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TECHNICAL BRIEF

Investing in Effective Learning Environments

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Executive summary

1. In recent years, the focus of education policy has shifted from ensuring access to schooling to promoting learning outcomes for all. This shift has raised the question of how learning environments, including physical facilities, can enhance learning outcomes and the acquisition of the new skills and competences required today.

2. Education infrastructure represents on average 8% of education expenditure in EU countries and constitutes the largest share of the international and national financial institutions' support to investment in education. A new trend of investments in innovative learning spaces is now emerging. However, research evidence on the impact of education infrastructure on learning outcomes is somewhat limited.

3. This paper reviews some of the findings on the links between learning environments and learning outcomes, highlights the limitations of the research evidence, and provides a number of ideas to guide reflections on how investments in learning environments can promote student learning and support better educational outcomes. Three aspects of effective learning environments are reviewed: the links between the characteristics of the spatial design and learning outcomes; adaptation of the physical environment to the demands of new competencies and pedagogies; and the impact of design on construction and operating costs.

4. Findings include:

   - ✓ The new learning environments promote not only openness but also flexibility and have the capacity to adapt over time to different teaching practices and individual student learning styles.
   - ✓ It is crucial to ensure that the potential of these new learning spaces is used effectively. To achieve this, an important role must be played by the school community to contribute to creating a vision for the school and by the teachers to develop the necessary competencies to make effective use of these new environments.
   - ✓ Many stakeholders are involved in the process that leads to the construction of a new school building. Coordination among them is essential to ensure that consecutive adaptations of the building in response to conflicting interests do not make it ineffective. Architectural choices and their cost implications need to be adapted to the national and local contexts.
   - ✓ Financial support to effective learning environments should include programmes that provide teachers with the necessary competences to work effectively in these new learning environments.

5. In order to enhance the knowledge on the impact of education infrastructure on promoting learning outcomes for all, the Council of Europe Development Bank has promoted the establishment of a network among Development Agencies financing education infrastructure. The results of the first meeting of the network are included at the end of this paper.

1. The International Context: Setting the Stage

Education has long been recognised as a basic human right and a key contributor to economic growth and individual wellbeing. Due in part to a lack of any other type of data, research into the benefits of education has for a long time focused on the number of years spent in school, the degrees obtained or the enrolment rates in order to assess the impact of education on jobs and well-being. With education access issues having been progressively addressed, the focus of education policies has now shifted to outcomes, or learning achieved through schooling, and the quality of the databases developed to focus on measuring knowledge, skills and competencies has grown accordingly.

Development of the *Program for International Student Assessment* (PISA) by the OECD in 2000 marked an important shift in the education policy area. PISA provides a rich source of comparable international data on the skills and knowledge of 15-year-old students every three years; the survey makes it possible to evaluate the equity, quality and efficiency of the education systems in participating countries. Accessing this type of data has enriched the debate and shifted the importance of education from schooling to learning, as evidenced in the latest *World Development Report* (World Bank, 2018) which places learning centre stage for the first time.

Concerns have emerged over growing inequalities in learning outcomes and difficulties in meeting the Europe 2020 target of reducing the share of low achievers. Policies and practices conducive to addressing inequalities in education systems and promoting learning for all have become prominent on the EU agenda, as reflected in the latest *Education and Training Monitor* from the European Commission (European Union, 2017). The First European Summit on Education that took place in January 2018 has contributed to drawing attention to these concerns.

Ensuring inclusive and quality education for all is one of the 17 Sustainable Development Goals (SDGs) that countries adopted in 2015, to be met by 2030. One of the targets identified for monitoring the achievement of this goal is to "build and upgrade education facilities that are child, disability and gender sensitive and provide safe, nonviolent, inclusive and effective learning environments for all".

The notion of designing inclusive and effective learning environments is of critical importance to all stakeholders investing in education infrastructure. A better understanding of how investments in learning environments are most effective can also help education systems better respond to the demand for new competencies and to the changing labour market, governed by technological changes, population ageing and increased globalisation. As one of the financiers of the education sector in Europe, the CEB has a key role to play in promoting investments that contribute to building a cohesive, competitive, resilient and fair Europe fully capable of achieving the SDGs.

The CEB's experience in Education

Since its establishment over sixty years ago, the CEB has approved €7 billion and disbursed €5 billion in loans for education investments, representing 11% of its total lending over the same period. Loans for the education sector have become more significant since the mid-1990s and even more so in the last ten years, during which 43% of the total education lending (or almost €3 billion) has taken place.

During this period, the largest share of CEB funds (€1.1 billion) was approved for Western European countries (38%) with the remainder split almost equally among the South, North and Eastern European regions (21%, 24% and 17% respectively). The largest share of the lending in the last ten years (69%) has been approved in support of national, regional or local authorities while the remainder has been approved through commercial banks supporting education investments.

The CEB's financing has targeted all education levels, from preschool to higher education. For example, it has contributed to increasing access to preschoolers (Montenegro, Romania), improving energy efficiency (Georgia), carrying out seismic retrofitting (Georgia, Cyprus), modernising and expanding school infrastructure (Albania, Croatia, Finland, France, Germany, Portugal, Spain), improving sports facilities ("the former Yugoslav Republic of Macedonia") and developing higher education campuses (Cyprus, Hungary, Latvia, Poland).

2. The Importance of Designing Effective Learning Environments

Countries invest significant amounts of funds in education infrastructure annually. Total gross capital investments among EU countries averaged 8% of total education spending in 2015, or €57 billion out of a total €716 billion spent on education. Investments in education infrastructure tend to respond to new demographic and urban planning demands, the urgency of damage caused by natural disasters, the need to undertake seismic retrofits and the removal of asbestos to ensure children's health and safety, or to promote their comfort through better insulation, heating and ventilation systems; modernisation trends to integrate technology and new education visions are also common reasons for investing in education infrastructure in Europe.

Despite the significant amounts of funds invested in the sector, data on the links between education infrastructure and learning outcomes is limited. Recent literature reviews have identified several limitations concerning the evidence available on this relationship, such as the type of variables used to assess student outcomes, the characteristics of the physical space observed, the research method used and the lack of focus on education practices (Blackmore, J. et al, 2011; Imms et al, 2017). Another element of difficulty in constructing environments conducive to learning outcomes has to do with the multiple stakeholders involved in the process from the design to the use of the buildings, with often different and disconnected agendas (Daniels et al, 2017).

The following sections review current trends in the literature on effective learning environments and present a number of ideas to guide the reflections on how investments in education infrastructure can promote student learning and support better educational outcomes. Effective learning environments comprise many dimensions, such as fostering learning outcomes, promoting inclusion and social cohesion, enabling more efficient and sustainable use of space and resources, ensuring safety and well-being, among others. The next sections will focus on three aspects: the links between the characteristics of the spatial design and learning outcomes; adaptation of the physical environment to new competencies and pedagogies; and the impact of design on construction and operating costs.

2.1 Physical aspects of spatial design that impact on learning outcomes

One strand of research concentrates on the links between the physical aspects of the spatial design of educational spaces, such as light, heat, ventilation and acoustics, and student outcomes. These aspects can be considered as essential to ensuring that a certain comfort exists in order for learning to take place. The research conducted tends to be quantitative and often fails to explore how different physical aspects interact with users over time (Tse et al, 2015). A recent review of the literature summarises key findings and confirms the importance of appropriate lighting, temperature and acoustics in school buildings for student achievement (Wall, 2016). Air quality has been examined from a health perspective, suggesting that poor air quality may result in increased absenteeism, thus having a negative impact on student achievement.

There are, however, disagreements over what are considered best practices: while natural light is favoured, it is recognised that it is not practical to rely exclusively on natural light. Similarly, the placement and size of windows is also subject to differences of opinion, with some recommending lowering windows for students to have a connection with the outside and others considering that low-placed windows represent a potential distraction. Again, while appropriate temperature is important, students' perception of optimal temperature may vary, which suggests that what is key is to ensure that teachers have the possibility to control the temperature level so as to adjust to activities and personal needs (for example, students with lower activity levels or mobility needs). Acoustics tend to be associated with health and engagement rather than learning, suggesting that poor acoustic quality can cause students to miss or misinterpret part of a teacher's lesson or that frequent teacher pauses lead to a reduction in teaching time. Learning space noise levels may negatively impact all students but particularly those who require learning support. Ensuring adequate acoustics is key in the design of open spaces: insulation material that reduces sound transmission and carpeting in learning spaces and corridors contribute to creating a calm environment.

Recent quantitative research carried out in the United Kingdom on the impact of classroom physical characteristics on learning has evidenced the importance of design in supporting learning outcomes. Differences in the physical characteristics of classrooms explained 16% of the variations in learning progress over a year for the 3766 students aged between 5 and 11 who were followed. The impact of moving an "average" child from the least effective to the most effective space corresponds to around 1.3 sub-levels; as a benchmark, students typically make 2 sub-levels of progress per year (Barret et al, 2015).

The study examined the relative contribution of seven design parameters organised around three categories: Naturalness (light, temperature, and air quality), Individualisation (ownership and flexibility) and Stimulation (colour and complexity). The conceptual model proposed by this study combines the physical characteristics of the space with human interactions, as captured by the "Individualisation" component, i.e. the capacity to adapt to the surroundings to suit individual preferences, and to the level of "Stimulation" appropriate for the activity taking place. The natural factors (comfort) traditionally studied account for only about half of the effect observed. The other two categories, which together account for the other half, evidence the important role played by dimensions that reflect the impact of people on the environment, and in particular how they make use of it.

A recent secondary school study (Anglican Church Grammar School, 2016) compared the achievement of learners in innovative learning environments to their counterparts in conventional classrooms within the same school and found improvement for the cohorts in the innovative spaces for all subjects tested (11% for Humanities, 16% for English and 19% for Mathematics). The teachers did alter their pedagogical practices in the different special layouts, which in the innovative learning spaces correlated with significant improvements in both student engagement and academic outcomes. However, the study clearly shows that it is the teacher's environmental competence, that is his/her capacity to make effective use of the potential offered by the innovative learning space, that is the predictor of success, not the learning environment by itself. Shedding light on the use of the physical spaces, not just their characteristics, is the focus of the following section.

2.2 New spaces for new competencies

The last decades have seen a shift in the skills and competencies required of students. In today's global economy and increasingly diverse world, graduates are expected to go beyond the basic literacy and numeracy skills and be capable of responding quickly to changing demands, collaborating and working effectively with people from different cultures and disciplines, displaying leadership and autonomy in solving problems, and showing persistence, curiosity and initiative. In this new, interconnected and multicultural world, it is expected and desirable that students have the necessary global competencies to acquire in-depth knowledge and understanding of intercultural issues, the ability to learn from and live with people from diverse backgrounds and the attitudes and values necessary to interact respectfully with others.

To promote these new competencies, teachers today are expected to guide students' discovery, to facilitate their learning and the development of new skills and competencies using collaborative teaching models, and to promote the development of their curiosity, innovation and autonomy by making use of different technologies. The learning space provided by a traditional classroom, with direct instruction occurring from the front and promoting a teacher-centred pedagogy does not seem

to fit these new demands. There is a wave of new schools being built today with more flexible and innovative learning configurations of space that respond to this trend. Significant amounts of funds are invested every year in building these new learning environments.

Finland is actively promoting a new vision of learning and accompanying it with a change in the physical environment, as witnessed in the investments carried out by several municipalities with the support of the CEB. In recent years the CEB has collaborated with some of Finland's most populous cities and regions – including Helsinki, Vantaa, Tampere and Espoo – to fund education related projects. Since 2013 the CEB has approved €310 million in loans to finance the construction, renovation and modernisation of day care centres, comprehensive schools, secondary schools and vocational institutes in these four municipalities with a combined population of 1.3 million.

The new curriculum for basic education introduced at the end of 2016 is grounded on a new vision of learning that is centred on the active involvement of students in the learning process, on the conception of the school as part of a learning community and on instruction being conceived as an integrative process. Within this new framework, learning takes place everywhere, not just in a classroom and not just at a desk. The new schools provide opportunities for learning to take place inside and outside the classroom, facilitate encounters, small group discussion as well as individual work in parallel with large group activities. Furniture has been adapted to have a "home" feel atmosphere, with different spaces for resting, reading, and chatting while learning. Flexible spaces combined with adaptable furniture and enhanced technology are key features of these innovative learning spaces. The space is designed to be flexible, with sliding walls that can be folded as needed, to create learning areas of different sizes, and classroom furniture that provides flexibility in its arrangement as well or that can even be replaced by pillows and bouncing balls. These non-traditional classrooms provide opportunities to experience new ways of learning, with emphasis on collaboration. Glass walls allow students to work in groups or to have a private space when they need to get away within an open atmosphere. Every interior and exterior space is a potential place for learning. There are enough open spaces in the broad hallways to sit, work and study. In other words, the design supports learning outside of the classroom. Finnish concerns over well-being (Nuikkinen, 2009) and the importance of flexible furniture and equipment to support pedagogical practices (Kuuskorpi, 2012) facilitate individual and pair work and group methods through different furniture configurations.

The idea of having an open and flexible learning space is not totally new. Already back in the 1960s and 1970s the "open education" movement aimed to make small classrooms disappear. This movement failed to deliver the expected outcomes - partly because of its overt architectural focus, the lack of teacher consultation throughout the design process and the limited guidance or professional development of teachers through the initial occupation period (Byers & Imms, 2017). The challenge today is to avoid the mistakes of the past and ensure that this new wave of investments in innovative learning spaces delivers the expected and desired student learning outcomes. The new learning spaces being promoted today are not just based on openness but rather on flexibility and have the capacity to adapt to different teacher practices and individual student learning styles. These new configurations of the learning space are exciting. At the same time, it is essential to ensure that the potential these innovative learning spaces offer is used effectively.

Observations by the CEB during its technical monitoring missions confirm that new environments by themselves are not enough to change practices. Notwithstanding some exemplary realisations, differences in practices were observed in the use of classrooms and facilities. Even though the furniture was flexible enough to promote different classroom arrangements, some of the classrooms visited continued to be organised following a traditional teacher-centred approach. The glass doors had been covered to prevent the transparency initially intended and none of the sliding walls enabling the creation of different sized environments were in use at the time of the visits.

A recent study of five new secondary schools built between 2003 and 2012 in the United Kingdom underlines the frequent conflicts that arise over time among the different actors involved in the different phases that lead to the construction of a new school building (Daniels, et al. 2017). From the

initial vision of policy makers to the design as reflected by the architects, the constraints imposed by construction and costs and their final occupation by teachers and students, some buildings suffer from so many contradictions that they become dysfunctional.

Similar findings by Zhang and Barret (2010) from a post-occupancy study of five primary schools in the UK concluded that there was a gap between design expectations and the performance achieved, primarily because the occupants were usually simply coping with the given environment rather than actively managing it. The authors emphasised the value of introducing education programmes for users to be implemented upon occupation as a way to ensure that the potential of the design strategy be fully realised.

These studies confirm the notion that space alone is not sufficient to have a positive impact on student learning outcomes. Attention to the education vision, guidance to teachers' practices and support during their transition into these new learning environments are all key to ensuring that the full potential of these innovative buildings is put to work. These concerns are at the heart of the Learning Environments Applied Research Network (LEaRN), a multi-disciplinary research project carried out in Australia since 2008. The focus of the project today is to improve the quality of design and effective use of learning environments and to provide robust evidence of what works. The evidence collected so far suggests that in spite of the large amounts of funds invested by the Australian and New Zealand governments to modernise their school buildings in recent years, a large majority of teachers in innovative spaces continue to teach the way they always have and the pedagogic approach remains teacher-centric (Imms, under review). These findings have led the LEaRN team to focus the next phase of research on finding ways to help teachers make full use of the potential of these innovative learning environments.[1]

2.3 Cost implications of design

An essential aspect to keep in mind when financing education infrastructure is the impact of design on construction and operation costs. Attention to certain key design features can make a major difference in costs. The Architectural Design Guidelines for Early Childhood Education published by the CEB in April 2018 present some key elements that should be taken into consideration to keep costs under control.

One of the principal factors to consider is the shape of the building, as it adds to floor, roof and wall surfaces. A widespread, linear and complex floor plan results in a greater surface to be built, more material spending and a longer building time. Such structures also tend to add to heat losses in comparison with compact plans. The same floor surface can have up to 75% additional façade surface depending on the different shape of the building.

Promoting flexibility and multi-purpose areas can also contribute to optimising and reducing the surface built. Having a central space that can be used for several activities, such as sports hall, theatre, art class, can reduce the need for special purpose rooms that are not used at all times and represent additional construction costs. Functional furniture that is easily moved and stackable, such as wardrobes, tables and chairs on wheels, ensures this type of flexibility.

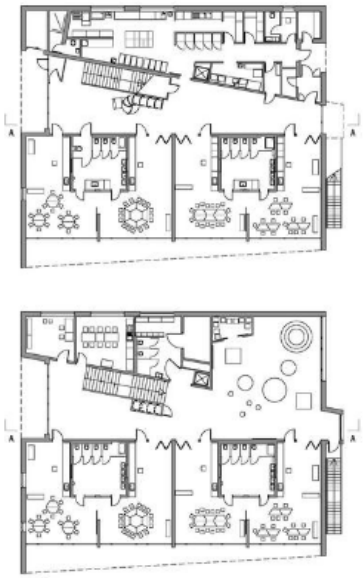
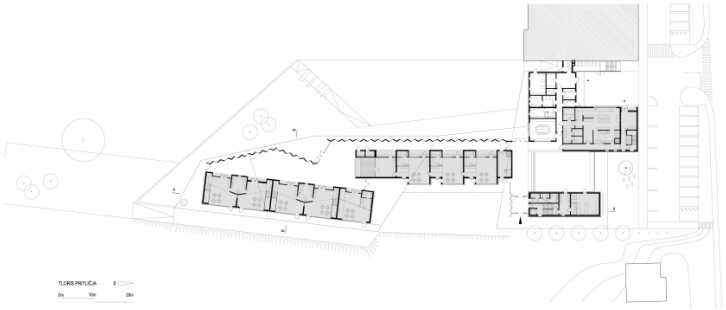
Reducing the number of materials used usually means fewer subcontractors and a lower risk of compatibility problems with the materials chosen. Simple details reduce the risk of failure and the time required for planning, production and construction, thus contributing to reducing overall costs. The position, size and colour of the materials chosen can add to the attractiveness of the façade without increasing costs. Access to natural light and proper insulation will also contribute to efficiency in operating expenditures.

[1] The next research features a quasi-experimental test in a sample of schools in Australia and New Zealand to measure the impact of different strategies to help teachers use innovative learning spaces on "student deep learning".

For comparison purposes, Table 1 presents the results of two award-winning early childhood facilities (S and P), both energy efficient, but, due to their design, very different in total surface, spatial functionality and cost (Kotnik, 2018).

The architects involved in the design of kindergarten S were able to reduce the total surface of the building by 260m² in comparison with the average kindergarten surface of 1 300m² for 8 groups in the country. This was achieved by reducing corridors, staff and service areas to a minimum, and by having flexible furniture and multi-use spaces, where the central area that is used for communication can also be used as an extension of the playground spaces.

Table 1: Comparison of construction costs

Kindergarten (Year of construction)	**S** (2015)	**P** (2014)
Size	1 040 m²	2 093 m²
Plan shape	Compact	L shape, linear
Plan		
Capacity/ Children	176	176
Total costs	€1.45 million	€2.8 million
Cost per child	€8 238	€15 909

Source: Kotnik J. (2016) Designing spaces for Early Childhood development, Images Publishing

Design and details can have a high impact on costs. This is illustrated by comparing two similarly compact kindergartens that differ in the level of detail of the facade. While total surface is less in kindergarten C than in kindergarten S, the total facade surface is 61% bigger in C than in S, as illustrated (833 m² vs. 518 m²) in Table 2 below. Details such as inclined windows make kindergarten C 65% more costly per child.

Table 2: Comparison of the unit costs impact of façade

Kindergarten (Year of construction)	**S** (2015)	**C** (2014)
Size	1 040 m²	780 m²
Plan shape	Compact	Compact core with meandering façade
Photo		
Capacity/Children	176	110
Total cost	€1.45 million	€1.5 million
Cost per child	€ 8 238	€ 13.636

Source: Kotnik J. (2018)

Recent experience from a CEB financed project provides additional evidence concerning the impact of design on construction costs and consumption of energy in the building. Kindergarten Z was the first kindergarten built in the country applying the principles contained in the CEB's Architectural Design Guidelines for Early Childhood Education (2018). Basic information is provided on Table 3 below. The cost of construction per m² built was 16% lower and resulted in a saving of around 29% per child in relation to a comparable kindergarten built nearby at about the same time. Annual energy costs per child are also 15.5% lower in Kindergarten Z.

Table 3: Unit costs comparisons

Kindergarten (Year of construction)	**Z** (2016)	**G** (2013)
Size	1 400 m²	1 900 m²
Plan shape	Round compact	L winged
Photo		
Capacity/Children	300	341
Total cost	€1.2 million	€1.9 million
Cost per child	€4 085	€5 813
Cost per m²	€875	€1 043
Energy cost per year	€16 139	€21 685
Energy cost per child	€53	€63

Source: Kotnik J. (2018)

3. Conclusions and the Way Forward

As key actors in the field of financing education infrastructure, Development Agencies have an important role to play in promoting effective learning environments for all students. Every education infrastructure investment financed is an opportunity not just to build or rehabilitate schools, improve energy efficiency, health and safety but also to contribute to promoting student learning outcomes and to meeting Sustainable Development Goal 4 on Education. Providing the adequate guidance at the design stage and subsequently supporting teachers and staff in making full use of the potential provided by these innovative learning environments can make an important difference in promoting learning, not just schooling.

Development Agencies should pay attention to the design and use of education facilities to ensure and promote the sustainability of the investment financed. Support should not be limited to the financing of infrastructure alone but should also include the development of effective and sustainable learning environments, capable of being used effectively by teachers and of adapting over time to suit evolving purposes. This implies going beyond the design and construction phase and also being engaged when the building is being used, supporting teachers in the development of the necessary competencies to make effective use of these innovative learning spaces so as to promote learning outcomes. Built infrastructure should have the capacity to adapt to changes in staff, leadership and vision over time.

To raise awareness of these issues and discuss what evidence can help investment decisions, the CEB spearheaded and organised the first meeting of Education Experts from Development Agencies involved in the financing of education infrastructure in Europe. The meeting took place on 10 April 2018 at the CEB premises and brought together representatives from the European Investment Bank, the French Agency for Development, KfW Development Bank and the World Bank. Participants agreed on:

- The importance of a comprehensive approach to education investments; infrastructure per se is not enough for learning environments to be effective;
- The need to further develop the research evidence on the link between education infrastructure and learning outcomes;
- The value of sharing knowledge resources developed on the topic and of facilitating exchanges of information

Participants also agreed to join forces to:

- Identify indicators with which to monitor the impact of investments in education infrastructure in order to support the need for evidence of their impact on learning outcomes;
- Develop criteria to guide the appraisal of education infrastructure investments that can be effective contributors to learning outcomes, paying particular attention to the critical role of teachers in the process of ensuring learning outcomes for all;
- Assess the impact of innovative learning environments on costs, taking into account the different starting points of the countries involved.

Development Agencies can contribute to "inspiring" design change and effective use of learning environments by increasing awareness of the issue, supporting research and knowledge development and promoting the exchange of lessons learned and best practices across countries and regions. It is a time of major investments in education infrastructure worldwide. International financiers have the development responsibility to ensure that the funds invested deliver the expected student learning outcomes.

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