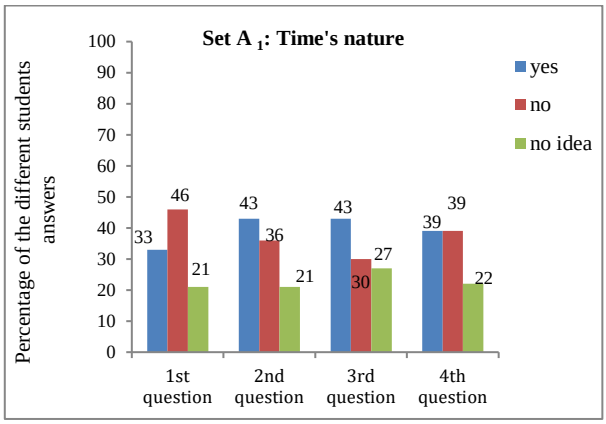

FIGURE 1. Represent the answers of students.

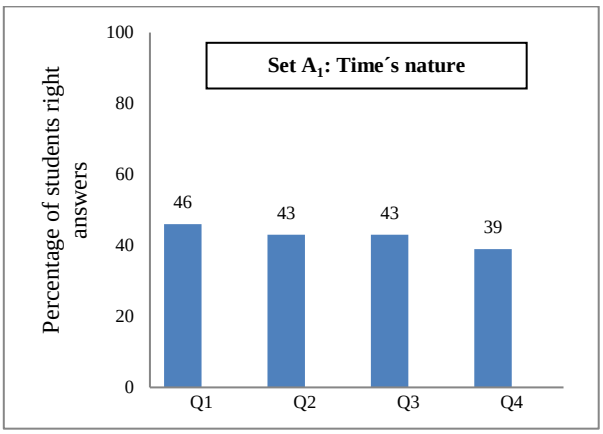

FIGURE 2. Represent the answers of students.

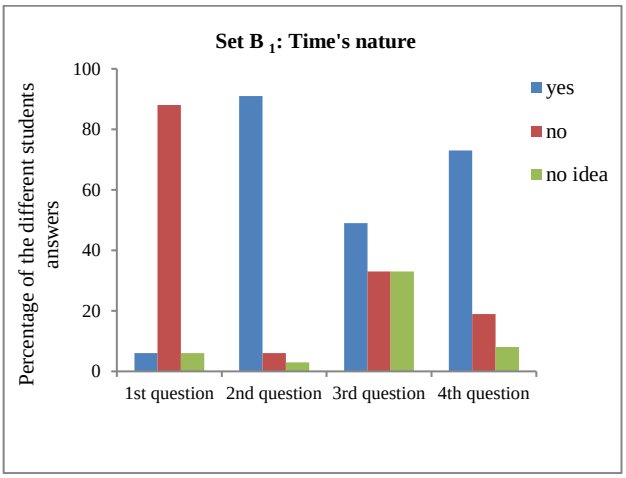

FIGURE 3. Represent the answers of students.

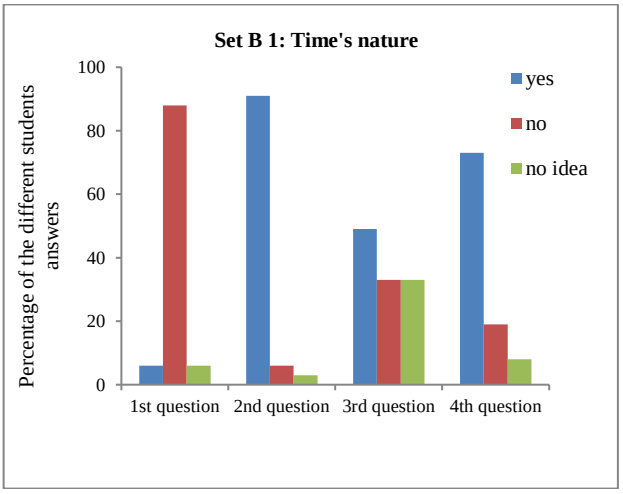

FIGURE 4. Represent the answers of students.

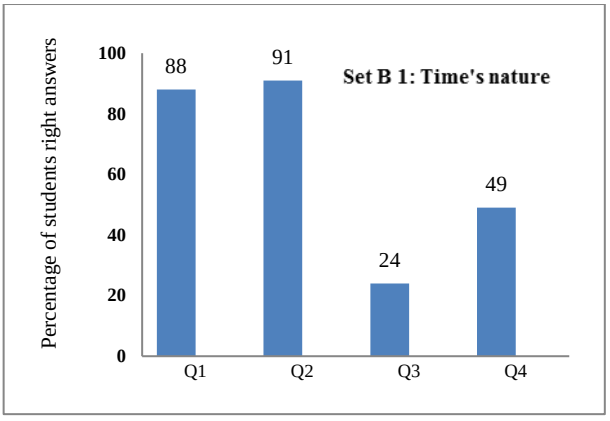

FIGURE 5. Represent the answers of students.

Questionnaire Results "Concept of time in physics" in the next table and figures:

TABLE II. Answers of students.

Questiones set	Yes	No	No idea
A_2	18	2	13
	26	4	3
	25	5	3
	16	11	6
B_2	3	23	7
	10	14	9
	11	11	11
	5	19	9

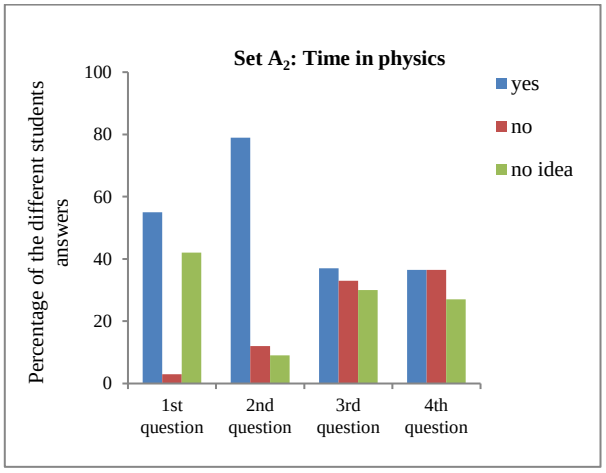

FIGURE 6. Represent the answers of students.

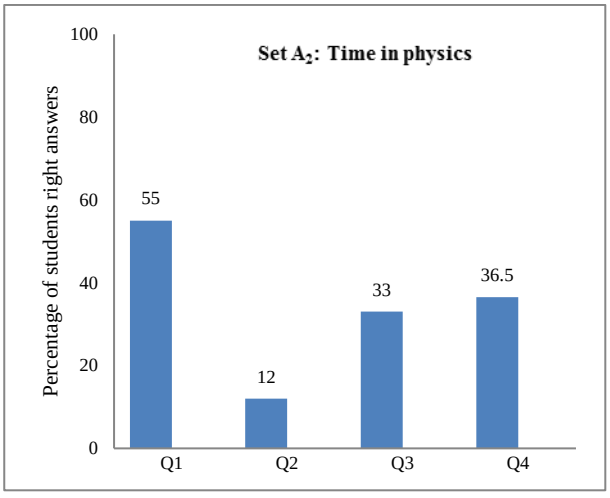

FIGURE 7. Represent the answers of students.

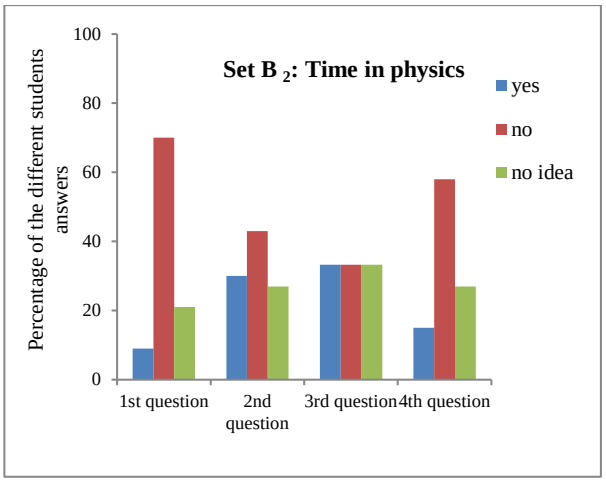

FIGURE 8. Represent the answers of students.

IV. DISCUSSION

First, we mention that some above right questions' answers are agreed, upon by all the physicists and epistemologists, while others are not. For those answers, which are not agreed upon by all the physicists and epistemologists, we provide our original modest opinions or answers, which are supported by some arguments.

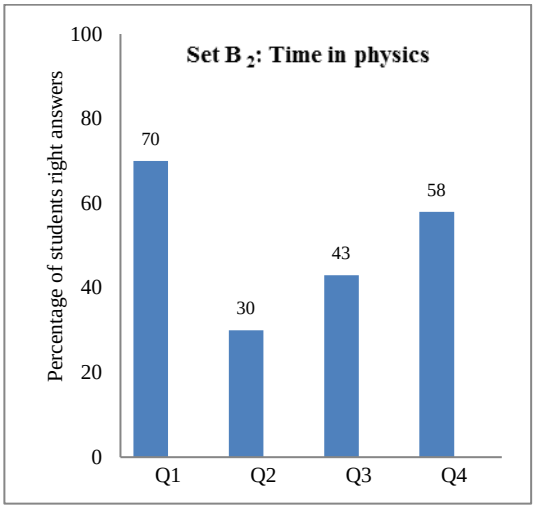

FIGURE 9. Represent the answers of students.

According to him, the time is like an arrow; one fired, it went unerringly towards its target, never wavering, never slowing down, and never coming back. It was a common-sense view, which was shared by everyone back then. So, one second on

Earth is one second on Jupiter, or anywhere in the universe; clocks tick at the same rate throughout the universe [1]. But now it is well known that, Newton's point of view concerning the time concept was wrong. The special relativity and GPS technology confirmed that, time (duration Δt) is relative, and is a dimension of our space: "Minkowiski space" [5].

$$\Delta t = \frac{\Delta t'}{\sqrt{1-\left(\frac{v}{c}\right)^2}}. \quad (1)$$

We can also conclude, that time has outset existence as well as the appearance of the motion; is synchronized with the motion. Concerning the question whether-r the time is cyclical or linear, we think that time is a cyclical in its nature, as well as the space form [6, 7]. About the continuity and quantification's question, we strongly believe that the time is spreading continuously, that just because is neither as a wave concept, nor particle concept, more than that if we believe that time is a quantified concept. This imposes that, there are a stages of existence (or events) without time!

We think the concluded above, third year Physics students right answers, of the "time in physics' questions" are not enough, and they reflect that students don't have strong knowledge about the time concept; the average of the right answers was just 42 percent. But for the nature of time "epistemological questions", we think that, the students' average right answers -which was about 53 percent- is acceptable, just because, the epistemological part of the time doesn't affect on the good understandings of physics.

Finally, we note that, there are not many educational studies, about the time concept -in the same time-. There are a huge number of the epistemological studies, but, despite the scarcity of educational works concerning the subject, we quote: from Iraq university [8], an educational study, concerning the concept of time, he has concluded from his study results that, Iraqi secondary school students have difficulties, to comprehend or perceive the time concept. In addition, he concluded that, there was no difference in the results between both, male and female students.

Important Notice: We noticed that most of students have misconception and confusions between the relative duration, and relativity of time. When we say the time is relative in different inertial frames, we mean the duration "Δt", which is relative, in deferent inertial frames.

V. SUGGESTIONS

Before we start our suggestions, we note that there are many papers and many books are written about the epistemological part, of the time and space concepts and meanings, but we noticed that, there are a few researches' results, about the didactic part related to it. It is important to the students, to have a conceptual understanding of the time and the space. Due to our long experience in teaching, in many physics field, and according to point of view of many teachers of Physics, and because of our notice during our experiences, where we noticed some obstacles in understanding the subject, we recommend the following suggestion:

Adding an extra course, distinct from all other physics courses, to the curriculum of all students of science -at least for Physics students-. This extra course should be related to the epistemological and historical evolution, of science in general, where the concepts, and the interpretations of the time and space concepts, should be deeply discussed. (See how was important the positive impact of understanding of teaching epistemology of Quantum Mechanics, to the third year physics student [9].

AKCNOWLEDGEMENTS

We would like to express our sincere gratitude to Professor Benchikou, A. for his valued guidance, really thanks to him; I learnt the basic concepts of the physics' epistemology.

REFERENCES

[1] Kaku, M., Physics of the impossible (Double Day Random House, New York, 2008)
[2] Chergui, M., Marcus, R. A., Thomas, J. A., Zhong, D., *Personal And Scientific Reminiscences: Tributes To Ahmed Zewail*, (World Scientific Publishing Europe, London, 2018)
[3] Davies, P., *About time "Einstein's unfinished revolution"*, (Simon Schuster Paperbacks, London, 1995).
[4] Crease, R. P., *Philosophy of physics*, (Stony Brook University, New York, 2017).
[5] Nabar, G. L., *The geometry of Murkowski, space-time*, (Publications Inc., New York, 1992).
[6] Kulkarni, R. S, *Curvature and metric*, Ann. of Math 91, 311-331 (1970).
[7] Michael, M. W., *Time, space, stars and man. The story of the big bang*, (University of York, London, 2013).
[8] Fadhel, M. K., Journal of Faculty of Education **17**, (2000).
[9] Ladj, R., Oldache, M., Khiari, C. and Belarbi, T., *On students' misunderstanding of the basic concepts of Quantum Mechanics: Case of Algerian Universities*, Lat. Am. J. Phys. Educ. **4**, 286-293 (2010).