Buildings & Cities

Grant, E. J. (2020). Mainstreaming environmental education for architects: the need for basic literacies. *Buildings and Cities*, 1(1), pp. 538–549. DOI: https://doi.org/10.5334/bc.41

RESEARCH

Mainstreaming environmental education for architects: the need for basic literacies

Elizabeth J. Grant[1]

Abstract

What are recent architectural graduates' perceptions about the level of knowledge required of interns entering architectural practice and the suitability of architectural education? Research is presented that examines recent alumni's engagement with environmental sustainability while in school. Two aspects of their educational experience are surveyed: their readiness for sustainable design work and their familiarity with the benefits of reusing existing buildings. Recent alumni of the Virginia Tech School of Architecture + Design were asked to explain the areas of practice for which they were best and least prepared, to identify additional educational topics they would have found useful, to name the key purposes and priorities of the discipline of architecture, and to articulate changes they wished to see in schools of architecture. The results point to a current pedagogy where the tacit and explicit knowledge that is critical to the adoption of sustainable approaches to design of new and retrofit structures is undervalued in architectural education. Suggestions from the literature and strategies to ameliorate this situation are presented.

Practice relevance

Two basic areas of literacy necessary for graduating architecture students are addressed. The first is readiness for environmentally sustainable work, which includes understanding building science concepts. Results of rating and open-ended survey questions indicate that many recent undergraduate alumni feel a sense of obligation to protect the natural environment through their design efforts, but do not claim facility with tangible means to achieve this goal in the design of buildings. The second is appreciation of the existing building fabric, which involves engaging a range of preservation and reuse strategies that preserve the embodied energy present in existing structures. Many alumni felt their education did not prepare them for renovation and reuse work that is often prevalent in their current practices. Architectural educators can take an active role to anticipate the changing needs of the profession and adjust their curricula to provide appropriate capabilities.

Keywords: architects; building science; education; energy; environmental literacy; environmental sustainability; zero carbon

1 Introduction

When considering how to mainstream environmentally sustainable architecture, one must step back and think about the education of architects more broadly. As future defenders of public health, safety, and welfare, it is worthwhile to question whether architecture students feel prepared by their education to tackle issues of environmental sustainability. A recent survey of undergraduate alumni of the Virginia Tech School of Architecture + Design (VT A+D) tackled the larger question of how recent alumni feel about the quality and content of their education after graduating. The central research question discussed in this paper was: How has the architectural education of recent graduates prepared them for a life of practice that embraces environmental sustainability? This can be further broken down into two key sub-questions: How have new alumni been readied to engage in environmentally sustainable design?, with an understanding that this includes education in basic building science and in building siting, envelopes, and systems; and How have alumni been prepared to address the preservation of existing building resources?

[1] School of Architecture + Design, Virginia Tech, Blacksburg, VA, US. ORCID: 0000-0002-5468-7990

Email: elgrant2@vt.edu

1.1 Background

Numerous previous studies and texts address architectural pedagogy in general, and the integration of environmental topics in particular. Donald Watson's chapter 'Environment and architecture' in *The Discipline of Architecture* (2001) presents the ethical obligation of architects to bring their design abilities to bear on the preservation of the Earth's resources. He introduces the idea that:

> Environmental issues are too frequently seen as 'merely' pragmatic or technical issues left for other specialists to worry about. When this is done, the profession misses a great opportunity, if not a responsibility, for renewal of its knowledge base and for reflection on the ethical consequences and values of architectural education and practice. (p. 159)

Selected studies and books are discussed below that address aspects of environmentally sustainable literacy and how they are addressed in architectural education.

1.1.1 Readiness for environmentally sustainable design

In a study entitled 'Zero net energy education: Mind the gap', Kwok *et al.* (2014) considered three central questions: Are architecture schools in North America adequately preparing students for a zero-carbon education?[1] Do these preparations extend to student design projects? Does the culture of architecture school support this preparation? Expanding on previous research with a survey instrument of educators of building science technology courses,[2] they tested two hypotheses: first, that the academy is falling behind in helping students become practitioners who can meet the goals of the 2030 Challenge;[3] and second, that energy modeling would be mentioned by their survey respondents as a typical strategy for accomplishing this educational goal.

For their first hypothesis, Kwok *et al.* found that while the content of building science technology lecture courses closely mapped the inverted pyramid of zero-net energy design strategies proposed by McGregor *et al.* (2013), studio courses were not adequately engaging with this material as part of an integrated design approach. In the terminology of the US National Architectural Accrediting Board (NAAB), students might have been achieving an 'understanding' of these concepts rather than the 'ability' to use them in their designs. Regarding their second hypothesis, Kwok *et al.* found that only one respondent of 26 indicated that energy modeling software was a viable approach to closing this gap.

Rider (2014) conducted a grounded theory investigation of architectural faculty addressing sustainability themes. The aim was to elucidate best practices for introducing concepts of sustainability into architectural design curricula. Rider addressed the difficult issue of defining terms such as 'carbon neutrality,' 'green building,' and 'sustainability' in her findings. Rider's inquiry defined sustainability as an approach that demands no detrimental effects on its environs. Through an iterative process of coding and interpretation, Rider discovered a strong focus on studio education as the most critical venue for incorporation of sustainability themes. She also uncovered a perception of a strong philosophical and methodological divide in the population of studio professors, between 'design' faculty focused on the visual and object qualities of architecture and 'non-design' faculty with interests in building science and a more process-oriented approach to the creative process. The suggestions Rider made for overcoming the tokenism of sustainability within the studio and support courses will be enumerated in the conclusions section below.

1.1.2 Appreciation of the existing building fabric

Cesal (2010) takes umbrage with the direction of the architectural profession, particularly in the wake of the nasty recession of 2008. Cesal speaks about architects as sorcerers who do not often disclose their means, but rather rely on mystique to prove their value to their clients and society. He recounts the common removal of parameters from design prompts in architecture school, which he feels is a misstep on the part of architectural faculty, saying, 'frequently the student is not even required to confront the inconvenient' (p. 158). Cesal further postulated that this attitude in schools is inherited from the much-revered Le Corbusier who, in *The City of To-Morrow and Its Planning* (1929), explained that 'proceeding in the manner of an investigator in his laboratory, I have assumed an ideal site to begin with' (Le Corbusier 1987: 4; cited in Cesal, 2010: 158). In such a context, the renovation and retrofit of buildings is seen as an inconvenience rather than as an opportunity.

In *Heating, Cooling, Lighting*: *Sustainable Design Methods for Architects* (2015), a staple text in many environmental control systems (ECS) courses in architecture schools, Norbert Lechner advocates for the preservation and reuse of existing buildings to save their embodied energy. He argued this is particularly critical in a time when embodied energy has become relatively more important in the life-cycle of a building, due to reductions in operational energy. Lechner asserted that the carbon sequestration benefit can be a compelling reason to preserve existing buildings. Combined with the urgency of preserving the decaying building stock for cultural, social, and economic reasons, the embodied energy argument helps architects and others advocate for renovation and restoration projects.

1.1.3 The Boyer Report

Ernest L. Boyer and Lee D. Mitgang published *Building Community: A New Future for Architecture Education and Practice: A Special Report* (1996). Commonly referred to as the 'Boyer Report,' this document takes a detailed look at architectural

education in the US and makes several recommendations about important changes that might help the profession more fully fill its obligations to society. Among its conclusions, the report recommends the greater involvement of professionals in the education of architects to ensure their training corresponds to what the profession needs, and that students have a clearer picture of what their future occupation entails. In many cases, they found that the education of architects in the areas of environmental sustainability and engagement with built contexts was lacking.

2 Materials and methods

The present study began with the author's empirical observations as an educator and practitioner, rather than with a theory that required testing through hypothesis. This necessitated the use of a mixed-methods approach incorporating grounded theory, as developed by Corbin & Strauss (2008), to generate themes, supported by a status survey to elucidate the defining characteristics of the studied population and loosely quantify general attitudes. The research framework is depicted in **Figure 1**.

2.1 Status survey

The survey instrument used in this research is what Kerlinger (1986) termed a 'status survey.' He distinguished between status surveys that aim to identify existing conditions and sample surveys that evolved in the 20th century as a tool for social science research, and which intend to unearth the relationships amongst variables. The generalizability of sample surveys is dependent on a clear definition of the general and specific problems to be addressed, careful random sampling, a well-defined and executed research plan and survey instrument, and a methodical process of coding and tabulation. Because random sampling was not used in the present study, it cannot be categorized as a sample survey.

The results section below only presents descriptive statistics from the rating survey questions. Inferential statistics are not used due to the use of a convenience sample and self-selection of respondents. In this convenience sample, it is possible that those alumni who remained in the profession were more motivated to take the survey. Because of these limitations, no claim is made that the conclusions pulled from these data can be extrapolated to the general population of alumni from this school, or architectural alumni in general.

2.2 Grounded theory

The hallmark of grounded theory is, in the words of Groat & Wang (2013: 235), to 'identify an explanatory theory as it emerges from the analytical process.' Grounded theory requires that investigators explore the situation of interest as holistically as possible, and with as few preconceived beliefs as possible.

Several educational and ecological theories can most likely be introduced to support and extrapolate the findings of this study, as is appropriate at the conclusion of a grounded theory research process, but these are beyond the scope of this paper. The next phase of the research will likely include the development of an overarching explanatory theory, as there are currently not enough data in the present survey to reach 'theoretical saturation' in grounded theory terms. The implications section below focuses instead on the pragmatics of education and policy, including suggestions to help bridge the gaps identified in the conclusions section.

2.3 Survey instrument

The survey instrument asked alumni about many aspects of their education related to both scholarship and practice, but this paper reports only the findings related to the central question of engagement with environmentally sustainable design. Both rating and open-ended questions were asked, with results reported in this paper, to situate the central research question within its broader educational context and to provide triangulation of results.

In this research, the current state of architectural education was assayed in terms of graduates' literacy in environmental sustainability and engagement with the existing building stock by collecting the insights of a population of recent architecture school graduates. With the cooperation of the university, all alumni graduating in any semester in the

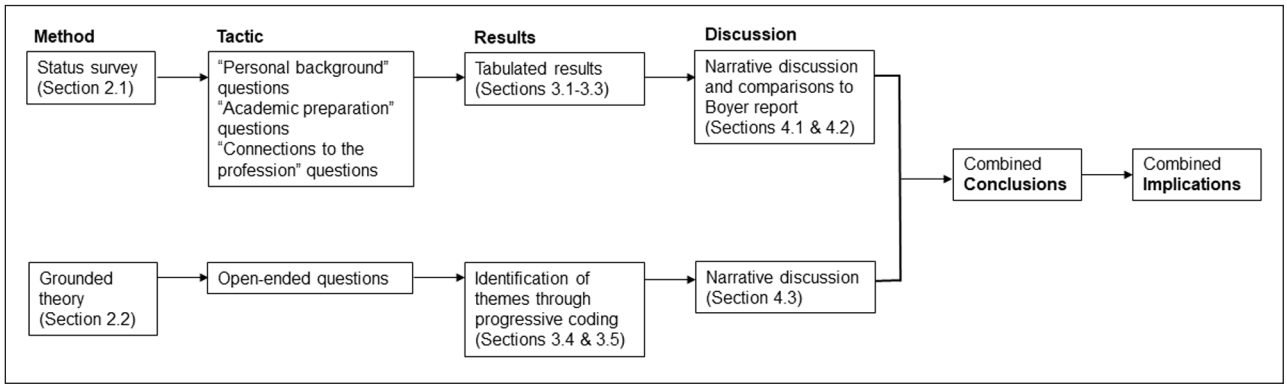

Figure 1: Research framework.

period 2015–17 with a Bachelor of Architecture degree from VT A+D who had supplied a valid email to the alumni office were sent the online survey. These alumni were asked a series of questions about their perceptions of architectural education and practice.

The survey used in this study was loosely based on the 'Survey on the Education of Architects,' on which the Boyer Report is based. The report was a well-funded, well-vetted, multi-year project of the Carnegie Foundation for the Advancement of Teaching. While several authors have commented on, argued against, and extrapolated from the findings of the report (Gregory *et al.* 2013; Neveu 2009; Segrest 1997), to the best of the author's knowledge, there have been no formal follow-ups to the survey to date.

Both the 'Survey on Education' and the present survey were divided into three sections: 'Personal background,' 'Academic preparation for architecture,' and 'Connections to the profession and society,' followed by a section of free-response questions. The present survey consisted of 42 questions in total: 20 in 'Personal background,' eight in 'Academic preparation for architecture,' nine in 'Connections to the profession and society,' and five in the open-ended section.

2.4 Limitations

Limitations included potential bias related to the use of a convenience sample and the self-selection of respondents, as explained in section 2.1. In particular, a high number of respondents (92%) had remained in the profession of architecture, which may have skewed the results. The discussion section below includes comparisons and connections between the alumni in the present study and those in the 'Survey on Education,' but it is acknowledged that the two populations are not fully comparable. Additionally, this study focused on a school of architecture in the US, and will be most relevant to academics, practitioners, and policymakers in that setting, but may also be of interest to international readers with similar concerns.

3 Results

3.1 Personal background

A total of 20 questions were asked in this section, mainly related to demographics and the current life situations of the alumni. The results of these questions are summarized here. Of a total of 224 receiving the survey link via email, there were 53 distinct sets of responses recorded. The median age of respondents was 25 years. Of 50 responding to each of the following demographic questions, 48% were male, 50% were female, and 2% were another gender identity. A total of 92% were US citizens; and 92% reported that they were currently working in the architectural profession. The gender and citizenship balance was well aligned with the overall student population of the institution at that time. None of the respondents was currently enrolled in a graduate degree program. A large majority of respondents were planning to pursue professional licensure and many had already taken steps to do so.

3.2 Academic preparation for architecture

There were eight statements in this section; the statement most relevant to the question of preparation for environmentally sustainable practice addressed in this paper was: 'I graduated from the VT A+D well prepared to be:' with the range of choices and degrees of agreement seen in **Table 1**. While alumni tended to affirm their preparation to take on almost all these identities, a 'creative thinker' ranked most highly, with 'a problem solver,' 'a life-long learner', a 'building designer,' and 'an effective verbal communicator' following closely behind, all with ≥ 90% agreement, shown shaded in light gray in **Table 1**. Most important for the present question, in the next tier, alignments with the

Table 1: Alumni responses to the statement 'I graduated from the VT A+D well prepared to be:'.

Identities	Strongly agree	Agree somewhat	Disagree somewhat	Strongly disagree	Responses
a) A problem-solver	82%	18%	0%	0%	50
b) A life-long learner	80%	18%	2%	0%	50
c) A designer of environmentally sustainable structures	14%	57%	22%	6%	49
d) An effective verbal communicator	32%	58%	10%	0%	50
e) A team worker	26%	46%	26%	2%	50
f) An entrepreneur	16%	16%	47%	22%	45
g) Attentive to needs of clients and users	31%	39%	27%	4%	49
h) A building designer	50%	44%	6%	0%	50
i) A creative thinker	96%	4%	0%	0%	50

identities of 'a team worker,' 'a designer of environmentally sustainable structures,' and 'attentive to needs of clients and users' were somewhat less emphatic, with 70–72% agreement, shown without shading in **Table 1**. The only answer receiving < 50% agreement was 'an entrepreneur', with just 32% agreement, shown shaded in dark gray in **Table 1**.

3.3 Connections to the profession and society

Alumni were asked to respond to nine statements involving the connection of academia to the profession and society. The following are responses to the statement most cogent to the sub-questions of this paper, which were how well schools align with the needs of the profession to engage environmentally responsible design, and to work intelligently within existing built environments.

The statement asked alumni to: 'Please indicate how effectively you feel the curriculum at the VT A+D promoted understanding of the following societal issues and concerns.' The responses again broke into three distinct categories. First, there was nearly complete agreement that the curriculum supported 'the relationship between design and human behavior and well-being' and 'the relationship between the physical environment and architectural design' (**Table 2**). Second, there was weaker but still majority agreement, at 58%, that the curriculum effectively dealt with 'balancing the architect's responsibilities to society and to the client.' Third, approximately half the respondents indicated that the curriculum dealt ineffectively with 'the renovation and reuse of buildings, especially in the urban context' and 'the connections between building design and changing family lifestyles.'

3.4 Results of coding open-ended questions

A grounded theory approach was used to process the data in the five open-ended questions. Open coding was performed on the answers to the questions to identify categories, and then axial coding was used to identify connections among these categories. Selective coding was then performed to make sense of these themes, and these interpretations are presented in the conclusions section below.

A sample of the open coding process for one of the open-ended questions is shown in Tables S1 and S2 and Figure S1 in the supplemental data online. As stated in the materials and methods section, other categories, connections, and themes, broadly involving the relationship between education and practice, were also investigated, but are not reproduced here.

3.5 Themes extracted from open-ended questions

3.5.1 Question 1: 'For what aspects of practice did your education best prepare you?'

Looking at readiness for environmentally sustainable design, one answer to this question read as follows:

> key technical classes, such as EBS [environmental building systems], structures, and building materials (2nd year) seem to have been beneficial in retrospect.

Another alumnus reported that:

> my education also provided me with exposure to different concepts in practice, building systems, environmental design, basic structures, etc., so that when I entered practice I was able to be professionally literate, even if I lacked specific knowledge.

Table 2: Alumni responses to the statement 'Please indicate how effectively you feel the curriculum at the VT A+D promoted understanding of the following societal issues and concerns:'.

Societal issues and concerns	Very effectively	Somewhat effectively	Somewhat ineffectively	Very ineffectively	Responses
a) The relationship between design and human behavior and wellbeing	40%	51%	9%	0%	45
b) The relationship between the physical environment and architectural design	56%	44%	0%	0%	45
c) The renovation and reuse of buildings, especially in the urban context	14%	36%	39%	11%	44
d) The connections between building design and changing family lifestyles	10%	38%	43%	9%	42
e) Balancing the architect's responsibilities to society and to the client	9%	49%	33%	9%	43

while another was less positive:

> Many, many, many of the subjects learned in school I do not deal with on a daily basis. LEED [Leadership in Energy and Environmental Design], green building systems, structures are all taken care of by your MEP [mechanical, electrical, plumbing] and structural engineers or not even considered in a project due to the increased cost. On a daily basis I don't even get to participate in the design of a new project.

There were no responses to this question directly pointing to the value of existing building stock.

3.5.2 Question 2: 'For what aspects of practice did your education least prepare you?'

Some responses pointed to a lack of exposure to building envelopes and systems, an understanding of which is fundamental to designing sustainable buildings:

> How to put a building together when you have to accommodate climate with readily available building systems. A lot of the designs I remember didn't even pretend to have building envelopes. I don't think we needed to get into the nitty gritty, but it's where a lot of our attention is in the real world.

One alumnus said:

> My education did not provide me a sufficient understanding of how buildings and building envelopes come together beyond a very basic residential construction type.

Another did not feel the school supplied adequate 'technical knowledge of how buildings systems and structural systems are integrated into a project.'

There were no overt references to existing buildings or renovation efforts in the answers to this question.

3.5.3 Question 3: 'What additional areas of study might you have found most useful in preparing you for practice?'

Responses were as follows: 'More emphasis on environmental/ecological systems and how they can play a role in buildings,' 'Building envelopes,' and this more extended response:

> Therefore, I believe that additional opportunity to learn more about environmental building design and building science, the ability of all students […] to participate in real scholarly research on these subjects, and knowledge of how to use contemporary digital tools as designers (not technicians) would have helped me bring more to the contemporary world of practice.

Addressing the lack of knowledge about retrofit/renovation gained in school, one alumnus replied:

> I wish I had had more exposure to historic preservation/adaptive re-use/restoration projects as an undergraduate.

3.5.4 Question 4: 'We would like you to reflect briefly on the purposes and priorities of architecture itself. Looking ahead to the next ten or twenty years, please summarize how you perceive the larger purpose of architects and architecture.'

A large number of survey participants wrote answers that dealt with preparation for environmentally sustainable design, albeit in a very broad sense. A representative sample of these are shown in **Table 3**.

Two responses addressed existing buildings, as follows:

> I believe the larger purpose is going to be preserving what is already here, improving upon it, and developing our environment (both built and natural) in a way that will best serve ourselves, society, and the natural landscapes that remain.

> To provide sustainable opportunities for growth while still preserving architecture of the past. Specifically, architects need to address the changing requirements due to climate change and devise ways for humans to continue to live and thrive in a new environment.

3.5.5 Question 5: 'What are some of the most important changes you feel are necessary if schools of architecture are to respond to, and keep up with, the emerging realities of the profession and society? Are the assumptions and methods that have governed architecture education for decades still valid?'

Several responses again focused on environmentally sustainable design, with one alumnus writing 'Sustainability in more ways than just LEED—what about sea level rise? Atmospheric pollution?' and others responding:

Table 3: Responses to question 4, regarding the purposes and priorities of architecture.

Architects' goals should be to improve the built environment. To provide comfortable, effective spaces for the user. To help usher the advancement of technology into the built environment. To design sustainable spaces.
I think it is the task of architects to inform our clients and the general public about steps forward in creating a more resilient environment. A singular building has such a large impact, yet is such a tiny drop in the bucket. It is important that we can inspire clients to make decisions that better the environment, both natural and man-made, and society. And inspire, that collectively, a big impact and forward momentum is possible. In summary, the larger purpose of the architectural profession is to spread knowledge.
Modern buildings also have a tremendous impact on the environment, so if one is to bring another building into the environment, it is the responsibility of the designer/architect to design a building that will negatively impact the environment as little as possible.
Architecture is something that people interact with every day, it is not only significant in terms of place-making and cultural identity, but also in the well-being of people and our environment overall. In the next 10 to 20 years, the questions of overpopulation, increased sprawl and urban density will increasingly be problems that need to be addressed by architects.
[...] I estimate the greatest contemporary priorities of architecture are to develop works that are at once beautiful and uplifting, but also environmentally conscious, and healthy. The need for all buildings (not the most expensive or a select few) to positively contribute to the global and localized environments is paramount if we are to continue to exist in a healthy natural environment. Passive design strategies, building energy and resources use, and other like topics are all contemporary issues of great concern. As architects, we should be able to provide beautiful and uplifting works that simultaneously deliver in the area of environmental performance.

> Building code today (especially energy code) is more prescriptive than ever before. We were taught to use constraints to push our designs to new levels and since this is one of most stringent constraints we face, besides cost, a little more attention regarding how it might redirect design in school means we will have more potential to experiment with the status quo once in practice.

> I think schools need to teach the programs that are being used at the time and to have them be mandatory courses. I also think schools could benefit their students by teaching about the current environmental standards in the profession, such as LEED and Earthcraft.

One respondent focused on existing contexts and preservation:

> Historic preservation is huge. Nothing was really emphasized regarding renovations/preservation of buildings. In practice, MOST of the projects that I have worked on currently have been historic preservation and renovations of existing buildings. Building a new facility is both expensive and long, so clients tend towards renovating existing buildings or additions.

4 Discussion

4.1 Academic preparation for architecture

The results of the present study were similar to those of the 'Survey on Education' (Boyer Archives 1994), as shown in **Table 4**. Most relevant to the questions of this paper, the middle tier of more lukewarm affirmations in the 'Survey on Education' points to less convincing perceptions of preparation for environmentally sustainable design, and for collaboration with design teams and clients. It is interesting to note that a substantially higher percentage of alumni in the present study (71% in **Table 1**) identified as 'designers of environmentally sustainable structures' as compared with 51% in the 'Survey on Education' (**Table 4**). It can be speculated that the greater attention paid to sustainability, even on a superficial level, in both architecture schools and the popular media in the 2010s versus the 1990s, might have contributed to this difference.

4.2 Connections to the profession and society

Both the present group and the 'Survey on Education' group felt confident in handling 'the relationship between the physical environment and architectural design,' at 100% (**Table 2**) and 88% (**Table 5**), respectively (Boyer Archives 1994). These results can be interpreted in two ways: either alumni felt comfortable addressing buildings' impacts on the larger ecosystem, or they were convinced they could address the more immediate spatial relationship of buildings to their physical surroundings, or both. More in-depth and precise questioning is needed to determine what this result signifies.

Table 4: In the 'Survey on Education' (1994), responses to the statement 'Architecture students leave this school well-prepared as:'.

Identities	Strongly agree	Agree somewhat	Disagree somewhat	Strongly disagree	Don't know
a) Problem-solvers	67%	29%	3%	1%	0%
b) Life-long learners	69%	24%	4%	1%	2%
c) Designers of environmentally sustainable structures	8%	43%	29%	19%	1%
d) Effective verbal communicators	29%	47%	18%	6%	0%
e) Team workers	26%	48%	22%	4%	0%
f) Entrepreneurs	13%	26%	35%	24%	2%
g) Attentive listeners to needs of clients	25%	35%	25%	14%	1%

Table 5: Responses in the 'Survey on Education' (1994) to the statement 'Please indicate how effectively the curriculum at this school promotes understanding of the following societal issues and concerns:'.

Societal issues and concerns	Very effectively	Somewhat effectively	Somewhat ineffectively	Very ineffectively	Don't know	Total
a) The relationship between structural design and human behavior and well-being[a]	16%	53%	21%	8%	2%	45
b) The relationship between the physical environment and architectural design	41%	47%	9%	2%	1%	45
c) The renovation and reuse of buildings, especially in the urban context	21%	40%	26%	12%	1%	44
d) The connections between building design and changing family lifestyles	13%	37%	28%	19%	3%	42
e) Balancing the architect's responsibilities to society and to the client.	13%	33%	38%	13%	2%	43

Note: [a]The wording of this statement is slightly different from that used in the present study. It was changed here to avoid an association with structural engineering, which seemed not to fit the intent of the statement.

The indication by half the alumni surveyed in the present study that they were inadequately prepared to deal with 'the renovation and reuse of buildings, especially in the urban context' is a critical finding. A great number of practitioners will be expected to contend with the aging building stock in creative ways and can, if properly prepared to take on the challenge, make a significant impact on energy and carbon consumption. It is therefore troubling that only half the recent alumni feel prepared to do so. The results of the 'Survey on Education' are notably different. Most alumni agreed that the curriculum was effective at addressing the renovation and reuse of buildings. This set of issues was rated 61% effective (**Table 5**) in the curriculum, in contrast to only 50% effective (**Table 2**) in the current study. While, as mentioned previously, it is not prudent to compare the two populations of alumni, this does raise a red flag. The lack of confidence in addressing renovation and reuse projects may be a characteristic specific to graduates of VT A+D, or it may point to the increasing oversimplification of design prompts lamented by Cesal (2010) (see section 1.1.2). Further investigation will be required to uncover the reasons for this change.

Interestingly, the 'Survey on Education' showed that a small majority of alumni (51% in **Table 5**) felt ill-equipped by their education to deal with 'balancing the architect's responsibilities to society and to the client,' while contemporary alumni were more confident with 58% (**Table 2**) feeling that their curriculum effectively addressed this need. This suggests that if societal and environmental needs could be better entwined in the curriculum and in architects' attitudes, perhaps a greater awareness of the importance of environmentally sustainable design might be inculcated. Further, if taking advantage of the social, cultural, and environmental value sunk into existing buildings by repairing and intelligently reusing them could be seen as a societal need, the newest generation of architecture students might

learn to embrace renovation and reuse and demand to learn more about this topic while in school. In the epilogue to their report, Boyer & Mitgang (1996: 149) address this very concern:

> The world needs more scholars and practitioners not only educated to prosper in their own careers but also prepared to fulfil social and civic obligations through the genius of design. There is much to be done. Federal studies calculate, for example, that $112 billion in work is needed to repair or replace increasingly squalid school buildings that our nation's children attend each day—at a time when neither government nor citizens seem much moved by the impact that collapsing ceilings, exposed wires, fire-code violations, or poor air quality might have on learning, or the lives of children. In these and countless other matters affecting the health, safety, welfare, and happiness of communities in this country [the US], the voices of architects must be heard and their talents meaningfully employed.

4.3 Open-ended questions

4.3.1 Question 1

In terms of preparation for environmentally sustainable design, the idea that 'technical' classes were seen as valuable as groundwork for architectural practice seems to have been recognized after the fact, but not while taking those courses in school.

One of the comments reflected the notion, likely learned in school, that someone other than the architect would be responsible for the building's environmental concerns. This respondent reported that these concerns do not form a critical part of his or her practice and that many systems that would lead to a more energy-efficient building are prohibitively expensive. There are several layers to unpack here, one of which is this recent graduate's surprise that as an entry-level intern, he or she was not on the design team—an expectation that might have been better managed while in school. Of more significance to the questions of this paper, the respondent felt that LEED and green building systems were only the purview of engineers or, even worse, tack-on systems that could be value-engineered out of jobs rather than integral elements of buildings such as siting, orientation, and basic geometry.

4.3.2 Question 2

In answering this question, alumni focused on the shortcomings of their education in preparing them to understand building systems and envelopes adequately. While they acknowledged that these topics had been raised, they seemed to feel that not enough time or attention had been paid them.

4.3.3 Question 3

Regarding readiness to design sustainably, some of the comments indicated a wish that more time in school had been spent learning building science concepts. Some alumni also had desired a greater emphasis on environmental systems, including widespread opportunities to engage in research and to learn how to incorporate these issues into designs using digital tools. This is a noble aspiration for a school of architecture, but perhaps not a realistic expectation of the undergraduate faculty, who are already tasked with introducing basic building science concepts to large classes. It may be that schools should aim to develop a series of advanced courses for undergraduates with demonstrated proficiency in this area who seek a deeper dive.

In the answers to this question, evidence also emerged of a desire to have learned more about ways to deal creatively with existing buildings while an undergraduate.

4.3.4 Question 4

A key take-away from the responses here is that most young architects seemed to feel that they have an obligation to protect the ecosystem, but they also seemed only to become passionate about this fact when prompted by a question. In most cases, as evidenced by the previous three free-response questions and the tabular data from the 'Academic preparation for architecture' and 'Connections to the profession and society' sections, the techniques necessary to meet this obligation were not highly emphasized in their curricula.

Answers about existing buildings centered on preserving the legacy of the past while accommodating present and future needs.

4.3.5 Question 5

The final question—really a series of questions—elicited similar responses about environmentally sustainable design, but specifically suggested that sustainability education be broadened to include more aspects of climate change, that student designs be challenged to meet energy codes, and that students be taught current building rating systems and software programs to help them meet environmental standards.

Finally, one alumnus brought home a point that is often neglected in schools: that for many practitioners, renovation projects make up the bulk of their work.

5 Conclusions

In answer to the central research question: How has the architectural education of recent graduates prepared them for a life of practice that embraces environmental sustainability? many alumni answered that they were insufficiently prepared for this aspect of their vocations. More specifically, new alumni felt uneasy about both their readiness to engage in environmentally sustainable design and their ability to address the preservation of existing building resources. This was often due to a failure to attain basic literacy in building science, envelopes, and systems, and a lack of engagement with renovation projects.

The results garnered from this survey are a first step in a longer process of assessing the fit between architects' education and their need to be prepared for environmentally sustainable practice, and in identifying aspects of curricula and policy that might be improved to help meet this urgent goal.

6 Implications

Several suggestions are offered here for curricular and systemic change to help prepare architecture students for sustainable architectural work. These are followed by a summary of recent initiatives within the US architecture profession and its accrediting body that might help bring needed change.

6.1 Initial suggestions for curricular and systemic change

The architectural profession's 'needs' are changing due to societal and environmental pressures, as well as architects' own desire to act responsibly. Schools of architecture need to be receptive to philosophical and curricular change based on the identified needs of former students who have recently entered the workforce. Surveys of alumni similar to that used in this paper could be used to unearth gaps and weaknesses in curricula, with the results made publicly available. Additional surveys of senior architects may also reveal other perspectives on what additional capabilities entrants to the profession will need. A transparent process is vital both to generate feedback on the existing curriculum and to help to accelerate change.

First, there needs to be broader attention paid to the importance of building science and building performance on the part of the faculty teaching design studios, since those studios are the heart of the curriculum. Unless that happens, no number of additional courses, whether required or elective, will address the core problem, which is the tendency for faculty to focus on the aesthetic and spatial dimensions of design while relegating building science (and any mention of energy or carbon) to 'support courses.' This goal requires influencing faculty attitudes and behaviors. Exposing students to more school-wide lectures with experts in building science and performance who are also excellent designers could be an option.

Rider's (2014) findings support this conclusion and offer some specific ways in which needed changes might be made. She found that most of her faculty (architectural academic staff) interviewees, while themselves teaching these classes, saw the incorporation of sustainability themes in ECS classes to be viewed as perfunctory by their students. They also felt that engaging students with these themes only in support courses was insufficient and agreed with the notion that meaningful education in these areas must be effected through the dominant studio model. She suggested that faculty attempting to introduce themes of sustainability to their students creates ordering methodologies for design work that relay foundational knowledge and define terms, provide frameworks to help guide students through complex design processes, and incorporate real-world contexts into studio prompts. Rider also observed that there are two scales at which change should occur: the level of curricular change mentioned above; and the level of philosophical change that challenges faculty to provide meaningful, substantive, broad understanding of sustainability concepts within an academic discipline and profession with a highly celebrated and somewhat inflexible design culture. This is a deeply complex problem rich with possibility for future study.

Even more specifically, there needs to be a stronger and more overt connection between the design lab and the supporting lectures in terms of prompts and assignments. This is a challenging proposition, even for faculty who teach both ECS classes and design studios. *Integrating Building Performance with Design: An Architecture Student's Guidebook* (2017) presents prompts and student work by students at the author's own and three colleagues' institutions that attempt to align studio work with the work of ECS courses (Grant 2017).

The question of when and how to engage energy modeling, simulation, and parametric design tools remains open as well. While Kwok *et al.* (2014) did not find this to be a predominant means used by faculty to engage zero-carbon topics in their research, some of the respondents in the present survey wished they had been exposed to such tools. As software becomes ever nimbler and user friendly, more faculty may be ready to accept the challenge of using these programs in the classroom and studio to support student design efforts.

While this shift occurs, educators may need to acknowledge that in undergraduate education, it may be unrealistic to prepare students fully to design buildings that meet specific performance metrics. However, all advanced students have an obligation to acknowledge the importance of building science, to design with its fundamentals in mind, and to enlist the help of consultants with specialized knowledge as necessary.

Second, graduates need to be prepared to work on the existing building stock. One tactic is to bring in experts with specialized knowledge in the design of building enclosures as guest jurors in student design competitions. These jurors emphasize basic building science concepts that help students design with thermal comfort, energy conservation, and

building integrity in mind. As many of these building enclosure consultants work heavily in preservation, renovation, and reroofing projects, they can speak directly to the prevalence of this work and its power to reduce energy use and waste, and to contribute to preserving culturally significant architecture.

6.2 Observations on the current state of the academy and the profession

The NAAB (2020) recently sought public review of its 20 May 2019 'Draft 0' of the '2020 Conditions for Accreditation' document that governs the accreditation of schools. The AIA COTE (2019) offered commentary on this document, pressing to include:

> climate action goals of decarbonization and adaptation with an understanding of the performance outcomes of integrated design solutions.

While the word 'carbon' or its variants never appear in the NAAB's '2020 Conditions for Accreditation' document, there is language in another section that includes some of the issues raised by the AIA COTE:

> 3—Program and Student Criteria, 3.1. Program Criteria (PC), PC.3 Ecological Knowledge and Responsibility—How the program instills in students a holistic understanding of the dynamic between built and natural environments, enabling future architects to mitigate climate change responsibly by leveraging ecological, advanced building performance, adaptation, and resilience principles in their work and advocacy activities. (NAAB 2020: 2)

In June 2019, the AIA (2019) ratified a Resolution for Urgent and Sustained Climate Action that stated:

> Be it resolved, that commencing in 2019 and continuing until zero-net carbon practice is the accepted standard of its members, the AIA prioritize and support urgent climate action as a health, safety and welfare issue, to exponentially accelerate the 'decarbonization' of buildings, the building sector, and the built environment.

The resolution further resolved that this be accomplished through a multi-year strategy for education, practice, advocacy, and outreach.

6.3 Future work

The work of this paper is a first step in a larger effort that must include in-depth interviews of students, faculty, alumni, practitioners, and other key decision-makers to determine a path forward to environmental literacy for all architecture students. The insights garnered from these stakeholders could then be combined with ideas brought forth by experts in pedagogy and curriculum development to create a well-rounded set of recommendations for meaningful improvement in the education of emerging architects who must act urgently to effect real change.

Notes

[1] Kwok *et al.* address the various names being given to zero-carbon design, including 'zero net energy' (used in their paper) and 'carbon neutral' (used in the 2030 Challenge). They also explain that energy efficiency is often the preferred focus in the US, and is nearly interchangeable with carbon reduction as most of the energy used in that country comes from fossil fuels. 'Zero carbon' seems to be a term used widely in the UK, based on government policy there.

[2] These courses take a variety of names, for example (environmental) building technology, (environmental) building systems, (environmental) building controls, and (environmental) control systems.

[3] The 2030 Challenge was developed by Architecture 2030 and Edward Mazria in 2006 as a series of targets to be adopted by those in the architecture, construction, and engineering fields for new construction and renovation, culminating in carbon neutrality by 2030.

Acknowledgements

The author acknowledges the contribution of Peter Ozolins to the inception of this project and to the development of the survey instrument, and thanks Devin Manzullo-Thomas, Archives Coordinator at The Ernest L. Boyer Center, Messiah College, for providing the survey and responses from the Boyer Report. Publication of this paper was supported by Virginia Tech's Open Access Subvention Fund.

Competing interests

The author has no competing interests to declare.

Data availability

Survey questions and responses included in this paper have been uploaded to a publicly accessible repository on the VTechData website (https://data.lib.vt.edu/files/ws859f86t).

Ethics and consent

Effective on 16 February 2018, the Virginia Tech Institutional Review Board (IRB) approved the research protocol entitled 'Recent Graduates' Perceptions of Architectural Education and Practice' (IRB number 17-938). The protocol was approved as Exempt, under 45 CFR 46.110 category 2. Informed consent was implied through the completion of the survey, and participants were made aware of this in a statement as follows: 'I have read the Consent Form and conditions of this project. I have had all my questions answered. I hereby acknowledge the above and give my voluntary consent by pressing continue on this survey.'

Supplemental data

Supplemental data for this article can be accessed at https://doi.org/10.5334/bc.41.s1

References

AIA. (2019). AIA resolution for urgent and sustained climate action. American Institute of Architects (AIA). Retrieved from https://www.buildinggreen.com/sites/default/files/AIA%20Resolution%20on%20Climate%20Action-final.pdf

AIA COTE. (2019). Comments on the Draft 0 NAAB 2020 Conditions for Accreditation from the AIA Committee on the Environment. *American Institute of Architects Committee on the Environment (AIA COTE)*. Retrieved from https://www.scribd.com/document/433400209/NAAB-Response-COTErev?secret_password=05irdhxdk4wFrYqmX4rd

Boyer Archives. (1994). *Survey on the education of architects*. Messiah College, The Ernest L. Boyer Center Archives.

Boyer, E. L., & **Mitgang, L. D.** (1996). *Building community: A new future for architecture education and practice: A special report*. Carnegie Foundation for the Advancement of Teaching.

Cesal, E. J. (2010). *Down detour road: An architect in search of practice*. MIT Press. DOI: https://doi.org/10.7551/mitpress/8802.001.0001

Corbin, J., & **Strauss, A.** (2008). *Basics of qualitative research: Techniques and procedures for developing grounded theory*, 3rd ed. Sage. DOI: https://doi.org/10.4135/9781452230153

Grant, E. J. (2017). *Integrating building performance with design: An architecture student's guidebook.* Routledge. DOI: https://doi.org/10.4324/9781315680071

Gregory, A., Herrmann, M. M., Miller, B., & **Moss, J.** (2013). Integrated practice and architecture education: The evolution of a pedagogy. *Paper presented at ARCC 2013: The Visibility of Research*, Charlotte, NC, US.

Groat, L., & **Wang, D.** (2013). *Architectural research methods*, 2nd ed. Wiley.

Kerlinger, F. N. (1986). *Foundations of behavioral research*, 3rd ed. Holt, Rinehart & Winston.

Kwok, A. G., Tepfer, S., & **Grondzik, W. T.** (2014). Zero net energy education: Mind the gap. *Paper presented at ARCC 2014: Beyond Architecture: New Intersections & Connections*, University of Hawaii at Manoa, US.

Le Corbusier. (1987). *The city of to-morrow and its planning* [1929], trans. and intro. of 8th edn by F. Etchells. Dover.

Lechner, N. (2015). *Heating, cooling, lighting: Sustainable design methods for architects*, 4th ed. Wiley.

McGregor, A., Roberts, C., & **Cousins, F.** (2013). *Two degrees: The built environment and our changing climate*. Routledge. DOI: https://doi.org/10.4324/9780203082997

NAAB. (2020). *Conditions for accreditation: 2020 edition*. National Architectural Accrediting Board (NAAB). Retrieved from https://www.naab.org/wp-content/uploads/2020-NAAB-Conditions-for-Accreditation.pdf

Neveu, M. J. (2009). Educating the reflexive practitioner. *ENQ (Enquiry)*, 6(1), 31–37. DOI: https://doi.org/10.17831/enq:arcc.v6i1.5

Rider, T. R. (2014). Reinterpreting architectural education: Exploring methods for incorporating sustainability themes. *Paper presented at ARCC 2014: Beyond Architecture: New Intersections & Connections*, University of Hawaii at Manoa, US.

Segrest, R. (1997). The architecture of architectural education. *Assemblage*, 33, 76–79. https://www.jstor.org/stable/3171382. DOI: https://doi.org/10.2307/3171382

Watson, D. (2001). Environment and architecture. In A. Piotrowski & J. W. Robinson (Eds.), *The discipline of architecture* (pp. 158–172). University of Minnesota Press.

How to cite this article: Grant, E. J. (2020). Mainstreaming environmental education for architects: the need for basic literacies. *Buildings and Cities*, 1(1), pp. 538–549. DOI: https://doi.org/10.5334/bc.41

Submitted: 02 February 2020 **Accepted:** 02 August 2020 **Published:** 04 September 2020

]u[*Buildings and Cities* is a peer-reviewed open access journal published by Ubiquity Press OPEN ACCESS