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School Buildings for the 21st Century Some Features of New School Buildings in Iceland

ANNA KRISTÍN SIGURÐARDÓTTIR*² AND TORFI HJARTARSON³

≈ The aim of this study is to identify features of change in the recent design of school buildings in Iceland, and how they might affect teaching practices. Environmental and architectonic features characterising school buildings designed and built at the beginning of the 21st century are examined in light of challenges involving architecture, educational ideology, school policy and digital technology. The sample for the study consists of 20 schools located in four municipalities. Four of the school buildings were developed and built in this century, while the other 16 were designed in the 20th century. The design of all of the buildings was explored and reviewed by a multidisciplinary team. Data was collected by observations and photography at each school site, as well as by reviewing technical documents. The relationship between school design and school practices was studied through a questionnaire survey among all teachers, in order to find out whether teachers working in new environments differ from teachers in more traditional classroom settings. The results indicate a clear shift in the design of educational buildings. Flexibility, flow, openness and teamwork seem to guide recent school design. Clusters of classrooms or open spaces, transparent or movable boundaries, as well as shared spaces allowing for manifold interactions in flexible groups seem to be replacing traditional classrooms along confining corridors. Teachers working in open classroom environments collaborate more often than their counterparts. Teaching practices are also characterised by more opportunities for pupils to choose between tasks and enjoy more variation regarding group division and workspace arrangements.

Keywords: Classroom environment, Collaborative learning, Individualised learning, Physical learning environment, School buildings, School design, Teacher collaboration, Teaching practices

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The history of public schools or school building design in Iceland is relatively short, dating back to the late dawn of the industrial age in the early 20th century (Guttormsson, 2009). As in other countries, school buildings have been influenced by social and educational needs. Design decisions, however, must have initially relied heavily on the available architects, who gradually grew in number and were educated abroad in various countries. In each individual case, consulting educationalists must have influenced decisions to some extent, reflecting different pedagogical ideas at each school site. According to Borrelbach (2009), a similar development can be seen in Germany, where school design has mostly been based on concepts agreed upon for each individual project.

The participation of many different stakeholders in the design process has only become common of late. A recent example in the Icelandic context is a policy implemented by education authorities in Reykjavik, emphasising individualised and collaborative learning (Sigurðardóttir, 2007). This is supposed to have consequences for all aspects of school, including the school building and the learning environment as a whole, as well as teaching and learning. According to the new policy, school buildings are supposed to offer flexible spaces for different assignments and group sizes, and take on the role of a community centre in their neighbourhood (Fasteignastofa Reykjavíkur & Fræðslumiðstöð Reykjavíkur, 2004). A so-called *Design Down Process* with a carefully chosen group of consulting stakeholders has been carried out in a number of cases to prepare new school buildings. The method was developed before the turn of the century by a research group based at the University of Minnesota (Copa & Pease, 1992; Jilk, 2005; Óskarsdóttir, 2001). The initiative in Reykjavik has been driven by a policy striving for individualised learning and student collaboration, and to support its implementation a measurement tool for individualised learning has been developed (Reykjavik City Department of Education, 2005). This measurement tool is now used as a frame of reference in our study, and within a more extensive research project looking at teaching and learning in Icelandic schools.

Seven emerging themes for 21st century learning environments have been defined by the OECD Programme on Educational Building and Department for Education and Skills (OECD/PEB & DfES, 2006). They were put forward by several leading architects and educationalists as follows: the challenge of designing schools in a changing world; the impact of new technology on school design; increasing access to education through school design; designing sustainable, comfortable school buildings; involving all stakeholders in school design; educational facilities as a learning tool; and assuring design quality.

Some of these themes are discussed in further detail below.

The challenge of designing schools in a changing world. Each school building is expected to serve its purpose far into an unpredictable future; the only thing known for certain is that the future will be different from the present. Therefore, the key challenge for designers is to attain flexibility (Copa & Pease, 1992; Dudek, 2000; Jilk, 2005; Nair & Fielding, 2005). This demand for flexibility applies to many different features of a building, such as spaces and environments for different group sizes and learning styles, dynamic boundaries and the ability to change facilities according to pedagogical needs and ideas. The purpose of design for the future, however, is not only to be prepared for some of the changes that might take place, but also to attempt to influence school processes, i.e., in accordance with new knowledge or ideas about learning and new requirements, such as those that come with new technologies.

The impact of new technology on school design. The introduction of information technology and new media calls for innovative solutions with regard to housing, spaces, furniture, communication, teaching and learning. Schools have responded to technical advancements in different ways. Earlier research in Icelandic schools suggests that the school library may have a key role to play when it comes to the effective use of information technology across disciplines. Many schools have tried to connect computer and library facilities, in some cases combining the use of traditional library resources and a computer lab in a unified information centre at a location of strategic importance (Macdonald, Hjartarson & Jóhannsdóttir, 2005).

Increasing access to education through school design. One important goal of school design is access for all. Architects and educational researchers alike need to identify school design elements that either encourage or hinder the integration of services and inclusive practices, in particular individualised and collaborative learning. Architectonic concepts such as detailing, overview, transparency, flow and flexibility may help to clarify some of the issues involved, as well as inclusive approaches for pupils with special needs, multicultural education, access to new media and educational resources. Community services within schools should also be considered, as well as student and staff access to the wider community.

Designing sustainable school buildings. Over the last few years, the sustainable design of buildings has gained growing attention. This is also the case in Iceland, but ideas or concepts in this field of expertise have only been realised to a limited extent. Sustainable design standards, like BREEAM (<http://www.breeam.org>) and LEED (<http://www.usgbc.org>), are used to conceptualise good learning spaces for flexible uses, applying natural daylight, natural ventilation

where possible, low energy use, low water use, good acoustics and the use of sustainable building materials.

Involving all stakeholders in school design. In order for the design of school buildings to fit our present and future needs for effective learning environments, it is considered extremely important to involve stakeholders in the design process from the very beginning (Walden, 2009; Woolner, 2010). The importance of involving students in the design process has also been pointed out. The *Design Down Process*, already mentioned above, serves as a good example. This process requires that a group of various stakeholders, such as teachers and pupils, educational researchers and administrators, representatives of the community, parents, technicians and architects, work together to define aspirations and local needs and develop a rough layout for the new building (Óskarsdóttir, 2001). Such a consultation process has also been applied when older school buildings are renovated and reconstructed. One aspect of the process has been to decide upon or identify key messages the building should send to students, staff and the wider community.

The building as a learning tool. Educational facilities and their surroundings can be a useful resource for teaching and learning in many ways. The shape of a building, lighting and facilities can serve as a subject for students in their studies. By making the building itself environmentally friendly, students can be taught to understand an environmentally friendly lifestyle. Architects might also consider opportunities to introduce interesting aspects of core subjects like maths, science and arts for teachers and students to reflect upon in different contexts. Patterns and lighting on the floor and ceiling might, for example, represent stars and galaxies, which then become a part of everyday life, and elements like doors, windows, light and shadows can be used to demonstrate colours, shapes, sizes and patterns (Nicholson, 2005; OECD & DfES, 2006).

There is currently little empirical evidence available on how school architecture affects educational practice (Gislason, 2010), and most of the relevant research is conducted from an architectural perspective. There are, nevertheless, several research results suggesting that the physical learning environment could affect child development and academic achievement in a number of ways (Higgins et al., 2005; Tanner, 2008). Most of these results, however, are somewhat limited and controversial. Relatively strong evidence supports the relationship between student learning and conditions such as the quality of air, temperature or noise, while other evidence, i.e., relating learning to colours and lighting, seems less profound. Results from a large research project lead by Walden (2009), involving school design initiatives in eleven countries throughout the world, indicate that good design can improve feelings of well-being and social

interaction, which in turn are related to higher assessment of performance.

The authors of the present study seek to contribute to the body of knowledge on school buildings and how they might affect educational practices. The aims are twofold: firstly, to identify features of change in the design of recent school buildings in Iceland, and, secondly, to detect how such features might affect teacher collaboration and teaching practice.

Methods

Research methods include guided and independent observations of school buildings, a questionnaire survey among staff, photography and document analysis. The sample consists of twenty schools selected in four municipalities, serving as a random sample for a large research project on teaching and learning in Icelandic schools at the primary and lower secondary level (Björnsdóttir & Jónsdóttir, 2010), and our study constitutes one part of this project. Four of the school buildings were designed and built in the 21st century, while the other sixteen date further back and were designed in the 20th century. The four most recent constructions, developed in the new millennium, are discussed here as examples of Icelandic school buildings of recent design. Three of them were built after an initial period in preliminary housing, while one is being built at a rural site to replace an older construction originally designed as a boarding school some five decades earlier. *Table 1* provides some profile information about the four schools.

Table 1: School profile information

	Year of establishment	New building	Age of pupils	Number of pupils	Size of building, m ² (approx)	Size per pupil, m ² (approx)	School district
School A	2001	2005	6–15	435	5,856	13	City suburb
School B	1965	2011	6–15	104	2,000	19	Rural area
School C	1999	2005	6–12	183	2,664	14	City suburb
School D	2005	2011	6–15	350	6,000	17	City suburb

The twenty school sites were explored and reviewed by a multidisciplinary team of researchers, including two educational researchers from the University of Iceland, two school principals and an architect. Data was collected by informed observations and photography at each location, as well as a review of technical documents, drawings and writings. Environmental and architectonic features were studied and described in detail with regard to classroom layout,

facilities for arts and crafts, public spaces and community halls, school libraries or information centres, the application of information technology, teacher workstations, facilities for outdoor teaching, ties to the outer community, and the design process preceding the construction of each school.

During the 2009–2010 academic year, an electronic questionnaire survey consisting of 244 items was carried out in four parts among staff members at all twenty schools. A total of 725 people responded to the questionnaire (a response rate of 92%), 601 of whom were members of teaching staff. The questionnaire items referred to in the present paper include teaching facilities, teacher collaboration and attitudes towards classroom environment and teaching practices.

A total of 62% of the teachers responding to the questionnaire maintained that they taught only or mostly in traditional classroom settings, while 18% claimed that they taught only or most of the time in open classroom spaces. Some comparison between the two groups is provided in the present paper.

Results indicating features of new design

Observations of the twenty school buildings reveal that the four most recent school sites differ considerably from older cases in our sample. Schools A, C and D were among the first schools in Iceland to be designed based on the *Design Down Process* (KKE Architects, 2001) and represent a clear shift in school design at a national level. The design of school B is based on a somewhat similar consultation process, resulting in clusters of small classroom spaces allowing for different openings and flow between rooms. School C combines small and large spaces in a flexible and transparent manner, while schools A and D are larger than the other two and equipped with extensive learning spaces where large groups of students are able to work in different setups, as shown with a fictitious example in *Figure 1*. The design of all four cases is described in more detail in *Tables 2 and 3*.

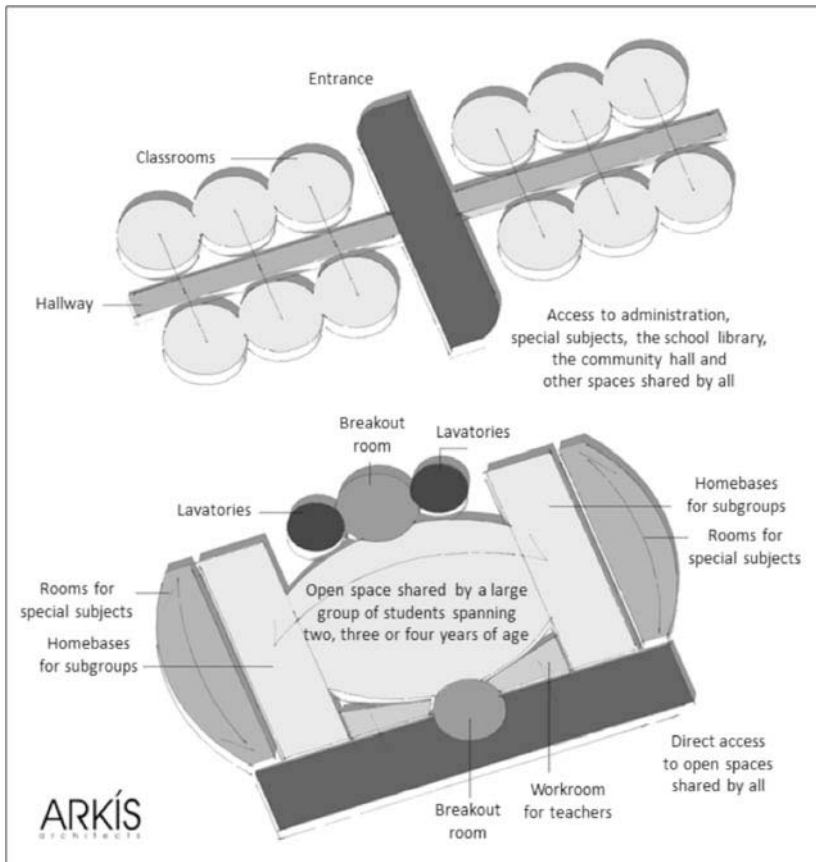


Figure 1: Conventional setup of classrooms along narrow hallways, typical for many schools in the twentieth century, as opposed to open and shared learning spaces with large groups of students and teaching staff characterising some of the most recent school designs. Illustration by ARKIS 2011.

In *Table 2* and *Table 3*, a schematic overview is laid out to describe some of the features characterising each of the four school buildings. In *Table 2*, features concerning classroom layout and grouping of pupils are described, while in *Table 3*, a short overview of community halls, school libraries, information technology and teacher workstations is provided. Some of these features are outlined in more detail below.

Table 2: Classroom layout and grouping of pupils**School A**

Large open classroom spaces for groups of about 80–100 pupils of mixed ages. The classroom spaces are partly divided by closets or walls, a staff room and one breakout room. By default, pupils sit in groups. Pupils in the oldest age group have their own individual desks or workstations. Each classroom space has immediate access to a central community hall and a completely open library. Arts and crafts are integrated with other subjects, but two small classrooms are used for messy work and storage. A music room of a similar size is used for music lessons and individual instruction provided by a music school.

School B

Three classrooms for 12 to 20 pupils each are grouped together to form clusters, three clusters in all, hosting classes spanning three years of age. Pupils are expected to sit in groups. Two out of three rooms in each cluster are divided by foldable walls, and the third room can be accessed through wide doors or via alternative access through small support rooms. Three classrooms dedicated to textiles, art and woodwork respectively form a cluster, with a small support area for shared use. A music classroom can be opened up to join an open hallway or community hall.

School C

Open classrooms for groups of about 30 to 60 pupils of mixed ages. Pupils sit in groups. Classrooms are framed by interior windows with an open view and direct access to a central information centre combining a library and a computer lab. A large classroom space for arts and crafts is divided into three semi-open sections dedicated to textiles, art and woodwork respectively. The music classroom has a sliding wall that can be pushed outwards to expand the room, and has a pile of beanbags replacing tables and chairs. A spacious classroom for natural studies is often used as a breakout room for special activities or group work.

School D

Large and open classroom spaces for groups of about 90–120 pupils of mixed ages. Each classroom space has immediate access to a central community hall. Classroom spaces are complemented with a paved rooftop garden or outdoor platforms. Each space has a breakout room of a regular classroom size, moveable tent towers for small groups, as well as curtains and moveable shelves or closets allowing for different arrangements of space. Pupils sit in groups. A large workshop with rooms and booths dedicated to art and crafts is designed for integration across subjects. A music hall allowing for band rehearsals is complemented with smaller rooms for music instruction.

Clusters of classrooms and open spaces

Schools A and D represent a radical step towards age blending and the integration of class groups by providing teachers with large open spaces for groups of up to 80 to 120 students. This approach to classroom layout has been encouraged by an emphasis on individualised learning and increased flexibility for adapting curriculum matter to pupils' needs and interests. A breakout room, movable furniture, foldable walls and curtains are used to create spaces for different group arrangements and private work. Teachers and pupils in school D will also be able to make use of paved rooftop gardens or balconies from their upper floor classroom spaces and open-air platforms outside classroom spaces at ground level.

The two other schools, schools B and C, represent small schools. They offer flexibility and open spaces but their classroom spaces are not as different from traditional classrooms as might be expected, being designed for relatively

small groups. Age blending or flow between age groups is, however, made much easier than in more traditional settings, as classroom spaces tend to be semi-open or screened by glass and form clusters based on age.

School B represents a design trend, also detected to some extent in older schools, towards clusters of traditional classrooms to allow for teamwork among teachers teaching classes spanning two to four years of age. In this case, there are three clusters of small classrooms for 12 to 20 pupils per classroom; three classrooms in a row, spanning three years of age in each cluster. A foldable wall between two of the classrooms, support rooms connecting two classrooms, and double doors between classrooms allow for considerable flow and interaction between the three rooms in each cluster. A more traditional setup behind closed doors and unfolded walls is also possible.

Transparency, flexibility and flow

An attempt to make school design transparent and easily comprehensible is apparent in all four schools. Designers have striven to make their buildings inviting, apprehensible and logical in their basic structure. They have paid careful attention to age division and made it relatively easy for each age group to identify their home area within the school structure as a whole, in order to create a feeling of belonging.

Community halls tend to be semi-open or given a central position as broad hallways for multipurpose use on an everyday basis. In school B, an open hallway on the lower floor cuts the upper floor and divides the building into two parts. This hallway can be extended at the lower level by opening up an adjoining classroom assigned to music.

In school C, the emphasis on transparency is apparent, with classrooms framed by tall interior windows providing an open view into classrooms and an information centre combining a library and computer lab. Glass walls and interior windows are common in recent constructions, such as extensions that have been built at older sites in our sample of schools. It should also be noted that in some of the older schools in our sample we found small windows on or beside classroom doors, offering an »insight into the culture«, as Fram puts it (2010, p. 476).

The flexibility seen in classrooms is also evident in other parts of the four schools. The community hall, as a rule, can serve many purposes and be adjusted in size to different needs. The music room and the community hall in school B are divided by a foldable wall. The music room and community hall in school C are divided by a sliding wall that can be moved inwards or outwards to enlarge either one of the two spaces when appropriate. In schools A, C and

D, the community hall can be merged with the gym. A broad hallway lies in the centre of schools A and D and serves as entrance, canteen and community hall. In school A, the library is also located in this open hall of shared use. All of the key zones of the two schools surround this central hall and are divided from the main hall by concrete walls, glass, curtains or wide doors, in order to encourage flow and transparency. Only the preschool facilities, also included within the walls of school D, are located in a somewhat separate realm.

Table 3: Community halls, school libraries, information technology and teacher workstations

School A

A long and spacious hall under a high, curved ceiling, with all of the classroom spaces in one and two-storey constructions running along each side. The hall serves as an entrance hall, hallway and community hall. The school library is located in the middle of the hall, resembling an open air restaurant in a large square. A wall to one end can be folded open to connect the hall with a large gym. Teachers have laptops and make use of laptop trolleys for pupils. Each classroom space has a small room for its team of teachers.

School B

The building in its basic form is a two-storey building, partly under ground level, with an open hallway on the lower floor cutting the upper floor. The hallway serves as a canteen and community hall and forms an open divide between clusters of rooms on both floors. Three clusters are made up of classrooms with small adjoining support rooms, one cluster is assigned to arts and crafts and another to staff and administration. The library or information centre is located in a confined space next to the spaces for staff and administration. A conventional computer lab resides in a separate room in another part of the building.

School C

A hallway resembling a small street or pathway runs through the school. To one side, the hallway opens up behind tall interior windows to a square-like area with an open library and an open computer lab. Classrooms partly screened off by glass surround this information centre on three sides. A community hall is divided from the hallway by a foldable wall. Behind the hall is a gym, and the hall can be opened up in one corner to connect the two rooms. A wall behind a built-in stage can be moved to deepen the stage or to enlarge a music room on the other side. Teachers have laptops and access to a laptop trolley. Small rooms for teaching staff, partly screened off by glass, are located between classroom spaces.

School D

A large triangular shaped community hall or central hallway rests under a high ceiling. Two sides of the hall are formed by two-storey constructions with enclosed balconies on the upper floor and several extensive classroom spaces. The third side is blocked by a gym that can be merged with the hall. The hall offers immediate access to all areas within the school. It can be divided with a curtain hanging from a bridge crossing its middle, and a stage can be mounted in the hall's centre. Pre-school facilities are located in a somewhat separate realm and the library is located in one corner on an upper floor. Teachers have laptops and access to laptop trolleys.

Social dynamics and teamwork

All four schools are designed to support cooperation and teamwork among teachers. One way of doing so is to locate teachers workrooms between classroom spaces with open doors or windows to both sides, as is the case in

school C. Each workroom is shared by a group of teachers who share responsibility for the same group of pupils, thus partially replacing central workrooms for teachers in administrative areas.

Access to information resources and digital media

Students and staff of school B will make use of a traditional school library and a conventional computer lab. School C, on the other hand, represents an arrangement where a traditional computer lab and the school library are united in a cohesive information centre, with hallways running along three sides. All class groups have instant access to bookshelves and desktop computers in this centre, and laptops are also provided. Complaints have been made about disturbing noises and indoor traffic in the open information centre. This might partly be explained by the large glass surfaces to all sides, magnifying disturbing sounds and visual stimuli affecting pupils and staff. Teaching in the open computer lab, in particular, is considered somewhat troublesome in this respect. Teachers in schools A and D rely on laptops, the idea being to let library resources and laptop trolleys flow throughout the school buildings on demand.

In spite of the ambition and the great costs involved in the design of recent school buildings, it should be noted that digital projectors are not built into all classrooms. Projectors, and sometimes also smart boards, are growing in number but have not yet become the norm in Icelandic classrooms at primary level. Trolleys with projectors may be provided, but easier access to technology and net-based resources would be ensured with fixed equipment installed.

Access to the environment and community ties

All of the four schools discussed here aspire to having close ties with their respective communities. Facilities for music lessons and sports, for example, are commonly used by other non-school staff. Offices and school receptions, however, are not as easily located upon entrance as guests might expect, often being placed on an upper level or in a confined corner, in order to push other key areas to the forefront in the overall design.

Some schools take community ties further than others. School D, in particular, is centrally located and fosters manifold ties to its young suburban community. A special coffee corner will be assigned to the elderly, a preschool facility is placed within the new school building and the school library might be set up to serve the community along with pupils and school staff. Special rooms are assigned to individual music lessons and band rehearsals. The gym will be used by local sports associations, although it is said to be a bit too small for their needs. A local church has not been built in the suburb and school facilities have

therefore been used on some occasions by the religious community. The playground has not yet been constructed, but it will lie at the heart of the suburb and has been designed to offer outdoor recreation for all age groups. The school also makes extensive and systematic use of a wooded area close by for outdoor teaching on an everyday bases.

Democratic design processes

The *Design Down Process*, mentioned earlier, was used to prepare and guide the design of buildings in schools A, C, and D. Educational administrators, politicians, teachers, architects, engineers, researchers, residents, parents and even students of a young age took part under the supervision of municipal authorities. This approach has proven to be fruitful and has influenced school building design in other parts of the country. Those who could play a part are involved in the process in order to make sound decisions and develop best educational practices in a rapidly changing society (Jilk, 2005). The design team is required to move sequentially through a series of design steps, with each step built on decisions from previous steps. In the case of school A, a group of 40 different stakeholders met three times for two days each time. By defining fundamental ideas and values that should underpin school work, they carefully followed each step of the process before going into the structure of pedagogical work. Finally, they made decisions about the building itself. A report was written and reviewed by education authorities in Reykjavik (KKE Architects, 2001), before assigning the final design to the architects and construction parties involved.

Results on teaching and learning in an open environment

Examples of recent designs of school buildings have been outlined above, but the crucial question, i.e., how new design features might affect teaching and learning, remains to be answered. We will not reflect on this question in any depth or detail in this limited study; only a few results are presented here, based on responses of teachers to a questionnaire survey conducted in all twenty schools. These results offer a comparison between teachers who work only or mostly in open classroom environments (18%) and those who teach only or mostly in traditional classrooms (62%).

Teachers seem relatively satisfied with their respective school buildings. Around 70–80% of teachers in all twenty schools maintain that both the building as a whole and the classroom environment suit their ideal instruction

methods. This is shown in *Figure 2*.

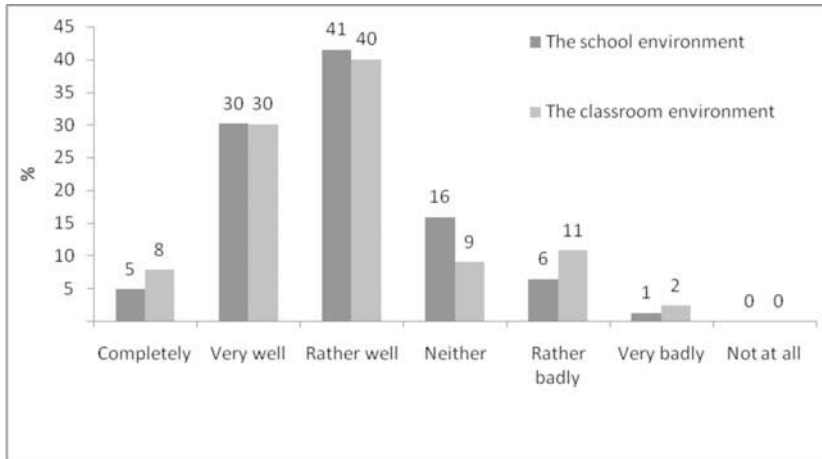


Figure 2: How well does the current school/classroom environment in which you work most of the time suit your ideal teaching methods?

Around 23% of the teachers who responded to the questionnaire maintained that their classroom environment suits their ideal teaching methods rather badly, very badly, or neither well nor badly. It has not, however, been determined what exactly this dissatisfied group would like to change in their classroom settings. When the teachers were asked to indicate, based on a choice of options, what they would like to do to a greater or lesser extent in their instruction, no significant difference appeared in the responses. Both the satisfied and dissatisfied group said they wanted to do a number of things to a greater or lesser extent. No significant difference appeared between those who taught only or mostly in traditional classroom spaces and those who taught in an open classroom environment.

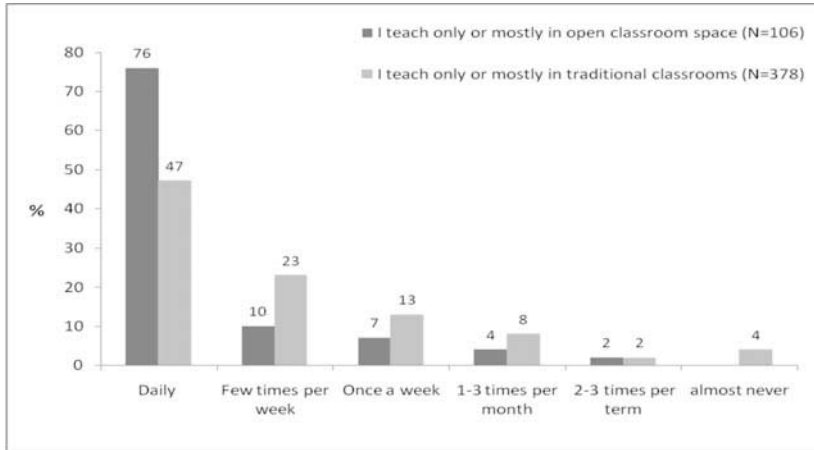


Figure 3: How often do you collaborate with your colleagues? A comparison between those who teach only or mostly in an open classroom space and those who teach only or mostly in traditional classrooms.

Teacher collaboration, as displayed in *Figure 3*, appears to be more common among teachers working in open classroom spaces. A comparison of mean scores, carried out using a t-test for an independent sample, indicates a significant difference ($t=4.42$; $p < .01$). However, little difference appeared when the teachers were asked about teaching methods, except that, according to their teachers, the pupils in open settings are allowed to choose between tasks more often than pupils in traditional settings ($t=3.3$; $p < .05$). These pupils also seem to enjoy more variation regarding group division ($t=3.12$; $p < .05$) and the arrangement of their workspace ($t=4.16$; $p < .01$). Data from our extended research project allows for further investigation into different relationships between the physical environment and teaching methods. Results from such studies will be presented at later stages of our research.

Concluding remarks

This particular study within a wider research spectrum focuses on four school sites chosen from a sample of twenty schools to represent the most recent design projects within the Icelandic school system.

The four school buildings seem to reflect the seven themes for 21st century learning environments defined by the OECD. All four buildings clearly represent a progressive approach in both architectural and educational terms, as well as reflecting a sociopolitical ambition to be at the forefront in school

development in a changing world. A gradual but definite shift towards a more open and dynamic school is clearly apparent in the design of these buildings. This shift is based on new knowledge and ongoing discourse about education and learning. It is manifested in many architectonic features and different ways of organising everyday work.

Features of flexibility, inclusive and open approaches, transparency, flow, active teamwork and social dynamics appear to guide recent school design. Clusters of classrooms, large and open classroom spaces, transparent and movable boundaries, as well as public spaces allowing for manifold interactions in flexible groups, seem to be replacing traditional classrooms with closed doors along confining corridors.

Design features reflecting adaptation to technological advancements are evident and efforts to make information resources and information technology accessible are apparent, as are attempts to foster manifold ties with the local community.

Sustainability issues are only vaguely evident in the present study, except for the general notion that learning environments need to be of good quality and adaptable to change. Teaching outdoors and open access to the environment, however, appear to play an important role in the design of the most progressive school site in our sample. Outdoor platforms outside classroom spaces, a multipurpose playground with manifold opportunities and an outdoor teaching area in a natural environment can be regarded as bridges between the school community and its environment in both physical and cultural terms.

Finally, the participation of many different stakeholders in the design process at preparatory stages, in order to obtain more appropriate facilities and encourage school change, appears to be a successful approach to designing school buildings (Walden, 2009; Woolner, 2010). An approach of this kind was introduced in Iceland at the turn of the century and has been used by a number of municipalities of late. Representatives of the local community, administrative staff, educational researchers, teachers, pupils, technicians, engineers and architects have joined forces in a democratic process and developed progressive designs reflecting new knowledge and new ways of going about teaching and learning. This has resulted in a more open and flexible environment, designed for collaboration and open ways of working at all levels.

When our results are viewed in light of the seven design themes outlined by OECD for schools in the 21st century, congruence is obvious for most of the themes. Recent school buildings in Iceland also seem to reflect a development similar to other countries and resonate with advanced school buildings in other parts of the world (Walden, 2009). It should be noted, however, that clusters

of classrooms and open learning spaces are not new arrangements; they have been tried in many school buildings throughout the past century in different countries, including Iceland. Examples from Sweden indicate that such initiatives have often been met with scepticism and have not necessarily lead to any radical changes regarding teaching and learning (Törnquist, 2005). This is also the case in the Icelandic context. However, new knowledge and insights into education and reform, as well as technological advances and local policies, seem to have paved the way for such initiatives of late and made them more likely to bring about profound change.

The present study on school buildings and physical learning environments and their relationship to school practices serves to throw light on contemporary design, to explore design features characterising new school buildings and to determine how design has evolved towards future needs influencing teaching and learning. Preliminary findings from a survey among teachers in our sample of twenty schools indicate that new learning environments may encourage teaching collaboration, which in the literature has been positively linked with school effectiveness (Sigurðardóttir, 2010; Teddlie & Reynolds, 2000) and increased pupils' choice. In later stages of our research, we expect to be able to determine in more detail how various pedagogical issues relate to arrangements of the physical environment. We will look at reconstructions and extensions of older buildings in a separate study and reflect on old constructions in view of present design. In addition, we will take a more detailed look at classroom layout and consider more closely the role of information resources, media and new technologies. It will also be of interest to follow further the development of the four schools included here, as well as other schools from our sample, in order to see how old and new designs fit future needs.

The main recommendation for educationalists and architects alike would be to collaborate closely with all stakeholders in the design process, with the ultimate goal of providing better education for pupils. Education authorities and school staff themselves will also have to develop the capacity to work in a new environment, and to ensure sustainable support from parents and other stakeholders. Furthermore, providers of teacher education programmes should consider how to best prepare prospective teachers for new ways of teaching and learning in settings different from previous practice.

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