Abstract

Architects are professionally obliged to engage in lifelong learning through CPD to augment their knowledge, skills and values. One such area for learning is sustainable design knowledge.

Currently within design practice, there is an ongoing deficiency in the application through design of this sustainability theory by many construction professionals including architects.

This deficiency manifests itself in continued high building energy use, in a performance gap between the design and performance of buildings, in the lack of sustainable buildings which go beyond tepid links to 'green' architecture and in the lack of robust sustainability confidence of many architects.

The author suggests that while sustainability knowledge has grown informally, importance should not be placed solely on architects gaining *possession* of such informal knowledge, but rather improving their learning through more effective CPD that gives them tools in the *application and adoption* of it within the design process.

While there are formal and informal existing CPD learning opportunities to help to meet these challenges (e.g. sustainable process guidance, environmental assessment guidance and software tools guidance) research conducted by the author revealed limitations to the guidance in its current form; with the consequence that many existing opportunities for CPD for architects in this area are not only incapable of answering the current sustainable design demand but are concurrently un-resilient for future needs.

These findings were verified by research undertaken through a design workshop, which indicated that of the guidance available, design process guidance has the most potential to be successfully developed to more effectively implement sustainable design and it should be the target for CPD in this area. This can be particularly effective as architects can immediately engage with process as an aspect directly within their control, instead of waiting for 'big picture' drivers to deliver the necessary CPD in this area (Figure 1).

Keywords: design process, architecture CPD, theory to practice, design workshop/charrette, sustainability, sustainable design guidance, inexperienced sustainable designers

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Ways of learning: incorporating sustainable design CPD into an architects design process

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Introduction

Architects are professionally obliged to engage in lifelong learning through Continual Professional Development (CPD) to augment their knowledge, skills and values. One such area for learning is sustainable design knowledge.

The impetus for gaining such knowledge is not solely to respond to a global, European and Irish legislative agenda but additionally to improve the user experience of buildings (through aspects such as increased comfort, lower energy use and use of more sustainable materials).

In Ireland, at a national level, there are various policies in place to encourage sustainable development in general, and Ireland seeks to make the transition to a low carbon, competitive, climate resilient country (Department of Public Expenditure and Reform, 2012). As such architects require sustainability skills, knowledge and expertise not only to respond in their projects to social, environmental and economic issues related to sustainability from the bottom-up, but to be able to respond to the current and future planned legislation coming from top down.

Although architects are not exclusively responsible for participating and managing the design process (Brophy and Lewis, 2011); as the building consultant with the earliest influence in the design of buildings through the client contract and brief, and as the consultant who has traditionally managed the entire design, construction and commissioning process, the need for architects to possess sustainable design skills and ability to bridge this gap is crucial for future sustainable development. Indeed, the survival of architects as built environment professionals is thought to depend greatly on how they deal with the challenge of sustainability (Bordass and Leaman, 2013).

Whilst there appears to be a reasonable understanding of concepts and theory surrounding sustainable design currently within design practice, there is an ongoing deficiency in the *application* through design of this sustainability theory by architects. This deficiency manifests itself in continued high building energy use (Sustainable Energy Authority of Ireland, 2011), in a performance gap between the design and performance of buildings (Clevenger and Haymaker, 2011), (Bordass and Leaman, 2013), (Derbyshire, 2001), in the lack of sustainable buildings which go beyond tepid links to 'green' architecture (Irish Green Building Council, 2012) and in the lack of robust sustainability confidence of many architects (NBS, 2012). While the body of knowledge on the theory of 'sustainable development', 'sustainable building' and 'sustainable design' is growing - along with an associated increase in software, internet tools, methods, publications and available CPD to act as design guidance in manipulating this theory - there still remains a consistent dearth of sustainable building both

globally and specific to Ireland at present, and robust green building practices are yet to develop (Korkmaz et al., 2010). The technologies, products and guidance for sustainable building are available, but they are not successfully exploited in design (Häkkinen and Belloni, 2011), and implementation of green building practice within the built environment sector generally remains low globally (Hoffman and Henn, 2008). The need for CPD in this area is therefore present and growing, however not all knowledge currently provided is addressing practitioner's needs (Van Bueren and De Jong, 2007).

The paper suggests therefore that while sustainability knowledge has grown informally, importance should not be placed solely on architects gaining *possession* of such informal knowledge, but rather improving their learning through more effective CPD that gives them skills in the *application and adoption* of it within the design process. Until this implementation in the design process it remains unlocked and dormant knowledge. The design process is therefore seen as key to effective execution of sustainable design knowledge CPD.

CPD can take many forms, and can be formally or informally undertaken. The focus of this paper is CPD in the form of available sustainable design guidance in the form of processes, methods or tools and the effective implementation of same by architects. Additionally the focus is on CPD as it applies to early stage design as these early stages are most influential (Ngowi, 1998) (Figure 1). Additionally the target audience in terms of who the CPD of sustainable design guidance is targeted at is inexperienced sustainable design architects who are interested in these issues but unclear how and when to implement them – the inexperienced 'eager novices' (Figure 2).

Therefore, this paper seeks to firstly summarise through reference to literature what the current stage of sustainable design knowledge in Ireland is and what form it should take to assist architects to develop sustainable design skills and ability. These broad findings are further discussed and verified by the findings of a design charrette conducted by the author which evaluated how current guidance is being utilised and offers suggestions on how sustainable design guidance and CPD should be offered in the future.

Methodology

It was necessary to examine the Irish early design context and in doing so to examine the effectiveness of current sustainable design guidance in the design of sustainable buildings at early stage design. A literature review was undertaken followed by a design charrette, which was chosen to enable aspects of the literature review to be enhanced and verified through further research (Macmillan et al., 2001). The charrette makes the thinking behind design evident, and can be analogous of actual practice and process (Edwards, 2009). The charrette is a "small scale experiment" involving a single test with a small number of groups (Cash et al, 2012 cited in Vallet et al., 2012), in order to enable characterisation of participants in relation to larger population [of architects] (Vallet et al., 2012). It is "experimentally realistic" in that it is realistic to the participant (Frankfort-Nachmias and Nachmias, 2000).

The charrette was constructed as quasi-experimental with both quantitative and qualitative aspects in its design and analysis of results. It provided an opportunity to observe design process in practice (Austin et al., 2001) and to test the applicability and validity of existing design guidance in from of process, methods and tools.

30 participants took part in design charrettes held over two days. Two of these participants were experienced sustainable designers recruited from the interview research phase and the remaining participants were selected through an advertised open call for architects inexperienced in sustainable design. In the main participants were from small practices and have less than fourteen years' experience (Figure 3). Participants worked on a variety of projects but mainly on private work. An unavoidable consequence of the workshop being held in Dublin that the majority of participants came from practices in that proximity. However by quantifying these aspects of the sample (experience of workshop participants, scale of practice, types of projects and types of contracts) it allowed for the charrette findings to be equated to architects with different roles, experiences and backgrounds and to allow for quantifying the extent of any possible generalisation of the findings.

The participants were split into 5 groups to test the effectiveness of available sustainable design guidance (Table 1). Participants were given the same small design task in groups. Each group was given additional guidance in the form of either process, method and tool guidance, with two groups given no guidance – one inexperienced control group and the interviewees as experienced control group (Table 2). A pre and post task survey recorded the attitudes of participant's pre and post design task, and compared to annotated observations made by the author during the task. It is recognised for increased confidence in the generalizability of these findings a larger sample size would be required, however the sample size was deemed to be in line with previous studies of a similar nature (Cash et al., 2013) and appropriate for the investigative nature of this research.

The limitations to studying - through a charrette - all the processes undergone be an architect in designing are acknowledged, such that even if all rules are noted down, it still would not completely explain where all the ideas have come from (Groat and Wang, 2002). Nonetheless, although the design process is somewhat a subjective exercise, and cannot be precisely defined, it is still guided by reason (Groat and Wang, 2002). As such you may not be able to get inside the black box of the design process to define absolutely how designs emerge, but you can discuss certain elements and aspects of the process (Groat and Wang, 2002). Additionally, although a charrette is still a "synthetic experiment that does not carry weight equivalent to a natural experiment" (Clayton et al., 1998) it is an attempt to approximate the field and reveal aspects of real world practice which can inform and direct current sustainable design guidance and CPD and future research in these areas rather than to gather indisputable facts (Clayton et al., 1998).

Literature review Findings

Whilst a wide body of literature on sustainable design exists, this paper focuses on the barriers to sustainable design and existing sustainable design guidance, and relates findings in terms of the value of these formal and informal opportunities for CPD for architects in this area.

<u>Barriers to sustainable design</u>

Broad literature tends to group barriers under broad themes, which can be summarized under the headings of steering mechanisms, economics, client understanding, process and underpinning knowledge (Häkkinen and Belloni, 2011). The specific literature on barriers to sustainable design do not see the major barrier as being unawareness or lack of knowledge regarding sustainability but instead an un-sureness of how to *apply and implement* this knowledge within the design *process*. Our understanding has grown, but basic changes have not been affected into our process or project delivery (Kibert, 2007).

A distinction has been made [by the author] between 'big picture' barriers and those within the architects immediate control:-'big picture' barriers include legislation and cost. The design process and education are barriers within the architect's direct control, and the client barrier sits between the two spheres of control (Figure 4). Of these barriers, it is concluded that architects can first engage with barriers at an individual level, instead of waiting for bigger picture barriers such as legislation to 'catch up'. The process barrier is the barrier in which the architect can address as an individual and which has the potential to subsequently address other barriers inherently.

Additionally, of those barriers that architects can tackle at an individual level *process* is the one most directly related to and in the control of the individual architect in their day to day practice and it is also the barrier that needs to be tackled by architects and professional bodies of architecture only – other barriers additionally require governmental and societal change. Additionally, while the other barriers are highly relevant it is found that it not the existence of effective legislation, theory and methods which improve sustainability, it is the *application and adoption* of these methods which does this.

<u>Existing sustainable design guidance</u>

There is currently sustainable design guidance and CPD content available in the form of processes, environmental assessment methods (such as LEED or BREEAM) and tools (software and manual) which are currently being deployed by architects in an attempt to effectively deliver holistic sustainable buildings. The benefit of CPD or knowledge which uses design guidance such as these is in the attempt to give some structure to a problem, and help to organise decision making sequences to help reduce design waste (Magent et al., 2009) and to encourage whole systems thinking over focus on particular aspects (Coley and Lemon, 2009). The current guidance interface of existing processes, methods and tools are not meeting this need fully as guidance rarely addresses sequencing issues, and often issues

are divided by topic or profession, and interdependencies between issues or professions are not highlighted (Lombardi, 2011).

Process

Traditional, linear processes are not capable of delivering sustainable design. In their current form they do not address the *definition, realisation* or *sequencing* of sustainable design ideas and standards The current design process offers a design process in which sustainability, where pursued, is added as an additional aspect to existing linear processes, manifesting in a

<div align="center">DESIGN PROCESS plus SUSTAINABILITY</div>

whereas what is called for is a

<div align="center">SUSTAINABLE DESIGN PROCESS.</div>

which incorporates sustainability *within* the design process.

This shift in design thinking requires appropriate design guidance to support it. This would require more than the provision of technology or product development (Hoffman and Henn, 2008) but requires a shift in design thinking (Hawkens, Lovins and Lovins, 1999 cited in Charnley et al., 2011). Though the most significant change may come from a fundamental change in how process is currently framed (du Plessis and Cole, 2011) it is possible that improvements which lead to sustainable building can be made within existing design processes. Indeed, if sustainable building should not be seen to be too complex (Häkkinen and Belloni, 2011) then it needs, at least initially, simple processes which are easily integrated into existing processes until a tipping point is reached when architects are increasingly capable of delivery sustainable buildings so that a 'sustainable design process' is simply a good design process (after which, from this more solid sustainable design basis, more radical change could develop). These simple process changes requires guidance and appropriate CPD to advise inexperienced sustainable design architects in how to make this shift.

Methods and Tools

Environmental assessment methods help to set the [aspirational] goals of sustainable design – the *definition* - but not the means to achieve them - the *realisation* and *sequencing* is not addressed by Environmental Assessment methods. They primarily intended as assessment methods, and as such are unable to guide design (Cole, 2012). There are many tools that are currently at an architect's disposal and as such are some use in *realisation* of sustainability. Essentially, tools are useful to measure progress and though early design tools are available, tools appear to be of more value at a later design stage - the 'early' *sequencing* is therefore not fully addressed by tools, or these tools are in the wrong format. Most tools are of a technical nature and relate to outcomes that can be clearly measured, meaning many tools are used to assess not to inform decisions (Schweber, 2013).

This suggests additional sustainable design guidance and appropriate CPD is required which does address sequencing is needed to fill this gap.

Summary

The focus of the literature review understanding converges on one consistent point: the gap between aspirational sustainable design theory and its implementation in practice. In general, it can be seen that with design process architects continue to not know exactly what they must do or why they must do it; nor do they know how to go about doing it or when to do it; while current method guidance helps to set the goals but not the means to achieve them and current tools guidance, though simple early design tools are available, appear to be of more value at a later design stage with the majority being used at this later stage to check compliance. While there are potentially many barriers to this and many perspectives this paper focuses on the perspective of design process and sustainable design process guidance in terms of effectiveness.

The reasons for this focus derive not only from the conclusions from the literature review but also the differentiation made between the different barriers. It is suggested by the literature that as a support for sustainable design, existing sustainable design guidance such as methods and tools are useful and equally as important as process guidance but which are structured to be used at a later stage in the design process for a much more developed design, and as such process guidance is best poised to offer most assistance to inexperienced sustainable design architects in early stage sustainable design. This calls for existing sustainable design guidance to be questioned and perhaps enlivened to deal with the practicalities of delivering sustainable buildings. Understanding must be gained on how to implement sustainable design knowledge, through exploration of what a sustainable design process and sustainable design guidance should be. Indeed, the intention of this research is to provide focused research that can inform the 'top' policy makers and institutions and also and 'bottom' players working within day to day practice (Pollington, 1999).

Design Workshop Findings

The main findings of the workshop relate to the knowledge and skills of the participants and the guidance used by the participants.

Knowledge and skill of participants

The main conclusions correlated to literature findings in terms of the deficiency of sustainable buildings and the need for education and CPD in this area. It should be noted that there was a distinction made between applicant's *knowledge* of theory and their skills in *implementation* of this theory through the design process in order to try to evaluate if there were any distinctions between the two.

The main findings can be summarised as:

- There is much scope for the improvement of architects sustainable knowledge and skills

- When a design process is framed with a sustainable design guidance, sustainable design knowledge of participants can be improved and the subsequent design can be framed with sustainability in mind.

Workshop participants expressed that architects in general do not have good knowledge of sustainable design or sufficient skills at implementing it (Figure 5). The relatively high level of ambiguity in the responses to this question may point to the fact the respondents are not sure of the wider field beyond their own experience, or to the fact that they are not sure exactly what sustainable design knowledge is or what it looks like when it is implemented. This confusion over how to define sustainable design is further implied in Figure 6. Of the 23% of participants who expressed their levels were 'above average', two are the experienced sustainable designers and the others were those who also stated they achieved sustainability on most projects.

Pre-task the majority of the participants expressed generally that their knowledge and skill level to be 'average' or 'below average' (Figure 5). It should also be noted that in a general question of this type participants are more likely to pick this middle ground so there is potentially more participants who believe their skills are 'below average' than has been indicated in the responses. This is reinforced when the specific questions are looked at which indicate more uncertainty. In any case, the general response obtained indicates that there is much scope for improvement amongst architects of this demographic – this is supported by the responses from the more specific findings that find equal percentages of participants (excluding the experienced designers) who find their understanding of sustainability is good versus those that don't.

Participants expressed more certainty regarding environmental aspects and objectives of sustainability than social or economic, which is not surprising given this is where the majority of the focus in terms of legislation and media attention has been for the last few years. What is encouraging is that post-task participants expressed they understood the social and economic aspects much more once they had been through the design task and were able to frame their designs in relation to these objectives (Figure 7).

Given the fact that post-task participants expressed their knowledge of sustainable design had improved, it signifies that when a design process is framed with a sustainable design brief and approached from this viewpoint that sustainable design knowledge of participants can be improved. This conclusion is also supported by the findings on the design guidance used by participants which also showed more engagement with sustainability where design guidance had been used.

Less clear is how participants believed their implementation skills improved post-task, with somewhat inconsistent findings from the responses to the different question relating to implementation. There was no significant difference noted between participant responses for their knowledge versus their implementation skills, however, when looked at in detail (Figure 7) the overwhelming majority (83%) expressed they require additional guidance on how to implement sustainable design into existing

design process, with the experienced designers amongst the 17% who either 'agreed' or 'neither agreed nor disagreed' that they don't require additional guidance.

Overall therefore participants expressed their implementation skills had improved post-task (Figure 8), but at both pre and post-task participants expressed they still required additional guidance on how to implement sustainable design into their process. This indicates that although the design task was useful in improving knowledge and skills, there is still the capacity and the need for sustainable design guidance for architects of this demographic in terms of *applying* sustainable design theory.

In defining and achieving sustainability pre and post-task the same trend is observed in that in general, it can be concluded that when the participants participated in a design task where sustainability issues are firmly set as targets to achieve and drivers for design, that this enables framing of design with sustainability in mind. In this case participants can relate architectural design which they do anyway to sustainability aspects. This is supported when it is noted that four of the Control Group C participants regarded the brief supplied as design guidance; though the author did not intend it as such. Indeed this brief allowed the groups to engage with and clarify the problem before problem solving (Goldschmidt and Rodgers, 2013) – which may not be something that happens in a typical design project for the inexperienced participants.

These findings correlate with literature findings in terms of the need for improvement in sustainable design knowledge suggesting that such CPD is required on an ongoing basis. They also take these findings one step further and suggest that when the knowledge is there it can remain dormant and requires additional activation to bridge the gap between theory and its implementation in the design process.

<u>Guidance used by participants</u>

Participants of Tools Group T, Process Group P and Method Group M – who all received additional guidance - were asked questions on the particular design guidance used by their group in terms of: i) how useful it was to aid knowledge and understanding, ii) how effective it was to help meet the sustainability targets set and/or direct the design process, iii) practically how useable and understandable it was and iv) how likely participants are to use the guidance in the future.

It should be noted that two participants in the Tools Group T chose to not answer these questions as they expressed they "*didn't get a chance to use guidance properly*".

The main conclusions can be summarised as:

- Participants expressed they still required additional guidance on how to implement sustainable design into their process. This indicates that although the design task – and the design guidance used was useful in improving knowledge and skills, there is still the capacity and the need for a more developed or different form of sustainable design guidance for architects of this demographic.

- When the design process is looked at in detail it is found the better design process performance is from Expert Group E and the worst Control Group C (in terms of activities engaged with and time spent on each activity).

- There were some differences between the inexperienced groups Process Group P, Tools Group T and Method Group M in terms of design process which suggest that the type of guidance used by the group influenced their design process.

- The Process guidance was more successful overall in eliciting a better design process response from participants than either of the Tools or Method guidance (and Control Group C), particularly for aspects related to knowledge, understanding and practical use.

- In general, existing sustainable design guidance (Process, Methods and Tools) is not completely effective to enable successful implementation of sustainability

(i)   Knowledge and understanding

From Figure 9 it can be seen that participants found the process guidance most useful and the tools least useful in terms of the ability of the guidance to aid consideration of the design targets with the brief.

(ii)   Effectiveness in relation to sustainability and the design process

In agreement with the above, the tools guidance was deemed by participants to be least successful at aiding integration of sustainability into the design process. The process and method guidance are observed to be of equal success in this regard as per Figure 10.

Similar trends are observed in Figure 11 where tools guidance is least successful in aiding coordination of design activity and process and method more or less equal, though more participants 'strongly agree' for the method guidance than the process guidance.

(iii)   Practically useful or understandable

In terms of understanding the guidance (Figure 12), the tools guidance was least understood, with similar proportions finding the method and process guidance understandable, though with slightly more strength of feeling observed from process guidance participants than method. This is reinforced in Figure 13; as although all groups expressed the guidance had the potential to be clearer if the participants had had more time to use it, the method participants responded marginally less enthusiastically to this than the process and tools guidance groups, and in Figure 14 where the tools and method guidance is found to be the least straightforward to use by participants. Although there is some uncertainty amongst the responses in terms of how useable and realistic the tools guidance is, it is still found to be least successful in this aspect, followed by the method guidance, with process deemed to be the most useable and realistic (Figure 15).

This same uncertainty is seen from the method group responses, where the majority are ambiguous as to whether the guidance did direct or did not direct the process, with only one more participant 'disagreeing' than 'agreeing' in this regard. As such, it is difficult to conclude suffice to say again, tools

guidance is observed to be least successful with a high degree of indefinite response from the other participant groups, though the overall [small] majority suggests perhaps the method guidance was marginally more successful than the process guidance in this aspect.

This same uncertainly is extended when participants are asked to relate the guidance to existing design processes in the building projects, with uncertainty from participants regarding the three forms of guidance, though process and method guidance found to be more slightly more likely to reflect design processes than tools guidance as per Figure 16.

(iv)   Potential Future Use

Although there is a degree of uncertainly for the tools guidance, the process and method guidance is expressed by participants to require further development to make it effective (Figure 17). Saying that, participants were willing to use all guidance on a future project, with participants most willing to use the method guidance, then the process guidance, and then the tools (Figure 18).

While this willingness is there, there is less certainty and less strength of belief from participants with regards to actually implementing the guidance as per Figure 19, with participants expressing more strongly that the process guidance would be implemented more easily than the method, followed by the tools guidance.

Where participants received no guidance

In terms of the participants who *did not receive any additional guidance*, the Expert Group E is ambiguous in their attitudes to potential additional guidance thought they are in clear agreement is in their willingness to use additional guidance. This indicates an openness and readiness that can be found amongst all participants to use and integrate design guidance into working design processes. On the other hand, the other group who did not receive guidance - the Control Group C participants – agree with all the statements concerning potential additional guidance indicating it would be useful. Both of these findings indicate that sustainable design guidance is welcomed and required by inexperienced sustainable designers to enable a more effective sustainable design process, and to a lesser extent by experienced designers to improve their existing sustainable design processes.

Effect of guidance on design process

In general, the expected 'better' design process performance from Expert Group E was observed through the number of design activities this group engaged with and the time they spent on particular activities (Table 3), indicating experienced sustainable designers follow a more developed, confident and successful sustainable design process than the inexperienced sustainable designers.

Of the inexperienced sustainable designers the Control Group C showed the least successful design process as observed through the number of design activities this group engaged with and the time they spent on particular activities indicating that additional guidance produces a better design process than not using additional guidance (Figure 20).

The general lowest level of engagement with the 'later' design activities in analysing, comparing and reviewing is not surprising given that all groups only considered one design concept, and given the relative inexperience of the participants as sustainable designers.

Whilst on the whole the inexperienced groups: Process Group P, Tools Group T and Method Group M showed no major differences in terms of activities engaged with or time spent on each activity, there were some differences – particularly in relation to engagement with design activities - which suggests this is in part linked to the guidance each group used, and that therefore perhaps the process guidance was more successful in eliciting a better design process response from participants than either of the Tools or Method guidance.

This may indicate that sustainable design guidance which centres around process may be more successful in instilling a sustainable design process than other forms of guidance, though caution must be used and this finding is not given as absolutely certain - further study would be required to test this hypothesis.

<u>Summary of design charrette findings</u>

In terms of the participants who *used some form of design guidance* during the task, the tools guidance is the least successful in all aspects as expressed by participants. The most positive results for the tools guidance are only in terms of the finding it would be more understandable with more time and it could improve the process in general.

Findings for the process and method guidance are broadly similar to each other (particularly in terms of facilitating the integration of sustainability into the process, realistically reflecting the design process as it is undertaken in buildings projects and the need for further development to make it effective). There are a few aspects where method guidance is more successful than the process guidance – for example at facilitating understanding of the sustainable design process; and marginally for aiding coordination of design activity, ability to direct the design process and willingness to use the guidance on a future project. All these aspects are mainly related to design process management and administration.

Notwithstanding this, the process guidance is more successful than method guidance when it comes to:

- considering design targets
- effective team working
- being useable, realistic and straightforward
- ease of future implementation in practice

and marginally more successful in terms of:

- understanding the guidance
- having the potential to be clearer if the participants had had more time to use it
- improving the process of sustainable design undertaken by architects'.

As such it can be seen that the process guidance is most successful overall, particularly for aspects related to knowledge, understanding and practical use – aspects which have more weight in terms of enabling an effective sustainable design process than the co-ordination success of the method guidance.

Note, these more quantitative findings are in line with qualitative findings in the taken in the observer notes during the design charrette workshops and in the general discussion which took place amongst the participants after the task in relation to the usefulness of the guidance used.

Conclusion

The aim of this paper was to explore the current stage of sustainable design knowledge in Ireland and what form CPD and guidance should take to assist architects to develop sustainable design skills and ability.

Literature findings suggest that while there are formal and informal existing CPD learning opportunities to help to meet these challenges (e.g. sustainable process guidance, environmental assessment guidance and software tools guidance) research conducted by the author revealed limitations to the guidance in its current form; with the consequence that many existing opportunities for CPD for architects in this area are not only incapable of answering the current sustainable design demand but are concurrently un-resilient for future needs.

These findings were verified by research undertaken through a design charrette which has been described and findings discussed and evaluation.

Within this research setting it was found that in relation to sustainable knowledge and skills there is much scope for improvement amongst architects of this demographic; which could be said to apply to the greater population of inexperienced sustainable design architects. This finding was in line with earlier limited literature for the Irish context on this area.

In terms of framing the design process within a sustainable design brief and the use of sustainable design guidance it was shown that when these occur, the sustainable design knowledge of participants can be increased and can enable participants to relate architectural design aspects which they prepare anyway to sustainability aspects. This enables framing of design with sustainability in mind.

The design charrette confirmed that experienced sustainable designers produce a more successful design process than inexperienced, and that inexperienced sustainable designers with some form of guidance produce a more successful design process than inexperienced sustainable designers with no guidance. The process guidance was most successful overall, particularly for aspects related to knowledge, understanding and practical use, though not absolutely successful - post-task participants expressed they still required additional guidance on how to implement sustainable design into their process, indicating existing sustainable design guidance is not completely effective in its current form to enable successful implementation of sustainability within early stage design by inexperienced sustainable design architects. As such the workshop findings relate well to literature findings in that

experienced sustainable designers have a successful sustainable design process already in place, and to literature findings that inexperienced designers respond well to design guidance though existing current design guidance is not the panacea in its existing form. It was found there is still the capacity and the need for sustainable design guidance for architects of this demographic which could apply to the greater population of inexperienced designers.

Overall, the findings indicated that of the guidance available, design process guidance has the most potential to be successfully developed to more effectively implement sustainable design and it should be the target for CPD in this area. This can be particularly effective as architects can immediately engage with process as an aspect directly within their control, instead of waiting for 'big picture' drivers to deliver the necessary CPD in this area.

Future work should examine and develop what form this guidance should take, what is should look like, and how existing guidance should improve in order for the current design process to move towards a sustainable design process – in terms of what individual architects can do to allow easier adoption and implementation of existing processes, methods, tools and theory.

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