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Deposited in *Repositório ISCTE-IUL*:

2018-06-05

Deposited version:

Post-print

Peer-review status of attached file:

Peer-reviewed

Citation for published item:

Pedro, N., Baeta, P., Paio, A., Pedro, A. & Matos, J. F. (2017). Redesigning classrooms for the future: gathering inputs from students, teachers and designers. In 11th International Technology, Education and Development Conference. (pp. 7908-7917). Valencia: IATED.

Further information on publisher's website:

[10.21125/inted.2017.1861](https://doi.org/10.21125/inted.2017.1861)

Publisher's copyright statement:

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# REDESIGNING CLASSROOMS FOR THE FUTURE: GATHERING INPUTS FROM STUDENTS, TEACHERS AND DESIGNERS

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## Abstract

The concepts of future classrooms, multimedia labs and active learning spaces have recently gained prominence in educational research. Evidence-based research shows that well-designed primary school classrooms can boost students' learning progress as much as 16% in a single year [1]. Also schools' heads, teachers and students are requesting for more flexible, reconfigurable and modern classroom layouts, where technology and active pedagogical practices can be easily incorporated. Under the scope of Project Technology Enhanced Learning at Future Teacher Education Lab (TEL@FTELab) of the Institute of Education of University of Lisbon, an empirical study was conducted in the first semester of 2016, with 21 participants (7 in-service teachers, 7 future teachers, 4 undergraduate students, 3 designers), aiming to capture their vision on what the classrooms for the future should be. Data was collected through a participatory design methodology. Participants were asked to form groups of 2 to 3 elements and challenged to i) reflect on the main differences between past and present learning environments and ii) to envision a future classroom. A specific toolkit was provided to them and their creation process was videotaped. This article presents the results of the data analysis focusing specifically on the most chosen images, icons and words. The results show that no major differences were reported regarding the past and the present classrooms; layouts and daily practices are seen as quite similar. Regarding the future classrooms, results shown that participants claim for more collaborative, diversified, interactive and flexible learning space.

Keywords: future classroom, innovation, school design, digital technology in education.

## 1 INTRODUCTION

In recent years, with all the scientific and technological advancements, there has been an increasing pressure for the development of more updated teaching and learning practices in the school. This urge for educational innovation also stimulated the awareness of educational agents for the need to design new configuration for the learning spaces, both in formal and informal contexts as well as in different educational levels – from kindergarten to higher education.

The Joint Information Systems Committee [2] pointed out, as an agency of the United Kingdom further and higher education sector, that today's learning spaces must be changed in order to "motivate learners and promote learning as an activity, support collaborative as well as formal practice, provide a personalized and inclusive environment, and be flexible in the face of changing needs" (p. 3). Also addressing the need to redesign classrooms, but focusing on elementary and secondary schools, Leahy [3] argues that the following aspects must be modernized: i) layout aspects – such as how the space is divided and used, where equipment and furnishings are placed, and how flexible the arrangements are; ii) human aspects – such as the spatial relationship of the teacher to their students and between the students, how these agents are allowed to move and how are they positioned for the activities; iii) physical aspects – such as the state of repair of the room and the age and quality of its furnishings and teaching equipment; iv) environmental aspects – such as air quality, noise, light quality and temperature (p.9).

According to Basye, Grant, Hausman and Johnston [4], thinking of innovation of the classroom practices without changing space layout and environmental elements is a fallacy. "The classroom environment is not neutral - it communicates what students will be doing in the classroom and what's important" (p.49). A room with rows of fixed individual desks sends a very different message from a

room with easily movable tables and different types of chairs that can be reorganized and adapted to students' characteristics. If communication, collaboration or any other digital-age skills are seen as important, students need a space that invites them to exercise these skills.

Over the years and in very different settings, a significant number of studies pointed out the relevancy of the physical environment on the learning processes [5] [6] [7] [8] [9].

A very recent study, developed in the United Kingdom primary schools, involving 153 classrooms and collecting the performance statistics of 3766 pupils, proved that design parameters can explain 16% of the variation in pupils' academic progress [1]. This study focused on the analysis of the sensorial impact of environmental factors of classrooms' space and schools building on students' performance. The authors listed a total of 10 parameters related to classrooms design that were organized around three principles: naturalness, individualization and stimulation. The 'naturalness' principle relates to the environmental parameters that are required for the sense of physical comfort, such as proximity with the outside (the 'nature'), light, temperature, sound and air quality. The second principle relates to way a classroom meets the needs of a particular group of students. It is composed by the following parameters: flexibility, sense of ownership and connection. "The Stimulation principle relates to how exciting and vibrant the classroom is" [1]. This principle contains two parameters: complexity and colour. Complexity related to how the different elements of the classroom are combined to create a visually coherent and structured environment or, when this parameter is not respected, a random and chaotic environment. Through the application of a multi-level model, this study concluded that 51% of the variation of students learning can be easily explained by six specific classroom design parameters: colour, light, (possibility of) choice, (promotion of) connection, complexity and flexibility [1].

This is the rationale to address the issue of innovative learning spaces for today and tomorrow schools. Taking into account the perspectives of different stakeholders – undergraduate students, in-service teachers, student teachers, interior designers and architects – a set of guidelines for designing future classrooms was developed under the scope of TEL@FTELab Research Project.

## **1.1 Project TEL@FTELab**

The Project TEL@FTELab - Technology Enhanced Learning @ Future Teacher Education Lab - is a three-year research project coordinated by the Institute of Education of University of Lisbon. The project began on January 2016 with the main goal of rethinking initial teacher education for the way future schools and classrooms could look like and therefore aiming to constitute a specially designed learning space for promoting the skills that teachers need to have to proficiently act as professionals in these future environments.

The project is based on the following research working hypothesis: Web environments and digital technologies provide affordances to the creation of new types of learning spaces, which can provide opportunities for a more effective, personalized and sustainable teaching and learning practices. This hypothesis is built upon the premise that the future will blur the boundaries between living, learning and working and this will result in the creation of flexible multiuse spaces that accommodate different types of learning activities. The first phase of the project focused on the design and setup of the Future Teacher Education Lab, a reconfigurable space organized in different zones where new learning scenarios enriched with digital technologies are experimented in teachers' initial and continuous training.

The research team was previously involved in the ITEC Project (Innovative Technologies for Engaging Classrooms). This four-year project involved 26 project partners, including 14 Ministries of Education and over its course, educational tools and resources were piloted in 2500 classrooms across 20 European countries. One of the main outcomes of the project was the development of the Future Classroom Lab [10]. This space was built in Brussels in 2012 and since then, more than 20 FCLabs have been built all over Europe. FTELab is one of the nodes of FCLabs network.

During the first year of the project, the research team (designers, teachers' educators, educational researchers, architects and technologists) worked together in order to define the best architectural characteristics of a 'future classroom'. Preliminary results of this work are described below.

## **2 METHODOLOGY AND DATA COLLECTION PROCEDURES**

For this study a qualitative research design was used, specifically Participatory Design (PD). This is an holistic research approach frequently used in the domains of design, architecture and urbanism. PD is

an approach to design that attempts to actively involve the people who are being served through design in the process to help ensure that the designed product/service meets their needs. This perspective involves the “users” throughout the design development process. This co-interpretation is not a confirmatory stage but an essential part of the research process [11]. It uses generative techniques and context mapping tools which involves end users as experts in their own experience by tacking them through a support process of fostering awareness, reflection and expression.

In this study the data collection process was constituted by 4 phases: Phase 1: Sensitizing and Engaging – participants were asked to design a postcard with their individual vision of a future classroom environment; Phase 2: Telling – Exploration of a collective vision of the past, present and future classroom of all the participants; Phase 3: Collective development of a 3D Model of the future classroom through the construction of mock-ups; Phase 4: Development of a Virtual Reality 3D scenarios of the future classroom based of the inputs of previous stages and evaluation of the scenarios by the participants.

This paper specifically addresses the data collected during the second phase.

## 2.1 Participants

The group of participants was constituted by 21 elements divided in the following subgroups: (1) Teachers group (in-service teachers); (2) Masters in Teacher Education student group (students of different Masters’ Program in Teacher Education, future teachers); (3) Students group (undergraduate students); and (4) Designers group (architects and interior designers). The group was formed by 6 males and 15 females. The age mean was 35 years (minimum 21 years old; maximum: 56 years old).

Table 1: Participants of the phase 2 of the study

Subgroups	Nº of participants at phase 2
1. Teachers group (in-service teachers)	7
2. Ms group (future teachers)	7
3. Students group (undergraduate students)	4
4. Designers group (architects and interior designers)	3
Total	21

With the exception of the third subgroup, all the participants were selected through a convenience sampling process. The group of undergraduate students was formed by the students that positively answered to the invitation sent to them, by the research team, for get involved in a four-phase study ‘Design the future classroom’. The invitation was sent through specific teachers of the following graduation courses of the University of Lisbon: Education, offered by the Institute of Education; Ergonomics, offered by the Faculty of Human Kinetics; Informatics, offered by the Faculty of Sciences-Department of Computer Sciences, and Design, offered by the Faculty of Fine Arts.

## 2.2 Phase 2 outline

The phase 2 took place between March and May 2016 in four different occasions; one session for each subgroup. The sessions were run at a conference room of the Institute of Education- University of Lisbon, taking around 60 to 90 minutes each. These sessions are based on a projective technique, involving past memories, present moment and ideal future.

The main aim of this session was threefold: (1) to encourage participants to reflect on the main differences between past and present learning environments, on a comparative perspective; (2) to collect participants vision and ideas regarding what makes a future classroom successful; and (3) to understand what elements and characteristics were seen as relevant in the design of a future classroom and how these differ in level of importance.

All sessions were video recorded with the written consent of all participants. Each session started with the required instructions. Participants were asked to form small groups of 2-3 elements and the two tasks that constituted the session were explained in detail.

At task 1, each group of participants was asked to think about how they perceive the past and the present classroom. A toolkit was provided to them. It included a white cardboard (42,0 x 59,4 cm), a glue stick, colour markers, printed icons, pictures of various classroom designs as well as printed words related to teaching and learning activities and classroom equipment [available at <http://tinyurl.com/h866eqa>]. These should be used to represent their story which, afterwards, would be shared with the rest of the participants in the room. They had 20 minutes to discuss and prepare their story and 5 minutes to present it.

At task 2, participants should maintain the groups and work together to represent their vision of the 'future classroom'. They were provided with another white cardboard and were asked to draw three concentric circles and hierarchically display their ideas in it. In the most inner circle, they should place words, icons and images representing what they saw as pivotal concepts in the design of a 'future classrooms'. In the middle circle, participants should put the second most important words, icons and images. In the outer circle they should place important ideas, even though they were seen as less important than the ones placed inside the first two circles. Again participants were given 20 minutes to complete this activity and 5 minutes to present the output to the colleagues. They should also use the same toolkit as in task 1.



Figure 1 – Photo 1: participants on the process of creating a story requested on task 1; Photo 2: example of the outcome of task 1; Photo 3: example of the outcome of task 2; Photo 4: participants explaining the decision process took for developing the hierarchical display requested on task 2.

## 2.3 Analysis Process and Results

In order to analyse the cardboards created in task 1 and 2, the research team looked at three main sources: i) The groups' oral presentations, video recorded; ii) The images, icons and words chosen as key concepts; iii) The displayed level of importance of those components in the inner circle, middle circle and outer circle of task 2. The team examined those in relation to one another and produced an overview of the most selected images, icons and words by all groups of participants, used either on task 1 or 2.

Regarding the past and present classroom, addressed in task 1, it was possible to notice that most participants expressed their story highlighting the resemblances of these two realities. Past and present classrooms tend to be based on a traditional way of teaching: students being represented in individual seats facing the front of the room where the teacher and the chalk board are positioned. Focusing on the past, participants noticed the high level of silence requested, the lack of interactivity and the rigidity of the environment. Analysing today's classrooms, participants expressed that teachers still take the central role in the classroom, not only in managing the space but also in the setting the pace for the learning process. By contrast, on the second part of the session, participants emphasised the central role of students in the learning process, focusing their ideas in collaborative work, participation and technology use.

### 2.3.1 Image selection results

There were 9 groups of participants. One group didn't include images in their white cardboard. The images chosen by participants to be in the white cardboard circles were all set aside and characterised as 'picture selected by group of participants'. If one image was selected by more than one group, we took note of how many times the same image was picked up by participants. The groups only chose an average of 7 images each and quite a few were selected more than once, so most images on the toolkit were not used. The following picture was the most chosen by the groups (Fig.2).

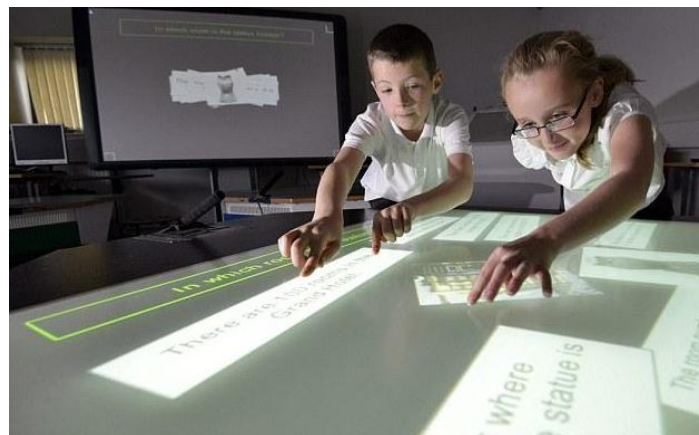


Fig. 2: The most selected image (selected by five groups). The image was retrieved from <http://preview.futurelab.org.uk/>

The images selected by participants show not only technology assisted learning environments, but also active students working in collaboration in a variety of spatial layout arrangements. Some appear to be working in groups of two or three whereas others represent larger groups. Some participants stated that *"in future classrooms we see a multiplicity of 'work areas' where, at the same time, students can work either individually or in groups"* (Teachers' group). Another participant added: *"We claim for classrooms with high interactivity and flexibility, allowing for students to engage in different activities which can be carried out in the same room"* (Teachers' group). Regardless of the size of the groups of students represented in the pictures, the key aspect was that student collaboration is seen as very important and classrooms should accommodate for that.

The informality of some of the spaces presented on the images also stood out, contrasting to past, and some present, classrooms designs. An open space classroom environment was also emphasised, particularly by one group that mentioned *"a wide, well lighted classroom has a positive impact on the students, particularly on (our) proactivity"* (Students' group).

### 2.3.2 Icon Selection

Icons were the least selected items to be placed on the white cardboard. In the 9 groups' cardboards only 6 icons were used. However, one icon stood out, since it was chosen by 3 of the 9 groups. This icon, a usual symbol for Wi-Fi connectivity, highlights the importance participants gave to the internet access in a future classroom environment. All the other selected icons were chosen only once. The selected icons are presented below (Fig.3).



	
<p>The most selected icon (placed 3 times on the white cardboards)</p>	<p>Three icons selected only by one group of participants.</p>

Fig.3: Most selected icons

### 2.3.3 Word Selection

The words participants chose also place a strong emphasis on collaboration and participation. The overall most chosen words were 'collaboration' (6 times) and 'participative students' (5 times). The words 'creation', 'flexibility' and 'technology' were picked up four times each. At the total 64 words were displayed in the cardboards of the 9 groups (Table 2).

Table 2: Words selected as important for a future classroom, by more than one group of participants, regardless of their level of importance within the circles.

Word (original language)	Translation	Number of times word was selected
colaboração	collaboration	6
alunos participativos	participative students	5
criar	create	4
flexibilidade	flexibility	4
tecnologia	technology	4
comunicação	communication	3
criatividade	creativity	3
espaço	space	3
feedback	feedback	3
imaginar	imagine	3
inovação	innovation	3
interação	interaction	3
aprender	learn	2
autonomia	autonomy	2
construir	construct	2
dinâmico	dynamic	2
experiência	experience	2
falar	talk	2

inclusão	inclusion	2
rede wireless	internet wireless	2
respeito	respect	2
social	social	2
<b>Total</b>		<b>64</b>

Focusing only in task 2 cardboards, it was possible to see that, at the inner circle, that is, to what participants believed were the most important concepts, ‘collaboration’ and ‘creation’ emerged as the most chosen words (Fig.4).

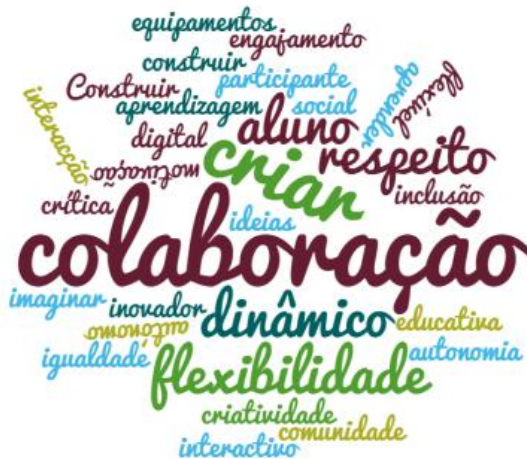


Fig. 4: Wordcloud of all the inner circle words - the most important concepts- concerning a ‘future classroom’ (in the original language)

The most frequent words in the middle circle were ‘participative students’ and ‘technology’ (3 times each), and in the outer circle was ‘space’ (3 times). The presentations and comments made by participants during the session put the flesh on the bone when it comes to promoting student participation: “students can no longer be afraid to have less support from teachers when making exercises and different tasks in class (...) autonomy should be promote” (Ms Teaching’ group); “activities in the classroom have to spring out from students’ ideas” and “the classroom space must promote participative, rather than passive, students” (Teacher’s group).



Fig. 5: Left side: Wordcloud of all the middle circle words - the second most important concepts- concerning a ‘future classroom’; Right side: Wordcloud of all the outer circle words - the third most important concepts- concerning a ‘future classroom’ (both in the original language)



In order to visually combine the most selected images, icons and words used by participants, on task 2, for describing a future classroom, the research team created three concentric circles, putting in the middle area and in larger size the most selected items from all the groups of participants white cardboards (Fig.6).

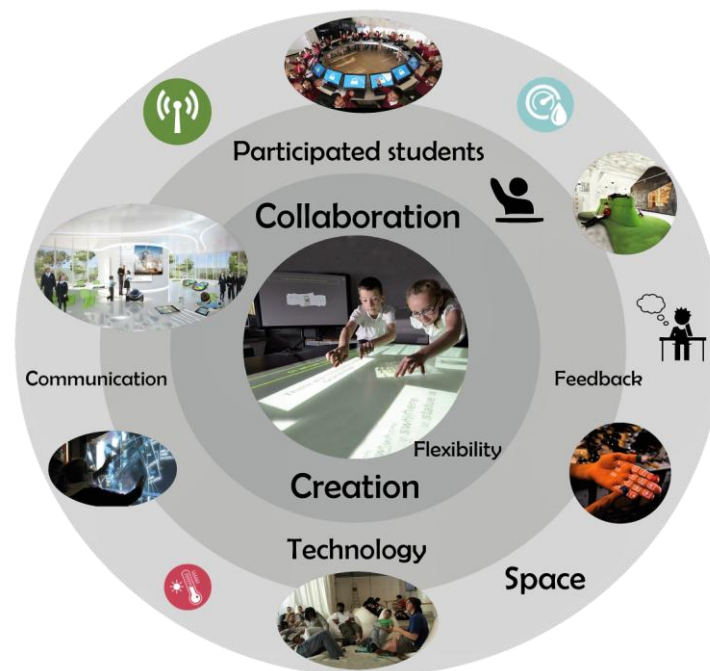


Fig.6: Representation of the most selected images, icons and words on task 2.

By combining the analysis of the participants' discourse during their presentations to the frequency of the words chosen, the research team can assert that for supporting the collaborative work and student participation, a future classroom must provide the necessary tools, as well as the adequate physical and spatial environment so that a collaborative work environment can succeed and motivate students to thrive; *"We wish for happy students and that they feel learning is something pleasurable"* (Teachers' group). Regarding the skills that were seen as important, creation, communication and feedback emerged as relevant. Environmental parameters such as light, temperature and humidity were represented too. The presence of technology (screens and multi-touch surfaces) and internet connectivity were also quite significant. It was also possible to notice that, although the group of participants was constituted by four subgroups, the results evidenced that undergraduate students, in-service teachers, future teachers, designers and architects present a very similar perspective about how past and present classrooms are organized, as well as how they should be improved for the near future.

### 3 FINAL REMARKS

It was possible to see that collaborative work is at the core of future classroom environments. Either in small or large groups, the central core of learning should be collaboration and team work. Students ought to have a strong and active role in their own learning experiences and the classroom layout need to successfully accommodate it. Basye *et al.* [1] highlights that this can be accomplished by developing classrooms that allow different configurations and/or that are built around different working areas, which allows multiple uses, concurrently and consecutively. The classroom space, along with other elements such as furniture and technologies should promote more student-to-student interactions. The classroom furniture needs to have high levels of flexibility, mobility, durability, commodity and ergonomics. According to Pearlman [12], the furniture of the classroom must support the development for large-group, small-group or individual work. The author argues that seats should be soft, padded and scattered throughout the space. Chairs should be easily movable and adjustable to students' characteristics in order to accommodate different students and to provide them a sense of comfort.

This study also evidenced that future classrooms are seen as technology-rich environments. Mobile technologies, wearable gadgets and multiple touch-screen surfaces were also seen as relevant in the learning environment and the high relevancy of wireless internet access was clearly pointed out. Therefore, an effective inclusion of digital technologies as assistive teaching and learning tools might be seen as a priority. For this point Wulsin [13] states that wireless technology, portable laptop and tablet devices, coupled with projectors, microphones and video cameras creates a fully connected new classroom experience. "This provides new ways of teaching and new ways of learning that require specific physical support." (p.2).

The results also evidenced that future teachers, in-service teachers as well as students as designers agree with the fact that future classrooms should be well climatized. Temperature, ventilation and humidity are essential for comfort and comfort proved to have a significant impact of students' concentration and performance [14] [15]. The level of natural light and the opportunity of direct eye-contact with outdoor green areas were also possible to identify as important characteristics. Studies [16] have shown that good lighting significantly influence the students' learning, considering that it contributes to keep students alert and active. The study conducted by Barrett *et al.* [1] concluded that lighting was the environmental parameters that presented the major impact on children' individual performance. Yet schools lighting tend to be an unsolved issue in a very high number of today's classroom [17].

Taking in account the main ideas that emerge from this study, the following guidelines are presented for the design of future classrooms (meaning every classrooms that aims to promote learning experiences that fully address 21<sup>st</sup>-century skills): i) all the architectural characteristics of the classroom (space, windows, walls, floor, etc.) must enable students' collaboration and active learning, it should energise students, encourage them to move, think, act and communicate; the space or the different spaces must be design for allowing multiple types of activities, the classroom layout should be flexible and reinterpretable; iii) furniture must be movable, multifunctional and reconfigurable in order for adjust to students and teacher' needs; iv) internet access and interactive technologies should be embedded in the classroom and used for educational purposes; v) an ambiance of comfort, pleasure and engagement must be built. Classrooms as any human living space must be seen as a dynamic environment, an evolving habitat that adapts to its user. And as Basye [4] stated, users - teachers and students- claim for a classroom where the space fits the learning process instead of a space to which the learning process must fit.

## ACKNOWLEDGEMENTS

This work was financially supported by the Fundação para a Ciência e Tecnologia, I. P. – Portugal, under the scope of the Project Technology Enhanced Learning @ Future Teacher Education Lab funded (contract PTDC/MHC-CED/0588/2014) and the PhD Program 'Technology Enhanced Learning and Societal Challenges' (contracts # PD/00173/2014 and PD/BI/127980/2016).

The authors wish to express their gratitude to the work developed by the research assistants Ana Rita Jacinto, Carla Ferreira and Abel Silva in the process of data collection and analysis, as well as to all the participants in the study.

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