Environmental Learning in Architecture

From Individual Choice to Collective Responsibility

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Nordic Journal of Architectural Research
Volume 20, No 3, 2008, 15 pages
Nordic Association for Architectural Research
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TOPIC: ARCHITECTURE IN A RESOURCE PERSPECTIVE

Abstract:

Most schools of architecture currently face a pressing demand by students, construction sector and media for a dramatic increase in environmental focus in architectural education. The construction sector expresses a dire need for knowledge, best practice examples and tools that are easy to implement without requiring a particular interest in environmental issues.

In this article, it is argued that a change of perspective in education is needed to fully accept sustainability issues as an intrinsic part of the architectural discipline; schools of architecture should not merely expand existing courses and add specialised teachers into the existing structure. There is need for a new role for educational institutions and a new set of learning tools, not only in interaction with students, but with the entire architectural community and building sector.

Using principles of experiential and environmental learning theory, the author describes a learning environment that is being developed at the Faculty of Architecture and Fine Art (AB) at the Norwegian University of Science and Technology (NTNU) as a framework for new knowledge and new recognition regarding sustainable resource use in architecture. The learning environment includes a range of measures aiming to (1) enhance the potential of the existing curriculum, (2) optimise the communication of practice and research knowledge and experiences into education, and (3) improve the development of competence, mastery and critical reflection among students and teaching staff.

This learning environment provides at the same time a good opportunity for academia and practice to reach out to each other and co-operate in order to answer to the challenges of climate change and resource scarcity society faces today.

The article is the result of a post-doctoral research project at the Faculty of AB at NTNU, including teaching experiences, research and pedagogical development in co-operation with the Faculty staff and students.

Keywords:

Architectural education, environmental learning, resource use, collective learning, experiential knowledge

Can a musician say: "Some days I play correctly, other days I play beautifully"?
[Belin 2008, translated from Swedish by author]

Introduction
The discussion is roaring in the construction sector. Now that society so blatantly has placed environmental and resource issues in focus, building professionals can't keep to business as usual and fall behind. It is uttered that environmental focus needs to become an intrinsic part of the architect's professionalism – a topic that relates to generalists as well as those with a particular interest in the matter. Schools of architecture barely manage to cope with the wave of students and professionals demanding adequate courses, tools and guidance.

Alongside society's rapidly increasing focus on climate change and sustainable development the past few years, architectural education has seen a widespread emergence of graduate and post-graduate programmes related to sustainability in the built environment [e.g., Voss & Heinze 2007; Holzer 2007]. But when it comes to the *general* architectural educational curriculum, uncertainty enters. It is not clear which weight environmental issues are to be given in architectural education, whether or not it is best to have specialised courses, and how this type of focus can – or should – be integrated in ordinary studio training. Several students and staff are even concerned that the extensive focus on these issues is going to stretch architects' responsibilities even more and leave them with a broader yet more superficial knowledge.

Until recently, one could argue that environmental practice in architecture is an individual choice. Surveys among Norwegian building professionals in the beginning of the 21st Century, for example, uncovered two alarming trends. Sustainability in architecture was progressively being reduced to quantitative measures such as energy efficiency, mainly as a response to advancing specialisation and ever more strict building codes. In addition, these measures were increasingly regarded as a technological problem for which architects felt no responsibility [Ryghaug 2003; Moe 2006; Kanstad 2007]. Bennetts [2008] shares the concern that recent advances in environmental design seem to have marginalised the architectural profession.

Rather than leaving it up to the individual professional to make an effort, there is need for collective learning mechanisms providing tools, examples and best practice transfer that fit the overall construction sector. These mechanisms should be easy to implement, and not require a particular interest in environmental issues. This issue will continue to increase in significance with the European Energy Performance of Buildings Directive [EPBD 2007] tightening its demands every five years – and Norway obliged to implement these changes. The entire architectural community in Norway, as in the other European countries, is forced to learn more about and to dramatically increase the environmental performance of its projects on a regular basis.

With environmental learning in architecture shifting focus from idealism to professionalism, the question is no longer how to make architects think 'green' thoughts, but how to make 'green' an intrinsic part of architecture. In a society that is urging for the mainstreaming of environmental issues in architecture and all other domains of every-day life, educational institutions need to rethink the way in which they prepare their students for a new type of professionalism in the construction industry [Nicol & Pilling 2000; Andrejko 2008].

A first measure is, of course, the update of the curriculum of architectural education. This issue has been the topic of a widespread scholarly debate during the past years [e.g., GBEN 2006; Nicol & Pilling 2000; TIA 2007; OXFORD 2008], with a large number of professionals presenting plans for new and revised courses and programmes on undergraduate, graduate and postgraduate level. The majority of architectural schools has recently updated its curriculum to the new EPBD directives or is currently doing so. Along with a number of public organisations, schools are providing courses in which the new and strict demands are explained, principles for meeting these demands in architecture are shown, and examples of good practice are demonstrated [e.g., NAL 2008; NTNU 2008].

However, in order for environmental issues to infuse education and practice on a daily basis, more widespread learning across all levels is necessary: students and teaching staff, practicing professionals and their offices along with private and public research organisations. While a technical update to new building codes may provide a quick-fix for a few years, a more holistic solution needs to be sought out and implemented to provide students, staff and practitioners with the overall environmental awareness and competency required in architectural practice today and in the foreseeable future. Environmental learning is no longer an individual choice, but a collective responsibility.

Environmental learning in architecture

While schools of architecture offer a relatively protected environment in which students can experiment with sustainable resource use in their projects, the harsh reality sets in as soon as they enter professional practice: a restriction on time and finances, a conservative construction sector, and a general lack of experience with environmental issues in architecture. They quickly find out that it is difficult to apply their acquired skills in a professional environment that does not favour those.

How can schools of architecture help evolve the professional construction sector towards a culture that does favour environmental architecture? Around the globe, a large number of educational institutions and professional organisations are addressing this question.

Amongst a range of initiatives in North-America is the Carbon Neutral Design Project, initiated by the Society of Building Science Educators, to bring together architectural educators and professionals and promote ecological literacy for students, staff and practitioners alike [Boake *et al.* 2008]. The American Institute of Architects (AIA) developed "50to50" in 2007, specifying 50 high-performance strategies for carbon reduction in architecture. They additionally offer a "2030 Toolkit" including information, tools and examples for more sustainable resource use in the built environment, and are currently working on possibilities to include environmental issues in the accreditation routines for schools of architecture [Andrejko 2008].

Olweny [2007] describes the restructuring of the 5-year architectural curriculum at the Uganda Martyrs University to change the categorisation of sustainability from being an add-on to an integrated entity in the entire curriculum, including the design studios.

The Australian Research Institute in Education for Sustainability (ARIES) has conducted a research project on the need for an educational shift towards climate change adaptation in the built environment sector. The project addresses vital questions regarding the type of skills young building professionals are or should be gaining at educational institutions, the efforts of the educational institutions to integrate and emphasise skills necessary to address climate change issues in the built environment, and the

Experiential and problem-based learning are often found in studio teaching at architectural schools. Problem-based projects and group discussions increase the learning effect. Architecture, Urban Planning and Landscape students discussing their common project during a workshop at the School of Architecture and Landscape Planning, Bordeaux, 2008. (Photo: A.Wyckmans) response of the accrediting bodies to this development [Lyth *et al.* 2007].

In Sweden, Chalmers University of Technology has during the past years restructured its architectural Faculty to integrate sustainability issues on all levels: research, education, campus development and work environment. All students are introduced to the curriculum by means of an introductory lecture on sustainability issues, and need to have taken at least one course explicitly linked to sustainability in order to be able to graduate. The University also offers several Masters courses in this field, along with a wide range of open lectures and activities [CHALMERS 2008].

In Norway, ECOBOX (previously NABU), a part of the Norwegian Architectural Association (NAL), aims to strengthen environmental competence and interdisciplinary co-operation within the construction sector. The organisation organises amongst others databases on materials and projects, courses and breakfast seminars [ECOBOX 2008].

Given continuous restrictions in national building codes and regulations, it is fairly safe to say that the environmental performance in architectural projects will increase. The selection of examples described above, however, emphasises that educational institutions can contribute considerably to an intensification of the environmental learning process, rather than to wait for the effect of education and legislation to seep into architectural practice.

This article uses the Faculty of Architecture (AB) at the Norwegian University of Science and Technology (NTNU) as a case. By means of experiential and environmental learning theories, it explores how schools of architecture can trigger collective learning processes and extended forms of collaboration in education and practice.

Experiential learning is a learning method strongly advocated already in the beginning of the 20th Century [Dewey 1998], the main aim being to learn decision making and problem solving skills by means of interaction, analysis and reflection – as opposed to, for example, listening to lectures. Experiential learning is widely used in architectural education and particularly in the design studio, in which the students not only acquire the necessary design knowledge but also the appropriate professional attitudes [Schön 1987; Nicol & Pilling 2000].

Bloom, one of the 20th Century's reference experts in pedagogy, was a strong advocate of experiential learning. He developed a taxonomy to document and aid learning progress. The taxonomy divides the learning process into six consecutive cognitive processes; in rising order of complexity: remember, understand, apply, analyse, evaluate, and create [Anderson &

The knowledge dimension	The cognitive process dimension					
	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual knowledge						
Conceptual knowledge						
Procedural knowledge						
Meta cognitive knowledge						

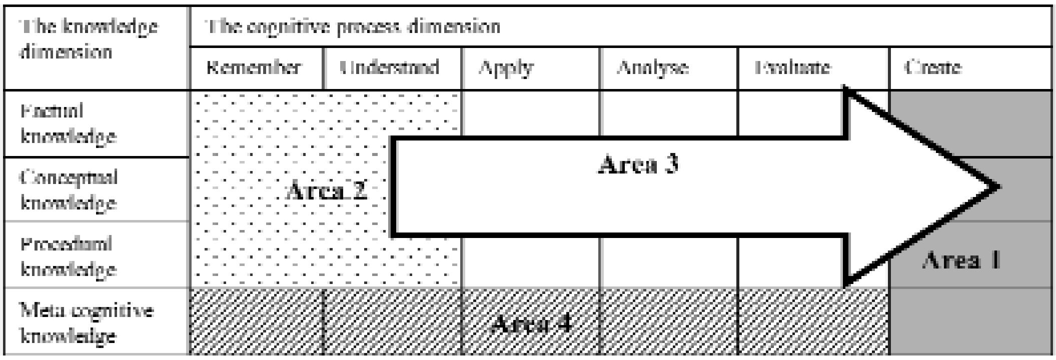
Bloom's revised taxonomy of educational objectives. (After Anderson & Krathwohl 2001)

Krathwohl 2001]. Anderson and Krathwohl reviewed the taxonomy and added a second dimension including four types of knowledge: factual, conceptual, procedural, and meta-cognitive. The result is a two-dimensional table in which learning aims, pedagogic activities and test items can be listed and evaluated.

Looking at this taxonomy, one could ask where it would be most useful to integrate environmental focus into the curriculum. In a world of restricted resources, efforts should be focused on the areas with the largest potential for change. In addition, it needs to be considered whether those efforts would be likely to persuade new students, teachers and practitioners, or mainly those who already were interested. In a hectic every-day workplace, it is easiest to stick to what one knows best – it is both faster and cheaper – unless one is particularly interested in a subject. Design routines are first learned in school, but maintained in architectural practice through every-day decisions and activities. In order to boost the environmental performance of current education and building practice, therefore, it is of the utmost importance that students, teachers and practitioners are not only given the opportunity to be updated on environmental issues, but also indeed choose those alternatives and replace their design routines with more environmentally favourable ones when available.

In order to promote resource efficient architecture, it is important that this type of design is being perceived as relevant and attractive for all students, staff and practitioners – not only those with a particular interest in the subject. This type of challenge is the topic of a branch of behavioural science called *choice architecture*, extensively explored amongst others by Thaler and Sunstein [2008], arguing that the manner in which people make decisions depends a lot on the manner in which the problem is framed. The authors claim that people, when given a choice, in most cases just choose the default option, unless they are especially engaged in the subject. This phenomenon, called the *Status Quo Bias*, is often used in product placement in supermarkets:

Representative examples can help persuade architects to integrate sustainable resource use into their own design routines. In the background, the PUSG School for Management by architects Lacaton and Vassal, Bordeaux. In the foreground, the Botanical Gardens, by Jourda Architectes. Both projects have strong focus on resource use. (Photo: A.Wyckmans)



Bloom's revised taxonomy of educational objectives. (After Anderson & Krathwohl 2001). (1), (2), (3) and (4) indicate specific challenges at the Faculty of AB.

putting groceries at eye level increases their sale in a predictable, easy and cheap manner, regardless of the type of product placed in this position. *What would be the equivalent for environmental issues in architecture?*

Tversky and Kahneman [1974, referred to by Thaler & Sunstein 2008] identify several rules of thumb for the factors on which people base their decisions. Particularly highlighted are the concepts of *anchoring, availability* and *representativeness:*

• *Anchoring* relates to the fact that, when making a decision, people start from something they know, and adjust this "anchor" in a direction they think is appropriate in the given context. Thaler and Sunstein argue that by suggesting a starting point for people's thoughts, it is possible to direct their decisions in a desirable direction.

• A second factor that guides people's choices is *representativeness*: is the situation and context representative of what one oneself has experienced or thinks is relevant?

• The third factor, *availability*, is related to the ease with which people come up with relevant examples. The more readily available relevant examples are, the more likely it is that these will influence people's decision making – for better or worse.

In this article, Bloom's extended taxonomy is combined with the behavioural concepts of anchoring, representativeness and availability to analyse the existing curriculum at the Faculty of AB and to describe a range of modifications that have been initiated in 2007-2008. In this analysis, four main challenges can be highlighted: (1) the ability of the students and staff to creatively explore the potential of environmental issues in architectural design; (2) the communication of theoretical and experiential knowledge in the curriculum to support informed design; (3) the transformation of theory into design routines; and (4), the creation of an arena for sustainability discourse.

Creative exploration

Students and professionals do not merely demand an increase in the environmental performance in architecture, but also a widening of the repertoire of design responses and, above all, a strengthening of the role of the architect [Nicol & Pilling 2000; Bennetts 2008]. Until recently, there has been a fairly limited repertoire of environmental architecture in modern times, basically jumping back and forth between low-tech and high-tech, as some special kind of architecture [Ryghaug 2003]. In the face of the environmental challenges society is up against, a more extensive focus on the potential repertoire of architectural solutions in education and the professional media is rightfully called for.

In general, a dual reflection can be identified in response to the rapidly rising demand for environmental performance in architecture.

Several professionals promote the argument that there is a sufficient amount of knowledge available – and there has been for a long time; professionals just need to ask the right questions and reflect more upon the significance of this type of knowledge and its implementation from the very start of a design project [Lyth *et al.* 2007]. An example of this pool of knowledge is the sturdy handbook of Lechner [2001] on the architectural integration of heating, cooling and lighting issues in a design project. During several decades, well-functioning architectural solutions have been demonstrated for use in a context varying from town planning to the building itself to the tiniest detail. If vernacular architecture has managed to reduce resource use through adaptation to the site and a restrictive use of energy and materials, it is argued, today's society with its much more advanced technological knowledge and computerised tools should surely be able to follow this example.

In order for environmental issues to infuse every-day practice, there is also need for a revision of internal routines and a general feeling of responsibility and empowerment among architects. It is argued that a new set of skills is required to change the built environment and make it more resource efficient. The architectural decision making framework needs to be expanded to make room for the challenges society faces today and in the foreseeable future. It is claimed that new knowledge on climate change and the manner in which it is affected by architecture pushes forward a new way in which to think about architecture; a new type of knowledge that needs to be translated into architectural methodology, material use and town planning [Andrejko 2008]. While such statements might seem odd and unnecessarily complex to those who have dealt with environmental issues for decades, it is also a positive sign. It signifies feelings of empowerment and engagement among architects, and the looking for solutions from within the architectural community. Ryghaug [2003], however, warns that an extensive focus on the appearance of environmental architecture might also include a risk of it becoming a formative element without substance.

The documentation, analysis and dissemination of local and context-specific architectural projects as empirical studies is, for the time being, lacking a systematic effort by the architectural community. The theoretical understanding of and academic research on environmental issues, on the other hand, are documented quite thoroughly [e.g., Berge 2000; Dunster *et al.* 2008; IEA 2008]. Despite the growing number of guidelines and databases on building components and examples [e.g., ECOBOX 2008; EULEB 2006; IEA 2008], the lack of simple and universally applicable answers regarding environmental issues presents one of the main challenges for the response of the architectural profession. With priorities and contexts varying in each project and new technologies and products continuously turning up with variable accreditation in the media and construction sector, it is difficult for architects to integra-

The Tribunal de Grande Instance by Richard Rogers Partnership in Bordeaux shows how vernacular environmental principles can be translated into a 21st Century expression. The shape of the cones, which serve as small courtrooms, is inspired by the ancient donjons nearby; the form simultaneously eases natural ventilation in the rooms. (Photo: A. Wyckmans) te environmental concerns into their projects. Working with environmental issues in architecture requires the continuous combination and creative exploration of experiential and research knowledge. There is no single perfect solution that can be transferred to each project.

Even if "architecture doesn't travel well" [Maritz 2008:19] and appropriate architectural solutions are necessarily local and context-specific, the availability of a range of good examples and good experiences increases architects' probability of making environmentally benign choices in their own professional context as well. A good example is the attention given to Austrian Passive House examples in Norwegian magazines, study trips and conferences [e.g., Passivhus Norden 2008]. However, environmental learning continues to proceed at a slow pace. The creative exploration of environmental issues in architecture is challenging in a professional environment in which each hour and all use of resources have to be accounted for.

With several hundreds of architecture students per school designing a new project each semester, schools constitute a natural laboratory for experimentation which can be used to understand the possibilities for, obstacles to, and consequences of environmental priorities in architecture. They can ensure the analysis of 'ordinary' architecture projects in which each decision that has had an impact on the project's environmental performance has been registered and analysed in empirical research as a form of creating and documenting experiential knowledge. And, eventually, this process will promote competency in how to trigger the environmental potential that lies within each architectural project, not just the demonstration buildings.

Imagine how many hundreds of thousands of man-hours are being spent each semester by students drawing, designing, exploring, analysing, evaluating – in short, a laboratory for experimentation in which experience, interaction and exploration, by teachers and students alike are the central issues [Dewey 1998]. It is exactly during their years in the school of architecture that students are learning to think conceptually – and have the time and opportunity to do so [Maritz 2008]. If the students' efforts are directed and used more consciously than they are today, this in itself constitutes an enormous body of knowledge that can help the promotion of environmental learning and the dissemination, recording and evaluation of experiential knowledge.

Of course, these types of experiences are also gained in architectural practice. While professional practice leaves less freedom to explore and create innovation, it does have a better view of what can be achieved within the boundaries of the current system of finances, legislation and standard routines in the building industry. Students, on the other hand, have the advantage of being in a place in which both academic and experiential knowledge are available and teachers with both of these competences are ready to facilitate the learning process among the students. This learning process forms a good complement to the experiences the professional practice is making. Therefore it is of the utmost importance that an exchange of these two experiences of the new reality finds place extensively and consciously. At the same time, the experiences from students and practising architects will need to be fed back to the research community in order to develop the latter's research priorities and agenda.

Communication of theoretical and experiential knowledge

At the Faculty of AB, graduate students can choose among a range of optional courses related to energy and material use in buildings, as well as sustainable town planning. Since the beginning of this century, students are also offered interdisciplinary courses in which architecture and engineering students co-operate on sustainable building projects; the aim of these courses is to encourage understanding, communication and co-operation among future professionals [Wyckmans *et al.* 2006; Wyckmans 2007]. In addition, post-graduate courses are offered in which decision makers in the construction sector can learn how to design buildings according to Passive House standards [NTNU 2008]. This type of courses, however, is absent in the compulsory undergraduate programme.

As sustainable resource use lacks an explicit link to the compulsory undergraduate curriculum, it is interpreted by the students to be a specialisation and not an intrinsic part of the architectural discipline. In addition, with the current pressure from the media and construction sector, students in the early phases of the education are starting to feel that the curricu-

Student housing in Vienna, Austria, by Baumschlager & Eberle architects. The housing complex has passive house standard, but has no visible green expression. (Photo: A.Wyckmans)

lum is not relevant for architectural practice as it does not explicitly include environmental design. At first sight, integrating sustainable resource use into every level of the five-year curriculum of architectural education seems to be the proper response to the urgent demand from the public opinion, the construction sector and the architectural students themselves.

Yet, the undergraduate architecture students do receive many tools to reach architectural quality, improve comfort in buildings and save energy and resources all at the same time. By properly designing the building envelope according to local site and climate, the zoning of functions and efficient layout of the building programme, and the choice of materials with the correct physical and structural properties, energy and resource use in a building can be reduced considerably even before technological installations are considered. In addition, the undergraduate programme features a wide range of issues that are vital to sustainable practice but not necessarily explicitly related to it, including a range of meta-skills such as the ability to optimise divergent demands into a holistic project, the ability to co-operate with many professions, and the ability to visualise and communicate information in an understandable manner to different professions and user groups [Mehaffy 2008].

These issues are not necessarily labelled as *energy efficient* or *sustainable*, but rather *good* architecture [Ryghaug 2003]. The use of this type of representative examples can convince students that good architectural quality can provide solutions that allow people to save energy without losing comfort, and have good comfort indoors without having to worry about energy consumption. The potential of architects' contributions just needs to be advocated more explicitly, not in the least to the architectural profession itself [Nicol & Pilling 2000; Lewis 2008].

Transforming theory into design routines

A decade of experience from the graduate courses at the Faculty of AB shows that it is relatively easy to teach architecture students how to find information regarding energy and material efficiency – particularly due to the appearance of online databases [e.g., ECOBOX 2008; EULEB 2006; IEA 2008]. Consequently, the environmental programmes the students prepare for their design projects tend to be quite ambitious in their goals regarding energy and material efficiency. However, in competition with other architectural issues, few students manage to translate their environmental programmes instantly into successful design projects, even in the protected environment of a university design studio. For effective learning processes to occur in architectural education, research indicates that in order for the students to be able to translate theory into design routines, they have to interact with the material and anchor it to previous experiences in order to make them personally meaningful [Nicol & Pilling 2000]. Hence, a series of small tasks, discussions, and presentations is needed to facilitate this learning process.

A range of international experts have addressed this challenging transfer from theory to design practice. La Roche [2008] discusses a successful undergraduate course in climate responsive design and the importance of studio and lecture integration and continuous co-operation among the participating teaching staff. Even the architectural history module comprises readings in contemporary sustainable design, enabling the students to have a thorough understanding of sustainability concepts and tools from the very beginning of their education. A similar argument is made by Lyth *et al.* [2007], addressing the need for integrating sustainability in existing practical professional courses rather than having the topic addressed by separate teachers. The authors stress that the integration of sustainability issues in the curriculum should be made with particular focus on key impact areas and professional practice skills to avoid the creation of climate change experts rather than general professional practitioners. The latter remark is shared by Gough and Scott [2007], stressing the difference between courses that are explicitly about sustainability and those that are not but do include important issues regarding sustainability.

In a graduate course on energy- and environmentally friendly architectural design at the Faculty of AB, a series of case studies, small calculation exercises, and analysis and improvement of existing structures is introduced in order to achieve this purpose, consistent with Bloom's taxonomy. In addition, the design experience the students are gaining is organised around a range of singular projects, each with a focus on a specific issue such as *site, material* or *energy and geometry*, forcing the student to react creatively in order to solve the challenge. These design experiences are in the second half of the semester integrated into a larger design exercise. The anchoring of the

"Flex it : Play it". Interdisciplinary student project, 2008. Design of a low carbon kindergarten in Trondheim. The project received the 2nd prize in the annual student competition between NTNU and Chalmers, organised with the financial support of The Norwegian State Housing Bank and Hans Eek Architects. The project group consisted of architecture students Ane Elise Alsgaard, Tore Hillestad and Andreas Broch, and engineering student Inger H. Halvorsen.

separate issues before embarking on a large project has been introduced into the graduate courses for several years, and it visibly aids the learning process of the students. Instead of pointing towards something completely new, the students can find relevant experience in their previous practice.

There exist two distinct challenges to this process, though. The set-up requires time and recurring experiences of trial-and-error, reflection and observation to obtain the desired learning effect. This is difficult to achieve within half a year, particularly when the learning experience is not sustained in the following semester. In addition, the structure of the graduate education actually makes it more difficult to prepare a series of small exercises and achieve continuity even within one semester.

A transfer of certain elements of the graduate course to the undergraduate curriculum can serve those two challenges simultaneously. The six semesters of the undergraduate curriculum focus on the issues of *space, structure and form; structural components; tectonics; housing; town planning;* and *complex building programmes,* respectively. It is clear to see that design issues related to *site, materials* and *energy and geometry* can easily be transferred to the undergraduate education without interfering with the existing structure of the programme. It is less confusing for the students, communicates the intrinsic nature of sustainability in architecture, and uses teaching resources more efficiently. The need to integrate the challenge of environmental issues into the undergraduate curriculum also offers new significance to existing teaching practice. Architecture students typically find building physics, for example, a dull and theoretic course, but in the light of the development of Passive House standards [e.g., Passivhaus Institut, Passivhus Norden 2008] and the representative architectural examples generated in this context, the building physics course gains new momentum.

In addition, the framework of the undergraduate programme facilitates a more integrated approach to theory and design practice, when compared to the graduate courses. In the graduate courses, the students choose 3 courses each semester: 1 design course of 15 credits, and two theory courses of 7.5 credits each. Usually, one of the theory courses is linked to the design course, but as the students can shop around for different courses, it is difficult for the teacher of each course to make a coherent whole and create a continuous link between theory and design practice. In the undergraduate courses, this is easier as the entire semester is managed by one teaching team and designed as a whole.

A third concern is the continuity of education throughout the six semesters. In the school year of 2007-2008, two out of six courses in the undergraduate programme have started to integrate issues of sustainability into their curriculum, and the teaching staff of the other semesters is discussing a similar approach. In order to avoid overlap and discontinuity, it is required that the Faculty of AB creates a framework for the undergraduate curriculum that distributes the environmental issues among the six semesters. This is an excellent opportunity to improve the consistency of learning objectives, pedagogic methods and assessment in the first three years of the education. It is, however, also a long-term process and requires an intensive co-operation with the entire teaching staff in order to avoid a formal mould that doesn't fit existing teaching practice.

Creating an arena for sustainability discourse

The range of measures related to the integration of environmental issues into the curriculum, discussed in the previous sections, does not suffice to communicate sustainable resource use as an intrinsic part of the architectural discipline. In order to promote resource efficient architecture, it is important that this type of design is being perceived as relevant and attractive for practicing architects in general – not only those with a particular interest in the subject. In order to support environmental learning at the Faculty of AB, a range of activities is organised to promote dialogue and discussion regarding sustainability in a visible and outspoken manner; to create an environment in which attitudes, opinions and experiences regarding sustainability can be shared, examined, tested and updated in order to facilitate the learning process [Kolb 1984].

The Faculty has a long tradition of guest lectures each Friday afternoon, in which Norwegian and international architects are invited to present and discuss their projects. In the spring of 2008, all of the guests were challenged to include into the lecture their experience of the changes in the construction sector and the significance of those changes for their own archi-

Public discussion of interdisciplinary student projects by a jury of building professionals at Chalmers University of Technology, Gøteborg, 2007. (Photo: A. Wyckmans)

tectural practice – regardless of whether they have an explicit focus on sustainability in their projects or not. Furthermore, in the undergraduate courses, a seminar was organised in which the students spent several days reflecting on their professional attitude towards ever more strict building regulations and the role of architects in a sustainable development. The activity was facilitated by a sociologist with research focus on the field of sustainable architecture. In addition, a *green lunch* arena [bareKRAFTIGarkitektur 2008] is created in which students and staff can gather every week to discuss issues related to sustainable resource use. In this arena, teaching experiences, information regarding reference projects and literature as well as relevant activities can be conveyed. In this forum, practitioners are invited to present their projects, the processes that lead to them and the successfulness of both in order to help bridge the gap between theoretical principles and practical design routines and promote more informed practice [Nicol & Pilling 2000; Lyth *et al.* 2007]. In addition, a series of breakfast meetings on the topic of environment-friendly building was organised by NTNU during the Fall of 2008, inviting practitioners and academics to a joint arena for discussion [KLIMAX 2008].

However, Gough and Scott [2007] also point out that individual experiential knowledge, gained in a particular context, is difficult to communicate, and one might not immediately regard it of any relevance to others. Even if most architectural offices now are looking at environmental issues with a more benign attitude and are incorporating them in singular projects, it might appear as if those merely are minor contributions in a vast sea of architecture that is not environmental. Therefore it is important to not only collect and disseminate the project results in the form of U-values and other environmental parameters, but even more so the decision-making process and the priorities made during the entire design, along with the context in which these were made and the consequences they had. The stories of how the projects came into being need to be told in order to build a collective repertoire of environmental learning in architecture. In the context of environmental learning in architecture, the availability of good examples and good experiences will increase architects' probability of making environmentally benign choices.

Conclusion
Schools of architecture carry a huge responsibility in the communication of theoretical and experiential knowledge. They need to collect, discuss and disseminate good practice: making knowledge in architectural research and practice visible and easily available, and presenting it in such a way that professionals and students can easily identify with it.

In this article, it is argued that universities and schools of architecture need to take a more active role in environmental learning, not only on behalf of their own students, but on behalf of the entire architectural community and building sector. Schools of architecture currently face the challenge of students, construction sector and media demanding more focus on environmental issues. In this context, it is important to maintain a reflective attitude and not merely expand existing courses and add teachers into the existing structure. There is need for a new role for educational institutions, and a new set of learning tools to promote environmental learning in architecture to a much larger degree than they do today.
In response to this urgent demand, a learning environment is being developed at the Faculty of Architecture and Fine Art as a framework for new knowledge and new recognition regarding sustainable resource use in architecture. The learning environment includes a range of measures aiming to enhance the potential of the existing curriculum, optimise the transfer of knowledge from expert courses to undergraduate education, and improve mastery among students and teaching staff.

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