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Space without Time and Time without Space in Education

ABSTRACT

Aims: The objectives of the article arethree-fold: first, to show that space and time are interrelated when teaching and learning is considered, creating the need to examine space and time in an integrated and inter-dimensional framework; second, to propose an integrated approach to the concept of space-time as a useful teaching and learningissue, allowing us to unmask the true time-space consideration in education; and third,to argue for the relevance of analyzing the concept of space-time (S-T) as a paramount issue in the research on teaching and learning.
Studydesign: Due to the ongoing societal and technological changes, the S-T is changing extremely fast and new conceptualizations are requiredin order to examine how such evolving space-time approaches can operate as a tool for teaching and learning. This paper provides such a conceptualization.
Methodology: This article should be considered as a theoretical contribution to how the existing conceptualization of space-time in education should be redefined to address emerging teaching and learning paradigm shifts, which have an impact on its consideration and use. As a theoretical paper it does not follow the traditional approaches of research papers (i.e., provide: exact methodology, collection of data, analysis and conclusions based on the analysis).
Results: It has been established: first, that in education the spatial domainis**not** defined by the classroom, while the temporal domain is**not**defined by the lessons' timing; second, space and time are multi-dimensional, which have an impact on how space-time should be considered; and third, the S-T has evolved from a four-dimension(space: x, y, z; time: t) consideration to a multi-dimensional and later on to an inter-dimensional concept,demandingan integrated approach to teaching and learning.

Key Words: The space-time concept, paradigm shifts of space-time, multi-dimensionality of space, multi-dimensionality of time, inter-dimensionality of space-time

1. INTRODUCTION

Teaching and learning in schools are determined by the space and time in which they take place. Allen [1] hasargued that successful educational communications depend basically on when and where they happen than on any other kinds of conditions. As a result, understanding and applyingthe S-Tis an essential aspect of teaching and

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learning and most importantly“independent of the subject or content being taught”[2]. Moreover, it is well known thatthe use of the S-T in teaching varies between contexts, (i.e., cultures, regions,resources etc.). In addition, our experience and directly and indirectly the literature [1] clearly show that the spatial domain is**NOT**defined by the classroom, while the temporal domain is **NOT**defined by the timing in any lessons.

Moreover, this paper is based on the following: firstthe disciplinary order proposedby Foucault [3] who having this order as histheoretical starting point,accepted that spatial and temporal aspectsshould be considered as tightly related between themselves or **interrelated**; and second, Eccles&Popper [4] consideration of our world into three parts: the physical world, our inner worlds and the cultural heritage, which has been established in our minds, and where the emphasis is on**integration**. Space-time, as a foundation for an integrated geographical/temporal consideration, tries to bring all these worlds together into a common framework, which is a very important characteristic, as it relates to S-T, in education. In other words,spatial and temporal aspects of student’s teaching and learning as well as their activities should be considered integrated principles in any modern school or classroom.

The S-T until the last few decades of the 20th century, was based on the assumption that the three-dimensional representation of our world (longitude, latitude and elevation) was distinctly different from time (the measurement of when events occur). The S-T took on a new meaning: first from the work of Einstein on thespecial theory of relativity[5]. Actually, the term **space-time** was coined by Einstein himself as he discovered the General Theory of Relativity; and second with theLorentz transformation, when Hermann Minkowski createda geometric interpretation of special relativity that combinedthe three dimensions of space and time into a single combinedexpression, known as the Minkowski space [6]. This interpretation proved fundamental in the developmentof the general theory of relativitybyEinstein.This unifying aspect of space and time,utilized in physical sciences, however has application in teaching and learning and is examined next.

2. TEACHING AND LEARNING

In terms of teaching and learning, as we are into the first quarter of the 21st century, important changes in both technological innovations and educational reformshave occurred leading into a new way the S-Tis viewed in education. But understanding such an issue is possible only through understanding the role of technology in education as well as examining the evolution of these two educational dimensions, which in turn determine the way we perceive and practice the S-T.

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On the first consideration it has been proven that the implementation and use of new technology tools forces new approaches in the didactic processes [7], including viewing important educational concepts such as S-T. Specifically, such tools promote the education stakeholders to directly question the meaning of these concepts and their need to actively engage in applying them. But mainly that the pedagogic value of such technological changes is rooted in the existing social conditions that determine theiracceptance and implementation in the classroom.

In understanding the second concern there are three issues that need to be clarified: first, the utility and comparison of chronotope with the S-T; second, the role of society in considering the S-T in education; and third the influence of educational paradigm shifts.

2.1 Chronotope

The term chronotope, is formed from the ancient Greek words chronos (time) and topos (place),and was proposed by Mikhail Bakhtin [8]. Bakhtin's idea has been erroneously considered itto be identicalwith the concept of space-time as it is considered in this paper and supported by the literature and common sense. The most avid proponents of chronotope in education Ritella et. al.[9] have stated that "the implementation of pedagogical approaches such as the flipped classroom [10], connected learning [11] and place-based learning [12] entail the transformation of the spatial and temporal organization of learning". In other words,chronotope is just a tool utilizing the pedagogical applications of technology for the organization of space and time in teaching and learning. For example, the use of flipped learning is related to share lessons through the internet at home (teaching in different places and times, as opposed to the same place and time in the classroom).

2.2 Changes in the space-time concept

The second issue is related to the factors, which bring changes of howthe S-Tis considered thatare the result of the shifts in the perceptions and beliefs of society. A basic principle of educational epistemology is that the way we practice teaching and learning is limited almost exclusively by the reality of the prevailing societal conditions, which in turn constitutes an inseparable part of our scientific envisagement of education as well as of our methods used, which in this case relate to S-T[13].Indeed, societal values and goals are changing through time, resulting in influential changes in all aspects of our lives, including the way the S-T is regarded and applied in education.

2.3 Paradigm shifts

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The third issue is related to the influence of educational paradigm shifts. In epistemology, in the last few years, important changes havetaken place related to the way we view educational issues as well as their basic principles[14]. The most important of these differentiations are the changes in the way we perceive the following:

- **Geographic space**: “from the assumption that the phenomena exist in order to be discovered to the perception that they constitute social constructs, our own creations” [14].
- **Time:**from the acceptance of the uniqueness of time to the perception that time is an abstract entity created inour mind on the basis of our experience of change[15].
- **Space-time:** from the belief that space and time are independent ofgiven realities to the perception that they are interdependent social constructs[14].

These perceptions are very important, because they outline the need for an epistemological treatment of the S-T in education. Indeed, S-Thas recently been involved in changes confirming what epistemologist Thomas Kuhn referred to as paradigm shifts and which are not unusual events in education [16]. As a result, it is necessary, in addition to defining the S-T, to examine itsevolution in accomplishing pedagogical goals.

For many years,reaching the end of the 20th century (1980’s), the space-time educational process usually explored on one hand where, and mainly why, events and phenomena take place in space. On the other hand, seldom do the educational stakeholders (students, teachers, curriculum designers etc.)explore the notion of time, or at best they are concerned only when and for how long these events and phenomena occur. That is, time functions considered mainlywithing a framework of a snapshot model “where several static snapshots of the subjects orphenomena of interest are captured so as to study the temporal trends and/or mechanisms behind such trends”[17]. As a result, the traditional idea of space-time is a conceptual model combining the three dimensions of space (longitude, latitude and elevation) with the fourth separate dimension of time and the educational approaches are following that model[18, 19].This view dominated most scientific and educationalapproaches and in general the literature up to the end of the 20th century. For example, an excellent review of this traditional S-Ton database models is provided by Pelekis et. al. [20].

However,nowadays this approach cannot be accepted, because of the educational paradigm shiftsthat have occurred.Considering that the S-Thas evolved considerably, itinevitably leads to the basic principle that the present approach to space-time in education, which can be termed as the **traditional four-dimension approach**(x, y, z and time), is now absolute and we are in the period of the **inter-dimensional**space-time

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teaching and learning. In other words, we consider theS-Tthat combines the three dimensions of space with a fourth separate dimension of time as an absolute approach. It is suggested thatfollowing societal changes due to technological innovations, there have been four educational paradigm shifts differentiating education approaches, including S-T,namely: Personal Computers, Internet/Multimedia, Mobile Devises and Artificial IntelligenceThissuggestion is in accordance with the Actor Network Theory [21], claiming that "societal and technological factors hold equal weight" at least in education.In very general terms the following S-T changes have been observed (Table 1).

Table 1: Space-Time paradigm shifts

PARADIGM SHIFT	USERS	SPACE-TIME
PERSONAL COMPUTER	few	4-DIMENSIONS
INTERNET-MULTIMEDIA	several	TRANSITIONAL
MOBILE DEVICES	many	MULTI-DIMENSIONAL
ARTIFICIAL INTELLIGENCE	nearly all	INTER-DIMENSIONAL

2.3.1 The Personal Computers Paradigm

There are many ways in which **personal computers** can be used to enhance the teaching and learning experience. For example, they can be used to access, examine and evaluate educationalmaterial. As a report by theOrganisation for Economic Cooperation and Development (OECD)[22] has pointed out, computer use in schools and in classrooms enhances students' performances.

The use of personal computers (PC) by students started in the '80s, but results from severalinitiatives and reports (e.g.,OECD[22]) made clear, that all education stakeholders first need to be equipped with digital competences, such as knowledge, skills and values,so that they can fully participate in developing a digitized society and digitized schools. In other words, in this paradigm, at least in the beginning the use and

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value of PCs by all stakeholders was limited due to the fast development of these technological tools and the consequent technological illiteracy of the educational stakeholders. Therefore, for all practical purposes space-time was treated in the **traditional** four-dimension approach (Table 1, first row).

2.3.2 The Internet/Multimedia Paradigm

In the middle of the 90s, schools started usingtools of Information and Communications Technology (ICT)to a series of educational processes, such as:communicate, create, disseminate, store, and manage information, based on the capabilities the **internet**could provide**.** In a few contexts and few schools ICT became part of the teaching and learning process. At the beginning replacing standalone machines without graphical interfaces and internet connectivity with connections to the internet and progressively computers with numerous local and online applications, as well as changing chalkboards with interactive digital whiteboards and shifting towards new learning experiences through digital environments.

The Multimedia educational messages refer to lessons containing both words and pictures, which can be in a static or a dynamic form. As a result, **multimedia instructions** can improve education,because meaningful learning can be achieved when studentscan select words and images to help organize their words into compact and the images into a coherent structure, integrating them into a comprehensible whole. Indeed, over the past 30 years, the literature from educational and cognitive psychology have presented evidence that human understanding can be improved substantially when appropriate graphics are added to the text [23]. It should be noted, however, that in multimedia learning, pictures do not replace words, but rather work together with words to form an instructional message that results in better teaching and learning.In short, people learn better from integrating words and pictures than from words alone.

But the internet/multimedia instruction, at least in the last century was not fully appreciated, even by some of the digital literate education stakeholders, and thus it was utilized by a small number of teachers andschools, which, however, were constantly increasing. Given, that S-T is measured by students' ability to take available resources (texts and images) and apply themin an integrated approach, the internet/multimedia paradigm was approaching the S-Tin a **transitional** way: asmall part as a multi-dimensional, but mainly as the four-dimension traditional approach (Table 1, second row).

2.3.3 The Mobile Devices Paradigm

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Mobile devices have become an integral part of teaching and learning very recently (the beginning of the 21st century or around 2005). Indeed, mobile devices such as laptops, personal computers and mobile phones have become successful learning and teaching toolsin and out of the classrooms. Although the literature on the use of mobile devices in education is very small, the few systematic analyses of the effects of mobile devises in education show that they are important. For example, a study by Sung et al. [24], has shown that: first, integrating mobile devices with teaching and learning can have a positive impact on students' learning performance;second, there are challenges facing educators when trying to incorporatemobile devices into the teaching and learning process; and third,mobile devises could effectively (and easily) be integrated into the classroom and enhance students' learning experience, without the need of labs or other educational approaches.

In general, mobile devices present excellent opportunities for students to work communicatively, creatively, collaboratively, and being 'mobile', as well as continue learning outside the classroom. As a result, the Mobile Devise paradigm, became usefulby helping bring the real world into the classroom. Moreover,as the number of stakeholders and their digital competences increased, the approach becamea truly multi-dimensional one(combining or involving more than one dimension of any subject, discipline or field of study), which was utilized by many schools and education stakeholders (Table1, third row).

2.3.4 The Artificial Intelligence Paradigm

Artificial Intelligence(AI) is a rapidly accepted tool providing knowledge, which is transforming the way we live, work, and from the perspective of this paper, learn [25].That is, AIis an emerging technology that started modifying teaching and learning tools and approaches as well as educational institutions. The existence of AIhelps all educational stakeholders: first,is changing the teachers' job, withoutforcing them to lose their importance, becauseeven withing the AI framework teachers arethe principal force in any educational practice (i.e., support their routine tasks, and mainly provide adaptive assessmentstools); second,it is a tool to improve teaching and learning (i.e.,offer to students effective support for individual and communal learning); and third, support innovation and administration of the educational system. In addition, Kengamet.al. [26]havemove a step further stating that AInot only can be used, but is already used in education in an ever-increasing pace, despite the fact that relative feweducation stakeholders have the knowledge to take pedagogical advantage of AI, and mainly how AI can impact teaching and learning.According to Swedish geographerLenntorp B. [27], "AI is a basic approach, and every researcher can connect ittotheoreticalconsiderations in her or his own way".

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As a result, all educational stakeholders through this paradigm have the means to consider the S-T in its real meaning (not simply as an organizational tool), which coupled with the rapid increase in users'numbers and digital competenceslead towards an inter-dimensional manner (combiningthe dimensions of educational systems, schools, and subjects)(Table 1, fourth row).

2.3.5 Shift Characteristics

It shoud be evident that theS-T in education is an evolving perspective of a combined spatial and temporal processes and events. Moreover, it has applicationin curriculum, teaching tools, stakeholders' interrelationships etc. But space-time is not simply a subject, but rather an ontological framework in which space and time are the integrated dimensions of an educational processes. The S-T as an academic concern was originally developed by human geographers, but today it is utilized in most scientific areas.

Moreover,education, with a century delay, has to start following the physical sciences in discarding the traditional four-dimension approach by examining space and time in an integrated and coordinated way.The necessity for such anapproach in considering the S-T can be adequately substantiated by the multi-dimensional nature not only of its basic dimensions (space and time), but of all their characteristics. And for this reason,a detail examination follows.

3. THE MULTI-DIMENSIONALNATURE OF SPACE

In modern mathematics spaces are defined as sets with some added structure. They are usually presentedas different types of frameworks, whose properties are defined largely on the relationships of the dimensions of the framework. Among them the most important space is the Geographic space.

The concept of "Geographic Space" is one of the most fundamental ones ineducation. There is not any activity in any subject that does not need to utilize it. Unfortunately, geography has yet to provide a succinct and explicit definition of geographic space. This fact has had negative consequences not only for geography in the development of its theory, methodology and application, but, in the interest of this work, its relationship with S-T, which should take into accountthe followingproperties of geographic space that influence its consideration:

- **Relational:** It acquires meaning and value only when it is related to other concepts.

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- **Supplementary:**Itshould be conceived as a supplement to entities, such as objects, phenomena and processes.
- **Individuality:**It should be conceived as a framework to individual spatial concepts.
- **Totality:**It should be conceived as related to the totality of human constructs. In other words, it is a systemthat is characterized as “synergic”, which includesits relationship to the S-T.

Based on the above, geographic space can be defined as the space determined and organized by society. It is a space within which human groups interact with human characteristics, social behavior as well as natural resources, emphasizing three different manifestations/dimensions, that also represent the academic context of teaching and learning, namely: location, spatial patterns and spatial processes.

3.1Location

Despite the many definitions, approaches and the various terms proposed by many Geographers, location can be fully described as a basic dimension of geographic spaceexpressed in a three-dimensionalsystem consisting of the **longitude**, the **latitude** and the **elevation**, whichrepresent its fundamental parts. In addition,however there is another dichotomy of geographic location,namely: absolute and relative location [28, 29, 15].In the former location (or the x, y and z coordinates) are determined by the known geographical coordinate system, while the latteris determined by an anchor/origin in the geographical space as a reference and all other locations are defined in relation to that origin. But most importantly making this component of space a **multi-dimensional** one.

3.2 Spatial Patterns

A spatial pattern manifests the distribution of a set of objects, or phenomena that determines the way they are arranged in geographic space and mainly their geographical relationship. Spatial patterns can be observed everywhere. They include **natural**spatial patterns in the physical world (e.g., the arrangement of plants life in a region),as well as **man-made** patterns (e.g., thedistribution of human behavior in a specific area). That is, a spatial pattern can be considered as an analytical tool to measure the distance between locations of two or more objects or phenomena. But more importantly, a spatial pattern reflects an underlying spatial process within a specific time domain. As a result, the generalization and quantification and at the end the examination of spatial patterns leads into understanding the complex processes determining the distribution of spatial entities.

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Spatial patterns are a **multi-dimensional** component of space, providing three main types, namely: **uniform** patterns, which denote an even distribution of specific points or surfaces in the geographic space; **random** patterns indicating that no special correlation exists between these points or surfaces; and **clustering** patterns when most of the points or surfaces are congregated in a specific geographic area, although they may not be separated evenly.

3.3 Spatial Processes

A common acceptable definition of spatial process is thatof a sequence of events leading to a particular outcome.Cheng&Adepeju[30] defined spatial distributions as these processes that are taking place in geographic space. That is, there is a need, in addition to describing**how**some subjects or phenomenaare distributed over geographic space,to provide an explanation of**why**these subjects or phenomenaaredistributed in a specific way over geographic space. Thiswhyquestion basically tries to explain the process or processes determining the observed distribution of data. As Harvey [31] noted: *"*different processes become significant to our understanding of spatial patterns at different scales",an observation expounded later by Cheng &Adepeju[30]who considered that spatial distributions are based on processes taking place in geographical space. This interest onthe process rather than only on the form has led to the development of many differenttypes of spatial process modelssubstantiating that this dimension of space is also **multi-dimensional.**

4. THE MULTI-DIMENSIONAL NATURE OF TIME

Radovan [32]argued that "change is ontologically and epistemologically a more basic phenomenon than time. Time is an abstract entity created by the human mind on the basis of the experience of change". The position of this paper is opposite to this thesis. We believe that the correct perception of the flow of time is a fundamental element not only of how humans understand the world, but also the human existence. Therefore, time, although part of change,is an important aspect of human life through which the intensity and amount of physical reality is measured.

In terms of education,there is abundant literature suggesting that time can assist teaching and learning in three ways (dimensions) that should be taught. The first basic dimension of time is its**nature** (i.e., spot or interval) in the temporal domain. For example, the concernis "when things occur"? The second dimension is related to the time **duration**, in which the concernis "when and for how long things occur"? The third

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dimension is the time **density**, which in essence is a constraint that has a dominant effect on the occurrence of events. The concern for this dimension can be:given a certain amount of time, “what will happen”? In sum time is also **multi-dimensional**.

4.1 Nature of Time

In general, the literature in education has avoided defining,but mainly avoided defining it. Yet it rules our lives, and we all… wish we had more of it. But what, exactly is time and its nature?Smolin, et. al. [33]have written “it is central to the success of attempts to understand reality itself”.Despite the many philosophical arguments, the concept of the nature of time can be described as a basic dimension of time depicted in a three-dimensional system consisting of the:

- Dimension of **understanding**representing educational, scientific, philosophical etc. issues.
- Dimension of **position** in the temporal domain.
- Dimension of **time perceptions** or temporal relationships.

These dimensions are integral parts of the nature of time. In addition, similar to location dichotomy, time can also be differentiated in terms of absolute and relative time.The absolute time is expressed by the standard time units (i.e., reding the second, minute, and hour in a watch) indicating a specific point in the temporal domain.On the other hand,relative time is defined in relation to a memorable event (death, marriage, birth, earthquake etc.), which indicate that this dimension of time is **multi-dimensional**.

4.2Time Duration

Common experience is that in a relationship the important issue is not how close it is, but **the time duration** during which such relationship exists. As a result, in the framework of determining the concept of time, duration is equivalent to the length of time, which however can be considered from different points of view, namely as the:

- **Amount of time** or a particular time interval within the framework of time, which leads into a progressiontowards the future with the passing of present events into the past.
- **Rate of time,** which is used to measure or record the time.
- **Length of time**, which is used to substitute an amount of time or a particular time interval.

In addition, however there is a series of other dichotomies of time duration: first, duration of time can be short, long or have other characteristics; second it belongs tothe

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past, which has ceased to be and only then can be described; third it cannot represent present time, for the present has no duration, because for an event or a phenomenon that is still going on, its duration cannot be assessed[28, 29, 15], making this dimension of time also a **multi-dimensional** one.

4.3Time Density

Time density is associated with the changes in the characteristic**of value of a time**, which can be divided into discrete (e.g., seismograms that measures earthquakes at the time they occur), and a continuously changing type (e.g., taxis moving in a city servicing different customers).Additionally,certain time entities never change or are stationary (i.e., historicdates), while other entities may be constantly changingor depend on the time itself (i.e., temperature) indicating the multi-dimensional nature of the valueof time.

Finally, an important time density characteristic is the **limit of time**.A formal definition of that limit is: a specific time by which someone has to do something or the time when something happens or is planned to happen. In other words, time may have a determining effect on the occurrence of events and therefore the third dimension of time can be considered as a constrain within the temporal domain. Traditionally, the following three different forms of time limits exist:

- **Official Time Limit**, which referrers to the notion that places constraints on when there is a need to set an artificial time limit.
- **Original Time Limit**, which concerns an agreed by all that an action should be completed at a specific time.
- **Statutory Time Limit,** which relates to submitting something that is impossible to do otherwise.

In sum all these subcategories of time density indicate that this dimension of time is also **multi-dimensional**.

4.4Example of Time Multidimensionality

The three major dimensions of time can be illustrated as follows: Consider a student after finishing his classes. He leaves his school at 4:00 pm. and is determined to be home no later than 5:00 pm. At the same time, he should stop in a bookstore to buy some items he needs to complete hishomework. It takes him about 10 minutes to get to the bookstore, and about 40 minutes to do the shopping. Finally, it takes him 10 minutes to walk homeand be there on time. In this scenario, there are: first, the nature of the

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time, whichexplains events and phenomena; second, the time span or duration (from 4:00 pm to 5:00 pm); and third a time limit/deadline that controls or at least has an impact on his schedule (i.e., his classes end at 4:00 pm and he should be home at 5:00pm). In this scenario, the multi-dimensional time has a determining effect on objects, events and phenomena.

5. SPACE-TIME IN EDUCATION

Hägerstrand [34]the father of space-time Geography was intrigued by "the workings of large socio-environmental mechanisms"involving how events in geographic space occur in relation to time. Actually, he realized that understanding space is impossible without taking into account time. He described that relationship as "life paths (which) become captured within a net of (time) constraints"[34], indicating that the interrelationship between space and time is a fundamentally important aspect of teaching and learning.

Moreover, in education, most space-time teaching and learning involves integration, ranging from determining the space-time environment, to reveling and predicting the pattern and process involved. Example questions can be: how will the objects, events or phenomena of interest will be located at certain times? or how will the extent of these entities change through time? which cannot be answered outside an integrated space-time framework.

5.1 Space without Time and Time without Space?

In examining the S-T in education, it should be noted that: first, the relationship between space-time and education is a complex one and has been studied from various perspectives. Actually, most studies are focused on space-time as a key aspect and determinant in educational processes[35]; and second, the significance of considering the changes that are taking place in the policy, practice, and the empirical and theoretical study of education has been shown to be animportantand determining factor in considering space-time. That is, recent developments in educational research,easily available, have established the significance of considering the way people experience and understand space and time[36], denying the notion thatSpace without Time and Time without Space is a valid one.

5.2 A new approach to Space-Time

Thispaper, following the previous denial and opposingcurrent approaches, presents a new and different approach to S-T. More specifically, a two-prong position in

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considering space-time is presented here, which is simple in its presentation and explanation, but radical when is compared withthe traditional framework in teaching and learning. The first point of this position is that the E-Texpressed in such issues as: address emerging learning issues,shaping the application of education,raising questions regarding the relationship between context and teaching and learning processes,indirect over explicit knowledge, as well as the sharing learning resources cannot be addressed in the traditional way. That is, in considering space-time we can neither rely on what we are taught about it (changes in the contents of teaching and learning), nor on how we are taught (changes in teaching tools), both aspects (what and how we are taught) are important [17], but we consider the approach to achieve them to be the determining factor. This proposed approach is not new, the difference is that the focus,proposed here,is not only towards the learner, but towards all educational stakeholders, who all play an important, but differentiated role.

The second point in considering the E-T is the idea of thresholds at which a change in educational approaches triggers a non-linear transformation in the consideration of the S-T in education. It is suggested that the four paradigm shifts proposed earlier represent the tipping points in considering space-time in education. More specifically, it is suggested that recently a mechanism has been developed characterized: first, by multiple changes of space-time considerations due to the paradigm shifts in teaching and learning, whichimply an evolution away from the initial four dimension space-time state and the creation of new states of space-time considerations that have been instituted from that evolution; second by a non-linearity or disproportionality between cause (paradigm shift) and effect (i.e., the impact of the new ICT teaching tools, which appear in shorter intervals than in earlier periods and with greater influence than previous tools); third, by fluctuations (FC), which express the competing effects of any triggerand expected resistance to that trigger (i.e., the resistance of stakeholders in accepting the paradigm shifts in teaching and learning); fourth, byfeedbacks (FB) as system-internal drivers of change in the space-time consideration as well as new state stabilizers (i.e., the increasing number of teachers' ICT literacy); and fifth the difficulty of the application of the new paradigms is getting easier and less time consuming especially at the later paradigm shifts(Figure 1).

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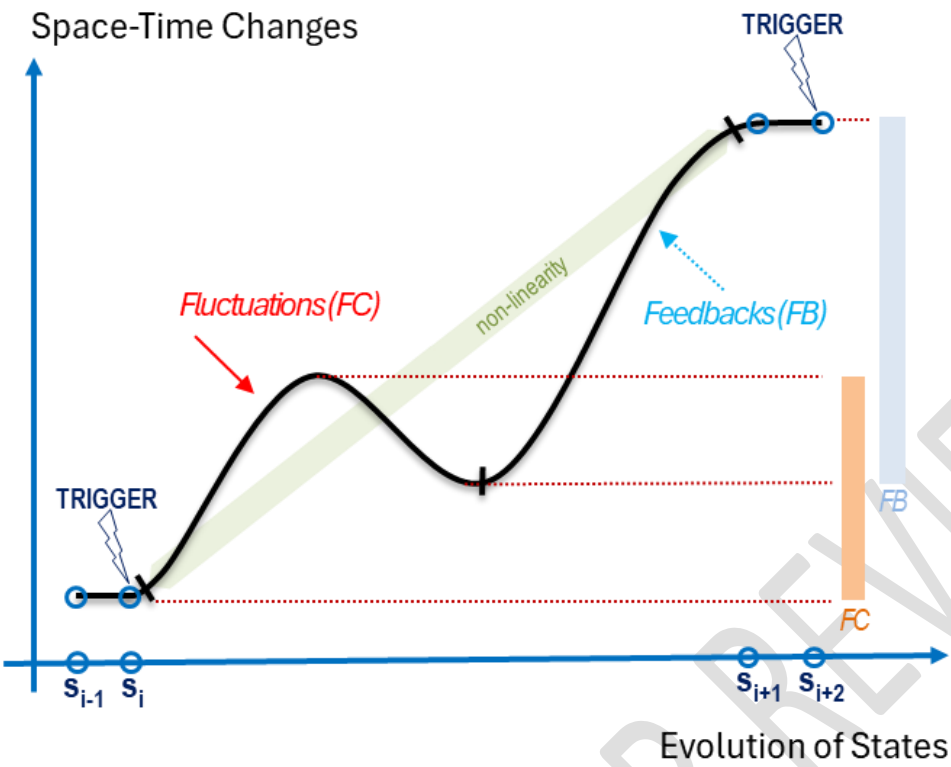

Figure 1: The Space-Time curve paradigm shift in Education

Therefore, the triggers or tipping points with regards to space-time considerations can be defined as a threshold at which teaching and learning changes trigger a non-linear educational process that initially resists any changes, but also is driven by system-internal feedback mechanisms that inevitably leads to a different state in considering space-time, which have different characteristics and are often irreversible.

Moreover, it is suggested that the proposed S-T confirms the actor network theory, which consists of actors (triggers in this paper terminology) or assemblages (network fluctuations and feedbacks in this paper terminology) that have the dynamic power to induce the S-T evolution or change of their state, but most importantly its principles support this paper's argument that there is no complete distinction between the social, the natural, and the technological aspects in one's actions.

An example,the paradigm shift from internet tomobiledevices,is presented to clarify the proposed concept. This shift has had the following characteristics and impacts on the consideration of the space-time educational approach. The trigger has been the appearance of a digital educational assistant in the form of mobile devices, while teaching and learning was impacted by the following transition (paradigm shift) factors: the fluctuations (resisting any changes) ranged from the denial of stakeholders in

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accepting differentiations brought by the new technology and consequently addressing the needed change in considering space-time to the difficulty in creating the necessary visual classes with the use of cloud- computing that have an enormous impact on space-time approaches, and which later on with the coming of COVID 19 was intensified. In terms of feedbacks (internal drivers of change), they ranged from the increasing number of teachers' ICT literacy to the availability of relative not expensive mobile devices (i.e., tablets), which have tremendously modified the approach to S-T. These resulted in the following:

- The fluctuationsand feedbacks processes, due to the uneven impacts of all the previous factors created a non nonlinear educational change.
- The principle that cloud-computing' use can be applied from **anywhere** (space) at **any time** (time) by anyone [37] was firmly established, facilitating a new approach in considering the space-time concept as well as creating the framework for the next paradigm shift (e.g., AI).
- There has been a change in the educational process of paramount importance, namely: from the mobility of the available ICT tools to the mobility of educational stakeholders, given thatmost mobile devices are not mobile! It is the educational stakeholder that is mobile (i.e., a mobile student carrying a non-mobile device).

5.3 Overview of the space-time consideration

Before addressing the specific aspects of space-time in education, there is first a need to provide a general theoretical overview of what space-time actually represents. It is argued that despite the differentiations in the consideration of space-time in many sciences (e.g., the physical and the social sciences), the most appropriate strategy for considering its use is to adopt a different approachfrom the traditional one, which will be attempted next.

From a philosophical point of view,the concept of space-time is regarded in terms of its ontology and epistemology.Actually,this focus has been central to philosophical concerns, resulting in a philosophy of space and time asbeen inspirational, but mainlyas a central component of analytic philosophy.Therefore, the subject of space-time focuses on a number of fundamental issues, the most important of which are: whether time and space exist independently of human minds;whether they exist independently of one another;and whether times other than the present moment exist; as well as questions about E-T's relationship and identity of the paradigm shifts, which are of paramount importance in this paper.

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Philosophicallythere are two approaches, as they relate to this paper,towards space-time: the traditional **realist** position, which declares that time and space exist apart from the human mind; and the **idealist**one,which,by contrast, deny or doubt the existence of objects independent of the mind. Immanuel Kant,the most influential philosopher on space-time, has resolved this dichotomy in his book the “Critique of Pure Reason” (1787). He proposed that**time** is a priori notion as is **space**, which together they allow us to sense experience. However, he insisted that neither of these notions are entities in themselves, or learned by experience. Actually, he proposed that space and time are mind-dependent, but also empirically real, and thus their combined effect is a part and determinant of human actions, including how we consider space-time in education.

In education all stakeholders (experts, administrators, teachers, and students) agree that learning is more than just the simple input and output of information. In education issues such as: value and forms of learning, freedom, exploration and discovery play an important role and thus they are vital elements to the teaching and learning process. For example, the literature[7,15], and experience have shown that students who are given a combined time and spaceopportunity, can be happier, more productive, and enjoy learning far more than students for whom this combined space-time experience is absent. While teachers can enhance considerably all aspects of their work.In general, at every level of learning, the integrated approach to space-time can have an extremely positive impact on education.

On the other hand, in aneducational environment of differentiated approach to spaceand time,it is believed that there is always a dichotomy.For example,the difference between outdoor recess and class work(i.e.,students have hard time focusing during class, when they can have fun outdoors), has no relation or impact to studentsspending time at rigid, fixed educational subjects(i.e., students prefer educational tools that tend to inspire them), which means that if we resolve one of these issues, it will not necessarilylead inresolving the other.The question is: can these notions be integrated? or learningboth inside and outside the classroom(space), can be influenced by temporalprocesses (time)? Our answer is a definite **YES**.

We strongly believe that the approach differentiatingspace and time cannot be acceptable, at least in education, anymore. We suggest that an integrated teaching and learning approach is needed,in which space and time are interrelated, in dialectic harmony and respecting all multidimensional geographic space and time characteristics, an integral part of which in education isall its stakeholders. As Openshaw [38] havewritten “the holistic nature of the space-time data model is simply science” and we might add education. In other words, we are arguing that an integrated approach is necessary in order to express the multi-dimensionalnature of space and time and the

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interrelationships and interdependencies of all their factors that constitute the C-T, which is the “whole”. As a result, an **inter-dimensional**approach is necessary, which can lead towards the integration of space and timeand thus overcome the fragmentation of the educational processes and subject knowledge.

In sum,it is suggested that there has been an evolution in the ways education has regarded the S-T. It commenced with the traditional paradigm of the four dimensions. Then through a transitional period evolved into considering S-T as a multi-dimensional and later on as an inter-dimensional concept.Moreover,it is suggested that ultimately, prioritizing the integrated S-T will help to redefine what is expected by educational stakeholders, but mainly of students, and more importantly, what they might hope to expect from themselves. By empowering for example, students to inhabit more authenticintegrated space-time environments can encourage them to be not only more productive, but also happier, and more conscious individuals. Positioning students at the center of the space-time educational process by acknowledging the incredible value of the concept (freedom, flexibility, innovation, discovery, and creativity in education), promises to overwhelmingly transform the contemporary learning experience for the better.The same holds true for teachersin utilizing opportunities of the concept in enhancing their work experience as well and for the rest of the education stakeholders. To put it in a different way, living in a world determined by space-time without understanding its true meaning and effect, is like been in a library and not using its books.

6. CONCLUSIONS

In conclusion,this paper suggests that this new time-space concept creates a foundation for a general educational perspective. It represents a new structure of thought that has been evolving in the last few years, which integratesboth the spatial and temporal perspectives of various aspects of education on a different basis than it has been considered thus far. Space-time is not ateaching subject area per se, or even lessa simple object, but rather an attempt to create a thought structure.We, therefore, propose to extend the concept of "**objects-to-think-with**" (as proposed by S. Papertin 1980 [39]) to the “**agents-to-think-with**” (as proposed by dos Santos et. al.,in 2023) [40]), and can be seen as a form of hybridization between human (education) and non-human (technological) actors, as suggested in the **Actor-Network Theory** (as proposed by Latour in 2005) [21]).Because the theories of social and technological determinism, which assume that phenomena or concepts can be described or explained exclusively either in terms of social or of technological factors, are not accepted anymore andthe name of the game is anymore integration.

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In addition, this proposal provides a new framework capable of enhancing two educational processes. The first is to provide the necessary knowledge to help everyday teaching and learning. The second is to reveal the inter-relationships of the S-T, exposing its nature, which has been ignored by the major educational stakeholders and unfortunately the researchers.

Moreover, it should be noted that the not differentiating and integrated approach in the consideration of the S-T, which certainly is**not** related simply to the organization of space and time in teaching and learning, requires the acceptance of the following:

- The existence of societal changes,which are the determining factor in considering and applying the S-T in education;
- The changes in S-T considerationsare based on paradigm shifts, which produce non-linear differentiations; and
- The applicability the new S-T is based upon the technological literacy of the educational stakeholders.

It should be noted that the proposed new E-T it will certainly face many, but not insurmountable, difficulties.A characteristic example is the way that teachers are facing teaching challenges such as:

- **Resistance to change**: Teachers may be resistant to change, especially if they are used to a specific way of teaching and doing things for a long time.
- **Lack of resources**: Schools may not have the necessary will or resources to make changes in order to implement new teaching strategies.
- **Lack of training**: Teachers may not have the necessary training or literacy to implement new teaching strategies or to use new technologies effectively.

A final statement to show our strong believes: the paper's position, might not very easy to grasp or accept, but so was Torsten Hägerstrandtime-geography concept many years ago.

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