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).

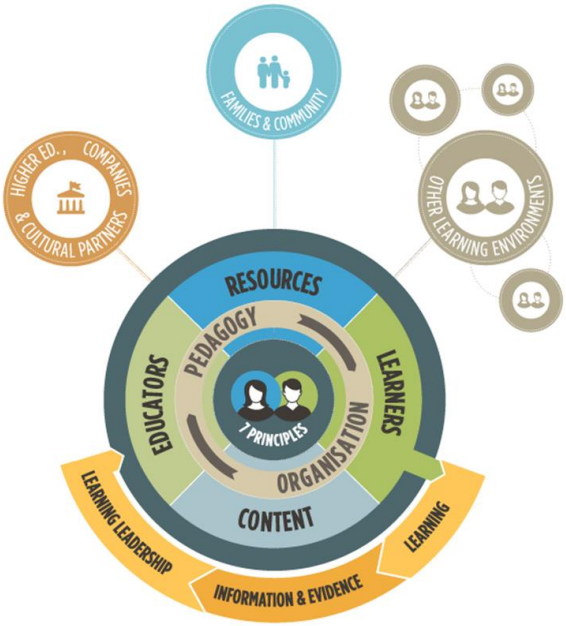


Figure 1.1 The learning environment: wider partnership circle.
Source: OECD (2013b), *Innovative Learning Environments*, OECD Publishing, Paris.

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.

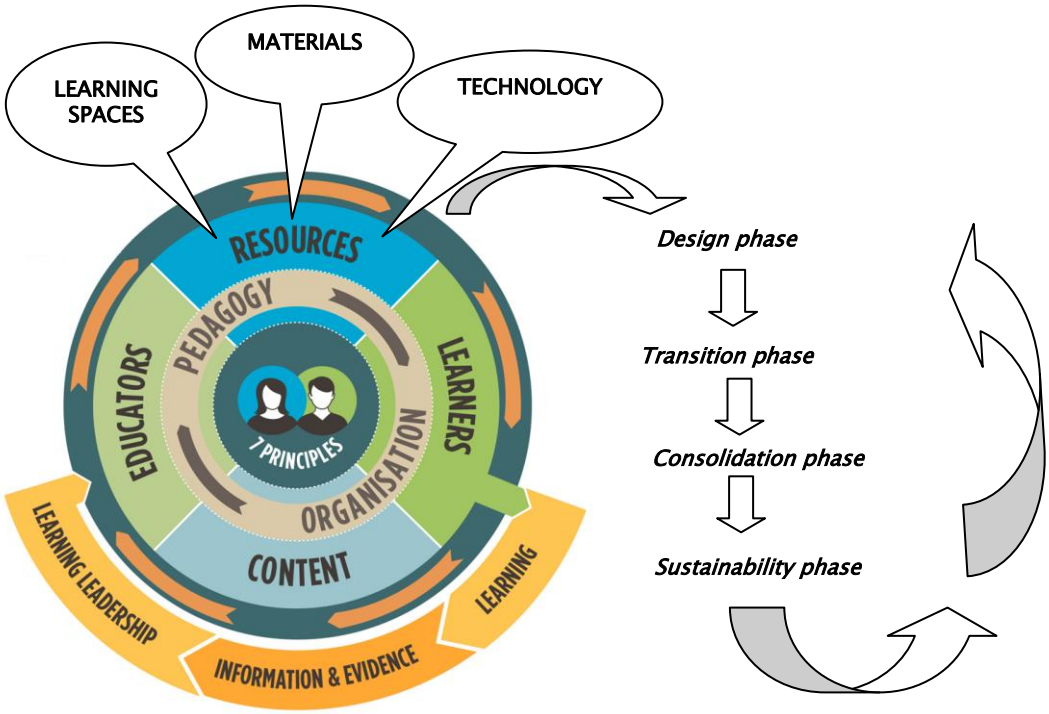
The evidence indicates that the built environment has indirect effects related to learning and other outcomes because space and ICT mediate relationships between teachers and students and their communities. Well-designed buildings and facilities with integrated ICT can be the catalyst for teachers developing 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?

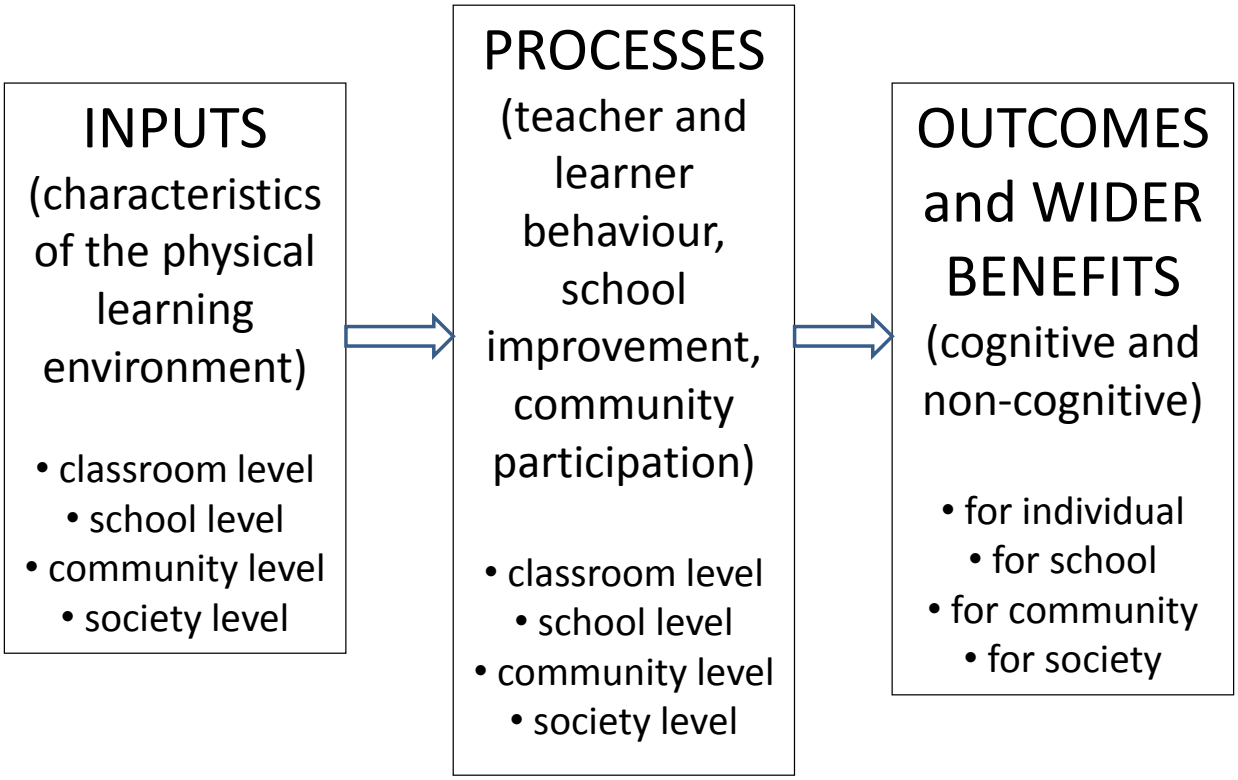
The temporal dimension of school improvement has always been significant. The time frame regarding judgments about efficiency and effectiveness are often longer than desired by those investing in capital works. School improvement studies indicate that reform can take a number of years to be embedded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

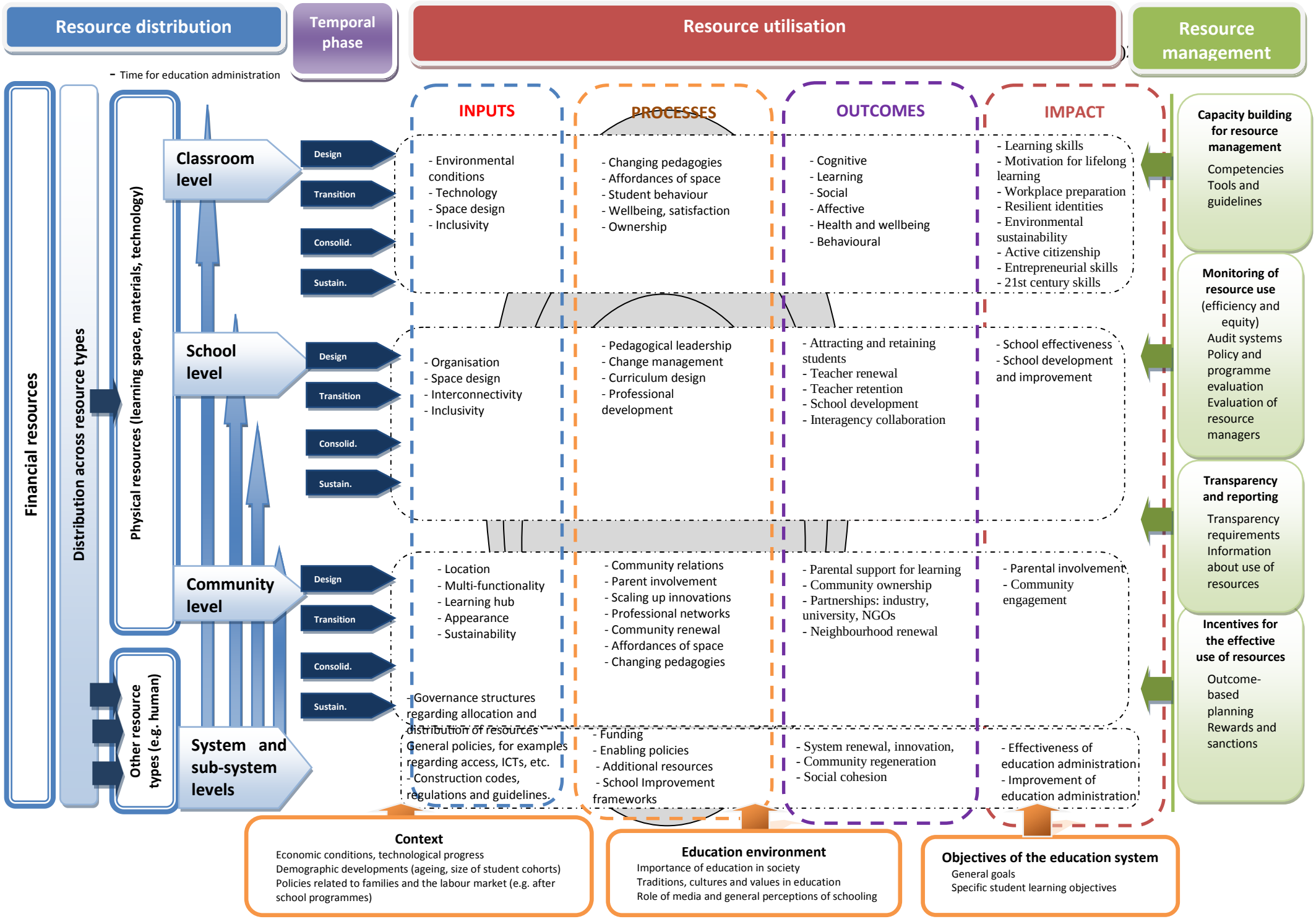
Level of analysis	Outcomes	Wider benefits
Individual	*Cognitive outcomes* (core skills from PISA and PISA-based Test for Schools): • Mathematics; • Reading; and • Science. *Other outcomes* : • Self-confidence, independent learning, collaboration and working in teams, and communication; • Critical thinking, 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.

Figure 4.2 Conceptual framework for the Module using an efficiency framework (adapted from OECD Efficiency project)



5 IMPLEMENTATION OF THE MODULE

5.1 Introduction

This section explores different parameters to consider with regard to the implementation of the Module, including suggested respondents; options for implementing the Module, for example with the PISA-based Test for Schools; possible formats for the Module instruments;; and sampling issues. Drawing on previous sections, a number of focus areas and sample questions are presented for inclusion in the Module instruments. As described in the Introduction, a "Module" is defined as a resource, which when applied, will provide schools with advice on a particular area of the learning environment, for example the physical learning environment. So each Module is modular in the sense that it is composed a specific set of questions, which can be implemented to support school improvement efforts:

- As part of the contextual information collected alongside the PISA-based Test for Schools, in accordance with the agreed guidelines for the implementation of the test (OECD, 2013a);
- With other national or sub-national student assessments; or
- As a self-evaluation instrument by individual schools.

The section concludes by presenting some options for reporting results from the study and reflections on the future development of the LEEP Modules.

5.1 Possible respondents

In order to best capture the "lived experiences of space" in this Module, three "voices" should be heard:

- Students;
- Teachers; and
- School principals.

It is expected that some respondents may be more appropriate than others to address the issues raised in this section (e.g. about leadership, preparation of teachers to use new spaces, etc.), while asking different respondents similar questions may result in some interesting comparisons (e.g. about connectivity, safety, etc.). While the use of questionnaires is proposed as the main data collection tool, the use of other methods, such as interviews, focus groups and observation involving students, teachers and the school principal, may be useful as a follow up to data analysis for example to assist the school to address the issues and challenges to school improvement identified in the data analysis.

5.2 Options for implementing the Module

5.2.1 Using the Module with the PISA-based Test for Schools involving students and school principals

In PISA and other international surveys, questionnaires have been the main means of collecting data on student outcomes and perceptions on the learning environment for the purpose of international comparison. Respondents are normally asked to choose an option from a list or to indicate on a scale known as a Likert scale. This scale gives respondents the opportunity to indicate, for example, how much they agree or disagree with certain statements.

For students, the PISA test consists of a two-hour cognitive assessment in reading, mathematics and science followed by a 30-minute background questionnaire. The same timing is used by the PISA-based Test for Schools. Contextual information is obtained from students and principals using background questionnaires known as the "student" and "school" questionnaires, respectively. Core components of the background questionnaires are included in every cycle of PISA and in the questionnaire for the PISA-based Test for Schools. There are also questions which focus on the major subject domain of assessment, which changes from cycle to cycle - in 2012 it was mathematics, while in 2015 it will be science. The types of questionnaires possible are:

- The ***student questionnaire****: In PISA this questionnaire* collects data about the student's home background including parents' occupation and education levels and language spoken at home as well as the student's attitudes to learning, including perceptions of teaching, the psycho-social classroom and school environment and self-concept. There are standard PISA indices calculated from the student questionnaire which can be replicated for the LEEP Module (for examples see p.115, OECD, 2010c).

- The ***school questionnaire****: In PISA this questionnaire* collects data from principals about school location, school size, teaching staff, physical and education resources of the school and the principal's perceptions of how resources are used and if there are particular hindrances to the education of the students in the school. In addition to the main student and school questionnaires, there are short optional questionnaires which countries can implement if they wish. These questionnaires include a parents' questionnaire, an ICT familiarity and perceived future educational careers. Full details of the existing PISA questionnaires are found in the *PISA 2012 Assessment and Analytical Framework: Mathematics, Reading, Science, Problem Solving and Financial Literacy* (OECD, 2013d). There are standard PISA indices calculated from the school questionnaire which can be replicated for the LEEP Module (for examples see p.122, OECD, 2010c).

- The ***teacher questionnaire***: In the past, the OECD has successfully gathered data from teachers through its Teaching and Learning International Survey (TALIS). With a focus on lower secondary education in both the public and private sectors, TALIS examined important aspects of teachers' professional development; teacher beliefs, attitudes and practices; teacher appraisal and feedback; and school leadership in 24 participating countries (OECD, 2009a).

But teacher questionnaires has never been part of the PISA survey, mainly because in the standard PISA survey, the student sample is age-based, not class-based, meaning that the sample could be spread across grades and across classes within grades. In PISA, therefore, it can be difficult to link teachers to students with the aim of exploring successful teaching strategies or, in the case of LEEP, linking teachers' perceptions of the learning environment with student outcomes. However, a teacher questionnaire will be included as an option in PISA 2015.

In the PISA-based Test for Schools, it is more likely that students can be sampled in class groups and so a teacher questionnaire would yield significant data. An opportunity, therefore, arises with the LEEP Module to evaluate the relationship between teacher perceptions of the environment and their teaching style, self-concept and morale and how this informs their practice. It could also get teachers' views about their attraction to the school and teacher retention. There would probably be no need to restrict items for teachers to the 10 minutes suggested for students. In addition, there is the possibility of adapt the teacher questionnaire in PISA 2015 to the PISA-based Test for Schools and LEEP.

A proposed model of implementing the LEEP Module is to develop additional PISA-type questionnaire items for students and school principals. These items could be:

- Integrated into the existing PISA background (student and school) questionnaires. This would yield a large amount of data about the school, students, the teaching staff and the resources of the school, keeping in mind that any correlations observed are at the school level, not the student level. For a more detailed description of the information available from these sources please refer to Annex 1. The Module would thus need to be of a restricted length to ensure that the students are undertaking the test in conditions similar to PISA. It might reasonably be expected that the LEEP Module could be the same length as the optional ICT Familiarity Questionnaire which has 56 response points spread through 10 questions and which takes students 5-10 minutes to complete.

- Implemented independently, without the PISA background (school and student) questionnaires. Although this option would yield less data about other aspects of the school and student, more time could be devoted to the Module, say an additional 20 minutes per respondent. 5.2.2 Using the Module with other national or sub-national student assessment

Another model is to implement the Module with an existing national or sub-national cognitive assessment instrument, for example the National Assessment Program – Literacy and Numeracy (NAPLAN) in Australia, which is an annual assessment for students in Years 3, 5, 7 and 9 or Provincial Achievement Tests in Canada for students aged 3, 6 and 9. The PISA-based Test for Schools would therefore not be used as the cognitive assessment instrument. While this would not allow eventual cross-country comparison, it may be more convenient for countries to integrate the Module into existing evaluation and assessment frameworks.

5.2.3 Using the Module as a self-evaluation instrument

A further model would be to simply implement the Module independently of any other assessment. This would give schools and systems a prompt, detailed set of data pertaining to their physical learning environment which they could use for school improvement and use as a starting point for future assessments of the physical learning environment. Valuable information would still be obtained about perceptions of the physical learning environment. Should this independent Module be implemented the opportunity exists to increase the number of questions and the time set aside for administration.

5.3 Format of the Module

As described above, PISA background questionnaires are typically composed of multiple-choice questions, with some restricted open-ended questions. While the LEEP Module presents an opportunity to use qualitative research methods (e.g. interviews, focus groups, observation, visual methodologies, see Blackmore, et al., 2007) with the cognitive assessment instruments, allowing a more profound understanding of different outcomes and the nuanced relationships, practices and interactions in the physical learning environment - which cannot be captured by empirical data alone - these methods have

serious resource implications, both in terms of the cost of implementation, respondent burden and comparative analysis (see OECD, 2014). Therefore, it is proposed that the format Module comprise:

- Multiple-choice questions on a Likert scale to enable in-school comparisons;
- Some open-ended questions, which would provide anecdotal evidence from teachers, students and school principals; and
- Contextual questions in a separate questionnaire to record the details of the physical learning environment in which the student, teachers and school principals interact.

5.3.1 Open-ended questions

Although the PISA background questionnaires do use open-ended questions, these questions are structured or very limited in their response patterns - for example "What is your father's main job or what level of education did your mother reach?". The main issue with using open-ended responses is that there needs to be a very clear rubric to record the responses consistently across schools. The disadvantage is that this process is more expensive and time-consuming because coders must be trained and employed to assess each response.

5.3.2 Collection of contextual data

It may be useful to collect information relating to "objective" aspects of the physical learning environment, which can be correlated with performance data and also compared with student, teacher and other perceptions of for example accessibility, comfort or health, and other non-cognitive outcomes, for example, health and wellbeing. The test administrator could complete a short questionnaire about the building where the test is taking place. In addition to allocating the correct booklets to the individual students, test administrators have to record the timing of the assessment, the number of students present and any problems that may contribute to a non-standard administration of the test. Currently for PISA, the ratio is a maximum of 43 students per test administrator, which means that there are two for the target of 85 students. Data collected would focus on built environment and the organisation of learning and pedagogy.

Built environment

- Comfort and health, e.g. complaints about bad air, number of days sick leave of staff & students due to health reasons;
- Efficiency. i.e. age of the building compared to money spent on renovation during the *x* years period etc.;
- Measures of air quality, temperature, light and humidity;
- School size, location and distance from home;
- Table/chair size;
- Wifi wideband speed;
- ICT infrastructure, e.g. whiteboards, Ipads, netbooks;

- Environmental features, e.g. solar power, water tanks, drought tolerant plants, kitchen gardens;
- Maintenance (expenditure, recent work, needs);
- Acoustics in large open spaces;
- Flows of space indoor/outdoor;
- Leisure space e.g. cafeterias/cafes; sporting facilities etc;
- Disability access; and
- Aesthetic features, e.g. artwork.

Organisation of learning and pedagogy

- Inclusion of spatial literacy in the curriculum e.g. curriculum policy or documents;
- Shared community spaces e.g. library, hall, sporting facilities;
- Community use of space, e.g. parents visiting the school, community organisations use of facilities?;
- Use of outdoor space, e.g. outdoors on sports fields, or if no sports fields;
- Source of funding for new facilities and maintenance e.g. parent councils, local government. NGOs, rental;
- Traditional classrooms and/or learning centres e.g. multi-age spaces;
- Specialisms e.g. drama, sport, science and technology; and
- Partnership with or other organisations e.g. industry.

5.3.3 Test format

The PISA-based Test for Schools has been administered so far as a paper-based test. However, consideration for the future implementation of the test will include the possibility of test delivery by computer via web-based technology. This mode of delivery has the advantage of directly capturing the data without the need for a separate data entry step, leading to faster, more efficient analysis of the data. Although there are some upfront costs in developing the system, experience from PISA suggests that the benefits are worthwhile (OECD, 2013d).

5.4 Sampling standards using PISA-based Test for Schools

5.4.1 Sampling schools

Sampling in the PISA-based Test for Schools is different to the sampling in the standard PISA cycle where schools are chosen randomly and then the required number of 15-year-olds are randomly chosen to participate. In the PISA-based Test for Schools, the selection is not random because it is the school and/or region choosing to participate. So the sample could include schools that have been recently built, partially

or fully, renovated, or without any new buildings or renovation. Any questions asked should specify which applies.

To ensure that there is a sufficient number of item responses it would be expected that each student undertaking the PISA-based Test for Schools would complete the cognitive assessment, background questionnaires and Module instruments. The PISA Technical Standards define all the requirements that countries need to meet so that their data will be included in the international database. These standards include translation processes, test administration procedures, print quality and sampling requirements. For PISA, the accepted sampling standards are a participation rate of 85% of selected schools and 80% of selected students from within those schools. These requirements are put in place to guarantee comparability of results across the countries. There is also a set of technical guidelines applying to the administration of the PISA-based Test for Schools to guarantee compatibility to the regular PISA surveys, which would apply in the case of the LEEP module. In the case of the PISA-based Test for Schools, the guidelines stipulate a sample size of 75 age-eligible students per school, with no fewer than 49 students in the case of smaller schools.

5.4.2 Sampling learning settings

Although the sampling process for PISA and the PISA-based Test for Schools does not include “type of classroom” (e.g. technology areas, common spaces, library, science, arts etc.) as a particular stratum, in the LEEP Module, it will be possible to provide information on classroom type for students, enabling the linking of student outcomes to a particular educational space. It could also be possible to ask students about their perceptions of a range of classrooms, in addition to their perceptions of the whole-school environment.

Because the PISA cognitive test is a combination of reading, mathematics and science, it would be instructive to link a student's outcomes in science, for example, to the student's perceptions of the science environment. The Module instrument(s) should therefore be quite specific about targeting different subject areas.

5.5 Focus areas, themes, possible instruments and outcomes for students, teachers and school principals

This section presents the focus areas and themes for the Module and outcomes for three respondent groups (students, teachers and school principals). The objective of this section is to assist the development of instruments for the Module. Selection of the focus areas was based on the following criteria:

- The information did not already exist in PISA background questionnaires (see Annex 1); and
- Potential for the enriching evidence base.

Some themes are explored by multiple respondents in order to compare responses – for example access and safety; comfort; affordances for teaching; and professional development opportunities – while other themes required only one particular respondent to address a theme, for example the issues of affordances for students, community collaboration and policy context. The themes address issues around both pedagogical and environmental concerns, all of which can be mapped against the non-cognitive outcomes identified in Table 5.1.

While most of the focus areas identified can be implemented in schools at the different phases identified in Section 2 - designing the learning environment; preparing for and transitioning into the new learning environment; consolidation of the new physical learning environment; and

sustainability/evaluation of the physical learning environment over time with different teacher and student cohorts - it may be useful in order to gain an understanding of time and change over time by posing key questions to students, teachers and school principals related to the physical learning environment. This could be completed following data analysis, for example, using interview or focus groups. For example:

- What has changed over time and why?
- With what effect?
- What has stayed the same and why?

5.5.1 For students

The focus areas identified for students address environmental issues, but also some important issues related to engagement in learning, preferred spaces for learning and concern for the environment (Table 5.1). "Affordances for students" (Gibson, 1977) can be defined as the conditions produced by the physical learning environment for students, which can mediate relationships that can improve effectiveness along a range of indicators (cognitive and non-cognitive) and the quality of relationships.

Table 5.1 Focus areas, themes and outcomes for the LEEP Module addressed to *students*

Focus areas	**Themes**	**Outcomes**
Access and safety	Accessibility and safety of the learning environment	Health and wellbeing
Affordances for students	Students' enjoyment of working in the (new) physical learning environment	Affective
Appearance	General appearance of the school building and classrooms	Affective
Comfort	Quality of the physical learning environment in terms of temperature, humidity, lighting (natural and artificial) and acoustics (i.e. noise levels)	Health and wellbeing
Concern for the environment	Involvement in activities related to environmentally sustainable practices inside or outside class	Learning
Connectivity	Frequency and ease of access to ICTs in class; availability and use of devices such as IPad and IPhone in class	Learning
Flexibility of furniture and space	Moveability, agility and movement of furniture and ICT to suit the learning activity; comfort in classrooms where there are moveable tables and chairs; sliding glass or operable walls/doors; comfort when moving around the classroom	Health and wellbeing; Learning
Outdoor spaces, social spaces, favourite spaces and shared visual workspace	Frequency and enjoyment of playing games outdoors; of sitting in a quiet place outdoors; of being in class outdoors; and of being in particular parts of the school; frequency of display of students' material; connectivity to the outdoors	Affective; Social
Specialist spaces	Preferred specialist spaces (e.g. arts, science, technology, etc.); expected and actual use of specialist spaces for the purpose for which they were designed.	Affective; Learning

5.5.2 For teachers

The focus areas identified for teachers share some commonalities with students with regard to environment-related issues in the school. Other more pedagogy-related themes are also addressed to school principals. "Affordances for teaching (and with technology)" is defined in Section 2 as the conditions (Gibson, 1977) produced by the physical learning environment, which can mediate relationships that can improve teaching along a range of indicators (cognitive and non-cognitive) and the quality of relationships.

There may also be a relationship between the profiles of teachers – their experience, qualifications, training, age and gender – and some of the themes identified in Table 5.2. For example, the extent to which the (new) physical learning environment – and/or the school leadership – encourages teachers to use new or innovative teaching methods (such as team teaching) and/or materials, employ more learner-centred approaches in general; work with other colleagues in teams; rearrange/adjust furniture/doors/ walls; change lesson plans or timetabling to suit the new spaces; or use ICTs (such as whiteboards, laptops and IPads) to better support teaching and learning.

Table 5.2 Focus areas, themes and possible outcomes for the LEEP Module addressed to *teachers*

Focus areas	**Themes**	**Outcomes**
Access and safety	Accessibility and safety of the learning environment	Health and wellbeing
Affordances for students	Behaviours of students in the (new) physical learning environment, such as more collaboration with peer-to-peer learning, more self-directed learning, greater engagement and self-efficacy, greater student choice in preferred learning space etc.	Affective; Behavioural; Learning; Social
Affordances for teaching (and with technology)	Extent to which the (new) physical learning environment – and/or the school leadership – encourages teachers to use new or innovative teaching methods (such as team teaching) and/or materials, employ more learner-centred approaches in general; work with other colleagues in teams; rearrange/adjust furniture/doors/ walls; change lesson plans or timetabling to suit the new spaces; use ICTs (such as whiteboards, laptops and IPads) to better support teaching and learning	Affective; Learning
Appearance	General appearance of the school building and classrooms	Affective
Comfort	Quality of the physical learning environment in terms of temperature, humidity, lighting (natural and artificial) and acoustics (i.e. noise levels), extent of user control over some of these elements	Health and wellbeing
Connectivity	Frequency and ease of access to ICTs in class; speed of network, bandwidth, currency of devices used	Learning
Equity	Allocation of space for different groups (e.g. ESL, SEN, adult re-entry students, indigenous etc.); actual use of space by different groups, including consideration of the challenges faced by particular groups of students and spaces that are dominated by particular groups of students	Behavioural; Learning
Flexible use of furniture and space	Ease of movement, agility and actual movement of operable walls, sliding glass walls and doors, furniture and ICT to suit the	Health and Wellbeing; Learning

	learning activity; comfort in classrooms where there are moveable tables and chairs; comfort when moving around the classroom	
Participation in design	Participation of teachers in the design of (new) spaces	Affective; Social
Professional development	Professional development (or related) activities to prepare teachers for pre- and post-occupancy; sense of professional efficacy	Affective; Learning
Recruitment and retention of teachers	Potential of new facilities to attract students and teachers to and retain teachers in the school; selection criteria for new teachers to teach in "Next Generation Learning Environments"	Affective; Health and Wellbeing; Learning

5.5.3 For school principals

The focus areas identified for school principals draw on some of the same areas as those for teachers and students (e.g. affordances for both teachers and students, professional development and participation in design), but also addresses policy-related issues relating to what is termed the "enabling" or "disabling" school policy environment and issues around community and parental engagement, and leadership and innovation (Table 5.3). *Enabling* policies are those that 1) support the core work of teaching and learning, 2) recognise the need to develop cognitive and other outcomes and 3) impart a level of professional autonomy for teachers and schools to address the specific needs of their students and communities. *Disabling* policies are those that are counterproductive to this core work, focusing on a narrow range of cognitive outcomes and standardisation (Macbeath, 2008; McNeil, 2009).

Table 5.3 Focus areas, themes and possible outcomes for the LEEP Module addressed to *principals*

Focus areas	**Themes**	**Outcomes**
Affordances for students	Differences in observed behaviours of students and teachers in the (new) physical learning environment, such as more collaboration, more self-directed learning, greater engagement, self-efficacy, etc.	Affective, Behavioural
Affordances for teaching (and with technology)	Extent to which the new physical learning environment – and/or the school leadership – encourages teachers to use new or innovative teaching methods and/or materials, employ more learner-centred approaches in general; work with other colleagues in teams; greater collaboration in general; rearrange furniture, change lesson plans or timetabling to suit the new spaces; use ICTs (such as whiteboards, laptops and IPads) to better support teaching and learning	Affective, Learning
Allocation and use of space	Allocation and use of different spaces for different student age groups and teacher groups over time; use of outdoor spaces for learning	Health and wellbeing; Learning; Social
Comfort	Quality of the physical learning environment in terms of temperature, humidity, lighting (natural and artificial) and acoustics (i.e. noise levels)	Health and wellbeing
Community collaboration (e.g. industry,	Collaboration with new community stakeholders (e.g. industry, interagency, etc.); involvement of the school in neighbourhood renewal; use and encouragement to use common spaces in school	Affective; Social

interagency collaboration)	hours; design of school zoning to facilitate community use	
Leadership and innovation	Responsibilities for learning and innovation in the school; structures and processes in place to support teacher leadership and professional development especially in regard to the physical learning environment	Affective; Learning
Outdoor spaces, social spaces, favourite spaces and shared visual workspace	Response of students to (new) spaces (indoor and outdoor spaces, specialist spaces, flows between spaces); intended vs actual use of spaces, especially multi-purpose and single purpose spaces	Affective; Health and wellbeing
Parental engagement	General interest and involvement of parents (in financial, expertise, labour terms) pre- and post-occupancy; use and encouragement to use common spaces in school hours; education of parents in next generation learning environments concepts, including evidence of how effective they are in affording better teaching and learning outcomes	Affective, Behavioural; Social
Participation in design	Participation of principals in the design of the new spaces; extent to which principals include leadership team; and extent to which this team includes classroom teachers; train the trainer programs on NGLE's	Affective; Social
Policy context	"Enabling" or "disabling" school policy environment with regard to additional funds, personnel, planning, professional development, integration of ICT, focus on standardised tests (cognitive) or non-cognitive outcomes for new spaces	
Professional development	Professional development (or related) activities to prepare school principals and teachers for occupancy and during occupancy; general responsibility for professional development activities; involvement of teachers in professional learning networks to share ideas about space	Affective; Behavioural; Social

5.6 Implementation schedule for the Module instrument(s)

This Framework should provide sufficient information to allow for the detailed development of the Module instrument(s). This process is undertaken by experts in the field of instrument development, who will work closely with the OECD Secretariat, the authors of this Framework and the OECD Group of National Experts on Effective Learning Environments.

In test development there are three levels:

- Initial piloting with a small group;
- Field trial with a reasonable number; and
- Final instrument.

A field trial is necessary to check that the items which have been developed are high quality, well targeted and can be completed in the time allocated. Table 5.4 presents an implementation schedule for the drafting and field trial of the Module instrument(s).

Table 5.4 Possible implementation schedule for the Module instrument(s)

Date	Task
December 2013	Agreement reached on the Framework for the LEEP module
January 2014	Terms of Reference drawn up for engaging contractor to draft the LEEP Module instruments
February 2014	Call for Tenders issued for drafting the LEEP Module instruments
March 2014	Contractor selected
April-May 2014	Initial drafting of the LEEP Module instruments Review of items and subsequent revision
June 2014	Meeting of the GNE to discuss draft LEEP Module instruments
June 2014	Piloting with a small group of respondents and subsequent revision
September 2014	Finalisation of field trial LEEP Module instruments
October 2014	GNE meeting
November-December 2014	Field trial
January 2015	Field trial analysis and final item selection

5.7 Reporting results

One of the biggest challenges after completing the LEEP module is to report the results in ways that will lead to policy discussion and subsequent school improvement. The central aim of the reporting and dissemination processes are to help the public and interested parties such as schools, communities and policy makers understand what the Module is about, what is contained in it, and how it could be used for school improvement purposes. However, there are two important caveats with regard to the implementation of the Module instruments:

- There will be no international benchmarking with results from the LEEP module because the questionnaire items do not yet exist in the main PISA study.

- The LEEP Module is designed to assist schools. It does therefore not seek to address the system level.

In 2012, each school participating in the pilot of the PISA-based Test for Schools received a report for their school, which included detailed comparisons of the situation in an individual school and how the school compared with schools nationally and internationally (OECD, 2012). Because it would not be possible to provide international benchmarks, reporting from the LEEP module can be focused in different ways, and by using different reporting tools. Aschool report, for example, would rather include results and provide recommendations to the school for school improvement, set in the specific context of the school, and its issues and challenges regarding the effectiveness and efficiency of the physical learning environment.

In the future, an interactive web-based tool could locate statistical and contextual information about schools and compare them with statistically similar schools in the country. A related option is to create a platform that also provides discussion forms, showcases good practice and promotes information sharing related to the results and recommendations for schools from the Module. It may be possible to adapt an existing Database of Best Practice in Education Facilities Investment to this end (http://edfacilitiesinvestment-db.org/).

5.8 Future development

The development, testing and implementation of this Module and the way results are reported is being shaped by the people who will use this tool, and they are the best placed to evaluate the Module's impact and relevance as a tool for school improvement. "Impact" could be measured by the initiation of a conversation or discussion, which may evolve over time to a policy-level debate. The objective is to use this collaborative process to develop or adapt other modules, and to monitor school improvement initiatives over time. As described above, a comprehensive database would provide a useful reporting tool, which could develop over the years as the LEEP modules are developed and refined.

5.8.1 Starting a discussion…

One important measure of the impact of the Module is the extent to which it generates dialogue and learning in and between schools on issues related to the learning environment. This could take the form of professional (and other) visits to schools for research projects; regional workshops or discussion forms, or live policy debates.

5.8.2 Developing other modules

This LEEP Module on the Effectiveness and Efficiency of the Physical Learning Environment is the first attempt at developing tailored methodological and reporting tools using a collaborative multi-disciplinary approach to support benchmarking and school improvement efforts in different countries. If schools and education authorities find this Module a useful tool for school improvement and wish to continue this work through LEEP, the Secretariat will develop, implement and use additional modules. Other modules will extend the range of learning environment data that can be used to evaluate cognitive and non-cognitive outcomes. The Group of National Experts on Effective Learning Environments (GNE) will oversee this work and advise the Secretariat on possible areas of interest for future research.

5.8.3 Measuring change over time

The LEEP module gives schools the opportunity to track the effectiveness of the physical learning environment over a period of years. It would be instructive to learn how student perceptions of their physical learning environment change before and after they occupy a new building. While the same students are not assessed from one year to the next, the opportunity exists for similar students to assess the same physical environment from year to year. Any changes in the environment could be linked to student outcomes, so the emphasis is about ongoing redesign and maintenance of quality. To measure these changes it will be necessary to ensure that some parts of the LEEP instrument remain

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ANNEX 1: EXISTING DATA AVAILABLE FROM THE OECD STUDIES PISA AND TALIS

OECD Programme for International Student Assessment

In addition to cognitive data available for the subject domains reading, mathematics, science, problem solving and financial literacy, PISA collects contextual data from the students and principals. The student questionnaire focuses on home background, attitudes to learning and perceptions of classroom and school. the school questionnaire completed by the principal yields information about the school, its size and location, the principals' perceptions of teachers and any barriers perceived. The taxonomy of outcomes and predictive factors is summarised in Table 6.1 of the publication, *PISA 2012 Assessment and Analytical Framework: Mathematics, Reading, Science, Problem Solving and Financial Literacy* (OECD, 2013d).

Table 6.1

Two-dimensional taxonomy of educational outcomes and predictive factors

	Input	Processes	Outcomes
Students	Gender, grade level, socio-economic status Educational career, grades Immigration background, family environment and support ICT experience, attitudes, skills Openness, problem-solving styles	Attendance/truancy Outside-class activities - e.g. participation in after-school programmes Motivation, engagement Learning and thinking strategies, test taking strategies Learning time (including homework and private tuition)	Mathematical performance Mathematics-related attitudes, beliefs and motivation General school-related attitudes and behaviour, e.g. commitment, truancy Learning motivation, educational expectations
Classrooms	Class size, socio-economic background and ethnic composition Teacher education/training, expertise	Quality of instruction: structure, support, challenge Opportunity to learn: implemented curriculum, assigned tasks, mathematics-related activities Instructional time, grouping, assessment and feedback	Aggregated student variables
Schools	Socio-economic background and ethnic composition Affluence of the community School funding, public vs. private School size Parental involvement	Achievement orientation, shared norms, leadership, teacher morale and co-operation, professional development Admission and recruitment policies, tracking, course offerings/school curriculum, evaluation Teacher-student relations, supportive environment	Aggregated student variables Promotion/retention and graduation rates Attendance
Countries (Systems)	Economic wealth, social (in)equality Diversity policies	School funding, tracking and allocation, policies for professional teacher development, support for special needs and language minority students, hiring and certification policies Accountability and evaluation policies, locus of decision making	Aggregated student variables Average graduation level

PISA Student Questionnaire

In addition to ensure that PISA can measure changes across time, there is a core section of the questionnaires which is included in all cycles of PISA. For the student questionnaire the core section is described in Table 6.3 of the publication, *PISA 2012 Assessment and Analytical Framework: Mathematics, Reading, Science, Problem Solving and Financial Literacy* (OECD, 2013d).

Table 6.3
Student questionnaire: Common part

Question nº	Description
ST01	Grade
ST02	Country study programme
ST03	Age of student
ST04	Sex of student
ST05	Attend <ISCED 0>
ST06	Age at <ISCED 1>
ST07	Grade Repeating
ST08	Truancy - Times late for school
ST09	Truancy - Days unexcused absence
ST115	Truancy - Times skipped classes
ST11	Family structure
ST12	Mother's occupation (ISCO); Component of ESCS
ST13	Mother's educational level – Schooling (ISCED); Component of ESCS
ST14	Mother's educational level – Post school (ISCED); Component of ESCS
ST15	Mother's current job status; Component of ESCS
ST16	Father's occupation (ISCO); Component of ESCS
ST17	Father's educational level (ISCED) – Schooling (ISCED); Component of ESCS
ST18	Father's educational level (ISCED) – Post school (ISCED); Component of ESCS
ST19	Father's current job status; Component of ESCS
ST20	Immigrant background
ST21	Age of arrival in test country
ST25	Language spoken at home
ST26	General home possessions plus country-specific wealth items; Component of ESCS
ST27	Number of certain possessions in household; Component of ESCS
ST28	Books at home

For PISA 2012, where mathematics was the major domain of assessment most of the remaining questions ask about the students' attitudes and self-concept with respect to mathematics. Questions are also asked about the amount of time that students spend on mathematics inside the classroom and at home. The questions are listed in Table 6.4 of the publication, *PISA 2012 Assessment and Analytical Framework: Mathematics, Reading, Science, Problem Solving and Financial Literacy (OECD, 2013d).*

ST29	Intrinsic and Instrumental Motivation for Mathematics	ST42	Mathematics Self-Concept (Q2, 4, 6, 7, 9); Mathematics Anxiety (Q1, 3, 5, 8, 10)	ST53	Learning Strategies (Control vs. Elaboration vs. Memorisation)
ST35	Subjective Norms	ST77	Teacher Support in Mathematics Class	ST55	Attendance of Out-of-School-Time Lessons
ST37	Mathematics Self-Efficacy	ST79	Teacher Behaviour: - Teacher Directed Instruction - Formative Assessment - Student Orientation	ST57	Total Hours of Out-of-School Study Time
ST43	Perceived Control of Mathematics Performance	ST80	Cognitive Activation in Mathematics Lessons	ST61	Experience with Applied Mathematics Tasks (Q1, 4, 6, 8); Experience with Pure Mathematics tasks (Q5, 7, 9)
ST44	Attributions to Failure in Mathematics	ST81	Disciplinary Climate	ST62	Familiarity with Mathematics Concepts
ST46	Mathematics Work Ethic	ST82	+ Anchoring Vignettes	ST69	Min in <Class Period>
ST48	Mathematics Intentions	ST83	Mathematics Teacher Support	ST70	N° of <Class Period> per Week
ST49	Mathematics Behaviour	ST84	+ Anchoring Vignettes	ST71	N° of All <Class Period> a Week
ST93	Perseverance	ST85	Mathematics Teacher's Classroom Management	ST72	Class Size
ST94	Openness for Problem Solving	ST86	Student-Teacher Relations	ST73	Experience with Word Problems
ST96	Problem-Solving Strategies (SJT)	ST87	Sense of Belonging to School	ST74	Experience with Procedural Tasks
ST101	Problem-Solving Strategies (SJT)	ST88	Attitude towards School: Learning Outcomes	ST75	Experience with Pure Mathematics Reasoning
ST104	Problem-Solving Strategies (SJT)	ST89	Attitude towards School: Learning Activities	ST76	Experience with Applied Mathematics Reasoning

PISA School Questionnaire

The principals respond to a 30 minute questionnaire which covers the following topics:

1. Structure and organisation of the school - including questions about whether the school is public or private, funding sources, the characteristics of the local community and whether there are competing schools in the neighbourhood.

2. The student and teacher body - focusing on the student enrolment numbers and number of teachers employed.

3. The school's resources - particularly computer resources and an assessment of whether a lack of some resources (human and physical) is hindering student learning.

4. The school's instruction, curriculum and assessment - principals are asked about policies relating to ability grouping, provision of extra-curricular activities, how assessments are used results are published and whether additional classes in mathematics are offered.

5. School climate - the principals are asked about their perceptions of students and teachers at the school (including issues such as truancy, teacher absenteeism, teacher-student relations), parental expectations and involvement, as well as teacher morale and teacher appraisal.

6. School policies and practices - including admission policies, the degree of autonomy the principal has and the general management style employed.

7. Financial education at the school - the principals are asked about the level of financial education in school, whether or not it is compulsory and where it lies in the curriculum.

OECD Teaching and Learning International Survey

The OECD's first Teaching and Learning International Study (TALIS) took place in 2008 with results reported in *Creating Effective Teaching and Learning Environments: First Results from TALIS*. (OECD, 2009a). TALIS is a survey of principals and teachers which yields extremely valuable information and focused on the following areas:

Principal questionnaire

1. *Principal background information* - including age, gender, qualifications and experience as a teacher and as a principal.

2. *School background information* - including questions about whether the school is public or private, funding sources, the characteristics of the local community, number of students and teachers at the school, broad background characteristics of the students and the admission policies at the school.

3. *School management* - including questions about how the principal manages the school, the teachers and the students. Principals responded to questions about leadership style, the use of assessments, time management and evaluation of the school.

4. *Teacher appraisal* - including an estimation of how frequently this took place, who carried out the appraisals and how they were used.

5. *School resources* - principals gave an indication of factors which may have hindered student learning at their schools including lack of resources, the quality of the teaching staff and the students themselves. The principals' perceptions of the level of autonomy they possessed and the process of induction of new teachers were also the focus of some questions in this section.

Teacher questionnaire

1. *Teacher background information* - including age, gender, qualifications, experience as a teacher and an estimation of the number of hours of work they do in a week in different areas of teaching.

2. *Professional development* - including level of participation, school support and impact on teaching.

3. *Teacher appraisal and feedback* - including frequency of appraisal, who conducts the appraisal, its aims and impact on working conditions and teaching.

4. *Teaching practices, beliefs and attitudes* - teachers were asked about their personal philosophy, their role in teaching at the school and their level of satisfaction. They were also asked about the leadership style of the principal,

5. *Teaching a particular class at the school* - teachers were asked to focus on one particular class and describe the subject, the student characteristics and the methods that they employ. They were also asked to give an estimate of the time spent on administration, keeping order and actual teaching.