LEVELS, DOMAINS AND INVOLVED FACTORS: MPLEMENTATION OF PEDAGOGICAL INNOVATIONS USING TECHNOLOGY

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Abstract

The rapid and pervasive implementation of new information and communication technologies (ICT) in the education system raises expectations regarding its potential for and contribution to the improvement of education. In spite of the accelerated implementation pace of ICT infrastructure in the educational system, including connection to the Internet, we are only at the beginning of a long process (Venezky & Davis, 2002). The goal of this study is to analyze the data collected in ten Israeli schools which have implemented ICT in unique ways and have succeeded in creating innovative classroom pedagogies and school system changes. In this paper we apply an analysis schema in analyzing data collected in the schools (e.g. levels and domains of innovation), thereby characterizing ICT-based educational innovations. We examine the level of innovation in the various domains and their variations among and within schools. We then examine the factors affecting successful implementation of innovative pedagogical practices using technology (IPPUTs) within these schools. We define these factors, measure the intensity of each factor's involvement and trace the connections between these factors and the levels of innovation in different school domains (e.g., learning, teaching, curriculum, time/space configuration). Our research questions were:

1. What levels of innovation were observed in the participant schools in the different domains, and how do they vary among and within schools?
2. What is the configuration and intensity level of the factors involved in the implementation of innovative pedagogical practices using ICT in schools?
3. What connection can be established between the intensity level of the factors involved in the innovation and the level of change in the various innovation domains?

We believe that the findings of this study will contribute to the clarification of the conceptual framework for ICT implementation in schools, point out the challenges faced by those involved in generating and implementing the innovations, and offer operational courses of action for decision-makers.

Keywords: ICT, educational innovation, pedagogical practices, case study, international study.

RATIONALE OF THE STUDY

Significant research focusing on educational change has been conducted dealing with factors involved in educational innovation in general (Fullan, 2001; Kinsler, & Gamble, 2002), and in ICT-based innovations in particular (Berman & McLaughlin, 1974; Malouf & Schiller, 1995; McLaughlin, 1991). The emphases vary: organizational aspects in the implementation of changes in structure and activities (Underwood & Underwood, 1995; Tyack & Cuban, 1995; Cuban, 1999); the teachers factor and their coping with the demand to change (Lortie, 1975; Lacey, 1977; Crofton, 1981;Hall & Hord, 1987); or outside-school factors' contribution to the implementation of ICT-based innovations (Venezky & Davis, 2001).

Research on the impact of ICT on educational processes has included a great deal of theoretical as well as empirical work (Becker, 1994; Mioduser and Nachmias, 2002; Pelgrum and Anderson, 1999).

The incorporation of ICT in schools affects the grammar of the school (Tyack and Cuban, 1995) and causes fundamental structural transformations (Watson, 2001). It has affected their functioning at multiple levels: creation of new configurations of learning spaces and timetables, incorporation of innovative teaching methods, adoption of autonomous and active learning processes, broadening of teachers' traditional roles and producing new ICT-based curricular solutions.

These changes include complex and dynamic processes, and have brought about considerable transformations in major aspects. Teachers' role has shifted from instruction to guidance, assisting students in developing personal learning methods and evaluation of learning processes and outcomes. Students, from being passive learners, have transformed into active learners, collaborating with their peers in performing learning tasks. Schools have become more connected to and integrated into society, and parents have become more actively involved in their children's schooling (Kozma, 2003).
The school, being an agent for the preparation of students to life in the information society, and applying lifelong learning methods, sees as its main goal to supply the skills needed to function in a world of continuous change (Fisher, 2000). An innovation refers to a shift in educational paradigm (Pelgrum *et al.*, 1997). Educational innovations may apply to one or more interrelated variables. Innovations can be defined in operational terms as the wide range of activities and means (e.g., curricular decisions, learning materials, learning configurations, lesson plans, tools and resources) that reflect the school's educational philosophical orientation towards lifelong learning.

Tools for the Analysis of ICT-based Educational Innovations

For the systematic examination of ICT-based pedagogical innovations in this study, two analysis tools were developed: an *analysis schema* focusing on domains and levels of innovation, and a *factors-categorization schema* focusing on sets of factors involved in the innovation.
The *analysis schema* appears in Table 1. The horizontal axis represents levels of innovation (3 major levels and 2 intermediate levels), from preliminary alterations of the school's routine and structure as a result of ICT implementation, to extensive transformations in pedagogical practices and learning processes. The vertical axis presents domains of innovation, focusing on four main components of the school setting: time/space configurations, students, teachers, and the curriculum (for additional details see Mioduser et al., 2003).

The *factors-categorization schema* was developed based on existing literature and on the conceptual model of the SITES-M2 international study (Kozma, 2000). Several factors are mentioned in the literature as involved in the success of pedagogical practices in general. The principal's support raises the probability of the innovation to succeed (Fullan, 1998; Sarson, 1984). His or her involvement indicates the seriousness of the practice and assists in resources and psychological support (Marsh, 2001; Berman & Mclaughlin, 1977). The principal supplies the vision and clarifies joint goals for the benefit of the innovation (Rosenholtz, 1989; Meier, 1995).
Teachers' resistance due to previous experiences, lack of adequate rewarding, contradictory messages, and group pressure can have significant implications on the success of an innovation (Fullan, 2001). Teacher training is vital to the introduction of innovation and change in schools (Goodlad, 1991; Sarason, 1993), the most efficient training being in-house and linked to the actual curriculum (Tubin & Chen, 2002).

Table 1: Levels and domains of pedagogical innovation using ICT

Domains	Levels		
	Assimilation	Transition	Transformation
Time and space configuration			
Physical space	Public spaces	Public and personal spaces	Personal and community spaces in school and beyond
Digital space	Desktop and Internet applications usage	Flexible Internet use and content creation	Virtual learning spaces and organizations
Time	Mainly embedded in the school schedule and timetable	Flexible access for individuals within constraints of school's schedule	Anytime for all in school hours and beyond
Student role			
Main roles	Using ICT for accomplishing curricular assignments	Development of ICT generic expertise – for usage, maintenance, and creation	Personal assimilation of ICT as learning, creation and working tool
Teacher role			
With students	Main source of leadership, information, and knowledge.	Pedagogic authority, mentor, supporter, coordinator	Expert colleague, partner to the process of discovery
With teachers	Acting individually, functional peer interaction	Team work, collaboration, mutual help	Acting cooperatively, organic solidarity
Curriculum			
Content	Traditional subjects enriched with ICT	Expanded subjects incorporating new knowledge resources	New subjects: design and development using ICT
Didactic solutions	Tutorial packages, constrained use of generic tools and Internet	Open assignments and projects using generic tools and Internet	Virtual environments; development of personal digital spaces
Assessment methods	Digital versions of standard assessment means	Criteria development for assessing digital products	Digital alternative assessment: projects, portfolio, etc.

Change in the school structure (allocation of classes and teaching units) and in the learning processes (teaching and assessment methods) is considered a prerequisite for significant change as a result of implementation of innovations (Sizer, 1993; Tyack & Cuban, 1995). This includes change in time and space configuration, role distribution, communication patterns among teachers and school policy.
Infrastructure resources (e.g. hardware and the quality and functioning of it, access to the Internet and available software) are considered a crucial factor contributing to the success of the innovation (Venezky, & Davis, 2002). Staff training must accompany available of ICT, including technical and pedagogical support (Pelgrum & Anderson, 1999).

External factors (e.g. the Ministry of Education, municipalities, academic supervisors and consultants, or private agents) foster tendencies of change as a result of the school functioning as an open organizational system with reciprocal relationships with its surroundings (Gibton, 2001; Scheurich & Fuller, 1995).
For the current study, seven major categories of factors involved in the implementation of innovative pedagogical practices using technology were identified.

Roles within the school – includes the principal, the computer coordinator and leading teachers and an innovation focus group. Their involvement is measured by the extent of identification with the innovation, the type (passive vs. active) and level of involvement.
Roles outside the school – includes parents, external institutions (e.g., academic, industries, business institutes, pedagogical institutes), subject-matter experts (e.g. virtual teachers, writers of curricula, researchers and academic faculty), position holders in the Ministry of Education (e.g. supervisors, ICT advisors) and municipal position holders (e.g. director of the education department, regional coordinator). Their intensity is measured by domains (financial-professional) and nature of involvement (formal vs. substantial).
Organization of learning – includes two factors comprising the school's organizational structure (Tyack & Cuban, 1995): the layout of the learning units (e.g. lessons, fixed time units, activity hours) and the allocation of students into learning groups (e.g. single-aged, multi-aged, according to fields of interest, content, etc.). The scale is determined by the extent of flexibility, mobility or rigidity in the school's timetable.
Organizational climate – includes ICT vision and goals, measured in terms of the stage of vision consolidation and clarity; also includes innovation history of the school, measured by past involvement in innovations, openness and readiness to experience innovations, and the course of diffusion of the innovation in the school (Rogers, 1995), measured by the number of participants and time allocated for the innovation.
Staff training and development – two factors are included: contents of the training activities, measured by their relevance (e.g. match teachers' needs) and the source of staff development, measured by accessibility of resources to the innovation operators (e.g. external and less accessible training to continuous and accessible internal training).
Infrastructure and resources –measured by student:computer ratio and amount of peripherals, and availability and use of infrastructure; includes technical support within the school (e.g. type of support and its accessibility), and budgeting of the innovation in terms of amount of resources and satisfaction from them.
ICT policy – includes national and local ICT policy, in parameters such as accessibility to the Internet, acquisition of equipment and staff training; measured by the type of support given as a result of these factors (budget, training) and its effect.
The factors involved in innovations using ICT divided into categories are interrelated with the innovation domains, including students, teachers, the curriculum and space/time learning configuration.
Significant change is becoming more comprehensive and complex over time, consequently displaying unrealistic timetables, unfit demands, simplistic solutions, and involving unsuitable resources allocation and inconsistency in performance (Fullan, 2001; Gibton, 2001). These drawbacks make more evident the significance of research on the generation, development and implementation of educational innovations, emphasizing levels and domains of innovation as well as the factors affecting these processes.

METHOD

The research focuses on ten Israeli schools that have implemented innovative pedagogical practices incorporating ICT, thereby creating school-wide changes. The methodology in this study comprises qualitative and quantitative data collection and analysis tools. The study was conducted as a multiple case study procedure appropriate for examining new, complex and unique phenomena (Yin, 1984).

Population consisted of ten schools throughout Israel, including two elementary, one junior high, three upper high schools and four 6-year high schools. All schools were chosen by the research team and research steering committee, which included leading figures from both the education system and the academy, in the field of ICT in education. In this paper schools will be referred as IL0XX, according to coding of the SITES M2 study:
IL001 – *"Beehive" Communication Projects*: Students participate in ten different virtual communities within a nation wide web-based learning environment, with an emphasis on developing language skills.

IL002 - *Computer Trustees*: students assist in maintenance of the school computers and construction of the school website, tutoring teachers as well as senior citizens and children with special needs.
IL003 - *ICT Saturated Learning Environment*: a school planned and constructed as a model for the future, that views ICT as a means for empowering students; computers are implemented in most spaces and subjects as well as in assessment, communication, pedagogical and organizational administration.
IL006 – *Computerized Radio Division*: radio broadcasting is directed and produced by students using electronic equipment, digital editing devices and broadcast production software, encouraging interaction between the community and the school.
IL007 – *Website Story*: a three-year construction process of a school Internet site, including information and interactive learning activities, based on the usage of innovative technology serving innovative teaching paradigms.
IL008 – *Aviv, a Virtual High School*: students from all grades participate in eight virtual courses dealing with several subjects, some linked to the regular curriculum, others being extra-curricular and complementary.
IL009 – *The Excellence Center*: deals with computer literacy and entrepreneurial studies, offering courses to 200 students. Its goal: raising future technological leadership; the center was adopted by local hi-tech industries.
IL010 – *The Peace Network Project*: combines usage of the web, e-mail, discussion groups and virtual means, as a lever for fostering peace and communication in the region. The web serves as a meeting place for Arab and Jewish students, initiating joint projects.
IL013 – *Man and his Surroundings Website*: contains descriptions and research of physical and human aspects of the area, mainly a salt flat; materials are related to the earth sciences, biology, computer sciences and the arts; also fostering joint work with peers in a nearby Jordanian school.
IL015 – *Computerized Greenhouse*: combines research and final projects for biology students, offering students opportunities for real-life projects in their accreditation studies. Data generated are shared with academic and educational research institutes.

Criteria for selection of the innovations included substantial influence on teaching and learning methods, changes in pedagogy, in teacher roles, in the curriculum, in student outcomes, and intensive usage of ICT. In addition, we considered the chances that the innovation be transferred to other domains and places (transferability); be widely implemented (scalability); be viable over a long period of time (sustainability) and be influential on school texture (ECD/CERI, 2000; Kozma, 2000).

Data collection tools included questionnaires, interviews and observations developed for the international study, translated into Hebrew. Interviews were held with principals, computer coordinators and supervisors. Focus group discussions included separate sessions with innovation teachers, teachers from the school not involved in the innovation, students participating in the innovation and their parents (Kozma, 2003).

Analysis and data processing method: categories and factors were examined and mapped by their intensity using the analysis framework. The mapping of the factors' involvement was measured by three independent researchers. Qualitative data included examples, quotes and statements, while quantitative data comprised of frequencies, means, standard deviations and correlations. A methodological reservation should be noted with relation to the validity of the statistical procedures, due to the relative small number of schools (ten altogether).

RESULTS

Research question 1: What levels of innovation were observed in the participant schools in the different domains, and how do they vary among and within schools?

Schools differed in many innovation aspects. Innovative practices do not involve all domains at the same level. Data indicate that most schools, in most of the innovation domains, are located at the transition level (72% of the 9 levels evaluated for each of the 10 schools -90 sub-domain-level-locations or SLLs). Only 19% of the domains reached the transformation level. In total, 53 SLLs (59%) are either at the transitional level or towards the transformational level. Only 20 SLLs (22%) are graded at the lower stages of the innovation scale.

Findings indicate variation among schools in average level (from 2.0 to 4.7) of the innovative practices. Three schools show a high average level of innovation, indicating that the practices have supported major changes in most domains. Four schools revealed average levels of innovation located between the assimilation and transition phases. Variation among schools implies that a high level of transformation in all domains is not necessarily a prerequisite for successful ICT implementation. Findings imply that different innovative practices address different aspects of the pedagogical process, leading to uneven impact in its various domains and related to the goals and scope of the practice.

Variation was observed among and within schools regarding levels of innovation in each domain, although all schools were selected for being innovative. Table 2 presents the level of innovation in all nine domains for all schools.

Table 2: Schools' levels of innovation by domains, average innovation level and SD

Domains	School									
	IL001	IL002	IL003	IL006	IL007	IL008	IL009	IL010	IL013	IL015
Time and space configuration										
Physical space	3	1	5	2	2	1	3	1	3	5
Digital space	3	2	3	4	4	3	4	3	5	5
Time	1	3	4	4	3	1	3	4	5	5
Student role										
Main roles	2	3	4	4	4	2	4	3	4	5
Teacher role										
With students	3	3	3	4	3	2	4	4	5	5
With teachers	3	1	5	2	3	3	3	3	4	2
Curriculum										
Content	3	2	5	4	2	3	5	4	5	5
Didactic solutions	3	2	4	3	3	2	3	3	5	5
Assessment methods	3	1	4	4	3	3	4	1	4	5
School average level of innovation	2.7	2.0	4.1	3.4	3.0	2.2	3.7	2.9	4.4	4.7
School deviation of domains	0.7	0.9	0.8	0.9	0.7	0.8	0.7	1.2	0.7	1.0

Findings reveal variation among schools in average level of the innovations, rating from 2.0 to 4.7. Three schools show a level of innovation above 4, indicating significant changes in most domains. Four schools rated an average bellow 3, between the assimilation and transition phases. This variation among schools indicated that the innovation could result in a high level of transformation in all domains; however, successful practices can be found even when schools are not rated highly on all domain levels.

The deviation of levels of innovation in different domains within each school indicates consistency, displaying low variation within and among schools (SD ranging from 0.7 to 1.2), i.e. relative homogeneity.

Research question 2: What is the configuration and intensity level of the various factors involved in the implementation in schools of innovative pedagogical practices using ICT?

Table 3 presents the rating of factors by their degree of involvement. Involvement levels of the factors cover an ample range of values (averages between 1.7 and 4.4). About a third of the factors show a high level of involvement; no overlap was found between the factors' average level of involvement and the categories to which they belong, indicating ample variation in level of involvement of factors within each category.
Factors related to "infrastructure" and to leading roles within the school are rated high in level of involvement in the innovation. In contrast, factors related to the "learning configuration" (e.g., time/space organization) are rated low in their involvement. Organizational aspects (e.g., climate, policy) were found to be clearly involved in the innovation.

Table 3 : Rating of factors involved in implementation of innovations using ICT according to average degree of involvement

	Category	Name of factor	Average	*SD*
HIGH	Organizational climate	History of innovation	4.4	.70
	Infrastructure	Technical support	4.4	.70
	Roles within the school	Principals	4.3	.82
	Roles within the school	Leading staff	4.3	1.26
	Infrastructure	Budgeting of the innovation	4.1	.88
	ICT policy	Local policy	4.0	.82
	Roles outside the school	Intervening organization	4.0	1.33
	Roles within the school	Computer coordinator	3.9	.99
MEDIUM	Infrastructure	Computers and peripherals	3.7	.48
	Organizational climate	ICT vision and goals	3.7	1.27
	Training	Source of training	3.4	.97
	Training	Contents of training	3.3	.82
	ICT policy	National ICT policy	3.2	.63
	Roles outside the school	Local ICT policy	3.2	.92
	Roles outside the school	Ministry of Education	3.1	.88
	Organizational climate	Diffusion of innovation	3.1	1.52
LOW	Roles within the school	School staff	2.5	.97
	Roles outside the school	Disciplinary experts	2.5	1.65
	Roles outside the school	Parents	2.3	1.06
	Learning configuration	Teaching units	1.8	.92
	Learning configuration	Class distribution	1.7	.95

Research question 3: What connection can be established between the intensity level of the factors involved in the innovation and the level of change in the various innovation domains?

Table 4 displays correlations between the involvement levels of the factors and the level of innovation in the domains of the innovative pedagogical practice using technology (for additional details about the domains of innovation, their definition and characteristics, see Tubin et al., 2003; Mioduser et al., 2003).
Factors within the school: significant correlation was found between involvement of staff members in the innovation and change in teachers' relations with their fellow staff. The more staff members and leading figures are involved, the expertise of teachers involved in the innovation grows and their collaboration increases.

Learning configuration: significant correlation was found between organization of teaching units and teacher roles among teachers and innovation content. The more flexible and varied the organization of teaching units, the more the relationships between teachers changed and the level of content innovation increased. Also, the more openness and flexibility displayed in allocation of students to classes, the more solutions related to the configuration of the physical space (e.g., learning within and beyond school hours), contents (e.g., implementation of inquiry tasks, projects) and teaching methods were innovative.

Organizational climate: a positive correlation was found between the school's innovation history and the level of innovation in relationships among teachers. The longer and the richer the school's innovation history, the more teachers display expertise and cooperation in the application of the innovation.

Staff training and development: a positive correlation was found between relevance of staff training and the level of innovation in teachers' role relating to their peers. Also, a negative correlation was found between accessibility of training and teachers' role relating to students. However, training was measured with relation to all staff members, while the innovation level of teachers' role was measured only regarding the innovation. Hence, the teacher's role becomes more innovative the less the training is shared by all staff members.

Factors in the categories of roles outside the school, infrastructure and ICT policy were not found to have significant correlation with innovation domains.

Table 4: Correlations between intensity of the factors involved in implementation of innovations using ICT and the innovation domains

Factors	**Domains**								
	Physical space	Digital space	Time	Student role	Teacher-student	Teacher-teacher	Content	Didactic solution	Assess-ment
Roles within the school									
Principal	.018	-.112	-.371	-.347	-.391	.405	-.044	-.115	.246
ICT coordinator	.267	-.046	-.055	-.057	-.162	.479	-.200	.243	.017
Leading staff	.248	.386	.006	-.046	.110	.670*	.477	.344	.432
School staff	.532	.000	.282	.294	-.118	.779**	.279	.378	.261
Roles outside the school									
Ministry of Education	-.135	-.079	-.295	-.457	-.210	.242	.124	-.036	-.019
Local authorities	-.016	.476	.290	.498	.225	.022	.236	.046	.422
Parents	.362	.022	-.436	-.270	-.087	-.067	-.119	.109	.271
Expert teachers	.089	.558	-.024	.173	.139	.092	.219	.222	.460
Intervening organization	.498	.000	.235	.429	.173	-.151	-.068	.236	.127
Learning configuration									
Teaching units	.578	.401	.307	.373	.275	.637*	.748*	.525	.588
Distribution of students	.685*	.461	.487	.542	.461	.607	.800**	.652*	.587
Organizational climate									
ICT vision and goals	.106	-.202	-.257	-.320	-.386	.540	-.116	.075	-.094
Innovation diffusion	.262	-.045	-.221	-.188	-.347	.603	-.107	.186	.155
Innovation history	.274	.428	-.022	.164	-.066	.780**	.362	.270	.507
Staff training									
Contents	.377	-.391	-.371	-.347	-.531	.650*	.066	.013	.041
Source (accessibility)	.122	-.524	-.584	-.592	-.643*	.564	-.112	-.239	-.070
Infrastructure									
Computers/peripherals	-.031	-.286	-.503	-.355	-.524	.355	-.299	-.239	-.070
Technical support	-.042	.099	.538	.491	.099	.058	-.026	.120	.024
Budgeting the innovation	.034	.184	.600	.326	.447	-.334	.227	.323	.077
ICT policy									
National ICT policy	.093	.509	-.074	.000	.145	.511	.486	.232	.480
Local/ regional ICT policy	-.542	.141	-.384	-.280	-.282	.000	-.332	-.385	.000

p<0.05* , **P<0.01

DISCUSSION AND CONCLUSIONS

ICT influence in education (e.g. school structure and functioning, pedagogical applications, student achievements) has been discussed in the research literature (Cuban, 1986; Schank and Yona, 1991; Venezky, 2001; Voogt and Odenthal, 1999). ICT implementation in schools is a multifaceted process, involving a wide variety of factors, and resulting in different innovation-configurations at different levels in different school domains (Mioduser et al., in 2003; Pelgrum & Anderson, 1999; Venezky, & Davis, 2002). This paper addresses these issues, based on data generated from ten Israeli case studies of schools implementing ICT-supported innovative pedagogical practices.

The participating schools were found to be in the transitional-towards the transformational level of innovation in most domains, although all practices were defined as innovative. Findings demonstrate that diffusion of ICT-supported innovative practices is complex, even when conditions are favorable (e.g., adequate infrastructure, highly motivated staff and financial resources). However, not all areas of activity are affected evenly. Most resources were allocated to promote the innovation's goals, to the detriment of other practices and projects. Consequently, significant changes took place mainly in the sub-domains relevant to the innovation focus.

The domains digital space and didactic solutions were the ones most influenced as a result of the innovation. Student role, teacher/student interactions, and assessment methods were mildly influenced. The least affected by the innovations were physical space and time configuration, content areas and interactions among teachers. To conclude, the main beneficiaries of the innovations were the students: new didactic solutions, roles, patterns of interaction with teachers, learning spaces, and assessment modes became involved in their performance.

Sub-domains that underwent important changes had the power to "upgrade" other domains. Evidently, all domains were functioning and interacting in a systemic fashion, and were affected in varying intensities by ICT implementation in the school. This resulted in certain consistency in the overall innovation pattern within schools.

Data also includes relevant information that goes beyond the innovative practices. An example of the nature of relation between the innovation and the school context is the phenomenon of "islandness", or "islands of innovation", which focused on transformations in particular sub-domains. Contrasting with this phenomenon, in other schools practices were embedded throughout the curriculum, e.g. innovative web-based projects and activities of various types. In these schools, encouragement of innovation was embedded in their explicit vision and policy, and the majority of staff members and students were committed to its implementation.

Findings regarding involved factors reveal that while a whole set of factors are involved in the innovation, their effect is uneven. The most important components are a history of innovation and encouraging local ICT policy, combined with leading forces: the principal, leading staff ("hooked" on the innovation) and the ICT coordinator. These forces attempt to implement the innovation by means of adequate infrastructure (e.g. finance, technical support), and employing external intervening organizations.

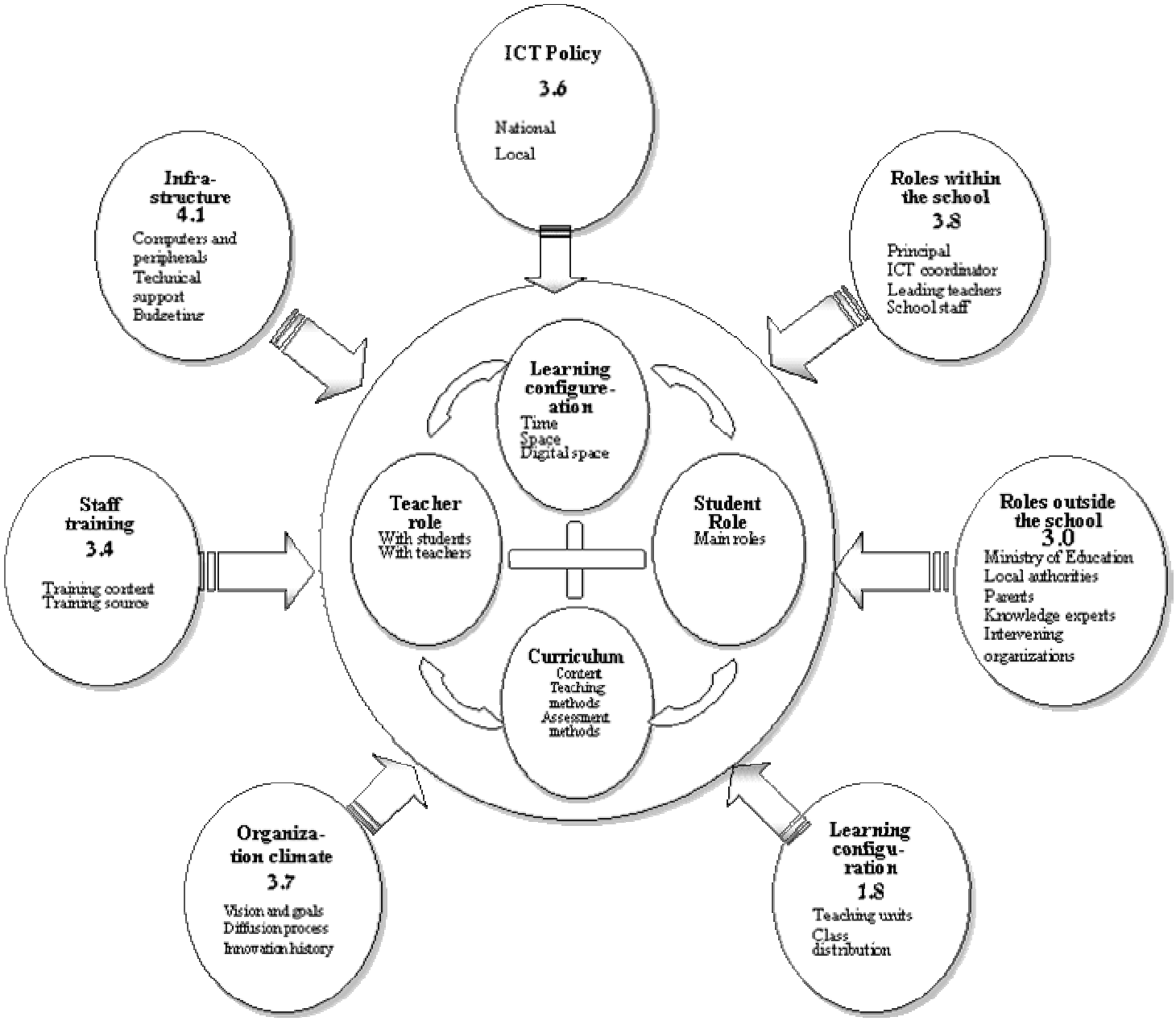
Our findings and conclusions bestow new meaning to other studies. For example, the statement that teachers' training is a major factors in change implementation (ECS, 1999) is proven to be inaccurate: a group of involved teachers constitutes an important factor, however, the staff as a whole is a less critical factor for the success of the innovation. Staff training is required to some extent for the innovation, though leading staff seem to base their knowledge on more interpersonal sources rather than on staff training.

Researchers agree that computers alone do not create innovation (Venezky & Davis, 2002). However, the amount of computers within a school is still considered an indicator of the scope of ICT implementation, more than the quality and quantity of technological or other support (Pelgrum, & Anderson, 1999). Indeed, data reveal that technical support is more valuable than the amount of computers within a school. Schools tend to be inventive in attaining support, by recruiting students as computer trustees, engaging expert teachers or external factors (e.g., a school graduate formerly involved in ICT-supported learning, a former student high-tech-genius coaching on a voluntary basis).

An additional conclusion involves the categorization of the different factors. According to the literature (Fullan, 2001; Kinsler, & Gamble, 2002; Kozma, 2000), the categories are evenly involved in the implementation of the innovation. Our findings argue with this conclusion, that they differ in the extent

of their involvement. One of the important conclusions is that categories related with the school itself (infrastructure, roles within the school and organizational climate) are of greater importance than external categories (e.g. ICT policy, training, external roles), as presented in Figure 1.

Figure 1: Configuration of the factors involved in innovations using ICT and average intensity of involvement of categories in the implementation of the innovation



The least powerful category is that of learning configuration. This, alongside low parents involvement, supports previous findings (Tubin et al., 2003, Mioduser et al., 2003), stating that ICT-supported innovations can be implemented even without a major change in learning configuration (e.g. time and space). Conservation of traditional school structure reassures parents, that usually seek a "real school" for their children (Tyack & Cuban, 1995).

An attempt to seek connections between the factors and the levels of innovation produced meek results: the factors mostly affect roles of teachers involved in the innovation, and to a minor extent – contents and teaching methods. Perhaps the assessment of a larger group of schools implementing ICT can

supply a more reliable picture of the interactions among factors affecting innovation diffusion and sustenance.

There seem to be evident signs of change in schools as a result of ICT-based innovation diffusion (Venezky, 2002). Transitions occur both in technology-use and in pedagogical aspects (Dede, 1996). Research should accompany these renewal processes, illuminate factors affecting success and failure, recognize trends, and help to create innovative and improved ICT-supported pedagogical practices. Other supplementary questions to be inspected in future research: Why are some factors involved in the innovation more important than others? Are their intensities related to, and do they change, as a result of transformations in the innovative domains, thereby affecting the life cycle of the innovation (e.g., its implementation stage, sustainability issues)? What are the correlations between the factors and the properties of the innovation? We believe that the findings of this study, addressing the initial identification of the various domains and factors of an ICT-supported innovation, and their intensity level of involvement in the innovations, can assist policymakers to face key issues addressing financial investments, e.g., computers or training, local supervision or support from intervening organizations, in the planning and implementation of ICT-supported school-wide educational innovations.

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