EFFECTIVENESS, EFFICIENCY AND SUFFICIENCY:
AN OECD FRAMEWORK FOR A PHYSICAL LEARNING ENVIRONMENTS MODULE

DRAFT

In this paper, the authors present the conceptual framework for the first Module of the Learning Environments Evaluation Programme (LEEP). Using this Framework, tools will be developed for possible use as part of the contextual information collected alongside the PISA-based Test for Schools. Drawing on the latest evidence-based research about how investments in the physical learning environment – that is "the physical spaces (including formal and informal spaces) in which learners, teachers, content, equipment and technologies interact" – can translate into improved cognitive and non-cognitive outcomes, the authors map the student-, school-, community- and system-level inputs, processes and outcomes, in addition to evaluating the feasibility of measuring learning and other outcomes relating to the physical learning environment in the Module. Finally, different parameters are considered with regard to the implementation of the Module, including suggested respondents; use of existing PISA question typologies and test formats; use of other research methods; and sampling issues. Focus areas and sample questions for inclusion in the Module instruments, some options for reporting results from the study; and ideas for future development of the Module are also explored.

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1 INTRODUCTION

1.1 Background and purpose of the Module

The physical learning environment is an influential element in the complex and highly contextualised nature of learning, characterised by dynamics and interactions between the learner, teacher, content, equipment and technologies (OECD, 2013b). For the purpose of this Framework, the **physical learning environment** is therefore defined as "the physical spaces (including formal and informal spaces) in which learners, teachers, content, equipment and technologies interact".

This paper presents a Framework for a Module on the Physical Learning Environment[1], which addresses the concepts of "effectiveness", "efficiency" and "sufficiency".

- **Educational effectiveness** refers to the ability of a school or school system to adequately accomplish its stated education objectives. Studies of educational effectiveness analyse whether specific resource inputs have positive effects on outputs, broadly defined (OECD, 2013c). There is a recent recognition that for schools and systems to achieve greater effectiveness against their own objectives requires in instances of disadvantage reduced efficiency in cost-benefit terms in the short or long term as additional investment is necessary particularly with regard to the built environment (Borman, 2005; Gorard, 2005, 2010; Harris and Chapman, 2006; Muschaump et al., 2009; Wrigley, 2004).

- **Educational efficiency** refers to the achievement of stated education objectives at the lowest possible cost. In other words, efficiency is effectiveness plus the additional requirement that this is achieved in the least expensive manner (OECD, 2013c). A more efficient school or school system achieves better outputs for a given set of resources, or it achieves comparable outputs using fewer resources. In order to analyse efficiency, it is necessary to have information regarding the cost of inputs (here physical learning spaces and technology).

- **Educational sufficiency** refers to the baseline components of the built environment which are considered necessary conditions for providing the affordances most likely to impact on student learning (e.g. access to safety, water, natural light, power, heat and technology) in changing demographic, social and political contexts (e.g. conflict zones, environmental disasters, economic and social instability, poverty) as stated in Dakar Framework's (2000) commitment to Education for All.

The idea behind these concepts is that resource inputs (i.e. learning spaces, materials and technology) are used in educational activities so that they produce desired outputs for the individual, school and community, such as greater engagement in learning, improved student performance and healthier and safer school communities.

A "Module" is defined as a resource, which when applied, will inform schools about how particular area of the learning environment, for example the physical learning environment, can support improved

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learning and other outcomes. So each Module is modular in the sense that it is composed of questionnaire items and a contextual questionnaire that addresses an aspect of the learning environment. This Framework describes the first "Module" to be implemented as part of the OECD Learning Environments Evaluation Programme (LEEP)[2], which aims to produce tools – such as frameworks and validated assessment instruments – and provide information and advice to schools, local authorities and communities about how investments in learning environments, including the physical learning environment, translate into improved outcomes, leading to more efficient use of educational resources.

This Module can be implemented by schools in different ways:

- As part of the contextual information collected alongside the PISA-based Test for Schools to support school improvement efforts, in accordance with the agreed guidelines for the implementation of the test (OECD, 2013a). This Module is not intended to be implemented as part of the main PISA study, which is conducted every three years;

- With other national or sub-national student assessments; or

- As a self-evaluation instrument by individual schools.

This paper draws from the latest research on school improvement, which identifies context, leadership, professional learning, pedagogy, supportive policies and investment in the built environment as critical to improving student learning. Recent studies of innovative learning environments indicate there are positive associations between whole of school improvement, spatial redesign and student learning (OECD, 2013b). Evidence is emerging about how a school's physical learning environment impacts on community and benefits the long-term health and wellbeing of students and communities (McLaughlin and Talbert, 2006; OECD, 2008).

1.2 Purpose and structure of the Framework

The purpose of this Framework is fourfold:

- To describe the conceptual underpinnings of the Module, drawing on the latest research evidence on the physical learning environment;

- To explore how the use of the Module, when used with the PISA-based Test for Schools or national student assessments, can improve the evidence base around effective, efficient and sufficient physical learning environments;

- To assist the next development phase of the Module, which is to develop and validate the questionnaire instruments; and

- To provide a template for the development and implementation of future LEEP Modules, for the purpose of school improvement.

It is divided into six sections:

[2] The work of LEEP is overseen by a Group of National Experts on Effective Learning Environments (GNE), which is composed of experts in the field of learning environments, including physical learning environments. OECD work on the physical learning environment in education was previously overseen by the Centre for Effective Learning Environments (CELE) Board of Participants. In 2013, CELE work was broadened and re-focused through LEEP and a newly created GNE.

- Section 1 describes the Framework's purpose and the background to the development of the Module within the context of LEEP. Key terms used throughout the Module are described, including learning environment, physical resources, use of information and communication technology (ICT) in education school improvement and outcomes; and the organisation of learning and pedagogy.

- Section 2 presents the conceptual and evidence bases for the Module, which is organised around the concepts of spatiality, temporality and connectivity and divided into four key phases: design, transitioning into new learning spaces, consolidation, and sustainability and evaluation.

- Section 3 identifies key research questions guiding the development of the Module;

- Section 4 maps the student-, school-, community- and system-level inputs, processes and outcomes, in addition to evaluating the feasibility of measuring learning and other outcomes relating to the physical learning environment in the Module;

- Section 5 presents the different parameters to consider with regard to the implementation of the Module, including suggested respondents; use of existing PISA question typologies and test formats; use of other research methods; and sampling issues. It also describes the focus areas and sample questions for inclusion in the Module instruments, presents some options for reporting results from the study; and reflects on the future development of the Module.

1.3 The importance of the physical learning environment

This Module addresses what Fisher (2005) calls a "deep spatial silence" or "unconsciousness" regarding the power of space and the influence it has over school organisational structures and learning. The focus on the physical learning environment has emerged out of a concern as to whether the pedagogies, curriculum, assessment and organisational forms necessary to develop the capacities in students for the 21st century require different built environments and usage. Other issues foregrounding the built environment include environmental sustainability, the integration of ICT to enhance learning, industry and university partnerships, educational inequality, neighbourhood regeneration in high poverty regions. Coinciding with managing new built environments, teachers and principals manage multiple curricula and assessment reforms that claim to focus on student learning, but that can have contradictory demands on time and space. Poorly designed and maintained schools, often found in areas of lowest educational achievement, can also have a detrimental impact on teacher and student morale and engagement, and impact negatively on aggregate student outcomes (Filardo, 2008). Collectively, these factors impact on teachers' work, attitudes and behaviours, and have flow on effects on student learning.

Health and wellbeing, affective, social, cognitive and behavioural characteristics of individuals are pre-conditions that can impede or enhance learning. They are also desirable learning outcomes. The physical environment is one factor in many impacting on student learning outcomes (OECD, 2010a). Schools now have culturally and academically diverse student and community populations (Alton-Lee, 2006). But school effectiveness and improvement studies often neglect context, rely on limited measures of outcomes and ignore the built learning environment (Bickford and Wright, 2006; Moos et al., 2008; Thrupp and Lupton, 2006). Clearly, further research is needed to better understand how the physical learning environment can support different outcomes for students, educators and communities – and how results from this research can be used for the purpose of school improvement.

1.4 Defining key concepts

1.4.1 Learning environment

The physical learning environment is one aspect of the learning environment, which includes social, cultural, temporal, physical (built and natural) aspects, as well as physical and virtual environments (McGregor, 2004). For the purposes of this Framework and other Modules, "learning environments" are conceptualised using the OECD Centre for Educational Research and Innovation's definition as "an organisational form that covers the particular learning arrangements for a group of learners in context over time, in which the learning taking place is an integral part" (OECD, 2013b).

The "pedagogical core" is the elements and relationship at the heart of each learning environment. It is composed of four core elements: learners (who?), teachers (with whom?), content (what?), and resources (with what?), with four organisational relationships connecting these elements: i) how learners are grouped, ii) how teachers are grouped, iii) how learning is scheduled and timed, and iv) innovative pedagogies and assessment practices. How the environment is shaped depends on learning leadership, which is the capacity and will to shape its main directions, and the wider circle of partnerships, for example engagement of people and communities in a supportive, interactive network (Figure 1.1).

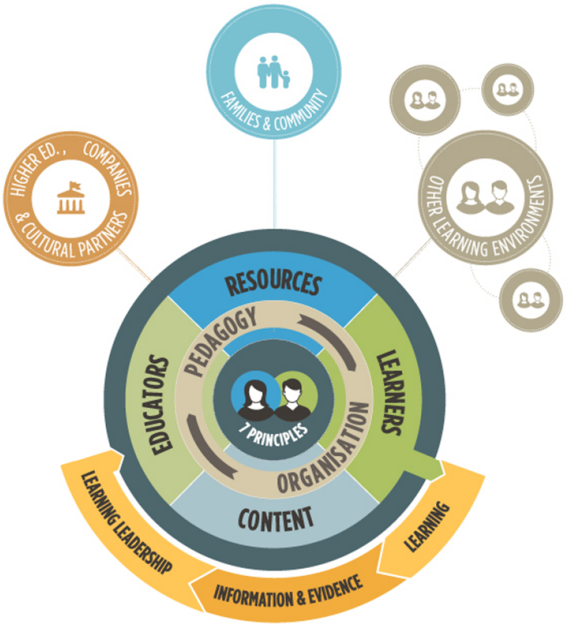


Figure 1.1 The learning environment: wider partnership circle.
Source: OECD (2013b), *Innovative Learning Environments,* OECD Publishing, Paris.

1.4.2 Physical resources and the physical learning environment

According to the OECD efficiency framework (OECD, 2013c), physical resources are defined as learning spaces, materials and technology. Like all resources, physical resources need to be wisely distributed, used and managed to support educational improvement objectives to the greatest possible extent, especially in the face of competing demands from a variety of actors inside and outside the education sector. This also raises question regarding sufficiency in terms of the built environment to ensure a quality education for all students. The term physical learning environment is used throughout the paper to describe the interplay between the physical resources and complex learning, social, online, and other environments (see Figure 1.1).

1.4.3 Use of information and communication technology in education

In this Framework it is important to analyse how modern technology is embedded and used in the physical space, and how it shapes the built environment and mediates the social practices of learning. In many of today's classrooms, it is not possible to separate learning spaces and ICT. Use of ICT extends and adds new dimensions to learning beyond the school grounds to encompass and connect with homes and communities locally, nationally and internationally. The quality and access to up-to-date hardware and software as well as the internet are critical issues for schools and families in high poverty or rural areas (Green and Letts, 2010; OECD, 2008), although the "digital divide" is decreasing with the connectivity

afforded by less expensive, often personal, mobile technologies and a reduced need for dedicated computer rooms (Facer et al., 2001; Pearson and Somekh, 2006).

1.4.4 School improvement, educational effectiveness, outcomes and wider benefits

School improvement and educational effectiveness are the results of the effective distribution and use of physical resources. They can be measured using different cognitive and non-cognitive outcomes (i.e. learning, social, affective, health and wellbeing and behavioural) and by evaluating the wider benefits to the student, education system and society over time. These benefits may take the form of improving social capital, reducing inequity and better preparing students for the workplace and civic life. The principal cognitive outcome measure in the Module is the PISA standardised test score, or equivalent national or local assessment measure, while other outcomes are defined as learning, health and wellbeing, social, affective and behavioural.

1.4.5 The spatial organisation of learning and pedagogy

The spatial organisation of learning and pedagogy is about how systems, schools and teachers incorporate spatial considerations into their planning, policies and practices. Pedagogy is the social interaction between teachers and students which promotes learning in its broadest sense.

2 CONCEPTUAL UNDERPINNINGS AND EVIDENCE BASE

2.1 Conceptual underpinnings

In order to better understand the role of the physical learning environment, this Framework draws on two OECD organising frameworks - which represent both macro- and micro-level approaches – and the Dakar Framework (2000) to analyse the effectiveness, efficiency and sufficiency of the physical learning environment. On the one hand, the physical learning environment is the result of an investment of physical and other resources, which must be used and managed over time. On the other, the learning environment is one of the pillars of the organisation of learning and pedagogy that is ever-present in our learning experience.

- The "OECD efficiency framework" is drawn from the project plan of the OECD Review of Policies to Improve the Effectiveness of Resource Use in Schools (OECD, 2013c). This considers how "physical resources" across schools and systems can be most effectively **designed**, **distributed**, **utilised** and **managed** to create environments that are conducive to teaching and learning. Physical resources (i.e. learning spaces, materials and technology) are but one type of resource – in addition to human, financial transfers between levels of the education system and administration, and resources for targeted programmes – which, when distributed, utilised and managed effectively by different stakeholders across and within education systems over time, can assist countries to achieve their educational objectives to the fullest (OECD, 2013c). Figure 4.1 thus presents the physical learning environment within an efficiency framework by looking at different physical resource **inputs** and **processes** at the classroom-, school-, community- and system levels, and the kinds of **learning outcomes** and **wider benefits over time** that could result from effective use of physical resources. This model is described in greater detail in Section 4.

- The "OECD learning environments framework" derives from work by the Centre for Educational Research and Innovation on *The Nature of Learning* (OECD, 2010a) and Innovative Learning Environments project (OECD, 2013b), in which **learners**, **teachers**, **resources** (i.e. space and technology) and **content** are the core elements. The processes of scheduling, planning and the change process are some of the elements that make up the organisational structure and pedagogy, and when considered in the wider social, educational and other contexts, can result in outcomes and wider benefits for all (Figure 2.1 and OECD, 2013b).

- The term "**sufficiency**" derives from the Dakar Framework (2000, pp. 17-18) which highlights the social and economic benefits of Education for All. A key strategic commitment of all member countries is to ensure basic learning through investment and planning focusing on a more equitable distribution of resources and basic facilities.

Importantly, the **physical learning environment** is not the same as **physical resources**. A physical learning environment is the result of interactions between physical resources (i.e. learning spaces, material and technology), learners, educators, content, learning leadership, society and policy (OECD, 2008; Tanner and Lackney, 2006) (Figure 2.1). The physical learning environment can produce conditions (also known as affordances) (Gibson, 1977) and mediate relationships that can improve student learning along a range

of indicators (cognitive, physical and mental wellbeing) and the quality of relationships. These are made more complex by the use of ICT, which mixes face-to-face and technology-based teaching (Bersin, 2004; Goodyear, 2008). There is also a distinction to be made between learning as a process of production of student identities and learning as distinct from being measured by one off achievement in tests (Dumont et al., 2010). Learning is a process of identity formation in which a sense of place is important (Abassi, 2009; Paechter et al., 2001). The notion of learning spaces raises issues around **spatiality**, **connectivity** and **temporality**; how these mediate pedagogical and other relationships that can improve student learning.

2.2. Evidence base

This section frames the existing peer-reviewed evidence base around these three concepts of **spatiality**, **connectivity** and **temporality** and outcomes research. In general, however, the authors agree with Woolner et al., (2007) that "the research indicates that there is an overall lack of empirical evidence about the impact of individual elements of the physical environment which might inform school design at a practice level to support student achievement".

2.2.1 Spatiality

Space (and place as natural and built environments) *"shapes"* social relations and practices in schools and communities (Leemans and von Ahlefeld, 2013; Lefebvre, 1991; McGregor, 2003, 2004; Massey, 1994, 2005). Social practices, formal instruction and informal social interactions change the nature, use and experience of space and that in turn varies for individuals and groups according to gender, ethnicity, race, religion and disability.

Much of the learning spaces literature has drawn from the fields of sociology, environmental studies, psychology, health, architecture and design as well as within-field specialisations such as educational philosophy, curriculum and learning theory (including brain science), occupational health, health and wellbeing, indoor and furniture design, landscaping, ergonomics, environmental psychology and environmental sustainability. Many sweeping claims about the possible effects of various aspects of learning spaces on student learning are not substantiated empirically (Blincoe, 2008; Tanner, 2000). Much of the early literature on learning spaces and learning outcomes came out of the United States and the United Kingdom (Earthman, 2004, 2009; Maxwell, 1999; Sanoff, 1995; Schneider, 2002; Sheets, 2009; Stevenson, 2001). The US-based research tended to be quantitative, seeking direct causal links between buildings and student outcomes, but the results were ambivalent as too many variables had to be excluded (Higgins et al., 2005; Hughes, 2006; Tanner, 2009). These large quantitative studies were reliant on principal interviews and data (student test scores, retention, attendance, etc.) and not qualitative data from teachers and students (Branham, 2004). It did conclude that the quality of air, sound, temperature etc. did have a significant impact on health and wellbeing (Higgins et al., 2005). A more qualitative approach in alternative research indicated the complexity of indirect links between learning spaces and outcomes, and provided greater depth of understanding about what actually happens in learning spaces (Fisher, 2002; Heppell et al., 2004). But there is clear epidemiological evidence that health and wellbeing impacts on learning, and that physical exercise is a significant factor (Dagkas and Stathi, 2007; Davidson, 2007) in the short term, and higher levels of education have impact on individual and community health and wellbeing in the long term (Ahman et al., 2000; Blackmore and Kamp, 2008; Tett, 2003; Wilkinson and Pickett, 2010). Studies carried out in the UK (PricewaterhouseCoopers, 2003) and in New Zealand (ACNeilsen, 2004) do indicate strong links between the physical learning environment and student, teacher and parent perceptions, if not yet establishing at this stage direct links to learning outcomes.

2.2.2 Connectivity

Learning spaces and technologies together mediate the relationship and social practices of teaching and learning, and are two factors among many in the complex relationships of teaching that inform learning in schools (Oblinger, 2006). Effective use of ICT in education requires that teachers are able to change their practices to be more student centred, to give over control, and that students are capable of self-regulated learning in the classroom and on line (Crook and Light, 1999; Luckin, 2010; Marjanovic, 1999; Moulds and Harper, 2008). Teachers and students also construct how technology is mobilised in different spaces (Bissell, 2002).

Selwyn (2011) warns that the digital technology rhetoric makes promises it cannot fulfil i.e. "digital disappointment". More research is needed on the effectiveness of ICT in the educational settings. "Where connections between the built environment and educational activities are made, the basis for doing so tends to be casual observation and anecdotes rather than firm evidence" (Temple, 2007). International research suggests that computer use at school had little impact on results, while using a computer at home had a more marked impact on results and produces a digital divide (OECD, 2010b). Many school buildings are not suitable for widespread networked and wireless technology – most have combinations of new and old built environments. Often 21st century digital tools are built into 19th century buildings where health safety and security issues impede the integration of these technologies. For example, whiteboards are often not used greatly due to: industry pressure to integrate whiteboards designed for offices not schools; government policies requiring a whiteboard regardless of demand; the social context of school with high crime rates; the material design of the buildings; the size of the primary school students relative to the height of whiteboards; the lack of adaptation into current pedagogical practice of this technology by teachers, and the necessity for practical solutions (Selwyn, 2011). "High access and low use" situations, together with the unequal distribution of ICT resources in schools and homes, often mean teachers and principals are blamed for recalcitrance in taking up digital technologies rather than poor planning and physical design (Cuban, 1998).

2.2.3 Temporality

The literature indicates that there is a temporal dimension to the development, use and impact of learning spaces. Changes in the nature and use of different physical spaces (open/closed; indoor/outdoor; physical/virtual; core/non-core hours) are related pedagogically and organisationally to changes in time organisation. Personalised learning, individual pathway planning, team teaching, inquiry approaches, student teamwork, problem solving, rich tasks and community-based service learning have different time demands (Anderson-Butcher et al., 2010). Large multipurpose, open and flexible spaces often require longer instructional time "blocks" than teacher-centred transmission pedagogies (Arnold, 2002). Large spaces require more planning and synchronicity of activities due to sound (Bruckner, 1997). Education systems have spatial and temporal orders: semesters, examinations, policy deadlines which impact on how time and space is utilised; subject timetable clashes and complexities (Nespor, 2004). Temporality is also key factor in how schools, teachers and students respond to new learning spaces over time and when evaluation can determine effects (Jacklin, 2004). Organisational and pedagogical change takes time to produce outcomes (short and long term) for student learning, often years (Paechter, 2004), while teacher professional learning programmes are widely variant across schools, systems and countries.

Blackmore et al. (2011), in a literature review of built learning environments, identified four overlapping temporal phases with respect to the design of, transition into, use and sustainability of new learning spaces, which shed light on critical elements for school improvement such as professional learning, leadership and systemic redesign (See also Silins and Mulford, 2010, 2002; Tanner and Lackney, 2006; Thomson and Blackmore, 2006). However, there is need to address the paucity of empirical research associating any phase with specific regard to student learning outcomes.

2.2.3.1 Designing the learning environment

It is assumed that good architectural and educational design leads to good teaching practice and improved learning because the quality of the building design has flow on effects on teacher and student behaviour, morale and practices and therefore learning outcomes. More recent studies of innovative learning environments, while not focusing on built environment, do indicate that built environments do matter but less directly with respect to some learning outcomes than assumed (OECD, 2013b).

A number of themes emerge around the design of learning spaces. The first dominant theme is that learning spaces need to be flexible, pedagogically and physically, in ways that reflect the nuances of different knowledge areas and specialisations (e.g. Butin, 2000). In particular, greater flexibility in design occurs around specialist studies in science, trades, arts and technology, with a focus on multi-functionality of spaces, often divided into wet and dry areas, science and technology, arts and drama centres. The mobility of technologies including wireless broadband has meant less need for dedicated computer rooms, and trade specialisms are often carried out in shared facilities with other schools or technical institutions off campus. Another trend is for building "schools within schools" (Dewees, 1999), as small schools are seen to facilitate safer and more collegial, multi-age environments conducive to cross-age mentoring (Darling-Hammond, 2002; Gabriele and Montecinos, 2001). And, finally, new schools are often part of system-wide restructuring in which schools become central to urban renewal and community capacity building (Comber et al., 2006; Gruenewald and Smith, 2008; Smith and Sobel, 2010). Schools are located in precincts co-located with other government and non-government services e.g. health, library, employment, welfare and early childhood and literacy centres, in order to facilitate interagency collaboration and the transition from school into further education or employment. Given these recent developments, there is some evidence as to how interagency collaboration and precinct models impact on learning (Millbourne, 2005, Sims, 2002). There are a number of models for categorising learning spaces (Fisher, 2005; JISC, 2006; Lippman, 2012), and each learning space is noted in these models as having different ICT needs. Yet there is little evidence as to the impact of these different spatial configurations and adaptable learning spaces on learning outcomes, although there is emergent research (Blackmore et al., 2011; Cleveland, 2009; Woodman, 2011).

Second, there is an emerging interest in the specific aspects of design that may impact on teacher practice and student learning outcomes with regard to environmental factors and how specific environmental conditions impact upon student learning such as noise, temperature, air quality, ventilation and lighting (Durán-Narucki, 2008; Higgins et al., 2005; Keep, 2002; Lackney and Jacobs, 2004; Earthman, 2004, 2009; McNamara and Waugh, 1993; Sundstrom, 1987; Weinstein, 1979). A large proportion of the design literature in early years and primary education (e.g. Bullard, 2010) is based on design possibilities in higher education with regard to ICT and flexibility (Willems, 2005), although there is some attention to the changed role of libraries as information hubs in schools, universities and communities (Folkestad and Banning, 2009; Leaderhouse, 2006; Londsdale, 2003). Simon, Evans and Maxwell (2007) conclude that much research linking school building quality to child development suffers from conceptual and methodological problems because it ignores both the quality of old and new buildings and children's response to new buildings (Fuller et al., 2009).

A third theme is the increased focus on the design process (Fisher, 2005; Higgins et al., 2005; Jamieson et al., 2000; Morgan, 2000; Radcliffe, 2008). Increasingly, "participatory" or "generative design" includes teacher-practitioners and students, thus enacting contemporary architectural and educational imaginaries (Abbasi, 2009; DEECD, 2008; Fisher, 2005; Higgins et al., 2005; Jamieson et al., 2000; Morgan, 2000; Radcliffe et al., 2008; Temple, 2007). This engagement of "users" (including teachers and students) in planning learning spaces imparts ownership so they identify strongly with their newly built environment (Clark, 2010; Dudek, 2000; Lippman, 2012). Students also create a sense of space (Loas and Oblinger, 2006; Loi and Dillon, 2006) and ownership, for example through artwork (Jeffrey, 2006;

Kangas, 2010; Killeen, Evans and Danko, 2003; Loughrey and Woods, 2010; Thomson, Jones and Hall, 2009). Teacher input is also critical because it leads to an investment in the process, imparts ownership and indicates they are valued (Loi and Dillon, 2006; Higgins et al., 2005, Sanoff, 1995; Temple, 2007). Staff morale and teacher attitudes and behaviours affect the use made of space, and lack of involvement can produce negative orientations to new spaces (Fisher, 2002; Temple, 2007; Wolff, 2003). Participation in designing a space is more likely to motivate teachers to change practices and to refine their teaching repertoire as well as improve morale (Morgan, 2000; Oblinger, 2006; Temple, 2007; Radcliffe et al., 2008). Teacher satisfaction, morale and professional efficacy is also linked to teacher retention (Buckley, Schneider and Shang, 2005; Louis, 1998; Ross and Gray, 2006). There is emerging empirical evidence supporting claims connecting the design process to impact on student and professional learning and teacher retention (see Blackmore et al., 2011; Buckley, Schneider and Shang, 2004; McGregor, 2004; Woodman, 2011).

2.2.3.2 Preparing for and transitioning into the new learning environment

Schools are part of wider patterns of spatial residential patterns (often of social segregation) which significantly impact on educational outcomes (Baker and Foote, 2006). The literature suggests that new buildings change community perceptions particularly in high poverty areas (Blackmore et al., 2011). Government engagement (PricewaterhouseCoopers, 2003) in schools is symbolic in that the local community feel that there had been a form of exchange with government: their needs are recognised and they become more actively involved in maintaining the school building and participating in decision making on the school council (Crampton, 2009). The physical environment of the school reflects the culture and aspirations of the community and indicates it is respected and valued. Both students and teachers identify with their school's image and reputation, preferring a reasonable standard of physical maintenance, a "good working environment", resources and buildings that are "inspiring" and "exciting", with little noise or distraction. (Flutter, 2006; Kumar, O'Malley and Johnston 2008; Rudd, Reed and Smith, 2008). Temple (2007) argues that students find the physical environment invites them to have an enhanced sense of control and personal autonomy. Bullock (2007) found a positive relationship between new and renovated buildings and student academic achievement based on academic tests in Virginia.

Blackmore et al. (2011) found that principals had to be actively engaged with all phases from design of buildings and ICT, the planning of transition into new spaces and acting as pedagogical leaders in terms of consolidation and evaluation. Not only are principals often actively engaged in generative design of new spaces, which requires knowledge about the pedagogical and architectural principles of good design and pedagogy, but they also had to prepare for managing the transitioning into new spaces by developing organisational plans, processes and mobilising additional resources (Chaney and Lewis, 2007; Newton and Fisher, 2010). Lingard et al. (2003) and Robinson, Hohepa and Lloyd (2009) argue that leadership by principals and teachers is most likely to produce changes in practice that will improve student learning are those which focus on pedagogies (practice) rather than transformation (vision).

However, there is little research on whether participation in decision-making during the design phase continues to inform processes and structures established to manage the transition into occupancy. Limited literature exists about the preparation required for teachers and leaders to develop pedagogical strategies suited to new spatial configurations. Blackmore et al. (2011) concluded that while new built environments provide an opportunity and can provide a catalyst for innovative pedagogies, changing teacher mindsets and practices with regard to pedagogy is the precondition for optimal use of redesigned built environments. This requires significant emotional management by principals and teachers as new environments produce a range of emotions, positive and negative (Cotterell, 1984; Leithwood and Beatty, 2008). This confirms a body of research in the school effectiveness and improvement literature (e.g. Hattie, 2011; Lingard et al., 2006; Potter, Reynolds and Chapman, 2001) and school change theory (Thomson, Jones and Hall, 2009). Managing transition into new built spaces was critical in terms of which organisational and

pedagogical practices were adopted. Teachers were more likely to use redesigned spaces differently if they had been encouraged prior to occupancy to plan, to take risks and experiment with the use of flexible spaces, and to develop new pedagogical strategies (Schneider, 2003). Robinson, Hohepa and Lloyd's (2009) literature review of effective leadership lists five dimensions most likely to influence student outcomes: establishing goals and expectations; resourcing strategically; planning, co-ordinating and evaluating curriculum and teaching; promoting and participating in teacher learning and development; and ensuring an orderly and supportive environment. However, little research considers the association between the design of built learning environments and the changing nature of school organisation.

2.2.3.3 Consolidation of the new physical learning environment

In order to understand how school improvement can be enhanced over time by newly built learning environments, it is critical to focus on the practices which become embedded in the post-occupancy phase. Fisher (2005) argues that existing literature that links learning spaces to student behaviour and learning is overly general and around key measures of building conditions. Blackmore et al.'s (2010) literature review found there was little research attention paid to the pedagogical and organisational practices post-occupancy over time. Some literature exists on environmental psychology which, as Gifford (2002) notes, methodologically has strengths and weaknesses at three levels: fundamental processes (perception, cognition and personality), social management of space (personal space, territoriality, crowding and privacy) and the complexity of behaviour within space (working, learning, daily life and community). With the focus on how to improve practice and student learning, the focus now shifts to pedagogical relationships, communication practices, organisational cultures and contexts and how these influence learning. Blackmore et al. (2010) suggests that it is the perceptual and affective dimensions, the intangibles, which play a key role in how teachers and students use different spaces (Abdul-Samad and Macmillan, 2005; Cotterell, 1984). This fits with both pedagogical and architectural literature on personalisation and the experiential (AIR, 2013; Lee, 2007; Manninen et al., 2007).

There is now a significant literature to indicate that innovation and capacity to address individual student needs is reliant on a teaching workforce that is treated respectfully, that has a degree of professional autonomy, has a collective sense of efficacy and a capacity to adapt and adopt curriculum and pedagogies as is required (Chism, 2005; Sahlberg, 2011). Personalisation in architectural terms often means gaining a sense of ownership associated with privacy (Maxwell and Chmielewski, 2008), although Higgins et al. (2005) found that there is "no robust research base for integrated and personalised learning environments".

Group work for students or teachers is not contingent on, but can be encouraged and facilitated by spatial configuration, although Blackmore et al. (2011) notes that teachers can change their pedagogy towards group work at any time, but flexibility of space and adaptability of furnishings and technologies can enable or constrain such activities. Woodman (2011) found that teachers see flexibility as about how to make the space work for them better and for the students pedagogically i.e. to engage students, meet the diversity of student needs enabling them to use a multiple teaching repertoires, resources and a range of activities. It was not just furniture or ICT or whether open or closed off areas, but more about space and how it can be reconfigured for different purposes. Students in particular voiced their desire for the capacity for flexibility and also mobility, to rearrange furniture and also be independent and social while moving around a space (Blatchford et al., 2006; Cleveland, 2009). Students also focused on what they learnt informally in the outdoor areas as well as new indoor spaces (Croem and Bradford, 2006; DfES, 2006). Student voice and informal outdoor spaces, leisure and play (Chism, 2005; Cilisez, 2009), and use of recreational time are neglected in research (Armitage, 2005; Blackmore et al., 2011; Croem and Bradford, 2006). Yet student voice is now considered important to school improvement (Clark 2005, 2010; Fielding, 2006; Rudduck and McIntyre, 2007). Dovey and Fisher (forthcoming) in an analysis of 50 award-winning school designs selected using criteria linking pedagogy with innovative design found that the

organisation of learning commons, learning streets, classrooms, outdoor linkages, meeting rooms, staff preparation rooms and specialist spaces did not necessarily fully afford the supposed pedagogies that were purported to be operating within those school designs.

Blackmore et al. (2011) found that new built environments provided a catalyst and opportunities for teachers to work more collaboratively, in teams and across disciplines and in professional networks across schools and systems, nationally and internationally (McGregor, 2003; McGregor, 1990; Morton, 2005; Nespor, 2004; OECD, 2003). Collaboration and team teaching together with peer review, from the professional learning literature, is more likely to lead to improved student outcomes (e.g. Darling-Hammond, 2008, 2002, 2001; Elmore, 2007; Gijlers et al., 2009), but only with significant teacher professional development and supportive school cultures (Given et al., 2010). Collaboration is not without issues: loss of autonomy, tension over work allocation, greater communication and interdependence among teachers and responsibility to share and communicate with others (Grant, 2009; Ministry of Education, New Zealand, 2013; York-Barr, Ghere and Sommerness, 2007).

2.2.3.4 Sustainability of the physical learning environment over time with different teacher and student cohorts

With the notable exception of a report commissioned by the UK Department of Education and Skills (PricewaterhouseCoopers, 2003), there is little recent literature that focuses on the long-term effects on student learning of new physical spaces and built environments. In part this is because there is a time lag between recent system-wide reform initiatives commencing in the early 2000s and now further stimulated by the Building the Education Revolution in Australia and the United Kingdom. One issue, as Langer (2005) indicates in US studies, is a lack of on-going funding for "green schools" means many sustainable strategies (e.g. reduced energy bills, less emissions, improved indoor quality) are limited, thus compromising both the design and opportunities to make schools into "living labs". Likewise, lack of maintenance and care for appearance has a downward effect in the long run in terms of how students, teachers and communities perceive their school (Plank, Bradshaw and Young, 2009). One of the few longitudinal studies of effects of neighbourhood, schools, peers and families on school success for middle year students by Bowen et al. (2008) found improvement in school engagement, trouble avoidance and grades. There is generally inadequate funding available for on-going maintenance, upgrade and change of purpose (i.e. more flexible learning spaces for learner-centred pedagogies) (Caldwell, 2009).

The question is, after the criterion of sufficiency is met (and what that means is context specific), is whether there a limit to which the built environment may indirectly have impact on learning and other outcomes? The literature suggests that improvement could plateau but again there is little evidence. It also depends on what element(s) of design are being considered light air quality, scale, usage in relation to what outcomes (social, affective or cognitive) and for what uses. In general, there is an inability of the various research paradigms (engineering architectural, psychological, critical pedagogy, ICT) to talk with and learn from each other, even though all are concerned about improving student learning. These are all discrete disciplines, each with their own professional associations and journals, and few are sufficiently cross-disciplinary to consistently and sustainably support such research and debate. More recent research is addressing this issue (see Blackmore et al., 2011).

2.3 Overview of evaluation tools

Few methodologies have included an outcome measure such as student performance to evaluate the effectiveness, efficiency and sufficiency of the physical learning environment. In general, qualitative research methods such as interviews, walkthroughs and visual methods of data collection - and stakeholder questionnaires - have been used to identify deficiencies in the physical learning environment at the school level and how to address them. For example, Sanoff's assessment tool (2001), the Building Evaluation

Assessment Method (BREEAM), Wolff's problem-based design model (2003) and the OECD Evaluating Quality in Education Spaces (EQES) pilot project (2009) all borrow from post-occupancy-type methodologies. However, findings from these studies provided limited input to school improvement, leadership and education effectiveness research due in part to the narrow focus on environmental and other variables at the micro-level, small sample size – and the absence of outcomes and control variables (such as socio-economic background of the school and students), which would allow a comparative assessment of the net effect of the physical learning environment on performance between and within schools. This section identifies several relevant qualitative and quantitative research methodologies and findings that could inform the development and implementation of this Module. The evaluation tools have also tended to be one-off summative evaluations and not formative evaluations which could be undertaken as part of participatory design and school improvement planning and processes through the phases from design, transitioning into, consolidation and sustainability of practice.

2.3.1 Preparing for and transitioning into the new learning environment

While there may be little empirical evidence to support the positive effects of a new school on community and student engagement, teaching practices, motivation and morale, etc., qualitative research methods have yielded abundant anecdotal evidence from educators, students and the community that shows that greater engagement on the part of the school community in a new school can translate into more positive learning and other outcomes. These methods have derived from post-occupancy-type methodologies, such as the OECD Pilot Project on Evaluating Quality in Education Spaces (EQES) (OECD, 2014; 2009b). National co-ordinators, students and teachers participating in this project – which involved 22 mostly new or newly renovated schools in 7 countries – recommended involving users in the design of new schools as a policy priority to improve the usability of the current space and to improve future design. Teachers in some schools wanted to be better informed in the project phase in order to avoid missing pedagogical and functional opportunities afforded by the new building. In addition, teachers and students reported that new or recently renovated facilities in this study did have an impact on attitudes to and engagement in learning and teaching, and student and teacher well-being: the new school was a catalyst for "cultural change", students "felt a sense of pride" in the school, there were fewer incidences of graffiti in the new school, etc. (OECD, 2014). However, the absence of an outcomes variable in these studies means that limited conclusions can be drawn about the net effect of investment in new schools in terms of improvement in learning and other outcomes.

2.3.2 Consolidation of the new physical learning environment

For this phase, a range of qualitative and quantitative tools have been developed and implemented in different cultural contexts to explore the relationship between the physical learning environment and outcomes, some of which have used the dependent variable of student test scores. For example, a recent study of 751 students from 34 classrooms in seven schools in the Blackpool area in the United Kingdom analysed the "demonstrable impacts of school building design on the learning rates of students in primary schools". Findings revealed that "colour, choice, connection, complexity, flexibility and light" accounted for a high proportion of variability in students' learning outcomes (Barrett et al., 2013). In the Latin American context, recent research conducted as part of the Second Regional Comparative and Explanatory Study (SERCE) in 2006, analysed school infrastructure and utilities data reported by principals and teachers; student performance in language, mathematics and science; and socio-economic characteristics of students reported by parents and more than 200 000 3rd and 6th grade students in almost 5 000 schools in 16 countries. Findings indicated that the presence of spaces that support teaching (libraries, science and computer labs); the connection to electric and telephone utilities; access to potable water, drainage and bathrooms are most significantly associated with learning outcomes (Duarte, Gargiulo and Moreno, 2011).

Other studies have used qualitative methods to explore the relationship between the physical learning environment and outcomes. In 2004, the Ministry of Education Property Management Group commissioned ACNielsen to complete a study on the factors influencing learning outcomes in classroom and learning environments in New Zealand. School principals in 15 primary and secondary schools identified reducing environment-related stress, enhancing pride of the school and classroom, allowing flexibility and variety in teaching tools and methods to deliver the curriculum, and enhancing students' concentration. Teachers cited the main design-related constraints to learning as lack of classroom space, poor ventilation, poor acoustics, inadequate lighting, seating discomfort, and poor décor/room maintenance, although reporting did vary in primary and secondary schools. A recent post-occupancy evaluation of five learning hubs in New Zealand (2013), conducted two years after the hubs were constructed, revealed a significant increase in student retention and greater confidence reported among teachers to use the learning space more effectively. Similar tools (see Cleveland and Soccio, forthcoming; Fisher, 2003; 2005; LEARN, 2012; OECD, 2014) have been developed to evaluate the quality of the physical learning environments for the purpose of improving the technical performance of new and existing schools, better aligning pedagogy and use of space; and streamlining the re-design process.

2.3.3 Sustainability of the physical learning environment over time with different teacher and student cohorts

Given governments' substantial investments in education infrastructure, relatively few methodologies have been developed to demonstrate the benefits of capital investments over time. One of the few research studies demonstrating a positive and statistically significant relationship between capital investments and student performance, particularly in community primary schools, was undertaken in 1999 by PricewaterhouseCoopers (2003) at the request of the UK Department of Education and Skills. A quantitative analysis of performance and investment data from 2 000 schools showed that the strongest positive correlations between investment related directly to the teaching of the curriculum, such as ICT-related capital spending and science blocks. Qualitative evidence drawn from interviews with headteachers, local area authority officials and others supported these findings, especially for "suitability"-related projects such as science laboratories, ICT suites, etc. and "condition"-related projects such as improvements to windows. Interviews also highlighted the wider benefits of capital investments for the community, particularly in those schools located in areas of high economic and social deprivation; for beneficial inter-agency partnerships with the school; and for improved health outcomes,

2.4 Conclusion

Analyses of the different tools developed to measure or explore the complex relationships between the physical learning environment and outcomes reflect the inherent challenges of developing a "best-fit" model to evaluating outcomes. Post-occupancy-type methodologies effectively capture the contextual issues and challenges in each school, but applying the lessons learned to improve future school design is difficult to achieve and the absence of empirical evidence demonstrating "value for money" is likely to weaken the policy impact of findings from these studies. In contrast, quantitative methodologies to date have interpreted outcomes only in terms of student performance measures, and models have focused on the built environment, to the detriment of pedagogy and the organisation of learning. There is therefore a need to develop *analytical tools* that borrow from both qualitative and quantitative approaches and *analytical models* that consider the physical learning environment as an influential element in the complex and highly contextualised nature of learning.

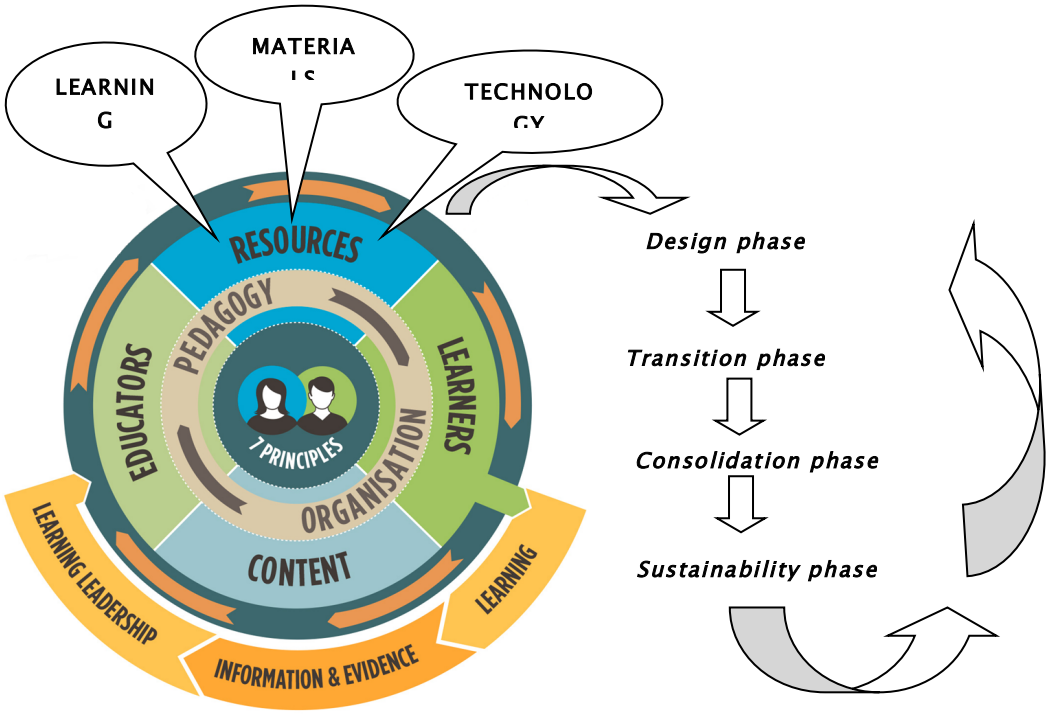
The evidence indicates that the built environment has indirect effects related to learning and other outcomes because space and ICT mediate relationships between teachers and students and their communities. Well-designed buildings and facilities with integrated ICT can be the catalyst for teachers developing innovative pedagogies that impact on student learning. Improved student learning is most likely

if there are certain conditions or affordances. These include teacher input into design and organisational planning as to the use of space relative to school improvement objectives, teacher professional development and system-wide enabling policies (Braun, Maguire and Ball, 2010). While innovative pedagogies that are most likely to improve student learning do not rely on new built spaces, well-designed learning spaces provide multiple affordances for innovative pedagogies through flexibility (Heppell et al., 2004), adaptability and connectivity.

Evidence suggests that flexible spaces can encourage more effective teaching (Anderson-Butcher et al., 2010, Oblinger, 2006) and team teaching, better planning, use of more diverse pedagogies, greater focus on personalised learning, and students to be self-reliant learners capable of working in groups (Dekker, Elshout-Mohr and Wood, 2006; Fielding, 2006). At the community level, new or significantly renovated built environments can attract students, particularly in high poverty and poor infrastructure communities, impart a sense of ownership to the community and can lead to greater involvement of parents, community and other organisations (Lupton, 2005; PricewaterhouseCoopers, 2003). Developing and sustaining the benefits of new or renovated built learning environments requires system-wide support through supportive policies (MacBeath, 2008), additional resources at the design and transition phase (Keating, 2008), professional learning linked to school improvement frameworks, and school and teacher leadership focusing on pedagogical practice (Day et al, 2009; Day and Harris, 2002; Halllinger, 2003; Hallinger and Heck, 2010).

This Module would provide a significant evidence base as to how built learning environments are conducive to school improvement. Data from this Module could be used with the multiple existing and emergent sources of data available to principals and teachers that inform practice.

Figure 2.1 Organising framework for the learning environment



Source: Adapted from OECD (2013b), *Innovative Learning Environments,* OECD Publishing, Paris.

3 RESEARCH QUESTIONS

This section briefly describes the broad research questions that arise from an analysis of the evidence base. These research questions will guide the development of the Module:

1. What is an "effective" and "efficient" physical learning environment?

Issues of efficiency have come to the fore (OECD, 2013c) because of greater diversity of student populations, reduced government funds, and inequities in student outcomes. It raises issues about how resources could be best allocated to optimise their impact on quality and equity in schooling. **The Module** should seek to define and evaluate an effective physical learning environment with reference to which resource **inputs** (e.g. characteristics of classrooms, school buildings and other spaces, technology, etc.) can be used in educational activities to produce the desired **outputs** (such as completion rates, diplomas and learning achievements) and the **processes** in between.

2. Under what conditions can the physical learning environment be "effective" and "efficient" (i.e. considering spatial, temporal, socio-economic and other contexts)? What critical factors impinge on the provision of effective and efficient learning environments?

The impact on a student of the physical environment is masked by contextual factors that may be social, economic, technological or demographic in nature; by other aspects of their environment; or by the broader objectives of the education system (Figure 2.1). **The Module** should seek to describe the different conditions under which the physical learning environment can be effective and efficient (or ineffective and inefficient), focusing the conditions that can improve or hinder learning and other outcomes.

3. Who are the stakeholders, drivers and beneficiaries of effective and efficient learning environments (i.e. students, teachers, parents, architects and designers, community, local authorities, policymakers)?

There are multiple stakeholders in provision of the physical learning environment. **Systems** want economies of scale, efficiencies and capacity for buildings to adapt over time to contraction and expansion while sustaining performance; scaling up of effective practices and improved outcomes. **Principals** provide supportive and caring processes, cultures and learning spaces; balance demands on limited time, resources and space; manage risk; and address parental and community perceptions around school environment. **Architects and designers** want quality of design, sustainability and to meet client needs. **Students** want enjoyment, to be with friends, experience success, express desire, be independent, feel safe and imagine a future. **Teachers** in this tangled set of relationships need to be seen as "adaptive experts" juggling efficiency (multi-tasking, organising to meet goals and not being overwhelmed) and innovation (moving beyond existing routines, rethinking key ideas, questioning assumptions, values etc.) (Hammerness, 2004; Hammerness et al., 2005; Nespor, 1997). Teachers want to adapt environments to suit pedagogies and diversity of student needs but have little time or energy to constantly change classroom configurations. **The Module** should seek to identify the stakeholders driving the effectiveness and efficiency agendas at the system, community, school and student levels, and the beneficiaries of these efforts.

4. What are the wider benefits and impact of the physical learning environment over time?

The temporal dimension of school improvement has always been significant. The time frame regarding judgments about efficiency and effectiveness are often longer than desired by those investing in capital works. School improvement studies indicate that reform can take a number of years to be embedded

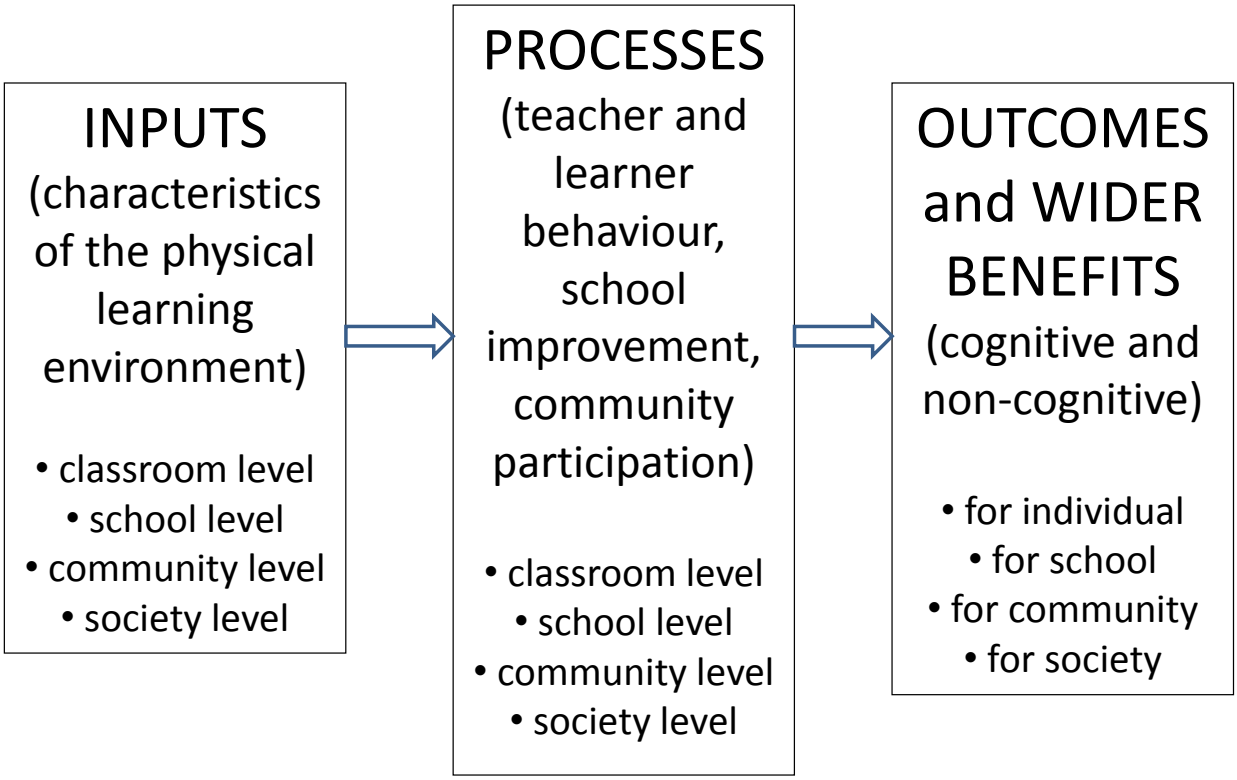
into and sustained in practice in a whole of school approach. And there is significant planning time to develop concepts around new built environments that are premised upon sound pedagogies and the community needs. After initial capital expenditures, serial redesign requires ways of thinking about how existing equipment and space can be reconfigured to address the needs of the next generations of teachers and students so that innovation can be maintained. **The Module** should seek to illuminate how the effective distribution, planning, use and management of resources over time can yield long-term benefits, for example although ICT often requires more time in terms of maintaining infrastructure and technical support, but "speeds up" how students and teachers undertake activities of learning and communication.

4 LINKING THE PHYSICAL LEARNING ENVIRONMENT WITH OUTCOMES

4.1 Outcomes and predictive factors

This section presents the multi-dimensional and complex interdependence of physical learning environment (input), learning and other outcomes and wider benefits (output), and the potential processes in between (Figure 4.1). The elements of physical learning environment and the processes have been divided into four levels: classroom; school; community; and society.

Figure 4.1 The general conceptual model on how physical learning environment may generate outcomes



4.1.1 What are the potential outcomes?

The general aim of LEEP is to produce instruments and provide information and advice to individual schools, local authorities and the wider community to assist school improvement efforts. Tools developed in the project will help to analyse how investments in learning environments (in this module, the physical learning environment) translate into improved cognitive, learning, social, affective, health and wellbeing and behavioural outcomes leading to more efficient use of education resources.

There are several challenges in defining these potential outcomes. It would be possible to narrow down these into "outputs" or cognitive learning outcomes measured either by grades or standardised tests like PISA. Or, alternatively the outcomes could be conceptualised more widely to include also other skills

and competencies like social skills and learning skills. There is also the question whether outcomes should be analysed against the aims of national or local curriculum, which may include objectives like innovation and entrepreneurial skills, sustainable development, internationalisation and so on. Another question is the time perspective as this Module may address immediate or short term outcomes (like learning results, wellbeing at school) and also so-called wider benefits (like increased learning motivation, wellbeing in adulthood). Finally, consideration must be given to whether the outcomes are measured at individual (student), school (teacher/principal), community or society levels (social cohesion, active citizenship, etc.).

4.1.1.1 Defining outcomes

According to OECD (2013c), there is little consensus about the desirable outputs of schooling, partly because education systems have different accountability systems and general objectives. For the purposes of the LEEP project, cognitive learning outcomes are defined as the core skills (reading, mathematics and science literacy) measured by PISA. These skills are fundamental for students' success in future study, employment and in life more generally. Alternative measures of outcomes could be the grades achieved by students. These may provide some information on learning outcomes, but the reliability and comparability of grades are often questioned (OECD, 2013c). Other widely used measures of learning outcomes in efficiency studies are the results achieved by students on standardised assessments (like PISA), but these are typically implemented only for certain age groups in a few core subjects and cover only a small range of intended curriculum goals (OECD, 2013c).

The challenge is to define educational outcomes more widely than as cognitive learning results only. Most studies of educational effectiveness and efficiency try to use precise measures of educational output by focusing on the readily measurable learning outcomes achieved by students (OECD, 2013c). The CERI Innovative Learning Environments (ILE) project (OECD, 2013b), on the other hand, has sought to go beyond school effectiveness research that has conventionally used limited measures of cognitive learning outcomes (OECD 2013b). The ILE project (OECD, 2013b) listed as learning outcomes:

- Knowledge and general cognitive outcomes;
- Deep understanding, specialist knowledge and expertise; and
- 21st century skills, values, self-regulation and social competences.

4.1.1.2 Wider benefits

A new OECD Review on Policies to Improve the Effectiveness of Resource Use in Schools (OECD, 2013c) aims to focus on school outputs that occur in school or immediately after schooling, but in addition consider the longer-term social outcomes of learning (e.g. social mobility, engaged citizens, earnings and work productivity), mostly drawing on the extensive work undertaken by CERI on Social Outcomes of Learning and Education and Social Progress (see OECD, 2007a). This so-called wider benefits approach in educational studies (see Desjardins, 2008a) is used to analyse how individuals, groups, organisations and society benefit from education. The main idea is to explore the wider outcomes and benefits, rather than only immediate learning outcomes and formal degrees obtained in the education system.

There are several well-known studies of the benefits of formal education (schooling, further and higher education), some of which have also a lifelong learning perspective (for example Desjardins, 2003) or focus on adult education (for example Feinstein and Budge, 2007; Feinstein et al., 2008; Manninen, 2010). The research conducted so far has focused mainly on the economic returns of education, but the social and personal returns of learning have been relatively under-researched. Some exceptions are

OECD projects on wider benefits (OECD, 2007a; 2010a) and research conducted at the University of London Centre for Wider Benefits of learning (e.g. Feinstein et al., 2008). Current research tends to focus more on the private, external, public and non-monetary benefits of education and learning (compare Desjardins, 2008b; Kil, Operti and Manninen, 2012; OECD, 2007a). In some new research, Fisher, Kvan and Imms (2013) are tracking students from secondary school to university to explore the relationships between innovative learning environments and teaching in secondary schools and performance at the university level.

Wider benefit studies (e.g. Darling-Hammond, 2002; Feinstein and Budge, 2007; Feinstein et al., 2008; Manninen, 2010; Schuller et al., 2002) show that there is a connection between education and several benefits, such as physical and mental wellbeing, civic and social engagement, social networks, learning skills and learning motivation. There is also a link between educational level and certain psycho-social qualities, such as self-confidence, self-esteem, self-efficacy, sense of identity and purpose, and the ability to cope effectively with change. Education may also have a positive influence on societal cohesion and on active citizenship as it appears to promote trust, tolerance, civic co-operation and likelihood of voting in adulthood. Education impacts on changes in behaviour and attitudes, on several health-related issues such as health behaviour (smoking, alcohol use). It also helps to develop communication and social skills, general skills, attitudes related to citizenship, creates a sense of group membership, and improves learner self-image. Studies made from the perspective of health sciences prove that educational improvements can be seen in the areas of physical health, health behaviour, and wellbeing (Blackmore and Kamp, 2008). Mental and physical wellbeing deals with a psychosocial quality that comprises an individual's own optimistic attitude and opportunities to influence one's own life (Field et al., 2000), or wellbeing in general (Desjardins, 2008b). For good summaries of wider benefits of education see Feinstein et al. (2008), Motschilnig (2012) and OECD (2007b). There is significant body of research in the health sector on the benefits of well-designed environments. Outcomes in this area, for example the impact that physical healing environment has on patient rates of recovery, are easier to measure compared to education (Ulrich et al., 2008).

The important lesson for this Module is that better learning outcomes in childhood bring wider benefits and better learning motivation in adulthood.

4.1.1.3 Outcomes for the community

Community-level outcomes should be considered as well. The following research indicates that schools as buildings have impact on the community. There is overall agreement that parental involvement significantly contributes to a school's programme and to individual student's academic and social outcomes through voluntary participation in school governance, fund raising, literacy programme or other activities e.g. fetes (Blackmore and Hutchison, 2010; OECD, 1997; Vincent, 2000). Better use of school buildings out of hours is often due to parental and community activities in sport, drama and other informal educational activities (OECD, 1998). If school buildings are used also in adult education and as community resource centres, they are likely to support student learning as well. Blackmore et al. (2011) reported two cases where a community-designed school building provided spaces for a monthly market, café and ICT and literacy programs for parents in a low SES area. A new open plan space was the catalyst for an innovative Year 6 program in a high SES area. Both spaces and activities encouraged wider student and parental engagement and satisfaction, as indicated in survey data (Blackmore et al., 2011). New built environments also attract and retain students. Wider benefit studies also indicate that participation in adult education appears to play an important role in promoting parental abilities (Feinstein et al., 2008). In a qualitative study, Brasset-Grundy (2004) shows that parents not only pay more attention to how their own children are raised but that they can also provide more support and communication when interacting with their children. Parental involvement in students' learning is seen to impact on early literacy, particularly in early childhood (Bowen et al., 2008).

Schools also promote other community-level outcomes. If schools are designed as part of precincts with multiple professional services, there are wider health, welfare and employment flow-on benefits for community and individuals due to community capacity building and neighborhood renewal (Warr, 2007). As summarised in Section 2, schools are part of residential area and community which significantly impact on educational outcomes (see Baker and Foote, 2006) by changing community perceptions of the value of learning, and as symbolic recognition by the council or the state. Parental and local community participation have positive but intangible outcomes as the physical environment of the school reflects the culture and aspirations of the community and indicates it is respected and valued (Flutter, 2006).

Increased adult participation around the local school may also promote additional benefits. Preston (2004) shows that people involved in adult education activities become politically active, vote and are on the whole politically motivated. Social networks build trust in others and in decision makers. Field (2005) shows that participation in adult education is closely linked to further involvement in social and community activities.

4.1.2 Predictive factors – how the physical learning environment may contribute to outcomes

The research findings cited in Section 2 include many aspects of physical learning environments that may contribute to improved outcomes in the **built environment** and in the **organisation of learning and pedagogy**. As mentioned earlier, the link is not direct and causal, but more indirect and conditional. Some aspects like temperature, ventilation and safety can be defined as basic conditions for learning (Barrett et al., 2013; Earthman, 2004; Keep, 2002; Higgins et al., 2005; Lackney and Jacobs, 2004; McNamara and Waugh, 1993; Picus et al., 2005; Sundstrom, 1987; Weinstein, 1979), some as more relative aspects, like colours used in classrooms, plants and aesthetics (Good, 2008; Higgins et al., 2005; Sundstrom, 1987, Temple, 2007) and Rinaldi, 2003 cf to Fisher, 2001, 2002, 2005 and JISC, 2006, Melhuish, 2009; Lomas and Oblinger, 2005; Nair, Fielding and Lackney, 2005), which may contribute to learning outcomes as well, although empirical evidence on that is relatively limited. Some aspects are related to space design, for example how flexible and adaptable the physical space is (Anderson-Butcher et al., 2010; Armitage, 2005; Barrett and Zhang, 2009; Edwards and Clarke, 2002; Gislason, 2007, 2009, 2010; Goodyear, 2000, 2008; Heppell et al., 2004; Jamieson et al., 2000; Leander et al., 2010; Oblinger, 2006). Table 4.1 summarises these findings.

Table 4.1 Summary of relevant inputs to the physical environment identified in the research

Level of analysis	Inputs to the physical learning environment
Classroom	• Environmental conditions. i.e. comfort, safety, noise, temperature, air quality, ventilation, lighting, colour, aesthetics, plants and furniture design; • Technology. i.e. ICT infrastructure, hardware and software, connectivity, presentation devices and audio systems, specialist equipment; • Space design. i.e. adaptability over time, space flexibility facilitating pedagogical flexibility; and • Inclusivity. i.e. disability access, cultural design principles.
School	• Organisation. i.e. multi-campus schools (K-12, junior/senior, work annexes), community spaces; • Space design. i.e. flexible, user friendly, environmentally sustainable; • Interconnectivity with other learning spaces (i.e. school grounds, home, work, community); and • Inclusivity. i.e. disability access, common spaces, outdoor spaces, gendered spaces, places of play.
Community	• Location relative to other schools and accessibility (transport); • Multifunctionality of spaces; • School as community learning and social hub (after school activities, library etc.); • Site in service precinct for interagency collaboration; • Time use (core school and non-core school hours); • Appearance; and • Environmental sustainability.
Policy	• Governance structures regarding allocation and distribution of resources; • General policies, for examples regarding access, ICTs, teaching time, teacher training, etc.; and • Construction codes, regulations and guidelines.

An interesting research question is: can shared community spaces (libraries, sport facilities, etc.) increase parental involvement, and how might this affect student learning outcomes? In particular, what is the changing role of libraries and their impact on learning outcomes e.g. information literacy. Can quality and maintenance of learning spaces (furniture, technologies and general improvements) invite greater community involvement in schools, and more efficient use of buildings?

4.1.3 The potential processes – how do the outcomes develop?

Earlier research indicates that built environments have impact on learning outcomes, but this impact is indirect and mediated through several processes. It can act as a catalyst (or hindrance) and opportunity for innovation and more modern teaching methods and learning processes (Blackmore et al., 2011; Lingard et al., 2003; Hattie, 2011; Oblinger, 2006; OECD, 2013b; Thomson, Jones and Hall, 2009). Table 4.2 summarises these processes at different levels.

Table 4.2 Summary of potential processes mediating the link between physical environment and outcomes

Level of analysis	Processes

Classroom	• Changing teacher practice and pedagogical approaches; developing teacher skills and competencies; nurturing teacher professional identity
	• Providing a catalyst for innovative pedagogies, professional relationships and different communication practices; and
	• Facilitating a pedagogical focus on:
	  • Teacher and student interaction, behaviour, morale and practices;
	  • Wellbeing, satisfaction, attractiveness etc.;
	  • Personalised learning (personalised space);
	  • Affective learning (sense of place, care);
	  • Student and teacher ownership of space; and
	  • Professional collaboration and planning.

School	• Pedagogical leadership encouraging a culture of learning and innovation; • Whole of school change management: timetabling, dedicated teacher time for planning and experimentation with space utilisation, curriculum design to integrate spatial and ICT; • Professional development and general capacity building through participatory design and redesign i.e. teacher renewal; • Attention to extracurricular activities, informal learning and interaction in informal spaces; and • Focus on environmental sustainability.
Community	• Context (socio-economic status of the community etc.); • Community and neighbourhood renewal; • Community relations; use of shared spaces; • Specialist schools e.g. science and technology, environmental sustainability; • Scaling up innovation across systems, interschool professional networks; • Parent involvement (funding, equipment, expertise); and • Research interest
Policy	• Funding, government investment; • Enabling policies focusing on innovation; • Additional resources (teachers, coaches etc.); • School improvement frameworks; • Professional learning frameworks; and • Partnerships (industry/universities/technical).

Teachers also tend to have a stronger sense of professional efficacy and commitment if involved in school design and implementation of innovation which in turn scales up into professional and school renewal. Teachers are also more likely to be attracted to and retained in quality built environments (Pricew aterhouseCoopers, 2003).

4.1.4 Outcome measures related to the physical learning environment

The Framework has defined outcomes according to the literature on outcomes. For example Higgins et al. (2005) use in their literature review as outcome categories attainment, engagement, affect, attendance and wellbeing. Similarly, outcomes in this Module are defined as both cognitive and non-cognitive, and relating to the built environment and pedagogy and the organisation of learning. The principal cognitive outcome measures in the Module are the PISA standardised test scores in reading, mathematics and science. Other outcomes are:

- **Learning**, as indicated by improved engagement in teaching and learning; development of critical thinking, self-managed learning, digital literacy, spatial literacy, environmental awareness, etc.

- **Social**, in terms of perceptions of improved student/teacher relations, working in teams, communication skills, etc.;

- **Affective**, as indicated by individual's perceptions as to a sense of belonging and self-efficacy;

- **Health and wellbeing**, including physical and emotional health and wellbeing; and

- **Behavioural,** related to retention, vandalism, absenteeism, disruption in class, etc.

A challenge for measuring outcomes is the fact that the number of potential outcomes is very large. Some of these outcomes are intended (like learning objectives stated in the national and school curriculum) or unintended and intangible longer term outcomes like parental support for learning through increased community involvement, or wider benefits like increased self-direction, active citizenship and wellbeing in adulthood.

Educational systems also have rather general objectives stated in national or school curriculum, or by international organisations like OECD and EU. These objectives include for example:

- Support for **innovation** or **innovative pedagogies** and **creativity** for all users (OECD, 2013b);

- Promote health, happiness, wellbeing, engagement, social participation and self-efficacy for the community, students and teachers;

- **Improve teacher effectiveness** and support **socio-constructivist** approaches to learning (i.e. co-operative, enquiry-based, individualised and adaptive approaches to learning) (OECD, 2010c);

- Prepare students for the **workplace** and working life;

- Foster **21st century skills and competencies** – grit, tenacity and perseverance (Shechtmann, et al., 2013) and "deep learning" (Fullan and Langworthy, 2013);

- Support formal and informal learning through provision of **formal and informal learning spaces**; and

- **Cross-curricular themes**, for example these listed in Finnish national core curriculum for basic education (2004): Growth as a person, cultural identity and internationalism, media skills and communication, participatory citizenship and entrepreneurship, responsibility for the

environment, wellbeing, and a sustainable future, safety and traffic, and technology and the individual sustainability, active citizenship, entrepreneurship.

For the LEEP Module, the practical precondition for identifying the outcomes is which outcomes (1) need to be prioritised and (2) are possible to measure empirically, keeping the available research resources in mind. These outcomes are summarised in Figure 4.1. The selection of outcomes is also based on already existing PISA tools (cognitive learning outcomes on reading, mathematics and science as well as some contextual measurement tools) (see Annex 1), and on the potential of new measureable outcomes.

In an effort to map and describe the whole phenomena in its all complexity, Table 4.3 summarises all potential outcomes described earlier in this document. Cognitive learning outcomes are measured by PISA and PISA-based Test for Schools. In addition, PISA and PISA-based Test for Schools measure also non-cognitive outcomes like attitudes, beliefs and motivation.

Table 4.3 Summary of potential outcomes

Level of analysis	Outcomes	Wider benefits
Individual	*Cognitive outcomes* (core skills from PISA and PISA-based Test for Schools): • Mathematics; • Reading; and • Science. *Other outcomes* : • Self-confidence, independent learning, collaboration and working in teams, and communication; • Critical thinking, self-managed learning, digital literacy, spatial literacy, environmental awareness; • Sense of control and personal autonomy; • Health and wellbeing; • Engagement with learning; and • Retention and completion.	• Learning skills • Motivation for lifelong learning; • Workplace preparation; • Resilient identities; • Environmental sustainability; • Active citizenship; • Entrepreneurial skills; • 21st century skills; and • Health and wellbeing.
School	• Attracting and retaining students; • Teacher renewal; • Teacher retention; • Teacher continuous learning communities; • School development, • Interagency collaboration; and • Environmental sustainability.	
Community	• Parental support for learning; • Community ownership and involvement; • Partnerships: industry, university, NGOs; • Neighbourhood renewal; and • Reduced vandalism.	

Society	• System renewal; • Scaling up innovation; • Increased retention and completion; • Education for life-long learning; • Community regeneration and capacity building; • Interagency collaboration integrating professional services; and • Social cohesion and improved measures of social capital.

4.2 Illustrating the conceptual model on how environment and outcomes are linked

Figure 4.2 presents only those inputs, processes and outputs we are going to measure in LEEP.