



## IDENTIFYING THE DIMENSIONS OF THE PEDAGOGIC-TECHNOLOGICAL INNOVATION IN ISRAELI ELEMENTARY SCHOOLS

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### ABSTRACT

Pedagogic-Technological Innovation (PTI) relates to different practices reflecting the changes in the role of teachers and class students today. PTI aims at preparing students for lifelong learning in the knowledge community. The new national Information and Communication Technology (ICT) Program, called "Adapting the education system to the 21st century" has been implemented in twenty-one schools in Israel that incorporated ICT, intended to generate a pedagogic-technological change.

The aim of the current study was to identify the underlying dimensions of the PTI in Israeli elementary schools, and expose the internal relationships between the attributes of this innovation, as well as the factors involved in this change in the school. 283 teachers in these twenty-one schools evaluated the level of incorporation of the ICT innovation in their schools. The teachers completed two questionnaires that were based on the analytical tools necessary for examining the integrated ICT innovation. A Smallest Space Analysis yielded a two-dimensional solution with a Coefficient of Alienation of 14. The axial facet relates to the factor domain, a well-known area of content in research on pedagogic innovation and ICT incorporated. The second modulating facet distinguishes between class components vs. school organizational components. Implementing PTI within the classroom signifies the most complex level and may be located at the center of PTI change in school. The findings of the analysis highlight the importance of the class environment as "the heart" of any educational activity, without which none of the organizational changes in the schools would have occurred.

**Keywords:** Pedagogic-Technological Innovation, change in the school, class environment

### Introduction

Various education systems around the world, such as in USA, Australia and UK employ special units that serve as a catalyst for performing innovative changes in the schools. These units encourage initiatives and innovation, in order to implement successful educational models within the education system (Chen, 2006). Similar to this concept, the new national ICT program in Israel "adapting the education system for the 21<sup>st</sup> century" employ twenty one schools as ICT demonstrators, with the role as a technological-pedagogical change generators at their schools, with the support of the Ministry of Education in providing the necessary infrastructure, professional development and advanced technological equipment, such as a computer for every teacher, interactive whiteboards and laptops for the students (Ministry of Education, 2011). These schools are considered to be groundbreaking since they are continuously and diligently engaged in educational, pedagogical and organizational innovation, all focused around ICT.

According to Rogers's model "Diffusion of Innovations" (Rogers, 2003), assimilation takes place in several distinct stages. The first is the "Knowledge" phase, in which the school staff is exposed to the concept of innovation and develops awareness of its necessities. As a result, the motivation to experiment with the innovative new tool increases. This enables the transfer into the second phase in which a positive attitude towards the new tool develops (the "Persuasion" phase). The positive attitude leads to the next phase in which the individual decides to adopt the innovative tool (the "Decision" phase) and work towards its implementation in the organization (the "Implementation" phase). The last is the "Confirmation" phase in which the use of the innovative tool is sustained for a long period of time while its advantages and efficacy are acknowledged.

The ICT demonstrating schools have a rationale that focuses on implementing an optimal pedagogy in innovative learning environments, while using the information and communication



technologies intelligently and adapting them to the needs of the school community (Ministry of Education, 2011).

The concept of optimized pedagogy was developed in recent decades, following the integration of theories and research from various fields, such as developmental psychology, constructivism, self-directed learning, motivation, learning styles, exploration and identity formation (e.g., Jung, 2005; Karagiorgi & Symeou, 2005; Overbay, Patterson, Vasu, & Grable, 2010; Salmon, 2009; Solvie, & Kloek, 2007; Strommen & Lincoln, 1992; Vansteenkiste, Simons, Lens, Deci & Sheldon, 2004). The interest of this teaching concept is to improve the skills of the teachers and create the necessary conditions for effective learning, with the vision that the future adult will be able to function effectively and independently in a competitive, dynamic and technology-rich global reality.

The groundbreaking schools provide a colorful and qualitative environment for a systemic organizational-educational enterprise, which include innovative educational processes expressed in the curriculum, the teaching methods, organization of the learning environment and the implementation of new ideas (Chen, 2006). It is apparent that the demonstrating schools function as a sub-group of the experimental schools, each with his own model such as: excellence in ICT, promoting writing processes in the ICT environment, using the system for managing the teaching and learning – Moodle, and CTC- Children Teaching Children in a technological environment. These innovative education models assist the development of the general ICT program, and may transform them into systemic educational models which will contribute to the progress of the entire education system.

The current study is based on previous studies that examined, in the framework of the international study of the IEA organization, SITESm2 (Second Information and Technology in Education Study), pedagogic initiatives that incorporated ICT in Israel and around the world, by the level and the domain of innovation in the school and by the involvement of the systemic variables (Mioduser, Nachmias, Tubin & Forkosh, 2006; Forkosh-Baruch, Mioduser & Nachmias, 2011). The current study used the same research tools presented in their study and compared between the findings of both studies. The difference between the studies is the innovation evaluation method which in the previous studies (Mioduser et al., 2006; Forkosh-Baruch et al., 2011) was performed by external referees who were all independent researchers, while in the current study the evaluation was performed by actual teachers in the schools. This procedure was based on the assumption that the teachers are a central and active part of the school, and therefore their views may reflect the PTI change that occurs in the schools (Halverson & Selwyn, 2010; Avidov-Ungar & Magen-Nagar, 2012; Cunningham, 2009; De Freitas & Smith, 2010; Oliver, 2005; Fullan, 2007). Previous studies that examined the demonstrating schools found that in comparison to regular schools the teachers' opinions in these schools is significant to the implementation of the ICT in the school, and they are based on a high pedagogical commitment which leads to optimal pedagogy in the technological environment (Magen-Nagar & Peled, 2013). Therefore, it is apparent that the teachers have the ability to assess the change of the PTI processes in their school from the closest point of reference.

### **Research goals**

To examine the PTI in the ICT demonstrating schools and to compare the results to the schools that participated in the SITESm2 study, and in this way to identify the dimensions of the PTI and the internal relationships between the attributes of the PTI and the involved elements inside the school.

### **The study questions**

1. What are the PTI elements in the demonstrating schools as compared to the schools used in the SITESm2 study?



2. What are the variables involved in implementing PTI in the demonstrating schools as compared to the schools used in the SITESm2 study?
3. What are the dimensions of PTI in the ICT demonstrating Schools?
4. What are the internal relationships between the PTI attributes and what are the elements involved?

## **Method**

### **Participants**

21 ICT demonstrating schools that were incorporated in the year 5771 into the national ICT program "Adapting the education system to the 21st century" (100%) participated in the study. On average 13 teachers from each school evaluated the level of the ICT integrated innovation.

### **Research tools**

The study questions were examined using two questionnaires that were based on the analysis tools developed by Mioduser et al., (2006) for examining the innovation that involve ICT. The first questionnaire was based on the analysis tool that examined the innovation level of pedagogical applications that integrate ICT in various areas of the school. The questionnaire contained 33 statements, which were constructed according to four areas (configuration of time and space, the role of the student, the role of the teachers and the curriculum) and three levels of innovation (implementation, transition and transformation). The questionnaire scale ranged from 1 (implementation level) to 5 (transformation level). The higher the average- the higher was the innovation level. The reliability of the questionnaire was 0.93 ( $\alpha=0.93$ ). The second questionnaire was based on the analysis tool that examined the strength of the variables involvement in innovative pedagogical applications that incorporate ICT. The questionnaire contained 14 statements that were built according to four groups of variables (internal functionalities of the school, training and staff development, infrastructure and resources, organizational climate and functionalities external to the school). The questionnaire scale ranged from 1 to 5. The higher the average- the higher was the variable involvement. The reliability of the questionnaire was 0.80 ( $\alpha=0.80$ ).

### **Research process**

At the end of a training course for teachers in-service from the demonstrating schools, conducted during the school year 2011-12, teachers were asked to fill out an online self-report questionnaire in order to examine their positions about the ICT integrated innovation level in the schools where they teach. The teachers took about 20 minutes to complete the questionnaires.

### **Data analysis**

The data were analyzed by using SPSS 18.0 for Windows and by SSA analyzes (Smallest Space Analysis).

## **Results**

### **PTI innovation in demonstrating schools as compared to schools used in the SITESm2 study.**

To examine the PTI components in the demonstrating schools and then to schools used in the SITESm2 study, the averages and standard deviations were calculated for areas and sub-areas of ICT integrated innovation in the 21 demonstrating schools. Thereafter, the averages of



the demonstrating schools were compared to the averages of the schools that participated in the SITESm2 study (Table 1).

**TABLE 1. Averages and standard deviations of the level of PTI in the demonstrating schools as compared to schools in the SITESm2 study**

	Demonstrating Schools N=21		Schools SITESm2 Study N=174	
	<i>M</i>	<i>S.D</i>	<i>M</i>	<i>S.D</i>
<b>Space format</b>	3.71	0.55	2.88	1.13
Physical space (Ranges between public space to private space)	3.45	0.69	2.69	1.42
Digital space (Ranges between desktop to online space)	3.90	0.61	3.16	1.21
<b>Student role</b>				
Main roles (Between Structured tasks to personal development tool for creating a learning environment)	3.31	0.63	3.23	1.29
<b>Teacher role</b>				
Toward the students (Ranges from the teacher as the main source of leadership, information and knowledge to an expert-associate who is partner to the learning and discovery process of the student)	3.46	0.56	3.18	0.92
Toward the teachers (Ranges from an independent teacher to an expert whose dependency on his colleagues strengthens as the task becomes more complex)	3.62	0.60	3.32	0.96
<b>Curriculum</b>				
Contents (Ranges between ICT integration in traditional knowledge disciplines to the construction and development of new areas of knowledge)	3.29	0.52	3.02	1.36
Didactic solutions (Ranges between implementing existing software applications to developing learning spaces)	3.73	0.67	3.10	0.98
Evaluation processes (Ranges between traditional exams to creating new evaluation tools, such as: digital portfolio)	4.11	0.77	3.07	1.16
<b>Total</b>	3.46	0.61	3.31	1.00
	3.61	0.62	2.92	1.45
	3.58	0.62	3.10	1.08

Table 1 indicates that the average level of innovation is higher in the demonstrating schools ( $M = 3.58$ ) in comparison to the schools that participated in the SITESm2 study ( $M = 3.10$ ). Also, in general it can be seen that in all the dimensions of innovation in the demonstrating schools there are high levels of pedagogical innovation that incorporate ICT in comparison to the schools that participated in the SITESm2 study, where the highest level of innovation in the demonstrating schools was in the 'curriculum' domain with the sub-domain 'contents' ( $M = 4.11$ ).

This means that in the demonstrating schools the ICT serves as a measure for expanding the knowledge domains and for creating new domains, and less as a measure for supporting existing knowledge. In contrast, the highest level of innovation in schools that participated in the SITESm2 study was in the 'teachers' role' domain, and in the sub-domain 'towards the students' ( $M = 3.32$ ). This means that in the schools that participated in the SITESm2 study the teachers



took the role of experts-associates and they were partners in the students' learning process and served less as a source of knowledge.

**The variables that are involved in PTI implementation in the demonstrating schools in comparison to the schools that participated in the SITESm2 study.**

In order to examine the variables which are involved in the implementation of PTI in the demonstrating schools as compared to the schools that participated in the SITESm2 study, averages and standard deviations of the variables involved in innovation in the 21 demonstrating schools were calculated. Thereafter, the averages of the demonstrating schools and the averages of the schools that participated in the SITESm2 study were compared (Table 2).

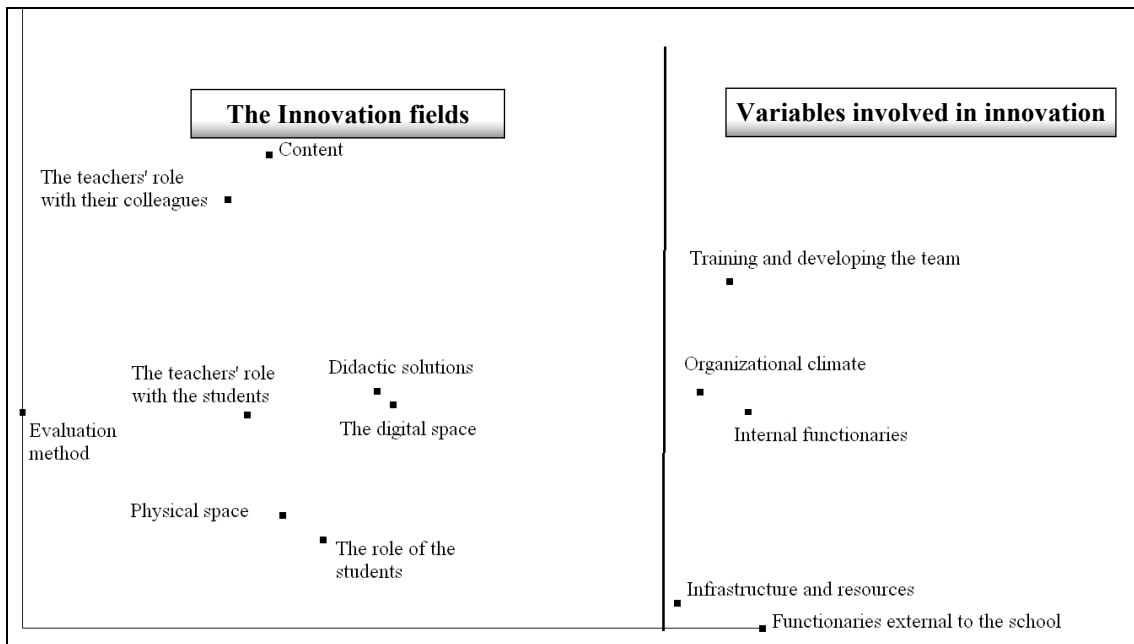
**Table 2. Averages and standard deviations of the variables which were involved in the implementation of PTI in the demonstrating schools as compared to schools in the SITESm2 study.**

	Demonstrating Schools N=21		Schools SITESm2 Study N=174	
	M	S.D	M	S.D
<b>Internal school functionaries</b> (School headmaster, ICT coordinator, officials and teaching staff)	4.58	0.45	3.62	0.79
<b>Functionaries external to the school</b> (Parents, intervening external body, experts of the knowledge domain, the Ministry of Education, the local municipality)	3.38	0.94	2.09	0.83
<b>Training and staff development</b> (The training relevance)	4.42	0.77	3.45	1.10
<b>Infrastructure and resources</b> (Various peripheral equipment, availability and integrity of the infrastructure and the technical support)	4.32	0.54	3.41	0.96
<b>Organizational climate</b> (Formulating the vision and ICT goals and scope for implementation of the innovation in the school)	4.54	0.56	3.40	0.96

Table 2 indicates that the level of involvement of each of the variables examined in the demonstrating schools was very high in comparison to schools that participated in the SITESm2 study. The range of the level of involvement in the demonstrating schools was higher (3.38 to 4.58) as compared to the schools in the SITESm2 study (2.09 to 3.62). It can be seen that the variable 'internal schools functionaries' is at the highest level of involvement in both the demonstrating schools and the SITESm2 study schools. This means that in both studies the schools' teams including the headmasters, the ICT coordinators, the support staff and the teachers are significantly engaged with the PTI processes that occur in their schools.

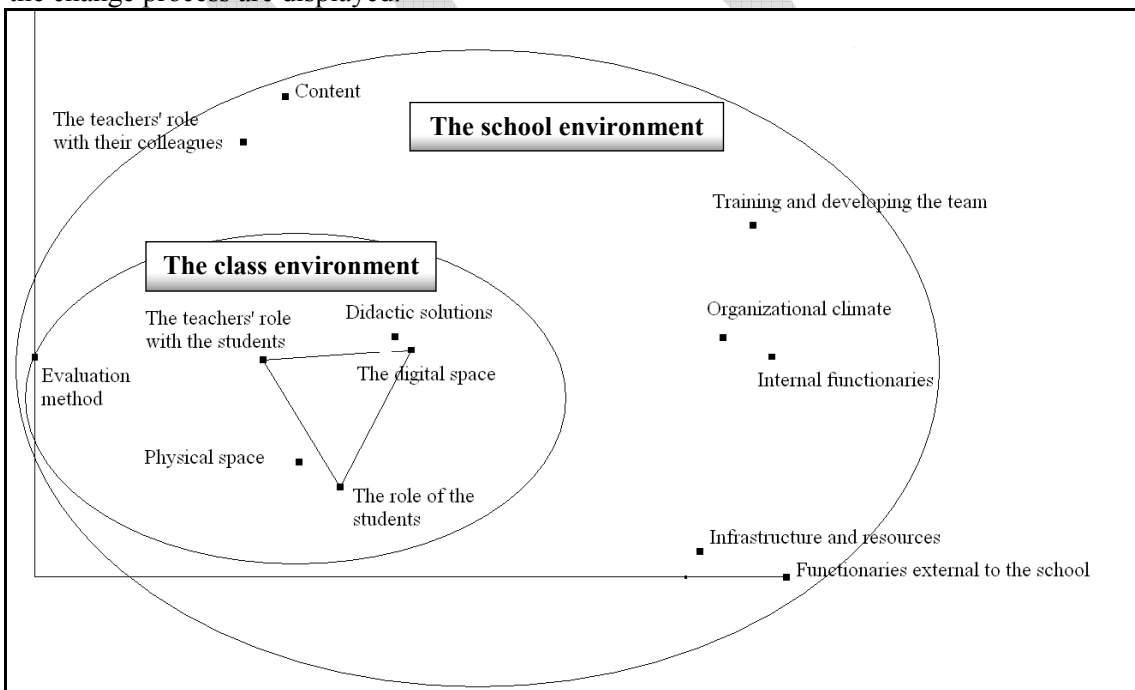
**The PTI dimensions and the internal relationship between its attributes and the factors involved.**

In order to identify the dimensions of the PTI in the ICT demonstrating school and the internal relationships between the PTI attributes and the variables involved in the change process a Smallest Space Analysis was performed. SSA analysis is a part of the Facet Theory which can identify the dynamic relationships between the variables (Guttman, 1982). The facet exposure creates the conceptual differentiation between the studied phenomena (Freidman 2012). Figs 1 and 2 display the distribution maps of the questionnaires factors in the two dimensional space (axial and modulation) with the extrinsic factor 0.14, which indicates to a good agreement. The analysis was performed by axis 1 X axis 3.



**Fig 1. Distribution of the factors in the PTI space according to Facet A**

The SSA map in Fig 1 displays the first dimension (Facet A) of the axial aspect, which distributes the space according to the innovation dimensions and the factors involved. This distribution is identical to the one performed by Forkosh–Baruch et al., (2011). On the left, the innovation dimensions are displayed and at an evident distance the factors which are involved in the change process are displayed.



**Fig 2. Distribution of the factors in the pedagogical- technological innovation space according to Facet B**



The SSA map presented in Fig 2 displays the second dimension (Facet B) in a modulation modewhich divides the space into the components of the class and the school level. The components of teaching and class organization are located in the center circle. These components are complex and significant, and include 'didactic solutions', 'digital space' and 'the role of the teachers toward the students'. The external circle includes components each of which have a unique effect that express the involvement of the variable in the PTI, the factors included are involved in the change process together with 'contents' and the 'teachers' role with colleagues'. In addition, the analysis indicates that the internal circle contains a triangulated close link between the factors: 'digital space', 'the role of the teachers and the students' and 'the role of the students'.

### **Discussion and conclusion**

The results of the current study suggest that in the ICT demonstrating schools the parties that are involved in the change process show high levels of PTI, as compared to the schools that participated in the SITESm2 study. These findings indicate that significant changes are occurring in the ICT demonstrating schools, and strengthen the argument that these schools are indeed demonstrating, in practice, the incorporation of technologies and updated teaching-learning tools and methods, while utilizing the potential of the information technology to its fullest. Moreover, these schools design and implement unique and innovative pedagogical models for incorporating ICT into the schools, which may, in the future, serve as prototypes and templates for other schools (Rimon, 2010).

The results of the SSA empirically demonstrate the extent of the pedagogic-technological innovation. The axial distribution of the map shows the domains of innovation alongside those which are involved in the change process and thus supports the approach of Forkosh-Baruch et al., (2011) which is based on two separate aspects. The first aspect is the identification of pedagogical innovation in the school's social environment, and the second is the examination of the variables that are involved in the performance of the innovative pedagogical initiatives that incorporate ICT. The SSA map shows a significant spatial separation between these two aspects, and thus point to separate content domains that are loosely connected. Sometimes loose connections in an organization are advantageous because they allow for each component of the organization to perform functional change, or to adapt to the change, in a rapid and easy manner since there is no dependency between the components. Still, the low coordination is also a disadvantage since it reflects the low coordination ability between the components of the organization, which render the effective functioning of all stakeholders difficult (Shahar, 2007; Weick, 1976). Therefore, it is likely that these alternative situations may occur during the process of the systemic PTI change that occurs in the school, which on the one hand expose the tremendous complexity involved in the changing school's components (Rogers, 2003; Sarason, 1998), and on the other the need for cooperation between the school and the elements that are active in its environment (Oplatka, 2007). It is therefore recommended for the schools to actively bridge the connections between the innovation domains that incorporate ICT and the elements involved, in order to create a substantial innovative change in the schools that face pedagogic-technological challenges.

Therefore it can be said that the first facet is well-known and recognized in the study of innovative pedagogy that integrates ICT (Forkosh-Baruch et al., 2011). However, the second facet, the Space Facet, is new and expands the perception of the PTI. With this facet the PTI can also be conceptualized as a modular continuum that revolves from classroom factors such as: methods of teaching, the teacher's role, the role of student and the physical and digital learning space, to school organizational attributes such as: school culture, resources, professional



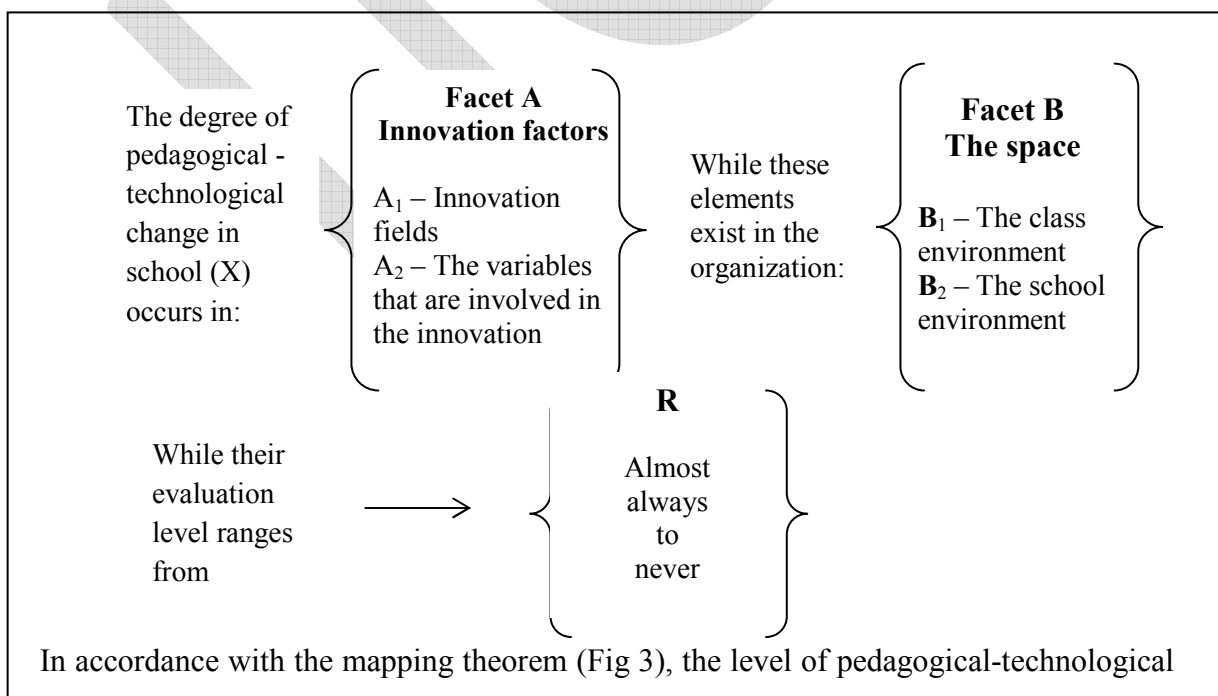
development, professional learning between peers and the learning content in the school. The ambition to implement PTI in the classroom is the most complex level, and it just may be that this is “the heart” of the PTI changes in the school.

The findings of the current study strengthen the argument (Law, 2008) that the ICT learning environment allows for achieving educational and academic goals, and more importantly, it has the potential to cause a significant change in teaching and learning processes. This is the pedagogical change that will lead to the required achievements. Our findings also complement other studies which demonstrate that the classroom is a significant social and learning unit in the context of teaching and learning (Salant, 2008; Magen-Nagar, 2010; Archibald, 2005; Delpit, 1995; Rumberger & Palardy, 2005). It is therefore advisable to promote innovation in the classroom framework as the core of the educational activity in the school, without which it will be impossible to perform the systemic change.

In addition, we believe that the basis of the PTI consists of three interdependent classroom elements: 1. A teaching style in which the teacher is an associate, expert and partner in the learning process of the student; 2. A teaching style in which the student uses the ICT as a tool for creating, learning and information sharing; 3. The virtual-digital learning space is a constructivist learning environment, where the teacher and the student share mutual responsibilities for structuring the knowledge (Bracewell, Sicilia, Park & Tung, 2007).

It is therefore appropriate that the national ICT plan should continue to nurture the teacher, the student and the virtual learning environment, and mainly act for the participation of all the entities involved in the process of change, both in the ICT demonstrating schools and the regular school. In conclusion, a mapping theorem is suggested for evaluating the pedagogical-technological innovation in a school (Fig 3).

**Fig 3. Mapping theorem for evaluating the pedagogical – technological innovation in a school**







innovations in the school can be characterized by the aspects of the innovation domains that incorporate ICT and organizational attributes in association with the classroom and the school environment.

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