Smart Classrooms: Innovation in formal learning spaces to transform learning experiences

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Abstract— **Despite entering a new century where agents and elements in education have changed, students, teachers, curriculum, resources and so on, the classroom, as the learning space in the school, has experienced no change as regards configuration and structure. Traditional classrooms with rows of desks facing the teacher and the board do not fulfill present-day educational needs and expectations; therefore the learning space at school requires adaptation to the new contexts and roles in education. In this paper the authors outline general principles on the design and methodology of** *Smart Classrooms***, new learning spaces which may better fit present and future learning needs and roles.**

Index Terms— **Smart classroom, future classroom, learning space, school innovation.**

I. INTRODUCTION

During the XX century the classroom and its formal learning space have experienced but few changes regarding configuration, traditional structure, methodologies and semantic arrangement, but in the meantime, everything else has changed: students, teachers, curriculum, resources available to both students and teachers, and the social context where schools exist. While there is an ample array of new tools, resources and methodological options and possibilities to be applied to education, as regards classroom arrangement we still find a traditional setup, mostly when seeing a space full of desks and chairs in rows facing a board and a teacher's desk. This traditional arrangement corresponds to an "industrialized" model of education, where the teacher is in possession of knowledge and is the main mechanism of transmission of that knowledge.   This 'transmissive arrangement' is radically opposed to present-day theories of learning and pedagogical paradigms, which are fundamental to the educational curriculum in many countries. A radical change is needed in the way teachers and the ecology of school understand learning space, that is, the classroom and its nearest spaces, if the focus is on key pedagogical ideas from present-day theories of learning, such as social construction of knowledge, autonomy of students in their learning, catering for diversity, collaborative and significant learning, curricular globalization, problem-based learning, and so on.

In terms of what the classroom space should be like, how it should be conceived, which elements should harbour, and so on [1], there exists the need for educational authorities and teaching staff to deeply reflect about methodologies in relation to technology integration and to other types of resources for a more efficient learning.

Recently there have been remarkable social and economic efforts in the deployment of educational policies for the integration of ICT, such as 1x1 projects, which have involved a considerable investment by governments in a good deal of countries, e.g. Educat 2.0, One laptop per child, Plan Ceibal, Enlaces, etc. Nonetheless, the discourse on how the learning space at school is arranged when ICT are intensively integrated is virtually non-existent. Even in the so-called computer classrooms, the traditional structure is kept unchanged, computers and screens are simply fitted over desks, and everything goes on as ever.

II. THE CONCEPT OF SMART CLASSROOMS

More often than not the concept of smart classrooms is wrongly associated with a traditional classroom which is heavily equipped with technology. In the discourse about these learning spaces the need for pedagogical changes such as innovation in the teaching role, or the new role students take, the role of the contents, who decides on the learning process, resources, etc., is usually overlooked. There may be a heavy integration of technology, but within a traditional classroom arrangement, usually under a traditional methodological paradigm. In fact, some authors argue that the concept of smart classrooms should precisely involve an invisible integration of technology with the learning space [2]-[3]-[4].

Whenever we speak about learning spaces we cannot dismiss what present-day classrooms are like, nor the way their architectural design may eventually end up exerting an influence on actual teaching; that is, *built pedagogy*, the ability of space to influence how one teaches [5].

The constructive design of a classroom and its functional and ergonomical design are crucial to have efficient and useful smart classrooms, as work teams and researchers in architecture have shown when dealing with these issues in

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depth [6]. The ideal scenario, when talking about innovation in the school's learning space, is to link both the architectural and functional design with the pedagogical approaches to be applied [7]. Thus, in reviewing graphical material and literature about learning spaces, we can find that every time authors mention spaces for creative or innovative work, or niches for collaborative work, or entrepreneurship, they refer to places which are clear, calm, and offer varied possibilities for people to meet and talk in a flexible arrangement [5], for instance, they explain that a given structure and space arrangement can promote exploration, experimentation, collaboration and discussion. Thus, the concept of smart classrooms rests on the intersection of three axes, interacting in the design and use of the learning space:

1. The classroom's architectural design and its ergonomy.
2. The functional, invisible, justified and intensive integration of technology, ICT particularly.
3. An innovative pedagogical methodology, appropriate to that space, which makes learning more efficient and satisfactory, and based on teaching principles such as collaborative learning, project-based learning, curricular globalization, students' autonomy, educational co-responsibility, etc.

Therefore, smart classrooms should be associated with organizing and setting learning space in schools in a way that the best conditions for learning, physical and methodological, are generated in the most efficient and satisfactory way possible for all agents involved in the process. Pedagogical design should consider, and maximize, learning space so as to make the most of it; teachers should also contribute to make space to be perceived in the same way as methodology, resources and learning activities are, all integrated and articulated for a learning proposal to end up being successful.

In traditional classrooms the board and the teacher stand out at one end of the room, and this is what makes classroom dynamics to be those of transmissive, unidirectional lessons. Precisely, an important justification as to why analyze modifications in space in order to improve learning is that the structure of a traditional classroom tells us the way learning will take place there, and that students' preferred styles and learning activities, considered to be chair-students, will not be taken into account. If we are providing new tools to teachers and students, and assigning a new role to them, we cannot keep using a classroom structure which strongly conditions the dynamics of the educational process.

III. PRINCIPLES OF SMART CLASSROOMS

There is no single model of a smart classroom. Around the world there are a number of innovative learning spaces in various educational institutions which, given their singularity and structure, can be considered to be smart classrooms or labs of didactic innovation, e.g. Stockholm University's Future Classroom in Sweden or Universidad Camilo José Cela's smart classroom in Madrid.

In order to establish universal principles as guidelines for the design, arrangement and pedagogical practice in formal learning spaces, our research group EMA (http://www.ub.edu/grupema/web_2013/cat/inici.html) carried out a thorough literature review about learning spaces and their features regarding architectural, design and pedagogical issues. In addition we did some research as well on various learning spaces considered innovative and facilitators of learning in schools in Stockholm (Sweden), focusing on the analysis of ICT integration, which resulted in important findings to guide the design and arrangement of classrooms in a non-traditional alternative way [8]. At the present time we are extending our research, in the Catalonia region in Spain, by means of research on various schools with classrooms organized differently in terms of space and of pedagogical aims. This research is reinforcing and widening our knowledge on the principles that we established.

The following are the principles for smart classrooms in terms of arrangement and pedagogical configuration which we have established as widely generalizable and which should be considered in order to transform any formal learning space into a smart classroom [9].

1. Flexibility of physical arrangement

The arrangement of a smart classroom and its elements should be such that it allows agile and easy variations in activities, that is, make it possible to change student grouping, the type of resources being used, use of various types of resources at the same time, ICT and non-ICT, for different students to carry out different tasks, e.g. searching information, discussing, watching a video, etc. Therefore classrooms will be supplied with varied furniture elements to achieve flexibility of space arrangement, for instance using movable, rolling desks and chairs, or stackable, folding chairs, ergonomical spaces, areas for different uses, etc.

2. Adaptability

From the idea that every teacher and every class is different, and that space can be adapted to their needs, the concept of smart classrooms includes the principle of adaptability to the type and needs of teacher and of each student. Adaptability has to do also with a space which enables the inclusion of students and teachers with special education needs. Therefore classrooms will have furniture and objects that help in catering for learning difficulties, such as the ones impaired students have.

3. Comfort

A smart classroom should be a place arranged to comfortably do various activities –reading, watching videos, playing, listening to music and audios, writing, talking, debating, experimentation, and so on. Under this principle, elements which enable this well-being should be included in the learning space for the various tasks to be done for learning, such as couches, pillows, rugs and carpets, comfortable chairs,

lecterns, desks and tables of various types, headsets, right lighting, etc.

4. Multiplicity

This principle refers to smart classrooms having features which enable the use of various types of resources and stimuli. While teaching and learning, the arrangement should enable possibilities for creativity, reasoning, logical thinking, etc., and it should be adapted as close as possible to learners' various needs and learning styles. Thus, it should be an open space where we can have access to any source of information, either physical or in digital format particularly.

5. Connectivity

The concept of connectivity has a twofold character. On one hand it is required that the learning space has a good network connectivity, both local and global, to use to the most the potential of mobile devices. Connectivity should be wireless, and this is fundamental to maximize physical mobility around the space and comfort in using technology. On the other hand, beyond digital connectivity there exists social and informational connectivity. Through networks, students live connected to teachers, friends, family, professionals and to a large number of information sources, both in their immediate surrounding and from distant places. This connectivity should not be underestimated by teachers, who should explore their possibilities and evaluate to what extent they can contribute to improving learning space and learning processes. To some extent this principle can be linked to the theoretical framework of Connectivism [10].

6. Personalization

Smart classrooms should allow students and teachers to personalize their environment according to their likes and needs. Therefore we are not referring to a standard, impersonal, cold environment, but a space which progressively teacher and students should make their own, personalizing it by means of activities which support and reinforce learning.

7. Order / Organization

This is an important principle, even though it is not easy to design, and attain, sustainable placing, storing, arrangement and rules of use of spaces and resources available. For this reason teachers should carefully consider the order and arrangement of spaces and resources so that these are the most adequate for the learning activities that will take place in their smart classroom. At times, a chaotic space may foster creativity, but in any case this chaos should be controlled and re-oriented whenever necessary. After each activity is over, resources should be available to another student, another group of students, or a different activity.

8. Openness

This principle relates to the false and rooted belief that learning takes place only in the formal space in the traditional classroom, where the teacher presents information and gives a lesson in a transmissive way [11]. Learning however takes place beyond the classroom space, both physically and virtually, and therefore activities put forward for smart classrooms should consider these extended learning places and learning times in order to learn beyond the classroom and the class times traditionally assigned.

9. Safety / Security

Learning spaces with heavy technological integration require that hardware and software have a high degree of security. Smart classrooms will have an arrangement which prevents users from having physical accidents and will also be safe in terms of access to information and communication on the Internet from the classroom. Therefore security systems will be taken into account when conceptualizing and designing smart classrooms.

In sum, the arrangement, structure, methodologies and principles of smart classrooms intend that learning experience be as likely as people's learning ways, preferences and styles, in a natural way and in a personal space; all this through active participation, experimentation, collaboration, solidarity, rapport, creativity, leadership, and so on.

IV. CONCLUSION

The structure and arrangement of traditional classroom space does not go with changes happened in educational agents, methodology and social context. Smart classrooms rethink learning space and learners' expectations about what this space, along with resources and methodologies, should be like. The concept of smart classrooms rests on the intersection of three axes: design of its space and ergonomy; integration of ICT in a functional, invisible, justified and intensive way; and an innovative pedagogical methodology, based on teaching principles such as collaborative learning, project-based learning, curricular globalization, students' autonomy, and educational co-responsibility. The design and implementation of a smart classroom should contemplate a flexible structure adapted to users' needs, comfortable, with multiple resources, socially and digitally connective, personalized, tidy, open to its immediate environment and to the world, and lastly, safe for its users and safe in its technological equipment.

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