anchoring the design process

A framework to make the designerly way of thinking explicit in architectural design education

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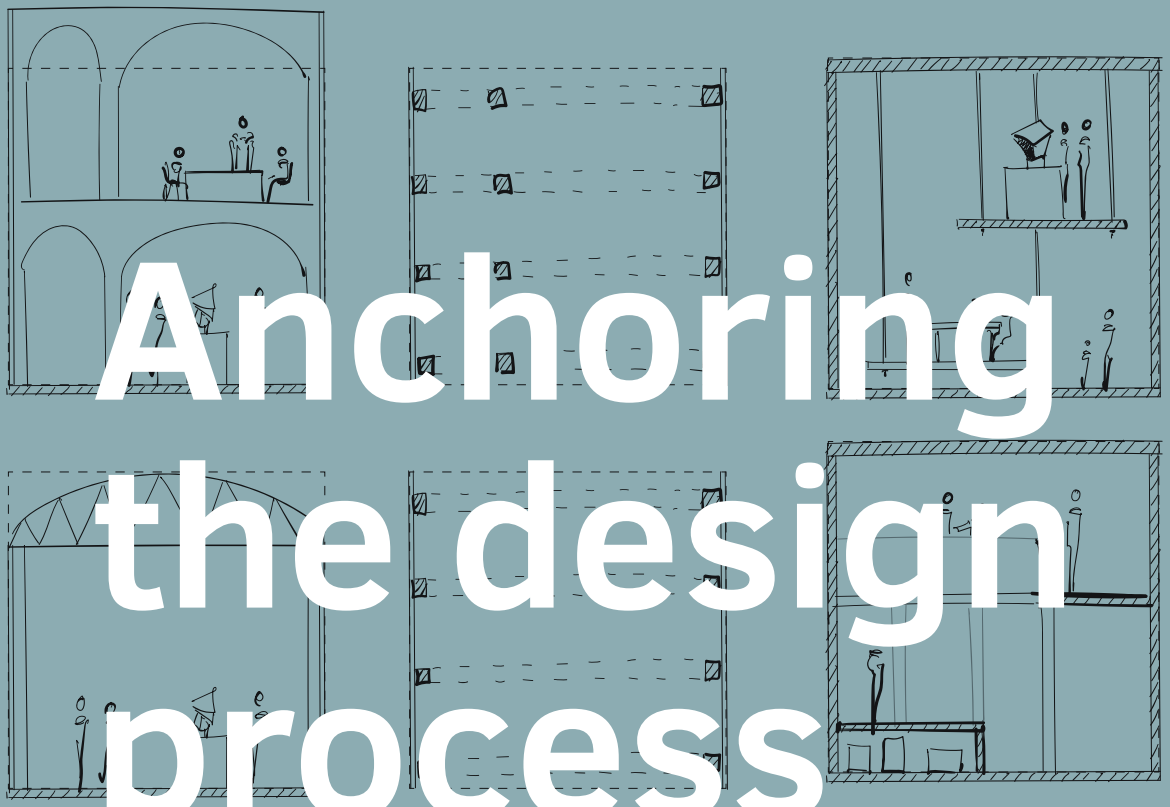

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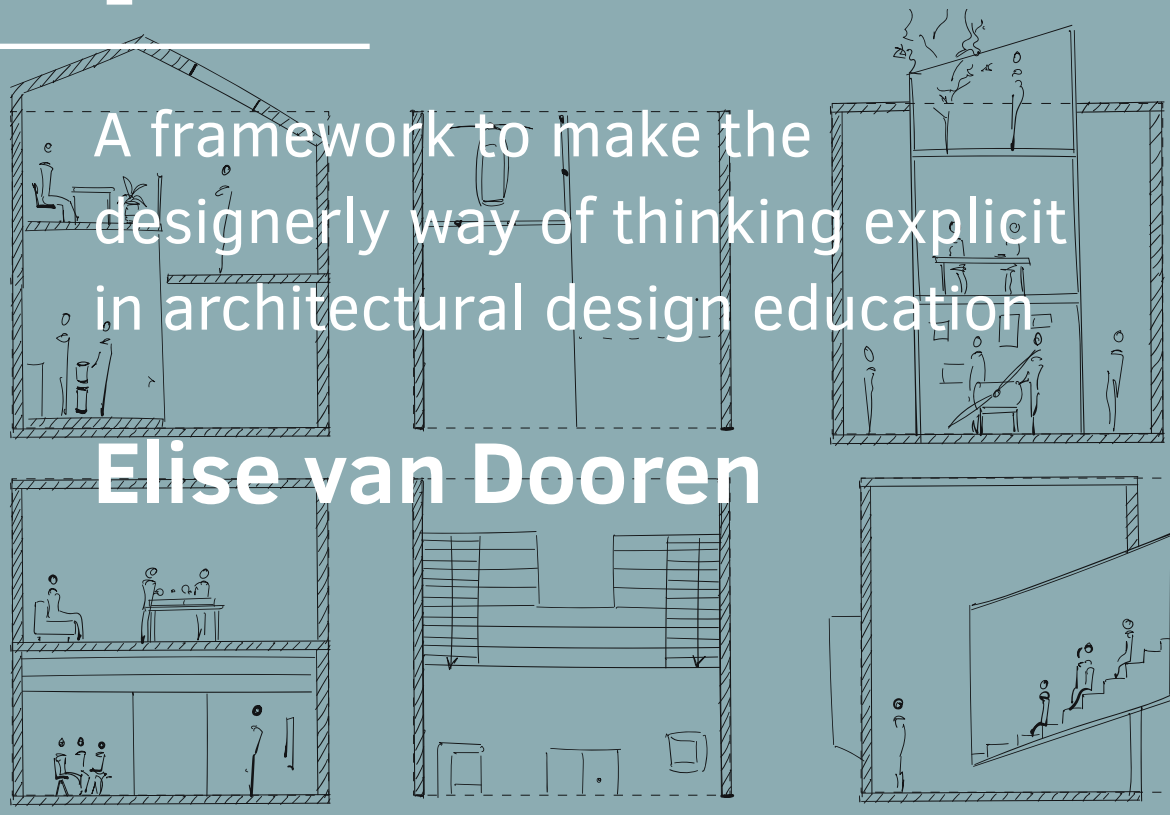

Elise van Dooren

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TOC

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A framework to make the designerly way of thinking explicit in architectural design education

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Thursday 15 October 2020 at 12:30 o'clock

by

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Contents

List of Tables

List of Figures

Summary

Introduction

Students traditionally learn to design in the design studio, where they work on a series of integrative, realistic, and progressively difficult design projects. Each time during tutorials in the design studio, teachers and students discuss the provisional design product, mostly presented in the form of sketches and models.

In essence, the goal of a design study such as architecture is to learn a 'designerly way of thinking'. Therefore, one may expect that the design process is the main subject of tutorial discussions. Nevertheless, observing dialogues in the design studio, teachers seem to mostly address the design product rather than the process. Discussions seem to focus on all aspects of the product, and all kinds of reasons regarding these aspects. They might discuss a void, a view, a living room, a window, solar panels, and the kind of light.

For an expert designer, it may be difficult to find words for the cognitive skills that normally are implicit. Professional designers who teach have not been trained as teachers. Until recently, little attention was paid to the educational side of being a design teacher. It was, and is often still assumed, that being an expert designer is the most (and even only) necessary qualification in design education. In the design studio, teachers discuss the design product with students much as they would with colleagues in the design office, or as they remember it from their own studies. They may find certain things so obvious that they do not realise that for students, this is not the case at all.

Beginning students have little or no experience. They start their design studies with layperson conceptions and vague ideas about what designers do. They often experience learning how to design as confusing. A student quoted by Schön (1987, p.98) described learning to design: "One of the things that really bugs me about architectural education is that a lot of things are really implicit, remaining under the surface and are not talked about."

Traditionally, learning to design seems to be a matter of learning by doing design tasks. Students start designing without knowing what it means to design.

To understand what to do on this 'journey into the unknown' and how to learn adequate habits, it helps if the implicit design process is made explicit as much as possible. Dewey (Logister 2005) concludes that knowing supports action; it helps one to understand the relationship between actions and their consequences. More understanding leads to better focus and acting more thoughtfully or intelligently, especially in new and unknown situations.

Aim, questions and method

To improve the quality of architectural design education and decrease the confusion felt by students, the aim of the research presented here was finding a vocabulary in order to make the design process, at least to a certain extent, explicit. Basically, three questions were asked and answered: (1) What should and might be discussed in reference to the design process? (2) Whether, and to what extent, do teachers address the design process? (3) Is learning to design less confusing for students if the design process is explicitly addressed?

To answer the first question, a framework was developed based on literature to make basic design skills explicit (Chapter 2). The framework was tested on validity by interviewing design experts (Chapter 3). The second question was investigated by observing and analysing the dialogues between teachers and students (Chapter 4). Finally, the third question and more specifically, the usefulness of the framework, was investigated in two case studies with questionnaires (Chapter 5).

Results

To answer the *first question* – (1) What should and might be discussed in reference to the design process? – the essential basic designerly skills are described (Chapter 2). The five elements are not meant as a prescription or recipe for design, and they are no guarantee of good design. Rather, they are anchor points to articulate the 'designerly' reasoning processes.

1. Experimentation or exploration and reflection

Designing is experimenting, it is a process of exploring and reflecting. Exploring refers to a process of being open, playful and curious, of coming up with alternatives and options, in both an intuitive and rational manner. Reflection refers to the process of being critical and thoughtful, of testing and evaluating possible solutions and looking for (un)intended consequences of provisional solutions.

2. Guiding theme or qualities

To come up with a coherent and meaningful design result, designing is about developing an inspiring direction. Guidance in an almost endless field of possibilities. The guiding theme is the personal and culturally influenced ‘answer’ of the designer. It is a dynamic process in itself. These qualities develop during the design process, moving from vague and abstract towards a concrete, elaborate solution that fits the situation at hand.

3. Domains or aspects

Designers have to address many aspects on different scale levels. For architecture: space, material, function, site, and a broader socio-cultural, philosophical context. In these domains, designers have to deal with a lot of knowledge and information, such as criteria, rules, preferences and cultural habits. Choices in one domain influence aspects in other domains. Designing takes place on the playing field of all relevant domains.

4. Frame of reference or (image)library.

The frame of reference is the common professional and personal library of knowledge and experience in the minds of designers. It consists of reference projects and abstractions, such as ideas, qualities, rules of thumb, principles and patterns. Designers ‘see’ the new design situation via existing knowledge and ‘images’. Both consciously and unconsciously, they explore and test principles and patterns; they use, reject and transform them in order to fit the current situation.

5. Laboratory or visual language

The design process unfolds via the physical language of sketching and modelling. The language of images is an extension of our limited working memory and complementary to the language of words and ideas. On the one hand it is open and vague, making creativity possible; on the other hand, it is precise, making critical thinking and analysis possible.

In Chapter 3 the framework is tested: designers with different personal styles and approaches have recognised the elements as generic design skills. The five elements provide a generic overview to distinguish basic design skills and to compare personal and cultural differences in design methods. Especially in the guiding theme, a richness of different approaches and visions can be seen.

With knowledge of the framework in Chapter 4, the *second question* was investigated: (2) Whether, and to what extent, do teachers address the design process? The answer: teachers rarely discuss it. They only (1) used implicit examples directly related to the present design project, without mentioning or explaining the underlying design process, and (2) referred "between the lines" to the design process by mentioning concepts such as research, variants, and sketches. These concepts mostly referred to the detailed level of the design product, such as a staircase, window, solar panels, or a view.

Finally, in Chapter 5 the *third question* is investigated and answered: Is learning to design less confusing for students if the design process is explicitly addressed? In two interventions in a Bachelor course (Delft University of Technology) and two Master design projects (Master of Architecture Groningen and TU Delft) positive results were found. Explanation of the design process by means of the framework was perceived as helpful by a substantial number of students, both formally in questionnaires, and informally in spontaneous discussion. The research showed a change in students' design concepts towards more expert ones and an increase in self-efficacy. The teachers involved experienced the framework as a useful structural tool, both for them to have an overview of the elements which should and might be addressed in tutorial dialogue, and also for the students to have a better understanding of the design process.

Discussion

The first experiences show that the proposed framework fills a gap in architectural design education. The elements form anchor points in a complex, personal, open-ended, and chaotic situation. By using the framework, the focus in design education moves from the design product towards the design process, including how designers think and reason. The design products are 'vehicles' to learn how to design. They are still topics of discussion, but fulfil the role of examples that help students experience the design process in different concrete situations. The elements help in clarifying the design process so that students can come up with coherent, meaningful, adequate, elaborate and imaginative design products.

Theoretical implications

Four theoretical implications regarding the framework and research studies can be distinguished.

First, the framework is a model or construction to make basic designerly skills explicit. Although the number and content of the five elements may remain a matter of discussion to a certain extent, they seem to be a good reflection of reality. The risk of a model is always that it is taken too literally. But the elements are meant as anchor points in design education, to enable students to make their own representations of the design process and architectural knowledge and transfer their experience and knowledge from one situation to another.

Secondly, the five elements were principally meant to uncover the ambiguity, vagueness and complexity in the dialogue between teacher and student. But they can be used in all kinds of situations in which mutual understanding and knowledge exchange is important, such as group work and collaboration between designers and non-designers. The framework may be useful in other design disciplines as well. Using the framework as a common vocabulary to investigate the differences and similarities in the design process between different design disciplines may lead to mutual understanding and learning from each other, which may in turn lead to broadening and intensifying the design processes and design education.

Thirdly, the five elements also provide guidance for organising design education in the design studio and curriculum. The framework can be used to develop more profoundly argued design projects and relationships between the projects and other courses in the context of the design curriculum.

Fourthly, teachers need time to get used to and work with the framework and to learn the richness of the anchor points. The elements include a ‘world’ of ideas and mutual relationships, related to the nuanced and rich reality of designing. In the context of the tutorial dialogue, it requires a shift in reaction from ‘what and why did you do it?’ regarding the situation at hand towards discussing ‘what might it lead to in the end?’ and ‘what might be the next steps?’.

Limitations

Obviously, the research presented in this thesis had its limitations. Basically, they concern the context of architectural design and design education in the Netherlands and the applied research methods, such as the number of participants and the duration of the second case study.

Recommendations

The following directions for future research and development are recommended.

First, replicating the research with a larger number of participants, control groups and doing so for a substantially longer period, with both Bachelor and Master students. This also enables research on students' designerly skills, next to self-efficacy and understanding.

Secondly, research on how architectural knowledge is cognitively processed and how to guide students during the design process in this respect (development frame of reference, knowledge storage and application in the form of (visual) principles and patterns).

Thirdly, research to learn whether, and to what extent, the elements can help make the design process explicit in other design disciplines as well. If so, the results may lead to similarities and differences between disciplines, and mutual understanding and learning from each other.

Fourthly, research on the use of the framework as one of the factors in designing the design studio and curriculum. Moreover, it is advised to combine the framework with the complex learning model of Van Merriënboer and Kirschner (2018). This 'four component instruction design model' includes important aspects, such as learning by doing the entire task, variation in learning tasks, and the emphasis on specific skills within the context of the whole. In combination with this educational model, the framework specifies the content of (architectural) designing and the way in which designers reason.

Finally, it is also recommended to develop a profound teacher training (e.g. a post-master year) and means (e.g. a book and online information, such as a MOOC) to teach instructors how to make the design process explicit in design education practice, since working with the framework requires a shift in thinking.

Practical implications

To understand the design process in all kinds of different situations, the elements have to be *repeatedly clarified and practiced*. The elements provide a basic set of notions, questions and instructions to help teachers make the implicit explicit. Obviously in discussion the elements will be present in combinations, such as experimenting with patterns in the context of a guiding theme; the questions and instructions should be directly related to the design situation at hand. In principle,

explicit guidance on the design process is the difference between telling students to design and asking afterwards why they did what they did, and telling them to experiment and develop a direction (theme or qualities), and discuss these in relation to how to proceed.

The elements help to achieve a shift from discussing all kinds of detailed aspects towards addressing the situation on a more *abstract, 'overview'* level. What should be articulated, asked or instructed depends on the situation. For example, in sketches almost all relevant aspects may be there, yet, it may not be coherent. The student may have an idea about the main qualities or direction, yet without having experimented with this idea. If teachers combine product-related comments with this kind of 'overview' conclusion, they enable students to achieve better understanding of the designerly way of thinking.

The framework also helps in the *design of studio and curriculum*. In principle, in each design project, all designerly skills have to be addressed. However, projects should differ in focus on theme and specific knowledge. This enables students to work with different positions, qualities or themes and with the means to achieve them. In this way, students build up a frame of reference and learn to interpret and develop commonly proved themes in a specific design situation. Having a basic understanding and skills regarding the design process, design tasks and design qualities may help projects become more complex, profound, specific and personal.

Final

This research project taught us that the design process can be made explicit, at least to a larger extent than design teachers usually do. The research shows that the framework provides a common vocabulary to improve mutual understanding. For teachers, the framework helps shift thinking from teaching students about products towards teaching them about the overall design process. For educational developers, these elements help both to design the design studio as well as the design curriculum. For students, design education in which the design process is made explicit within the framework leads to a richer understanding of the design process and an increase in self-efficacy.

Samenvatting

Introductie

Traditioneel leren studenten te ontwerpen in de ontwerpstudio. Ze werken aan een aantal integrale, min of meer realistische en steeds complexer wordende projecten. Docenten en studenten bespreken in iedere begeleidingssessie de voorlopige resultaten, gepresenteerd in schetsen en maquettes.

In principe is het doel van een ontwerpstudie zoals architectuur te leren denken als een ontwerper. Het lijkt dus logisch dat het ontwerpproces het hoofdonderwerp in de discussie is. Toch lijken docenten nauwelijks aandacht te besteden aan het ontwerpproces. De meeste aandacht gaat uit naar het ontwerpproduct. Ze discussiëren over de vide, de eetplek, het raam, zonnepanelen en de lichtinval.

Voor ontwerpers is het waarschijnlijk lastig om woorden te vinden voor de cognitieve vaardigheden die normaal impliciet blijven. Docenten zijn professionele ontwerpers, ze zijn niet onderwijskundig geschoold. Tot voor kort werd er weinig aandacht besteed aan de onderwijskundige kant van het lesgeven. Het werd en wordt nog vaak aangenomen dat de meest belangrijke (en zelfs enige) voorwaarde is dat docenten expert ontwerpers zijn. In de ontwerpstudio lijken docenten met studenten te spreken zoals ze in hun bureau met collega's discussiëren en zoals ze het zich vanuit hun eigen studie herinneren. Ze lijken een aantal dingen inmiddels zo vanzelfsprekend te vinden dat ze zich niet realiseren dat deze voor studenten helemaal niet vanzelfsprekend zijn.

Beginnende studenten hebben nauwelijks of geen ervaring. Ze starten hun ontwerpstudie met leken-concepties, vage ideeën over wat ontwerpers doen. Ze ervaren het leren ontwerpen vaak als verwarrend. Zoals een student geciteerd door Schön (1987, p.98) het formuleert: "Een van de dingen waar ik gek van word in het architectuuronderwijs is dat er veel dingen impliciet zijn, ze blijven onder de oppervlakte, er wordt niet over gesproken."

Traditioneel lijkt leren ontwerpen een kwestie te zijn van leren door te doen. Studenten beginnen te ontwerpen terwijl ze nog niet weten wat dat inhoudt. Om in deze 'zoektocht naar het onbekende' te begrijpen wat gedaan moet worden

en adequate gewoonten aan te leren, is het zinvol het impliciete ontwerpproces zoveel mogelijk expliciet te maken. Dewey (in Logister, 2005) concludeert dat weten handelen ondersteunt, het helpt de relatie tussen acties en consequenties te begrijpen. Meer begrip leidt tot meer focus en intelligent handelen, vooral in nieuwe en onbekende situaties.

Doel, vragen en methode

Om de kwaliteit van het ontwerponderwijs te verbeteren en de verwarring van studenten te verminderen, is het doel van dit onderzoek een vocabulaire te vinden om het ontwerpproces in ieder geval tot op zekere hoogte expliciet te maken.

In principe zijn er drie vragen gesteld en beantwoord: (1) Wat kan en moet er besproken worden in relatie tot het ontwerpproces? (2) Bespreken docenten het ontwerpproces en zo ja, tot op welke hoogte? (3) Is leren ontwerpen minder verwarrend voor studenten als het ontwerpproces expliciet wordt gemaakt?

Om de eerste vraag te beantwoorden is met behulp van literatuuronderzoek een raamwerk ontwikkeld om de basis ontwerpvaardigheden bespreekbaar te maken (hoofdstuk 2). Dit raamwerk is op juistheid getest door middel van interviews met expert-ontwerpers (hoofdstuk 3). De tweede vraag is onderzocht door de dialoog tussen docent en student te observeren en analyseren (hoofdstuk 4). Tot slot zijn de derde vraag en meer specifiek de bruikbaarheid van het raamwerk onderzocht in twee gevalsstudies middels vragenlijsten (hoofdstuk 5).

Resultaten

Om de *eerste vraag* te beantwoorden - Wat kan en moet er besproken worden in relatie tot het ontwerpproces? - zijn de essentiële en basale ontwerpvaardigheden beschreven (hoofdstuk 2). De elementen zijn geen recept of stappenplan, ze zijn geen garantie voor een goed ontwerp. Wel zijn het ankerpunten om de wijze waarop ontwerpers denken duidelijk te maken.

1. experimenteren of onderzoeken en reflecteren

Ontwerpen is experimenteren, een proces van exploreren en reflecteren. Exploreren verwijst naar een open, speels en nieuwsgierigheidgedreven proces, naar het ontdekken van nieuwe alternatieven en opties op intuïtieve en/of rationele wijze. Reflecteren verwijst naar een kritisch en nadenkend proces, naar het testen

en evalueren van mogelijke opties, naar het onderzoeken van (on)verwachte consequenties van de voorlopige oplossingen.

2. richtinggevende thematiek of kwaliteiten

Om tot een samenhangend en betekenisvol geheel te komen, is ontwerpen het ontwikkelen van een inspirerende richting. Een houvast in een schier eindeloze hoeveelheid aan mogelijkheden. De thematiek is het persoonlijke en cultureel beïnvloedde antwoord van de ontwerper. Het is een dynamisch proces op zich. De kwaliteiten ontwikkelen zich gedurende het ontwerpproces, van vaag en abstract naar concreet en uitgewerkt, passend in de specifieke context.

3. domeinen of aspecten

Ontwerpers doen uitspraken over veel aspecten op verschillende schaalniveaus. Voor architectuur: ruimte, materiaal, functie, de directe fysieke situatie en een breder sociaal-culturele, filosofische context. In relatie tot deze aspecten hebben ontwerpers te maken met condities en informatie - zoals regels, criteria, voorkeuren en culturele gewoonten. Keuzes in een domein beïnvloeden aspecten in andere domeinen. Ontwerpen vindt plaats op het speelveld van alle relevante domeinen.

4. referentiekader of (beeld)bibliotheek

Het referentiekader is de gezamenlijke professionele en persoonlijke bibliotheek aan kennis en ervaring van de ontwerpers. Het bestaat uit referentieprojecten en abstracties zoals ideeën, kwaliteiten, vuistregels, principes en patronen. Ontwerpers ‘zien’ de nieuwe voorliggende ontwerpopgave via bestaande kennis en beelden. Bewust en onbewust worden de patronen en principes toegepast, getest, afgewezen of getransformeerd in de voorliggende (ontwerp)situatie.

5. laboratorium of (visuele) taal

Het ontwerpproces ontvouwt zich via de fysieke taal van schetsen en maquettes. De taal van beelden is een uitbreiding van het beperkte werkgeheugen en complementair aan de taal van woorden en begrippen. Enerzijds is het vaag en open, en maakt het creativiteit mogelijk. Anderzijds is het precies en maakt het kritisch denken en analyseren mogelijk.

In hoofdstuk 3 is het raamwerk getest: ontwerpers met elk hun eigen verschillende persoonlijke stijl en aanpak hebben de elementen herkend als generieke ontwerpvaardigheden. Met name in de richtinggevende thematiek is de rijkdom

aan verschillende aanpakken en visies zichtbaar. De vijf elementen voorzien in een generiek overzicht om de basisvaardigheden te onderscheiden en de persoonlijke en culturele verschillen in ontwerpmethodes te vergelijken.

Met de kennis van het raamwerk is in hoofdstuk 4 de *tweede vraag* onderzocht: Bespreken docenten het ontwerpproces en zo ja, tot op welke hoogte? Docenten blijken het ontwerpproces nauwelijks te bespreken. Ze (1) gebruiken impliciet voorbeelden, die direct gerelateerd zijn aan het voorliggende ontwerpproduct, zonder uitleg van het onderliggende ontwerpproces en (2) ze refereren 'tussen de regels door' naar het ontwerpproces met begrippen zoals onderzoeken, varianten en schetsen. Deze begrippen verwijzen meestal naar een gedetailleerd niveau van het ontwerpproduct, zoals trappen, ramen, zonnepanelen en uitzicht.

Tot slot is in hoofdstuk 5 de *derde vraag* onderzocht en beantwoord: Is het leren ontwerpen minder verwarrend voor studenten als het ontwerpproces expliciet wordt gemaakt? In twee interventies in een Bachelor cursus (Technische Universiteit Delft) en twee Master ontwerp projecten (Academie van Bouwkunst Groningen en TU Delft) zijn positieve resultaten gevonden. Uitleg van het ontwerpproces met behulp van het raamwerk is als positief ervaren door in ieder geval een substantieel deel van de studenten, zowel in formele vragenlijsten als in informele gesprekken. Het onderzoek toonde een verschuiving bij de studenten naar meer begrip en zelfvertrouwen. De betrokken docenten hebben het raamwerk ervaren als een structurerend middel, voor zichzelf om een overzicht te hebben van wat besproken moet en kan worden in een begeleidingssessie en voor studenten om grip te krijgen op het ontwerpproces.

Discussie

De eerste onderzoeksbevindingen tonen dat het voorgestelde vijf-elementen raamwerk een ontbrekende schakel is in het architectuur-ontwerponderwijs. De elementen vormen ankerpunten in een complexe, open, onzekere en chaotische voorliggende ontwerpsituatie. Met het raamwerk verschuift de focus in de begeleidingssessies van het ontwerpproduct naar het ontwerpproces, naar de wijze waarop ontwerpers denken en redeneren. De ontwerpproducten zijn een middel om te leren ontwerpen. Ze blijven onderwerp van gesprek, maar meer in de vorm van voorbeelden. Ze helpen studenten de ontwerpvaardigheden te ervaren in verschillende concrete situaties. Het raamwerk ondersteunt het ontwerpproces om tot samenhangende, betekenisvolle, adequate, uitgewerkte en verbeeldingsvolle ontwerpen te komen.

Theoretische implicaties

Het raamwerk en de onderzoeksstudies kennen een viertal theoretische implicaties.

Ten eerste, het raamwerk is een model of constructie om de basale ontwerpvaardigheden expliciet te maken. Ondanks dat er altijd discussie mogelijk zal zijn over het aantal elementen en hun inhoud, lijken ze een goede afspiegeling van de werkelijkheid te vormen. Er is altijd het risico dat het raamwerk te letterlijk wordt genomen. Maar de elementen zijn bedoeld als ankerpunten in het ontwerponderwijs, om het studenten mogelijk te maken hun eigen representaties van het ontwerpproces en architectonische kennis te ontwikkelen en de kennis en ervaring van de ene situatie in een andere om te zetten.

Ten tweede, de elementen zijn in eerste instantie bedoeld om dubbelzinnigheden, vaagheid en complexiteit in de dialoog tussen docent en student inzichtelijk te maken. Maar ze kunnen in allerlei vormen van wederzijds begrip en kennisuitwisseling worden gebruikt, zoals groepswerk en samenwerking tussen ontwerpers en niet-ontwerpers. Het raamwerk lijkt ook zinvol te zijn voor andere ontwerpdisciplines. Als het raamwerk gebruikt wordt als gemeenschappelijke taal om verschillen en overeenkomsten tussen de ontwerpdisciplines te onderzoeken, zou dit tot meer wederzijds begrip kunnen leiden. Dit kan weer leiden tot verbreding en verdieping van het ontwerpproces en het ontwerponderwijs.

Ten derde, de vijf elementen vormen ook een houvast om ontwerponderwijs te organiseren in ontwerpstudio en curriculum. Het raamwerk kan worden gebruikt om meer beargumenteerde ontwerpprojecten en relaties tussen de projecten en andere vakken in het curriculum te ontwikkelen.

Ten vierde, docenten hebben tijd nodig om gewend te raken aan het raamwerk en de rijkheid van de ankerpunten te leren kennen. De elementen omvatten een wereld aan begrippen en wederzijdse relaties, in relatie tot de genuanceerde en rijke ontwerprealiteit. In de context van de begeleiding gaat het om een verschuiving in reactie, van ‘wat en waarom heb je iets gedaan?’ in relatie tot het ontwerpproduct, naar de discussie ‘wat wil je aan het eind bereiken?’ en ‘wat kunnen de volgende stappen zijn?’.

Grenzen

Natuurlijk kent het onderzoek zijn grenzen. Deze liggen vooral in het feit dat het om architectuur en ontwerponderwijs in Nederland gaat en in de gevolgde onderzoeksmethoden, zoals beperkingen in het aantal participanten en de duur van de (tweede) gevalsstudie.

Aanbevelingen

De volgende richtingen voor toekomstig onderzoek en ontwikkeling worden aanbevolen.

Als eerste, onderzoek met meer participanten, controlegroepen en gedurende een langere periode in zowel Bachelor als Master-onderwijs. Naast begrip en zelfvertrouwen is het dan ook mogelijk de ontwerpvaardigheid van studenten te onderzoeken.

Ten tweede, onderzoek naar hoe architectuurkennis cognitief verwerkt wordt en hoe studenten hierop te begeleiden (ontwikkeling referentiekader, opslag en gebruik van kennis in architectonische principes en patronen).

Ten derde, onderzoek naar of en tot op welke hoogte de elementen ook in andere ontwerpdisciplines het ontwerpproces expliciet kunnen maken. In dat geval kunnen de resultaten leiden tot verschillen en overeenkomsten tussen de ontwerpdisciplines en onderling begrip en leren van elkaar.

Ten vierde, onderzoek naar gebruik van het raamwerk als een van de factoren om de ontwerpstudio en het curriculum te ontwerpen. Meer in het bijzonder wordt het geadviseerd het raamwerk te gebruiken in combinatie met het complexe vaardigheden model van Van Merriënboer and Kirschner (2018). Dit 'vier componenten instructie-ontwerpmodel' omvat belangrijke aspecten zoals het leren door steeds de hele vaardigheid te oefenen, variatie in leertaken en de nadruk op specifieke vaardigheden in de context van de hele vaardigheid. In combinatie met dit onderwijskundige model, specificeert het raamwerk de inhoud van het architectonisch ontwerpen, de wijze waarop ontwerpers redeneren.

Tot slot wordt de ontwikkeling aanbevolen van een intensieve docententraining (bv. post-master jaar) en middelen (in de vorm van een boek en/of online informatie, zoals een MOOC) om te leren het ontwerpproces expliciet te maken. Het leren werken met het raamwerk vraagt immers om een verschuiving in denken en gewoonten.

Praktische implicaties

Om grip te krijgen op het ontwerpproces in verschillende soorten situaties, moeten de elementen *herhaaldelijk expliciet gemaakt en geoefend* worden. De elementen voorzien in een basisverzameling aan begrippen, vragen en instructies om docenten te helpen het impliciete expliciet te maken. Vanzelfsprekend zijn in de discussie de elementen aanwezig in combinaties, zoals experimenteren met

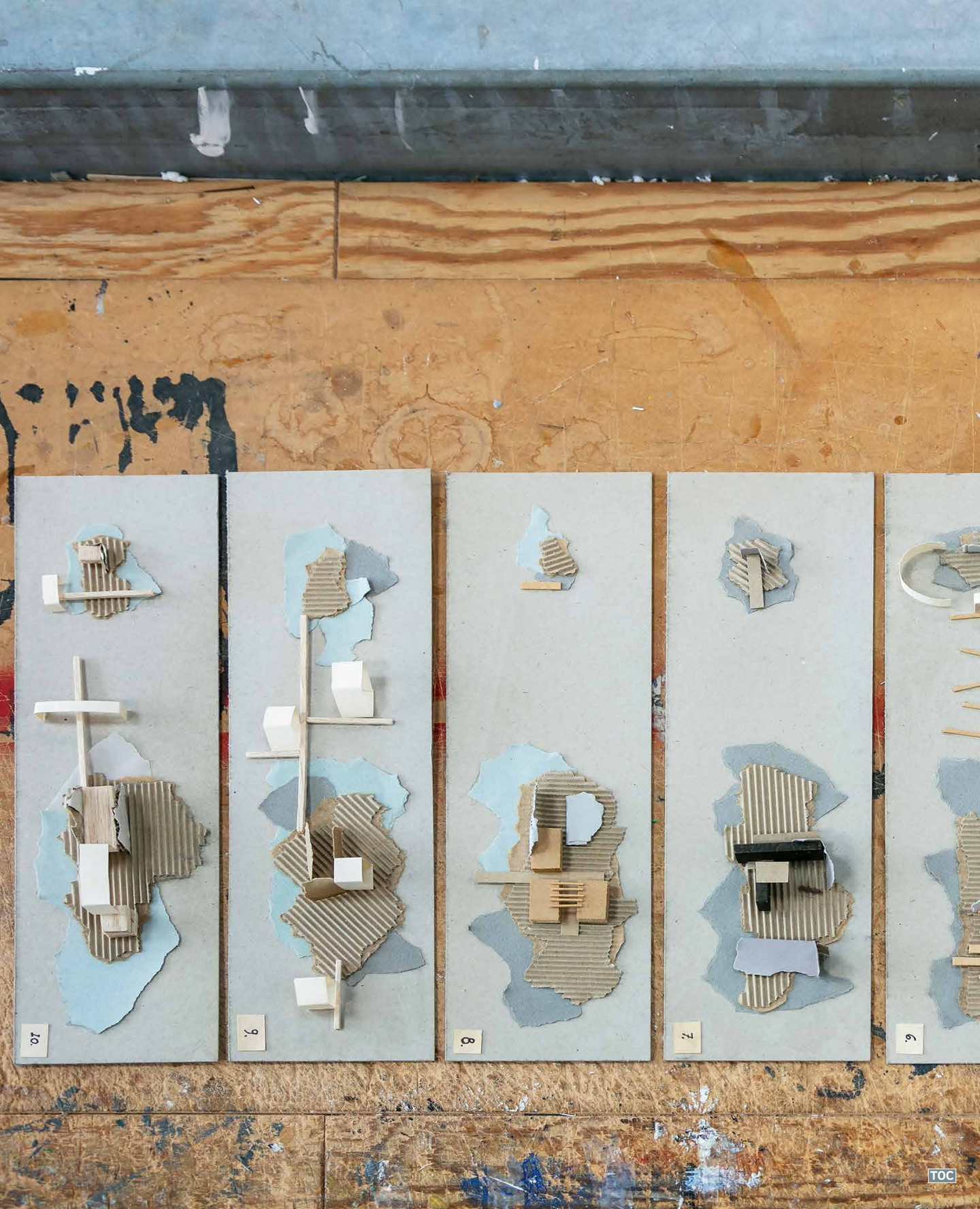
patronen in de context van een thematiek, en moeten vragen en instructies direct gerelateerd worden aan het ontwerpproduct op dat moment. In principe betekent expliciet begeleiden op het ontwerpproces het verschil tussen studenten vertellen te ontwerpen en achteraf naar de reden te vragen waarom ze iets hebben gedaan, en studenten vertellen te experimenteren en een richting (thema of kwaliteiten) te ontwikkelen en deze te bespreken in relatie tot hoe verder te gaan.

De elementen helpen in een verschuiving in de discussie van allerlei gedetailleerde aspecten naar *een meer abstract overzicht* in relatie tot de specifieke ontwerpsituatie. Wat besproken, gevraagd of geïnstrueerd moet worden hangt af van de situatie. Bijvoorbeeld, in schetsen kunnen bijna alle relevante aspecten aanwezig zijn, maar nog zonder samenhang. De student kan een idee hebben van de te bereiken richting, maar nog zonder daarmee te experimenteren. Als docenten de product-gerelateerde opmerkingen combineren met dit soort 'overzicht' conclusies, geven ze de studenten beter de mogelijkheid te begrijpen wat een ontwerpende wijze van denken inhoudt.

Het raamwerk helpt ook in *het ontwerp van studio en curriculum*. In principe moeten in ieder ontwerpproject alle ontwerpvaardigheden geoefend worden. Maar de ontwerpprojecten moeten ook focussen op specifieke thema's en specifieke kennis. Dit maakt het voor studenten mogelijk om te werken met verschillende posities, kwaliteiten of thema's en middelen om deze te bereiken in een specifieke situatie. Op deze wijze ontwikkelen studenten een referentiekader en leren ze gemeenschappelijke en beproefde thema's te interpreteren in specifieke situaties. Als een basisniveau aan begrip en vaardigheid bereikt is, kunnen ontwerpopgaven en ontwerp kwaliteiten meer complex, diepgaand, specifiek en persoonlijk worden.

Tot slot

Dit onderzoeksproject leert ons dat het ontwerpproces expliciet gemaakt kan worden, in ieder geval veel meer dan docenten gewend zijn te doen. Het onderzoek laat zien dat het raamwerk voorziet in een gemeenschappelijk vocabulaire om het wederzijds begrip te vergroten. Voor docenten helpt het raamwerk in een verschuiving in hun denken en in een verandering van begeleiden op ontwerpproduct naar begeleiden op ontwerpproces. Voor onderwijsontwikkelaars helpen de elementen de ontwerpstudio en het curriculum te ontwerpen. En voor studenten leidt ontwerponderwijs waarin het ontwerpproces meer expliciet gemaakt wordt met het raamwerk tot een rijker begrip van het proces en meer zelfvertrouwen in hun ontwerpend denken.



TOC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TOC

1 Introduction

"One of the things that really bugs me about architectural education is that a lot of things are really implicit, remain under the surface and are not talked about."

An anonymous student quoted by Donald Schön (1987, p. 98).

Students traditionally learn to design in the design studio, where they work on a series of integrative, realistic, and progressively difficult design projects. Information is given in the form of the design task (a brief or function and a specific site) and what is expected in the end (the kind of products). Extra information may be given in the form of a work scheme or an inspirational text. Each time during tutorials in the design studio, teachers and students discuss the provisional design product, presented in sketches and (sometimes) models. The following two fragments of tutorial dialogues in a Bachelor first-year design project for a house plus atelier are typical of the dialogue between teachers and students:

Student[1]*: … Yes, in fact, I don't know… how I should proceed … investigate …*
Teacher: *Through drawing, drawing, drawing, drawing. And by looking at what I'm doing. This (pointing at drawing) is the atelier.*
S: *Yes.*
T: *How do you think the artist works in his atelier?*
S: *Well … all up from this side… and… over there, like this… (points at drawing).*
T: *Ehm … Yes. So, here is (points at drawing) glass and over there, glass and there everything opens into the … living room.*
S: *Yes.*
T: *This is the only wall with … 'backing', with… Maybe he will set a cabinet here, which makes it still open and at the same time a bit private. Furnish it and look how … if the window has to come entirely over there or that the window maybe can …*
S: *Yes.*
T: *… beautiful if it is an edge. Maybe it is beautiful if it is the same edge as here (points at drawing). Over here (points out another point on the drawing), you already make it smaller.*

1 transcription 3

TOC

S: *Ehem.*
T: *These… are all choices you've made. In the overall picture…and you can do that in the section as well.*
S: *Yes.*
T: *Does the glass really have to reach up to the top? Or may it just a little bit lower? And over there, I mean there are a lot of reasons for and against.*
S: *Yes, maybe it can…*
T: *So, sections…*
S: *Yes.*

Teacher[2]*: Do you have … Which investigations do you have to do?*
Student: *Yes, I have to look at the facades, materials and the roof, how I want to have it exactly. Because there probably has to be solar panels.*
T: *Yes.*
S: *So, I think I'll work on the appearance and look if the roof was in my other sketch model.*
T: *Eh, Yes…instead of solar panels I could see it more as an investigation.*
S: *Yes.*
T: *So, then, how to make this house as sustainable as possible?*
S: *Yes.*
T: *So, what partly…How can you deal with this in the architecture?*
S: *Yes.*
T: *That can be even, ehm…there are also translucent solar panels letting the light through. You could provide the upper side with them.*
S: *Yes.*
T: *How it filters the light influences the experience of the house. An extra slope. And another thing is if you work with the roof, you may create something new.*
S: *Do you mean more separate rooms in the house?*
T: *Yes. And try to set different variants next to each other. Like you did before.*

These fragments illustrate the confusion students may feel. Is designing about the view, openness, the way artists work, composition, light, or solar panels? If designing is about investigation, drawing and having reasons, then how do you investigate, what should you draw and what kind of reasons are meant? What do teachers actually mean?

2 transcription 11

In essence, the main goal of a design study such as architecture is to learn 'the designerly way of thinking'[3]. Therefore, one might expect that the design process is the main subject of tutorial discussions. Nevertheless, based on observing dialogues in the design studio, teachers seem mostly to address the design product. Discussions seem to focus on all aspects of the product, and on all kinds of reasons regarding these aspects. Most of the time they discuss a void, a view, the living room, the window, solar panels, and the kind of light. In the first fragment, for example: (1) *Maybe he will set a cabinet here, which makes it still open and at the same time a little bit closed. Furnish it and look how…if the window has to come entirely over there or that the window maybe can…* Only to a small extent, almost between the lines, do teachers refer to the design process. In the fragments: (1) *Through drawing, drawing, drawing, drawing. And by looking at what I'm doing*, (2) *And over there, I mean there are a lot of reasons for and against*, and (3) *And try to set different variants next to each other. Like you did before*.

For an expert designer, it may be difficult finding words for cognitive skills that are normally implicit. Until recently, little attention was paid to the educational side of being a design teacher. It was, and is often still assumed, that being an expert designer is the most (and often only) necessary qualification in design education. While teachers are professional designers, they have not necessarily been trained as teachers. In the design studio, teachers discuss design products with students much as they would with colleagues in a design office, or as they remember it from their own studies. They may find certain things so obvious that they do not realise this is not the case for their students.

Beginning students have no or little experience. They start their design study with layperson concepts and vague ideas about what designers do. Donald Schön (1987, p.93) refers to learning with a paradox. Although at first students cannot understand what they have to learn, they can only learn by trying to do it. However, with the right kind of instruction, they will eventually learn to see, and do exactly what is needed to design well.

Teachers do not seem to have a vocabulary to address the design process. When they refer to the design process, they refer primarily to its more 'visible' parts: reasons regarding product aspects, sketches and models. The less visible part of the design process, the way in which professional designers reason and work with a known and proven body of knowledge is barely discussed. Returning to the student

3 Cross, N.G. (2007). *Designerly ways of knowing*. Basel, Boston, Berlin: Birkhauser.

quoted by Schön (above), it is clear that the design process, the designerly way of thinking, stays ‘really implicit, remaining under the surface’.

Therefore, in the research project presented here, the focus is on (the lack of) making the design process explicit in design education and more specifically, in design tutorials. The general aim of this research is finding a vocabulary to make the design process explicit in order to help teachers improve both the quality of design education, as well as decrease the confusion felt by their students.

Before presenting our research in the following chapters, this chapter will provide background information. First, information about what kinds of implicit knowledge and values might play a role in design education, with notions such as situated, embedded and encapsulated knowledge and values. Next, the body of knowledge this thesis is based upon will be briefly introduced in two short sections: studio dialogue and design process. Finally, the aim of the research project will be defined and the chapters are introduced shortly.

1.1 Implicit and explicit knowledge and values

To underscore that knowledge is not an asset in itself but is always strongly related to phenomena and actions, it is called ‘contextualised’ or ‘situated’ (Brown, Collins, & Duguid, 1989). Knowledge, phenomena, skills, actions and notions make sense in context. Professionals are engaged in skills and cultures, such as (architectural) design. To a large extent they perform tasks implicitly, but phenomena, actions and objects experienced can also be made explicit, at least to a certain extent. Naming and framing may lead to a development in understanding these skills and actions.

Skilled performance is in principle a combination of implicit doing and explicit knowing. The implicit and explicit form a continuum. On one side of the continuum is knowledge, which we might not be able to explain. Polanyi (1966) coined the notion ‘tacit’ knowledge. Meaning, this is knowledge we cannot explain but rather ‘feel’. In fact, we are largely unable to make it explicit. In the words of Polanyi: “We can know more than we can tell.” He illustrates tacit knowledge with an example of being able

to recognise a person's face among a crowd of thousands. Though we recognise the person, we cannot explain how we do this.

On the other side of the continuum is explicit knowledge. Knowledge is an active human construction emerging from action. Depending on context and purpose, implicit knowledge may be described in different ways. Whatever kind of descriptions are used to make explicit what to do and how to do it, it will always be a matter of constructing meaning related to existing phenomena.

Knowing makes us understand the relationship between our actions and their consequences. Dewey (in Logister, 2005) concludes that knowing supports action; it is especially important in unknown and new situations. The phenomenon of (supportive) construction is illustrated by the image of a pipe, painted by Magritte. The image is not (the feeling and use of) the pipe itself. However, there is a strong relationship between the image and the real thing. Seeing the image of the pipe may help us learn about the real pipe. Exploring and finding more adequate and effective notions and images helps us focus better and act more thoughtfully and intelligently.

To understand the implicit and explicit more profoundly, several (overlapping) ideas can be distinguished, such as embedded and encapsulated knowledge and values.

Professional knowledge is *embedded* in action, in experience. Experts perform skills in an interwoven and integrated way, based on common practice and routine (Collins, Brown, & Holum, 1991; Van Merriënboer & Kirschner, 2018). Designers think 'designerly'; what they do feels natural. In the context of the design studio, Schön (1985, 1987) used the notions "knowing-in-action" and "reflection-in-action" to address the phenomenon that relevant knowing is made available by doing rather than thinking.

Knowing-in-action refers to how we act spontaneously, in fluent sequences of activities, without thinking about it. The notion of reflection-in-action refers to the moments of reshaping and trial-and-error, emerging in the process of knowing-in action, without interruption. It occurs in cases of unexpected results and at moments when we look at things from a new angle. Schön illustrates both notions with the example of jazz. The musicians improvise in a kind of conversation, which includes conventional routines, known patterns, moments of surprise and unexpected turns of phrases. For expert designers, it works similarly. For example, designers see their sketches and models and 'know' or 'feel' that it is 'still not what it could or should be'. It is an interwoven process of acting and learning from those actions.

In the interwoven process of exploration and reflection, experts make use of a library of relevant knowledge, a web of 'knowledge chunks' or 'information packages' stored in long-term memory. In the context of chess, De Groot (1965) showed that expert chess players work with chess positions, and the specific meaningful patterns of chess pieces. They recognise these patterns and know what they (might) mean. In the context of medical sciences, the term *encapsulated* knowledge (Van de Wiel, Schaper, Boshuizen, & Schmidt, 1995; Rikers, Schmidt & Boshuizen, 2000) is used to refer to the clinically relevant, diagnostic concepts experts have built up and work with. Encapsulated concepts can be triggered by information about signs and symptoms. In the context of design, encapsulated knowledge seems to run parallel to typical solutions, abstract patterns, principles and schemes. These 'knowledge chunks' stand for an integrated package of known and proven knowledge. All solutions, principles and patterns stand for a set of implications: certain things may be not possible anymore, others are arbitrary or just logical to do.

Designers work with this library of knowledge. They 'reshape' examples, patterns and principles in unique situations, in unfamiliar combinations and unexpected exceptions. Schön (1987, p.67) calls this process 'seeing as', it is seeing "the unfamiliar, unique situation as both similar to and different from the familiar one". Based on their experience, designers 'feel' which patterns and principles might be right and adequate in the situation at hand. They play with patterns and see possible problems, which may cause rejection or lead to creative solutions.

The way in which designers interpret and transform common and proven knowledge into the situation at hand is directed by *personal, professional,* and *cultural values*. All professional designers have their own unique backgrounds and attitudes, values and interests (Lawson & Dorst, 2009). Values ranging from personal, 'subjective' beliefs concerning 'good architecture' towards generally accepted 'objective' professional and cultural knowledge. The architectural landscape is a fascinating and rich variety of design products and design approaches (Bielefeld & El Khouli, 2007; Jormakka, 2008). Often, these values are implicit in the design process and in design education. Schön (1987, p.98) refers to implicit claims in the design studio: "When Quist [the teacher] expresses such judgements, is he also conveying the message that they are normatively binding for everyone? Or is he saying only that she [the student] must invest her design with values of her own, regardless of their fit with his? Are the differences among schools of architecture objectively grounded, or are they matters of taste or ideology? On such issues even Quist is silent."

To sum up: to a large extent, expert designers know implicitly how to approach a design process. They have gained knowledge through study and experience. They feel how they should proceed and how to relate common and proven knowledge

to the specific situation they are working with. Their work is directed by personal, professional and cultural values, developed over the course of time. Their knowing and knowledge became unconscious and 'obvious'. In fact, they may be surprised when other people do not seem to understand the concepts they use. Nevertheless, teachers have to make the implicit explicit as much as possible. They have to guide students in their discovery of what 'designerly thinking' is (Collins, Brown, & Holum, 1991; Van Merriënboer & Kirschner, 2018). As teachers, professional designers have to find the words and notions to make the implicit explicit to their students.

1.2 Studio dialogue

The design studio and tutorial dialogue, in particular, are subjects of limited research. Investigated by interviewing teachers and/or observing tutorial sessions, the intentions and utterances of the teachers have been analysed and described in different ways. Four main topics can be distinguished: the implicitness of the content, the description of knowledge categories, the difficulties of making the implicit explicit, and the focus on the product.

Most studies seem to take the implicit character of the content as given; designing and education are cultures (Strickfaden & Heylighen, 2010) or praxes (Uluoğlu, 2000). Michels (2018) describes design (education) as an intuitive feeling for professional knowledge, which can be illustrated with examples. Dialogue in the design studio is meant to develop what she calls students' 'aesthetic judgement', an emotional response with intersubjective validity in the context of the architectural profession: by reflection-in-action and arguments about the design being discussed in terms such as good / bad quality, boring / compelling and ugly / beautiful.

The knowledge in tutorial dialogues is often described with similar and overlapping categories and types, all related to the discussion of the design product. Michels (2018) distinguishes differences in structure (beginning, body, and end) and in patterns related to this structure. For example, in a 'hybrid and spontaneous discussion' different detailed stages are distinguished: a problem stage, a hypothesis stage, and a thought experiment. Goldschmidt, Hochman and Dafni (2010) distinguish eight kinds of utterances: (1) report, review, analysis of the state of design, (2) clarification questions, (3) proposals for change or improvement, (4) references to design precedents, (5) explication of design issues, theory, principles,

norms, conventions, (6) statements regarding design methodology, presentation, (7) praise, expression of satisfaction, encouragement, and (8) questioning, pointing out of mistakes, shortcomings, expression of dissatisfaction.

The difficulties of making an implicit culture or praxis explicit in dialogue are described by Schön (1983,1985,1987) and Dinham (1987). Schön describes the discussion between teacher and student with four notions: telling, listening, showing, and imitation. As in all communication in a tutorial dialogue, ambiguities, vagueness and misunderstandings may occur. For example, when the teacher tells the student 'to draw, draw, and draw'. For a professional, drawing may refer to doing an experiment, or drawing in order to discover the consequences of various possibilities. Students, however, may understand the idea of drawing as being a visual representation only.

Another example is given by Dinham. It concerns difficulties in relation to the cultural and personal styles and approaches of various teachers. The criteria used to judge the work of students when providing feedback and assessments may vary by school, but even more so by teacher, each possessing his or her personal views. These criteria can be related to styles such as historicism, rationalism, and functionalism, but also to the social and cultural context and client/user needs. Being an 'outsider' Dinham (1987) made an interesting observation. To understand why it was difficult for her to understand teaching based on other viewpoints, she had to become aware of her own 'hidden' values: 'a blend of functionalism and user need, with aesthetics as second influence' (p.7).

Finally, all research studies show concrete examples of how teachers discuss the work of their students. The dialogues focus mainly on the personal and relatively detailed aspects of (preliminary) design products. The design teacher asks questions and thinks aloud in direct relation to the specific design. The design process typically remains implicit and is barely discussed.

1.3 Design process

The design process is studied almost as a separate and parallel track. In general, two extreme positions or paradigms can be identified: a 'technical rationality' paradigm and a 'reflective practice' paradigm (Schön, 1983,1985,1987). In principle, both are present in the design process, depending on the design discipline and situation.

Inspired by the successes in scientific disciplines, there has been discussion—at least theoretically—about what science and concepts of rationality and objectivity might mean for the design process. Researchers assumed that the ideal design process is a process of rational problem solving (Simon, 1973). From this point of view, design methods had to be systematised. From the 1960s until the 1980s, theories referring to the design process identified two or three stages: analysis, synthesis and, sometimes, evaluation (Zeisel, 1984). Feedback loops were often included. In these models, designing is a matter of breaking down the problem into separate aspects, solving these and combining them into an end result. From this perspective, the relevance and value of the design emerge through solving all of these aspects. In other words, from the point of view of technical rationality, in design, meaning and value are expected to be the end result.

Where analysis, synthesis and evaluation are actual activities in designing, the fixed sequence seems to have a prescriptive function. The descriptions of the design process based on the ideas of technical rationality seem to be far away from daily practice. In contrast to the 'technical rationality' or 'rational problem solving' model, Schön (1983) distinguishes a 'reflective practice' model in which the design process is a matter of experimentation and learning about the consequences and implications of experiments. It is also called a process of conjecture and analysis (Hillier, Musgrove & O'Sullivan, 1972) and a process of ideation and evaluation (Goldschmidt, 2014). Instead of relying on scientific knowledge, designers are assumed to rely on intuition, on embedded and encapsulated knowledge and experience. The logic of the design product is not built up by arguing and solving each aspect step-by-step. Coherence and significance are imposed and discovered in a process of experimentation, in a process of knowing-in-action and reflection-in-action (Schön, 1983, 1985, 1987).

From the perspective of the atomistic point of view or technical rationality, the variety of personal approaches and values is considered a problem or at best the artistic part of design; an extra 'unnecessary' outcome. From the perspective of a broader human and cultural way of thinking (reflection-in-action), personal

approaches and values are important. They constitute human and cultural life. They give direction to the future we want to live in.

Over the course of time, the 'reflective' design process has been described with different, partly overlapping notions. Different clusters of notions can be distinguished in what might be called an experiment-based attitude, a knowledge-based attitude, and a pre-structured or value-based attitude.

Schön (1983,1985,1987) describes designing as a process of doing (small) *experiments*, as 'making a web of *moves*'. He defines the moves as changes in ideas and representations, in configurations, sketches and words; he describes the consequences and implications of a move as traces in the virtual world of a drawing or model. Starting with ideas and sketches, and proposed solutions, the designer explores the problem and possible solutions with an open mind. The experiments or moves are evaluated, and further experiments are done. Making moves means creating new problems and seeing things in a new way, constructing new meanings and intentions. Schön calls this process of experimenting a 'reflective dialogue' and 'conversation with the situation'. It is also captured in the notion of the co-evolution of a problem and its solution. Designers are solution-led, coming up with potential solutions in an early stage of the design process (Eastman, Newstetter, McCracken, 2001; Lawson, 2004, 2006; Lawson & Dorst, 2009). They use conjectures to explore and define the problem and the solution together.

The act of designing takes place in a professional *culture of knowledge*, in the context of design tradition. Nigel Cross (2007) points out that the knowledge designers use is stored in the real world. Over the course of time, professional designers have developed a large library of references, images, understanding, and a repertoire of skills. Designers experiment with commonly known and proved knowledge. They see the current design situation through their acquired knowledge and experience (Schön, 1983, 1985, 1987).

Hillier, Musgrove and O'Sullivan conclude that design proceeds by conjecture – analysis, rather than by analysis – synthesis: "designers must, and do, *pre-structure* their problems in order to solve them" (1972, p.3). They see similar developments in science and philosophy. In science, a paradigm shift takes place by eliminating or reducing preconceptions in order to get at the truth towards an interest in how we interpret the world. "The question is not whether the world is pre-structured, but how it is pre-structured, and whether the designer is prepared to make this pre-structuring the object of his critical attention." (1972, p.7). Darke (1979) proposes an extension of the paradigm: generator - conjecture - analysis. She introduces the "primary generator", a single idea or related objectives that generate potential

solutions. The primary generator forms a ‘way into the problem’ for the architect, instead of analysing and listing all the constraints. Lawson (2006) introduced the notions guiding principles and central idea to refer to the pre-structuring process. Value is set by the designer, rather than the outcome of rationality and rational analysis.

1.4 Aim and questions

The research presented here focuses on the (lack of attention for the) design process in design tutorials. Teachers barely seem to address the design process in their teaching. The main subject is the design product. Preliminary design results are discussed in terms of aspects, such as space, form, composition, material, structure, energy, site and function.

Traditionally, teachers are not used to articulating the design process. They are expert designers, not trained teachers, and seem to act in class the same way they do in the design office when speaking to colleagues; or how they remember from the time they were students themselves. A vocabulary for discussing the design process seems to be missing. However, the quality of design education may improve if the design process is explicitly addressed. It may become less confusing, students’ conceptions may become more adequate and effective, and their self-efficacy may increase. In the end, their design skills may improve.

The general aim of this research is finding a vocabulary in order to make the design process, at least to a certain extent, explicit in the architectural design studio. It is meant to help teachers in teaching and students in learning how to design. Basically, three questions were asked and answered: (1) What should and might be discussed in reference to the design process? (2) Whether, and to what extent, do teachers address the design process? (3) Is learning to design less confusing for students if the design process is explicitly addressed?

1.5 Chapters in this Thesis

The present research differs in approach and perspective from earlier research on design studio tutorials. Instead of making a profound analysis of what actually happens in the dialogue and what categories of knowledge are involved, this PhD research starts by formulating what seems to be missing in the design studio as a teaching and learning environment. Based on the body of knowledge of the design process and personal design education experience, it formulates what could and should be the subject in the design studio: the design process. It is not taking implicit and subjective knowledge for granted, but trying to come up with a way to address the content and place it in a broader perspective. In essence, the research consists of the construction of a framework to make the design process explicit and includes a series of studies to investigate and evaluate the framework in practice. In the end, the framework provides not only a basis for improving dialogue, but also structuring the design studio and design curriculum.

Apart from this Introduction and a final General Discussion, this thesis consists of four chapters (see Table 1.1). Each chapter is a paper that has been published in a scientific journal (Chapter 2 and 3 in the *International Journal of Technology and Design Education* and Chapter 4 and 5 in *Design and Technology Education: an International Journal*). As they are all independent, coherent entities that can be read separately, there is some redundancy, specifically the framework.

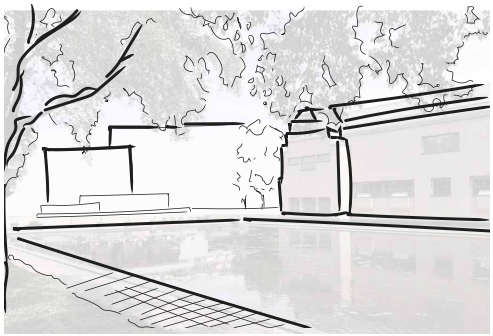
In the second and third chapters, the first question is answered: What could and might be discussed in reference to the design process? In Chapter 2, a framework is presented that enables teachers to make the design process explicit. If teachers are not used to and do not have a vocabulary, the question is: what do teachers have to make explicit and what do students have to become aware of in learning to design? Five generic elements dealing with basic skills in the design process are based on a body of knowledge. In Chapter 3, the framework is investigated in professional practice. It is explored whether the framework relates to actual design practices and if it helps to compare different design methods and approaches. Several designers are interviewed: do they all recognise the generic elements in their design process?

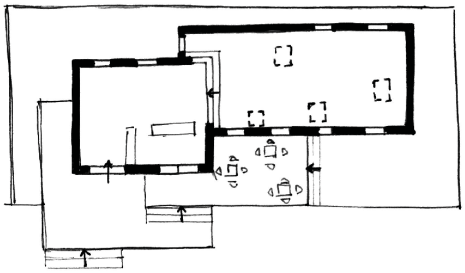
After the elements are known, which can be made explicit in reference to the design process, the second question is addressed in Chapter 4: Whether, and to what extent, do teachers address the design process? Tutorial dialogues between teachers and students in the design studio are investigated. Do teachers articulate these designerly skills, and if so, to what extent and using which kinds of expressions?

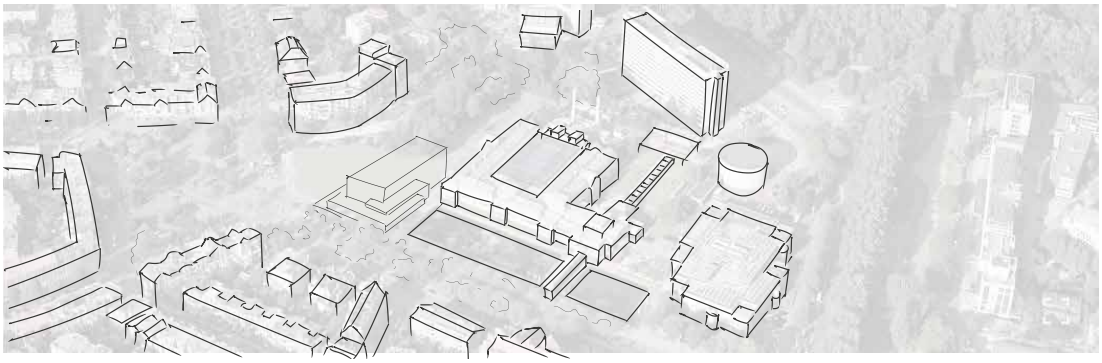
Finally, in Chapter 5, the third question is addressed: Is learning to design less confusing for students when the design process is addressed? Two exploratory case studies are presented. How did students and teachers perceive addressing the design process? Did students, being guided in the design process, acquire more sophisticated conceptions and did addressing the design process increase their self-efficacy? In the sixth and final chapter, a General Discussion of the whole PhD project is provided.

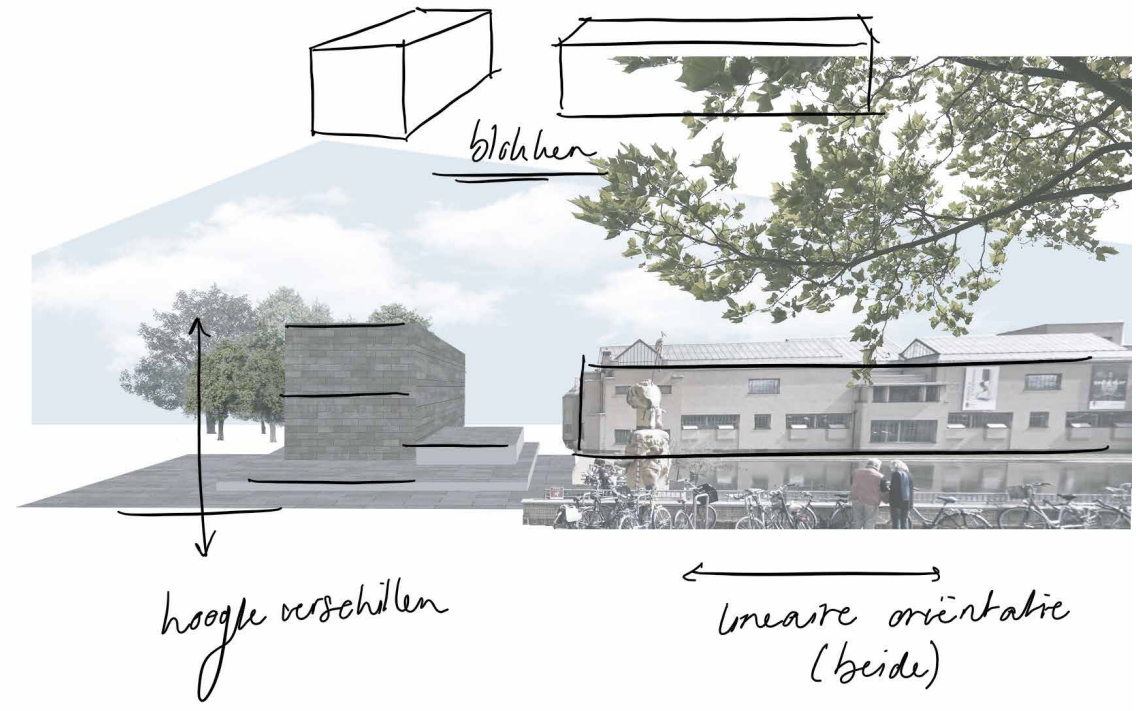
TABLE 1.1 Relationship between questions, assumptions and chapters.

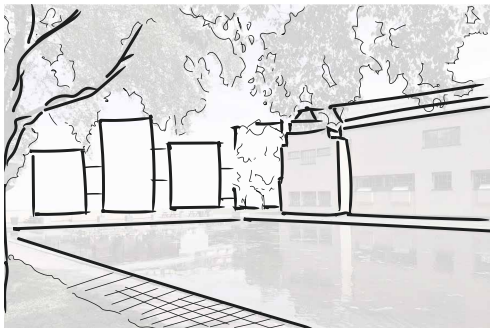
Question	**1** What should and might be discussed in reference to the design process?		**2** Whether, and to what extent, do teachers address the design process?	**3** Is learning to design less confusing for students if the design process is explicitly addressed?
Assumption	A vocabulary for discussing the design process seems to be missing.		Teachers barely seem to address the design process in their teaching. The main subject is the design product.	The quality of design education may improve if the design process is addressed. Students may be less confused.
Chapter	2 Framework five design process elements	3 Interviews expert designers	4 Observations, dialogue between teachers and students	5 Case studies, questionnaires, perception, self-efficacy and understanding
	Development key elements vocabulary	Test elements in design practice	Test whether teachers address the design process	Test framework in educational practice

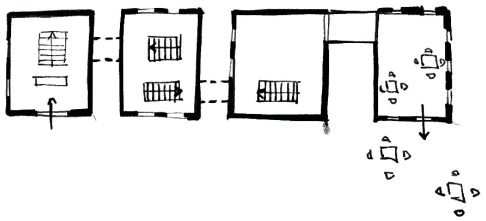


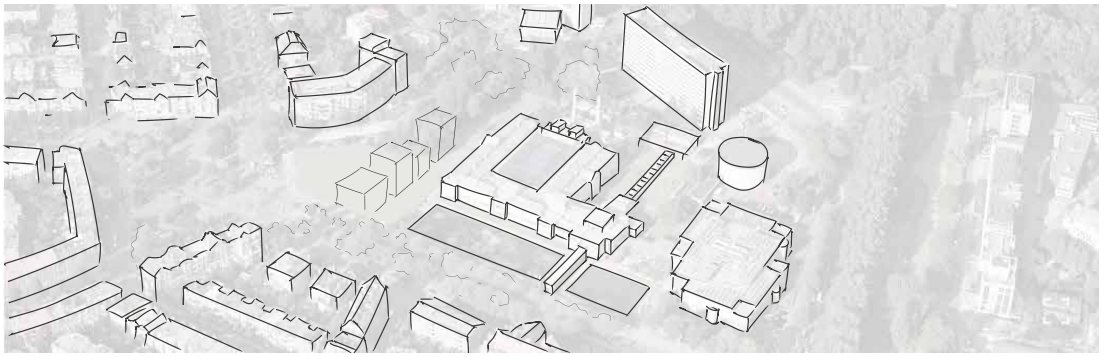












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2 Making explicit in design education: generic elements in the design process

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ABSTRACT

In general, designing is conceived as a complex, personal, creative and open-ended skill. Performing a well-developed skill is mainly an implicit activity. In teaching, however, it is essential to make explicit.

Learning a complex skill like designing is a matter of doing and becoming aware how to do it. For teachers and students therefore, it will be helpful to make the design process explicit.

In this paper, a conceptual framework is developed to be more explicit about the design process. Based on research of the design process, on differences between novices and expert designers, and on personal experience in design education practice, five generic elements in the design process are distinguished:

– experimenting or exploring and deciding;
– guiding theme or qualities;
– domains;
– frame of reference or library;
– laboratory or (visual) language.

These elements are generic in the sense that they are main aspects and always present in the complex, personal, creative and open-ended design process.

KEYWORDS

design process, generic elements, design education, making explicit.

2.1 Introduction

2.1.1 A complex, personal, creative and open-ended skill

In general designing is conceived as a complex, personal, creative and open-ended skill. Dreyfus and Dreyfus (1986) label the design process as 'unstructured'. Lawson (2006) sees it as a 'prescriptive job', creating (some features of) the future. Schön (interviewed by Goldhoorn 1991) points out that designing is complex: it is about different kinds of knowledge, about developing a personal system of preferences, and about using a specific language of sketching and modelling. For experienced designers the process is not split up in separate steps and actions but the process is an undivided whole with automatic, unconscious steps, actions based on common practice or routine, and moments of reflection and exploration.

The question is how teachers can help students learn such a complex, personal, creative and open-ended skill like designing. How they can improve their teaching?

To answer these questions, we need to look deeper into the process of learning and designing. In this paper, in the first place, the importance of making explicit in teaching and learning is discussed, which generates another question: what teachers have to make explicit and what students have to become aware of in learning to design? In this paper, we suppose that spontaneous talk between teachers and students mainly regards the product but that a vocabulary for discussing the process is missing. To help making the design process explicit, a conceptual framework with five generic elements will be presented in this paper. After first defining the starting points and criteria and giving an overview of the framework, it will be worked out in more detail in the second section. In the concluding section it is discussed how teachers and students may benefit from this framework.

2.1.2 Doing & making explicit

Traditionally the 'designerly way of thinking' (Cross 2007) is learned in the studio. Designing is learned in a kind of master-apprentice system, or in educational terms: in a process of learning-by-doing.

In his studies on the architectural studio Schön (1985,1987) pointed out the paradoxical character of design education. He stated that the student "is expected to plunge into the studio, trying from the very outset to do what he does not yet know how to do, in order to get the sort of experience that will help him learn what designing means" (Schön 1985: p.57). For the student this is a confusing situation.

The teacher faces a similar problem. In principle, the teacher is an expert designer. However, in general, performing a skill like designing is largely an implicit activity (Dreyfus & Dreyfus 1986; Lawson 2006; Ryle 2002)). For experienced designers it is often difficult to make explicit what they do and how they do it. Schön (1985, 1987) refers to this as "knowing-in-action", addressing the phenomenon that relevant knowing is only available by doing rather than thinking.

Yet, in the process of learning and teaching a complex skill like designing, making explicit and becoming aware how to do it are essential. In that respect it is similar to learning a sport, which is also a complex skill. Though mainly a matter of doing, the trainer explains and repeats the main principles while the learner is practicing. Dewey (Logister 2005) refers to this as "knowing is supporting to action". Knowing makes us understand the relation between our actions and their consequences. A better understanding of these relations helps the learner to focus better and act more thoughtfully, more intelligently. Especially in unknown and new situations, it is important to use this knowing. Also in the learning cycle of Kolb (1984) doing and making explicit are integrated. Kolb describes learning as meaningful when four phases are included: (1) concrete experience or 'feeling'; sensory perceptions of concrete objects, (2) reflection or 'watching'; observing and thinking, mental experimenting, (3) abstract understanding or 'thinking'; translating experiences in general notions, conceptualising, relating, and (4) active experimenting or 'doing'; physical experimenting. And Reigeluth (1999), in looking over the rich landscape of learning- and instruction theories, sees an overlap and establishes a difference in basic and variable methods. The variable methods are more specific and explain learning and instruction from different points of view. The basic methods are rooted in experience and have been proven effective. They enhance the learning process. Doing, explaining, showing, and providing feedback are basic learning methods in most learning and instruction theories.

Dewey, Kolb and Reigeluth suggest that learning a complex skill like designing is a continuous process of doing and making explicit. It is about acquiring habits and patterns that are mostly implicitly used by an expert designer. As a student you learn by doing and by becoming aware of how to do it. The learning process *arises from* largely implicit knowing and acting, *includes* making explicit and becoming aware, and *results* again in largely implicit knowing and acting (see Figure 2.1).

However, the conclusion that making explicit is essential in the process of teaching and learning, does not answer the question as to what teachers have to make explicit, and what students have to become aware of in learning to design. To answer this question subjects or layers in the dialogue between teacher and student will be distinguished first.

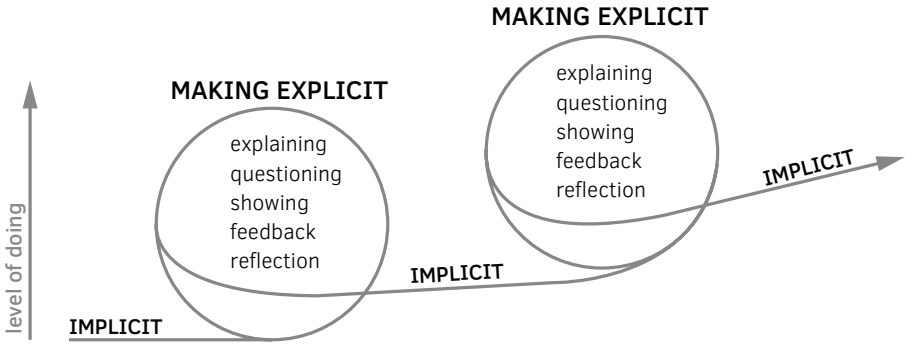

FIG. 2.1 Making the implicit explicit in learning

2.1.3 From product to process; the development of a teaching tool

To help the student in the process of doing, the teacher and the student in a studio have regular talks. In the dialogue between teacher and student, Schön (1985, 1987) distinguishes two levels: in and about the design process. It is an intertwined process of language and meta-language. The language is about doing architecture: the teacher talks about architecture by drawing and explaining. The meta-language is about the process of designing. It describes features of the process demonstrated, and introduces reflection on the design action.

Here, more layers are distinguished and defined: 1) To become experienced designers, students learn by doing, by working on a case study: the *design project* at hand. 2) At the same time, they learn to apply personal and general knowledge, they learn about heuristics, rooted in experience and proven effective rules of thumb in the design field: the *design principles*. 3) Often implicitly, a teacher or student may follow a personal or cultural approach: a *design method*. 4) However, students study to become a designer; they have to learn about the generic elements in designing, going beyond the personal and cultural 'filling in' or expression: the design *process*.

Informal observations of design teachers at work suggest that student-teacher conversations mainly regard the product. Principles and methods are discussed less often, while the process is almost always left implicit.

In a design education course for design teachers[4], we try to make the levels of conversation mentioned above more tangible. The teachers carry out short design exercises, following by a role play (teacher, student and observer) to practice the teacher role.

In the spring of 2012, a group of 12 design teachers was given an assignment to design an easy chair in approximately 15 minutes in a paper / cardboard / wooden sticks model while thinking aloud. A 15 minutes' workshop like this, with thinking aloud during the design process, is a simplified, accelerated and condensed design process. It illustrates many of the characteristics of a more complex design process. Later in this article, we will reflect on the design process observed.

In the present context, the role play - teachers practicing being a teacher, by playing the role of teacher and student - is very telling. Most of the dialogues between role-playing teachers and students were focussed on the design product only. The teachers questioned the students about the chair: Why do you make a 'collapsed' chair? Will this chair be a comfortable chair? For what kind of sitting is your chair meant? Why do you choose a soft material? Could it be another material? Is the material for a surfboard the right material for a chair? Why do you make this particular form?

In the protocol of a teaching conversation published by Schön (1985, 1987), the teacher to seems pay more attention to the design process. Schön concludes that the teacher conducts an experiment at a point where the student got stuck. However, also here, it seems to be more a teacher implicitly showing the process, not making the implicit explicit, not naming and explaining the process of designing. By mentioning notions such as geometry, L shape, broken open, screwy contours,… the teacher explicitly talks and draws about architecture, implicitly showing the process of experimenting, of making a move and exploring the consequences. Schön concludes similarly: the teacher "reflects very little on his own reflection-in-action, and it would be easy for a student or observer to miss the fundamental structure of inquiry which underlies his virtuous performance" (Schön 1983: p.104).

4 Developed and given by Elise van Dooren and Luc Willekens, TU Delft.

In their studies about the design process Lawson & Dorst (2009), in respect to design education, conclude that they immediately 'feel at home' to a considerable extent, when teaching in design departments anywhere in the world. Because the way in which design is learned (and taught) seems to be the same in many fields and in many countries. Design education "relies heavily on project work, appears student-led, takes place in social context and explores and develops individual talent and creativity" (Lawson & Dorst 2009: p.218). Defining major features of the core of design education, the design studio, they conclude that the studio is "the place where things happen, where knowledge can be found and advice given" (Lawson & Dorst 2009: p.226). Knowing integration to be essential in designing, they assume that the studio is so successful because of its integrative quality. At the same time they also question the way in which the studio works pedagogically, especially in respect to the integrative character: "It is somehow assumed that we must set projects demanding integration and that somehow students will achieve it" (Lawson & Dorst 2009: p.234). Students are generally set a series of design projects, progressively more difficult. "However, most design schools still teach relatively little material in terms of the essential and central skills of designing that we have identified here. Students are simply expected to pick these up through a process of learning on the job as it were" (Lawson & Dorst 2009: p.236).

Also Oxman (2001) concludes that traditionally design education is based on the replication of professional task performances and argues that, having developed a considerable body of cognitive design knowledge, it is needed to redefine the educational models from the production of design artefacts to an orientation on designerly thinking. In Oxman (2001: p.273) words: "By contrast to the explicitness of knowledge which must become part of the design educational process, the design studio today is still characterized by the faults of product orientation, creative design as a black box, and the pedagogical distance of the tutor. In all of its institutions there is generally a lack of explicit definition of the requisite knowledge of design, and a neglect of attention to thinking in design as legitimate pedagogical content. Although there may be an integration of design concepts, formal skills and knowledge which are 'learned by practice' in the studio, the explicit learning of the cognitive content of design is ignored and left to be gained implicitly through experience."

These analyses lead to the conclusion that design teachers lack the concepts and vocabulary to make the design process explicit. Therefore, in this paper, a basic framework to make the design process explicit is described, distinguishing five generic elements in the design process. The framework is meant as a tool, which can be used in design education, to make the design process explicit in a more structured and clear way.

2.1.4 Literature

Starting point and foundation for defining generic elements is what researchers have written about the design process. Schön (1985,1987) describes what happens in the design studio, and others like Darke (1979), Lawson (2004, 2006), Cross (2007) and Lawson & Dorst (2009) write about the design process in general.

Apart from substantiating the generic elements in research about the design process, it is important that they are defined from an educational point of view. Therefore literature on differences between novices and expert designers (Eastman, Newstetter & McCracken 2001) was studied.

The research studies about the design process and the differences between novices and expert designers, cover several disciplines. However, it is assumed that the different design disciplines have a lot in common (Cross, 2001).

Rooted in literature and tested in educational practice, the generic elements are chosen and defined in an iterative process.

Before continuing, a remark has to be made. The research in this paper focuses on architectural design, but for reasons of readability, the shorter notions ‘designing’ and ‘design process’ are used. At the same time, the suggestion is made that the generic elements may be useful in different design disciplines. Research on the design process (Cross, 2001) seems to point in that direction. So did discussions on the proposed framework in a design education network (TU Delft), in which several participants from different design disciplines meet regularly.

2.1.5 Requirements

The following requirements for a workable educational framework for the design process were formulated:

In the first place, the elements have to be generic in the sense that they are almost always part of a design process, no matter how personal, complex, open-ended and creative the process is. The framework should describe the characteristic elements in the design process, beyond personal and cultural methods. And, in doing so, it should help in comparing the methods, seeing the similarities and the personal and cultural differences in emphasis and nuances.

In the second place, the generic elements should present a balance between the process followed by expert designers and the aspects students have to learn to become such expert designers. Students lack certain knowledge and skills expert designers have. Training students in those aspects is essential in learning to design.

In the third place the framework has to be clear and easy to remember. It should be a coherent and 'logical' or natural way of describing the design process. Designing being complex, students are often drowned in a chaotic approach to their design work. A clear overview may help students to come to grips with the process. The elements should help in talking about the design process in all its (main) aspects.

Informal observations, literature and the requirements formulated, resulted in the following conceptual framework.

2.1.6 Framework

The conceptual framework consists of the following elements (see Figure 2.2):

- The process of *experimenting or exploring and deciding* is a dialectical process of being open and alert, analyzing and associating, coming up with alternatives on the one hand and finding criteria, testing and evaluating on the other hand. It is a process of diverging and converging.
- In the process of experimenting, one has to come up with an inspiring direction: a *guiding theme or qualities* as something to hold on to during the design process and to help create a coherent and consistent result.
- The process of experimenting and coming up with a guiding theme takes place in different *domains*, or work fields. A designer has to make statements in all these domains. For architectural design these are: space, material, site, function and socio-cultural context.
- The design process is inseparably embedded in a broader context: a f*rame of reference or library*. All knowledge is stored in the environment, in books and, often implicitly, in the designer's mind. The references provide patterns, diagrams, rules of thumb and solutions to be used in the experiments.
- The design process has its own *laboratory*. For architectural design the laboratory consists of a *visual language* of sketching and modelling. The physical counterpart of the mental process is an external, extended memory and tool for reflection.

Designing is an interwoven process: the generic elements are to be distinguished, not separated. The generic elements are not meant as a recipe for the design process. They are general principles or common features, present in one form or another in any design process. The elements emerge in the design process, next to and interwoven with each other. There is no fixed step-by-step sequence, and the emphasis on and the way in which the elements are filled in or 'coloured' differs, depending upon the kind of project, the designer and the design discipline.

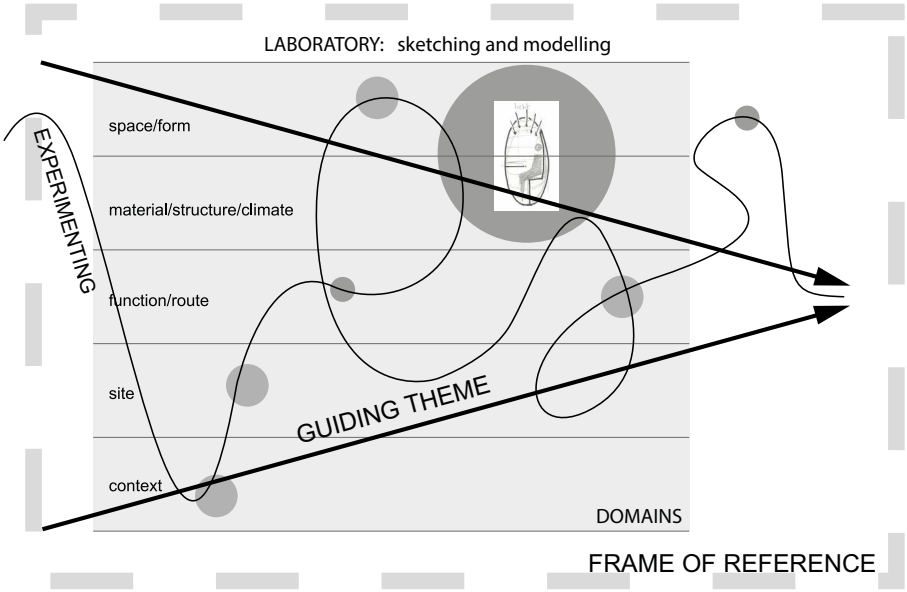

FIG. 2.2 The five generic elements in the design process: experimenting, guiding theme, domains, frame of reference and laboratory.

TOC

2.2 Generic elements

In this section the generic elements will be worked out more in detail, starting by defining each element, including references to research on the design process. After that, the educational aspects will be discussed, including references to research on design education and, finally, the elements will be illustrated with examples from the 15 minutes' 'design a chair' workshop.

2.2.1 Experimenting or exploring and deciding

The design process is a process of thinking in broad outlines and in detail, of doing and reflecting, of intensive work and taking distance, of naming and valuing, of questioning and answering, of diverging and converging, and of seeing what is and what could be there. It is a process of balancing between opening up possibilities, seeing new ways, analysing, discovering alternatives, associating, encircling a subject and abstracting on the one hand and on the other hand reducing possibilities, testing, selecting, evaluating and making decisions. To summarize all these dialectical and often paradoxical actions: designing is first and foremost a process of exploring and deciding, of experimenting (see Figure 2.3).

Designing is conducting experiments and learning about the consequences and implications of these experiments. Schön (1985) describes this process of conducting (small) experiments as 'experimenting' and as 'making a web of moves'. He defines the moves as changes in ideas and representations. The experiments or moves are evaluated and further experiments are conducted. Making moves means creating new problems to be described and solved. And making moves may serve in seeing things in a new way, in constructing new meanings and intentions.

Schön concludes that making a move in a situation may serve, at the same time, as testing a hypothesis, exploring phenomena, and affirming or negating the move. About the decision-making process Schön concludes: "the designer evaluates his moves in a threefold way: in terms of the desirability drawn from the normative design domains, in terms of their conformity to or violation of implications set up by earlier moves, and in terms of his appreciation of the new problems or potentials they have created" (Schön 1985: p.49)

In a way the process of experimenting is a process of questioning or in Schön's words (1985) a 'reflective dialogue' and 'conversation with the situation'. The designer is exploring and testing in experiments or moves with questions like: What if I do this?, What do I have to do to achieve this?, What is happening here?, Do I like this?, Does it fit in with what I want to achieve?, Which criteria are important in this situation?.

Researchers, like Cross and Dorst (Cross, 2001), refer to this process of experimenting as well when they talk about a co-evolution of solution and problem spaces. They conclude that, for designers, the evaluation of the solution is more important than the analysis of the problem. Relatively early in the process the designer's attention shifts to possible solutions. Simultaneously with the exploring of data and features, the designer explores ideas and directions to solve the problem. Analysis and synthesis occur simultaneously.

Another perspective from which to look at the process of experimenting, is the process of creativity, of intensive work and taking distance. Poincaré (Boden, 1990; Csikszentmihalyi 1996) distinguished four characteristic stages in creative processes: (1) preparation, a period of intensive work and studying, of consciously searching for an answer, (2) incubation, a period of taking distance, of working in the unconscious, (3) illumination, a moment of seeing the light, the 'eureka' and (4) verification or evaluation, a period of elaboration, conscious work, testing the new conceptual ideas. Lawson (2006) ascertains that being creative is not a matter of being novel and different. It is a matter of generating and testing alternatives, of transforming ideas, of using parallel lines of thought, and of accepting 'incomplete and possibly conflicting ideas coexisting, without attempting to resolve them too early in the process'.

For students it is important to learn about the experimental character of designing: designing is about conducting experiments in an open and at the same time focused way. They may have all kind of misconceptions about the design process, such as being creative in a mystical sense or coming up with something logical based on a lot of analysed facts. They also often think they have to come up with 'perfect' solutions, solving all aspects and problems at once. They have to learn to be open and to consider designing as a step-by-step exploration, as experimenting, as a process of trial-and-error, of 'making mistakes' and learning from them.

In general, students work in a more linear way and are focused on one solution. Newstetter & McCracken (2001) observed among other characterizations of typical student behaviour, that students tend to stop considering alternatives, once they have an idea, and that students act as though designing is a linear, not an iterative process.

Also Atman & Turns (2001) found that students might get stuck in scoping out the problem and spending much time (or too much uninterrupted time) in modelling a single solution.

Expert designers have more sophisticated skills in their exploration and in gathering and structuring information. They frame or perceive problems in terms of relevant solutions. In an overview of different research studies, Cross (2001) concludes that experts, being more experienced, have a better feeling for distinguishing relevant and irrelevant information. Their decision-making is based on more considerations. Students may become stuck in gathering lots of information, without moving on in the process of experimenting and testing of ideas. Experts move more rapidly to potential solutions and use these as a means to further explore and understand the problem.

For example a student is exploring a more or less chaotic site with different building masses and a park, to come up with a building 'fitting in with the context'. He analyses all building masses in the site, hoping this will logically lead to a fitting building mass. An expert designer, in this case the teacher, demonstrates the trial-and-error approach: putting a building mass in the site and testing what it brings about.

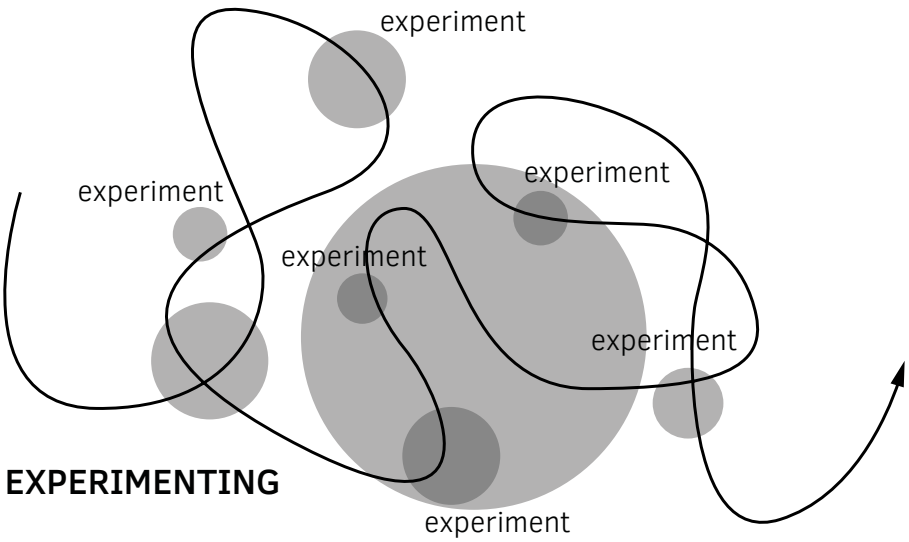

FIG. 2.3 Designing is experimenting: a process of exploring and deciding, of trial-and-error.

In the 15 minutes' 'design a chair' workshop, at the outset, a process of experimenting or exploring and deciding started. Even in the short time available, the process consists of a series of small experiments. Often implicit, sometimes explicit, it looks like a process of questioning and answering. What if I do this? What do I want to achieve?

A designer who connected an easy chair to meditating, followed a train of thought like: 'For meditating a quiet, minimalistic space is needed.' / 'A concrete block will do, in an enclosed, small garden with stones, some plants and a tree.' / 'Some wood will be there as well, for: 'my partner doesn't like all the concrete and stone'.'

One of the designers asked himself: (1) 'is lying in the grass comfortable?' (2) 'what makes lying in the grass uncomfortable?' (3) 'what can we do to make lying in the grass (more) comfortable? and came up with the idea to make some kind of shape in the grass.

The interpretation of lounging as 'finding your way', sitting in a flexible, springy shape, led to the following train of thought: (1) 'So, it has to be a large, soft, massive volume, to use in all kinds of shapes. (2) 'However, I cannot make that in paper, so how can I produce something like it?' (3) 'I have to make a bended shape, on top of a resilient, zigzagging structure.' Then, in the process of making it, the designer concluded that it would be much better to integrate the resilient structure in the vaulted shape; he was very satisfied with the result. He now saw an open volume, soft on top, with a metal sheet inside. So a transformation took place from a massive to an open form, caused by the fact that making the chair in this particular situation was a difficult thing to do. This shows that, to a certain extent, designers may find themselves taken by surprise in the situation at hand.

Another designer made a transformation like that. She started with an egg shape as a protected seat for children. She struggled with the modelling material, and therefore came up with a more open shape, more like a flower with leaves. She liked it, because the enclosed feeling still remained, but at the same time more openness was achieved.

2.2.2 Guiding theme or qualities

Designing is exploring and deciding within a potentially endless number of possibilities, to come up, in the end, with an internally coherent whole. To be able to create a coherent whole, a designer needs an inspiring direction or order. Using a guiding theme or qualities not only gives the design its character and identity in

the complex and open design process, it also helps in making choices (see Figure 2.4). The guiding theme is the way in which the designer sees or frames the design situation at hand. Designing is a process of naming and framing, of attending to matters and of making a context to work with them.

Different researchers and designers name and describe the guiding theme in their own way. A colleague of the authors and very experienced design teacher, Robert Nottrot[5], asks students what 'qualities' they want to achieve. Schön (1985, 1987) describes designing as 'a situation of complexity and uncertainty which demands the imposition of an order' and as 'experimenting with a hypothesis'. He also writes about 'constructing an order', 'giving meaning' and 'naming and framing'. Darke (1979) calls it a 'primary generator', a 'relatively simple idea', a ground for making choices and for analyzing what the important aspects in the design are. According to Lawson (2006) working with two or more 'primary generators' is characteristic for the design process. Bielefeld & El Khouli conclude: "Every design begins with a search for an idea or for an intuitive understanding of how an assignment should be solved. This idea is the start of a long journey on which the designer defines the idea more precisely, modifies it, adds details and repeatedly rejects results" (2007: p.7). Other phrases used are: organizing principle, parti, statement, pattern, paradigm, concept, conceptual drive, leitmotiv and guideline.

All the different phrases for what we call the guiding theme illustrate that the character of a guiding theme may vary. The guiding theme may be a quality, an image, a meaning, a material fascination, a functional theme or a kind of 'form language'. In fact different 'variations' often come together in the guiding theme. It would be better to describe the guiding theme as a sequence, a 'train of thoughts', developing in time. For example: it may start with a meaning or quality, vague and abstract, and then gradually transforms into a more concrete, still open and multiple 'form language' to fill in. However, it can also take place in reverse order: starting with concrete facts or ideas about form, material or function, a meaning or quality is found and translated into other aspects. Lawson and Dorst write about the evolution of a solution: "The initial ideas can be seen as the first primitive objects, evolving and becoming more subtly tuned to the design problem over the generations" (2009: p.36).

Working with a guiding theme may be schematised as the process of exploring to come up with one or some qualities and then exploring those qualities, transforming

5 Personal communication

them in architectural means. In the fractal-like process of testing solutions, in the creative process of intensive work and taking distance, an overall guiding theme often seems to emerge; one or a few qualities occur as the main character of the design. The selection of proper, relevant or 'design problem fitting' guiding themes or qualities is subjective, but also based on cultural judgment. It is based on experience, on being part of and having in mind a 'designerly frame of references and inspirations', and on the choice of what is liked or seen as adequate in the particular context. Often the choice is determined by the situation at hand, the design task or problem. It may, however, also be a theme in which a designer has been interested for some time. Lawson (1994) refers to these themes as designers bringing their own intellectual programme with them into each project. Sometimes these programmes are result of a lifetime of study and development. They provide in a series of 'guiding principles'.

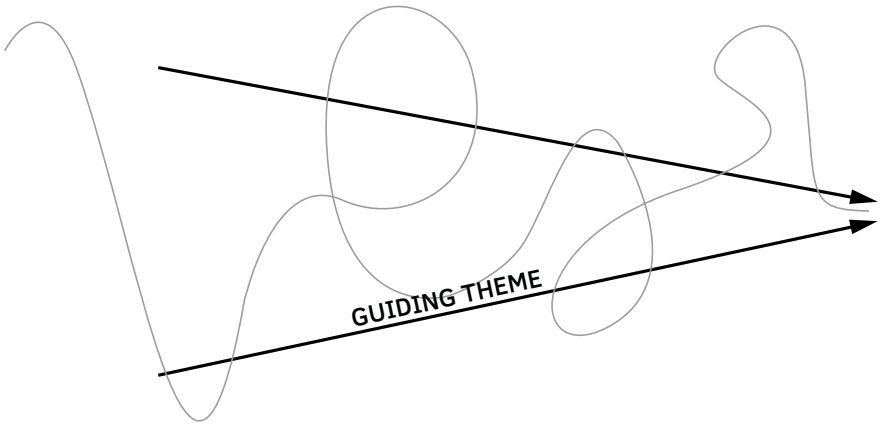

FIG. 2.4 Designing is developing a guiding theme: discovering qualities or imposing an order.

Students have to be trained not only in developing guiding themes, but also in really using them during the process. Moreover they have to study and experience different kinds of guiding themes, learn about their relevance and discover their personal fascination when choosing guiding themes.

In an overview, Cross (2001) refers to different studies showing that expert designers use guiding themes more intensively. They explore the guiding themes or concepts more rigorously and profoundly than starting designers. And because they are more experienced, they choose a relevant analogy more easily.

Newstetter & McCracken (2001) observed that students believe that proper designing is coming up with good ideas. Yet, expert designers are always concerned with the feasibility of ideas and they evaluate ideas based on informed decision-making analysis.

In the end the guiding theme is often recognizable in the character of a design result. Examples are the lack of perspective of the Jews in World War II in the Jewish museum in Berlin by Libeskind, the uplifted landscape in the university library in Delft by Mecanoo, the geometric harmony in the museum of arts and crafts in Frankfurt by Richard Meijer and the human eye in the arts and science center in Valencia by Calatrava. Examples in the discipline of industrial design are the user friendliness in the Apple products and the 'come back' of the unique handcrafted product in the industrial production of series in the work of Hella Jongerius.

Early in the process of the 15 minutes' 'design a chair' workshop, the designers came up with a guiding theme or quality. A process of transformation or a 'train of thoughts' was started. In a process of reflecting about a 'good' easy chair and their own ideas about an easy chair, the participants came up with an association, a statement, an image or an idea.

One designer took 'easy chair' literally: she came up with the idea of a chair in an 'easy' posture. To another, an easy chair meant meditating. And a third designer saw sitting as a verb, so his chair would challenge the user to move. In this design task, no site was defined. However, designers in architecture often connect an assignment to a site and / or some specific use. Some designers did associate lounging or being idle with sitting or lying in the grass, in the sun or under a tree, together with someone else or alone with a glass of wine and a book. There was also a designer who connected the design of the chair with his home, which is situated in a barn and therefore has large, open spaces. The chair needed to offer the family members a protected place to sit in, in the openness of the large room.

2.2.3 Domains

The act of designing, of experimenting with a guiding theme, takes place in a work field, in the real world of shape and material, gravity and use; a designer works with physical elements. Putting it another way: the act of designing takes place within and across domains. To think and communicate about the concrete world, we use words, we categorise it. Schön (1987) calls these categories in architectural design, domains. "These domains contain the names of elements, features, relations and actions and of norms used to evaluate problems, consequences and implications" (Schön 1987: p.58).

Depending on the design discipline, the domains differ. For architecture, Schön (1985) distinguishes relatively many (twelve) domains., They vary from program and site, building elements and organisation of space, to scale, costs, precedent and representation. By giving a general definition for architectural design here, an effort is made to give the domains the character of an overview and develop a common-sense and therefore relatively easy-to-remember order. 'Architectural design is about creating space and using material. The space is meant for use by a defined target group and is situated within a defined site and a socio-cultural context.' In line with this working definition, five main domains can be distinguished: (1) form and space, (2) material (3) function, (4) physical context, and (5) social, cultural, historical and philosophical context (see Figure 2.5). In the different domains many aspects, such as composition, light, texture, climate and movement come together.

In the design process a lot of information in the different domains is involved. Experiments or moves are made in all domains and implications of moves are found in all domains. Schön & Wiggins (1992: p.143) conclude: "a move informed by an intention, formulated within one domain, has consequences in all other domains. Because of our limited information processing capacity, we cannot, in advance of making a particular move, consider all the consequences and qualities we may eventually consider relevant to the situation." Designers have to deal with all this information. Lawson quotes Michael Wilford, who compares this complex work of a designer with a "juggler, who's got six balls in the air… and an architect is similarly operating on at least six fronts simultaneously and if you take your eye off one of them and drop it, you're in trouble." He concludes: "The only way to keep them all in mind at once, as it were, is to oscillate very quickly between them like a juggler" (Lawson 2006: p.151).

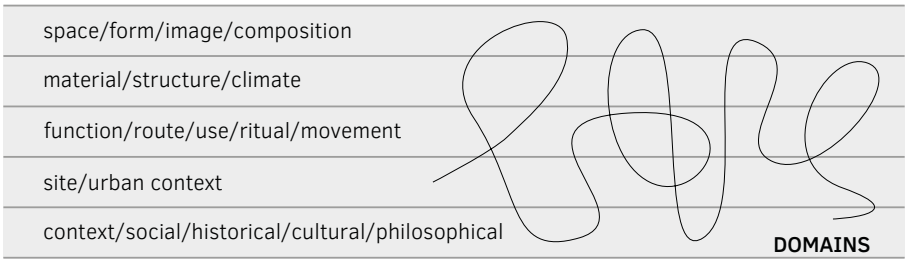

FIG. 2.5 Oscillating like a juggler, a designer has to make decisions in a lot of domains.

Students have to be trained in oscillating across the domains and in seeing relations between all aspects. Students tend to solve and finish the domains one by one, they often work in a linear sequence. Most expert designers make more transitions,

they move more frequently across domains, cycling back and forth. An experienced designer seems to work simultaneously in several domains, the designer moves a lot across the domains. Cross (2001) concludes from several studies that expert designers and more successful students work across different domains. Especially during creative periods, these designers rapidly alternate the focus of their attention between different aspects or between different modes of activity.

An example of working within and across domains is designing the structural part in a building. Besides the aspects of stability and strength, aspects of availability and sustainability of material play a role and the structure often has an important relation to and influence on the spatial and functional order and routing. Students have to learn to see all aspects and relations and get an overview of all different aspects by experimenting across the domains, to be able to come up with integral decisions.

In the 'design a chair' workshop, even in the relatively short time of 15 minutes, different domains were overviewed: form, function, material and site. Often designers started with an idea (or guiding theme) about sitting, lounging and the meaning of an easy chair, varying from a movable 'garden chair', to a place to meditate. These ideas were then developed into more real shapes and material. Also the functional aspects, such as sitting comfortably, became more real. A designer asked himself: 'what circumstances make sitting outside a relaxing experience?' To come up with a good design solution he concluded: 'you want to be able to sit in different places, dependent on the weather and other circumstances like sitting alone or in a group, so, the chair has to be light and easy to move'. He then explored the material needed: 'What material is light?' 'Of course wood is light, but probably the material surfboards are made of will be better.' In a parallel line of thought he added some requirements: 'Besides having a movable easy chair, you need some kind of table or 'tool' to put a glass of wine and a book on.' The designer coming up with the grass shape immediately concluded that he should ask a gardener how to make that shape.

Often, in an idea several domains are already included. The literally easy chair refers to an archetypical chair of wood and covering. The idea of a protected space refers to soft and warm material around you: the designer, making the enclosed, protected space in the large open area in the barn house, came up with a round object, hanging in the space, made of soft, warm material. On the other hand, it may also happen that studying one of the domains leads to unexpected insights. The designer, who wanted to make a flexible, springy shape, started with a massive flexible form and ended with an open zigzag form, caused by the fact that making the chair in this particular situation was not feasible.

2.2.4 A frame of reference or library

The act of designing takes place in a professional culture, in the context of the design tradition. Designers talk, sketch and think in patterns, in what is often called 'precedents' or 'references' (see Figure 2.6). Cross (2007) points out that the knowledge designers are using, is embedded in the artificial world. The collected knowledge is analysed and stored in images and diagrams. Designers build up a library or frame of reference, for use during the design process, within which the examples are used, tested in the situation at hand, rejected, transformed, and so on. Having a repertoire of patterns, they recognize or see certain elements as variants of experiences stored in their unconsciousness. Schön (1985) concludes that the designer has a repertoire of particular situations. These exemplars and images enable a designer to see a new situation, to a certain extend by constructing variations on familiar themes.

Chess players, as shown in research by De Groot (Lawson & Dorst 2009), seem to recognize, rather than analyse a situation. Playing against amateurs, they win the game, by using patterns. However, playing against opponents of the same level, they have to come up with something new, original and surprising. Lawson & Dorst conclude that we see expert designers do the same; they do not just solve problems, but add something new to the pool of precedents designers use.

This process of using and transforming is also illustrated by the different types of creativity Boden (1990) distinguishes: (1) making unfamiliar combinations of familiar ideas; generating, deliberately or unconsciously, poetic imagery, collages, analogies or associations. It requires a rich store of knowledge in the designer's mind and the capability of moving around with it in many different ways. (2) Exploring conceptual spaces; coming up with a new idea within a thinking style, within a culture. It is about seeing possibilities not noticed before, seeing the potential and pushing back frontiers in this thinking style. And (3) transforming the space; while exploring a structured conceptual space or thinking style, a new conceptual space emerges in your mind, which you could not have thought of before. It radically transforms the pre-existing style. Kneller (as cited in Lawson 2006, p.157) formulates it this way: "One of the paradoxes of creativity is that, in order to think originally, we must familiarize ourselves with the ideas of others… these ideas can then form a springboard from which the creator's ideas can be launched."

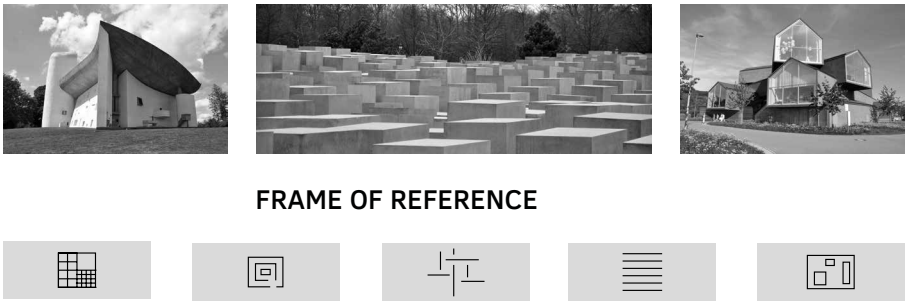

FIG. 2.6 Designing takes place in a professional culture, a frame of references. (photographs by R. Maleki).

Students do not only have to study all kinds of references, but they also have to learn (how) to work with them in their own design process.

In an overview of different studies, Cross (2001) concludes that expert designers frame or perceive problems in terms of relevant conjectures: they work with known, and previously applied patterns.

For example: Toyo Ito works in his Mediatheque with open floors, to achieve a fluent and flexible space. This pattern is also used by Le Corbusier in the Domino house and other architects such as Herzog and the Meuron and MVRDV. In these examples the structure varies from concrete columns to open compound steel columns. And somewhere a new pattern emerges; an architect discovers that bending and curving the floors connects these horizontal open spaces with each other much more fluently, creating a more vertical perception.

In the 15 minutes' workshop, one designer associated the easy chair literally with a chair in an easy posture. She came up with an archetypical chair, yet, on a lazy or collapsed base.

Also other references were used: the designer who designed a place for meditating used ideas of minimalistic spaces and Zen gardens for meditation.

Most designers admitted afterwards that, though not having mentioned it during the design process, they did have an image of a chair in mind. It was either a vague general or 'combined' idea, or a specific chair.

2.2.5 Laboratory or (visual) language

Engineers have laboratories for experimenting. Designers have their own laboratory for the process of experimenting: the language of images. Apart from its function in presenting a design result, the visual language of sketching and modelling is a way of thinking out loud during the design process. Through the sketching and modelling, the design process unfolds (see Figure 2.7).

The process of modelling and sketching runs parallel to the process of using words. Both languages capture meaning and are, to a certain extent, vague. They can express different meanings, which is an important feature in the open and creative design process.

Sketches and models are used as a way of reflective thinking, of understanding, analysing and experimenting. They function as a visual way of making solutions explicit in order to understand them. In sketches and models, elements are analysed by reducing and simplifying them. Designers "externalize some features of the design situation in order to examine them in a more focused way", to "stand back and look at them" (Lawson 2004: p.46). In the process of sketching and modelling, the designer becomes aware of the implications of a choice. Sketching and modelling are processes of making choices, formulating, reformulating, and evaluating. In the process of experimenting, or 'web of moves', Schön (1985) describes the moves as changes in ideas and representations (configurations, sketches and words) and the implications of a move as traces of a drawing or model in the virtual world. While sketching and modelling, the designer explores the problem and possible solutions.

Expressing thoughts in the sketch and model, the designer also discovers new insights and new ideas. Often the processes of making explicit and expressing on paper or in a model brings about discoveries; the thought appears to be different when it becomes concrete in a sketch or model. The designer wonders what is happening. Seeing unexpected things happen, the designer starts reframing the situation at hand.

In the design process, designers also sketch to develop and capture what could be there. What Fraser and Henmi (Lawson, 2004) call visionary drawings are speculative drawings. They are often considered to be art. They have the intention "to express wonderful or fantastic qualities. These drawings are not used to test an idea, but rather to let it flourish and develop so they are usually 'uncritical'."

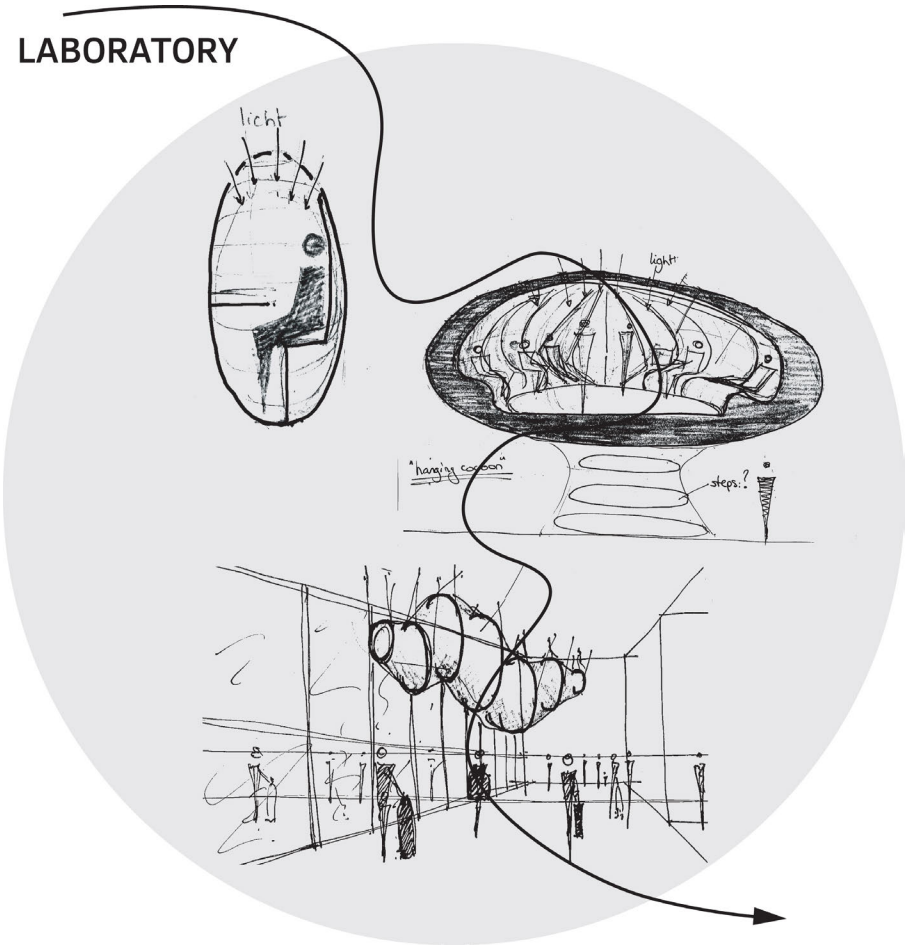

FIG. 2.7 The visual language of sketching and modelling functions as a laboratory for experimenting, it is a kind of physical thinking. (sketches by R. Maleki, Designing an Abri).

Our conscious memory has a limited capacity. The sketches and models function as an external and extended memory, needed in a complex and interwoven process with all kinds of (provisional) decisions and implications. Pallasmaa sees the unity of mind and body as an important factor in craftsmanship and artistic work: “The knowledge and skills of traditional societies reside directly in the senses and muscles, in the knowing and intelligent hands, and are directly embedded and encoded in the settings and situations of life” (Pallasmaa 2009: p.015). During the last few decades the idea of human consciousness as an embodied consciousness has been developing. Lakoff and Johnson (Anderson 2003) showed that our concepts of space

– up, down, forward, back, on, in – are deeply tied to our bodily orientation to, and our physical movement in, the world. Gallese and Rizzolatti (Keysers 2012) showed that on a neural level there is a direct relation between what we see and what we do: the same neurons participate in both – previously thought separate - senses. Sketching and modelling seem to be more than an external memory and scale model of reality: they are embodied cognition.

For students learning to design, it is important to understand the role of sketching and modelling. Especially when they start, they consider designing as thinking, an act in the mind, and as coming up with a solution. Sketching and modelling, in their view, are meant for presenting the result. However, sketches and models function as a laboratory; they are the (three dimensional) tryouts during which the process of experimenting, of exploring and deciding takes place. Especially the three-dimensional character of sketches (perspectives) and models and the process of abstracting in diagrams have to be trained by frequent doing, during the design process.

In the 'design a chair' workshop, the designers had to come up with a small paper / cardboard / wooden sticks model in the end. Yet, even in the short time of 15 minutes, some designers started with sketching. Other designers worked with the model, changing it in the process of experimenting. And some of them managed to make a set of a few small work models. They conduct their experiments with the help of sketches and models, or to put it in other words: in making the sketches and models they were answering their questions and testing their ideas.

2.3 Conclusion and Discussion

2.3.1 Making explicit the design process

In this article we departed from the observation that, in the studio designing is learned in a process of learning-by-doing and that teachers mostly talk about the design product. Students may learn a lot from this approach. However, students who want to become designers have to learn about the process of designing. Therefore, the design process should also be part of the discussion. It means that the teacher

should not only address the product, but also talk explicitly about the process, in order to teach the student the ‘designerly’ way of thinking.

Paying attention to the design process means talking about or questioning within the scope of the generic elements. What kind of experiments did you do? What are the implications, advantages and disadvantages of each alternative? Are the shape and the material you use in line with the guiding theme you want to achieve? Are there more alternatives to express this quality? Did you sketch perspectives? What references may be useful for the guiding theme and for the architectural means, needed to express the guiding theme?

2.3.2 Construction

The framework of the five generic elements seems to be a pragmatic and workable description of the design process. The elements describe, in very general terms, how expert designers work to come up with a design. They describe, in broad outline, the essential aspects of the design process. Being a scheme or construction, the framework may help in structuring and restructuring all the interwoven actions and aspects in the design process during the teaching and learning process. However, they certainly do not form a framework, which guarantees a (good) design outcome as long as you follow the rules.

The framework is a construction, an abstraction of the rich and differentiated design process. The generic elements offer a tool for making the design process explicit in a more systematic and structured way, without losing the open, creative and personal character of the design process. Reality is much richer and more differentiated. With formulating the generic elements, a process of exploring and explicating the richness and differentiation may be started.

Learning a complex skill is a matter of doing and becoming aware of what has to be done: it is a cyclical process of doing, experimenting, reflecting and understanding. The framework helps in becoming aware, in reflecting and understanding.

2.3.3 Perspective

It is hoped that explicitly knowing the broad outline of the design process and working explicitly with the generic elements in the design process, will lead to more understanding, for students and teachers alike. It should help design students to act more thoughtfully and be more focused.

For teachers, it would mean that they might educate the students in the design process in a more focused and structured way. Focusing on the generic elements, may lead to a better understanding of what students have to be trained in, where students get stuck and where the focus of attention should be in education. It may help train the total design skill and all different sub skills within a design course and it may help structure the curriculum.

For students, being more explicit in the design process may be helpful in the overall confusing learning process. To a certain extent, the framework may help in distinguishing and comparing the different approaches and methods expert designers use. Being more consciously aware of what designing is about, a student may get to grips with the 'open, personal, complex and creative' more easily. This may make her or him more independent in the design process.

The intertwined process of defining the generic elements by literature research, experimenting with them and further developing them in practice, will be continued. More detailed research will be conducted. The results will be subject of further research studies.


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3 Architectural design education: in varietate unitas

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ABSTRACT A fascinating and rich landscape of personal views and approaches can be seen in architectural design and in architectural design education. This variation may be confusing for students. This paper focuses on the question: is the framework of generic elements that we developed for explicating the design process helpful to compare the differences in architectural design approaches? The results of interviewing a variety of 15 architectural, urban and landscape designers show all kinds of personal approaches that have a set of five underlying generic elements in common. Therefore, the framework may be helpful for teachers and students to describe these personal approaches and may help students in understanding differences and similarities and in finding out what their own personal approach may be.

KEYWORDS design process, design education, design strategy, design methods, architectural design.

3.1 Introduction

Architecture students are confronted with a lot of different design views and approaches. Hector Guimard used the shapes of flowers in his designs for entrances to the metro stations in Paris. Eero Saarinen shaped the terminal for JFK International airport New York like a bird ready to fly away.

Berlage, Le Corbusier and Richard Meijer worked with proportional systems and geometrical grids. Wassily Kandinsky, Paul Klee and Steven Holl translated musical compositions and sounds into visual, spatial and architectural configurations. Rem Koolhaas used montage to combine programmatic elements and quoted other architects in his work. Coop Himmelb(l)au created a formal configuration based on an explosive-like sketch, drawn with eyes closed. Aldo Rossi used meaningful spatial types. Venturi deliberately designed a composition with contradictory typologies. Hassan Fathy applied ancient construction methods in Egypt such as adobe. He also used traditional courtyards to provide passive cooling. Together reveal these examples (Jormakka, 2008) a fascinating and rich landscape of design products and design approaches. In the words of Lawson and Dorst: “Designers all have their own unique backgrounds and collections of skills, attitudes, values and interests. Designers work on their own set of problems and circumstances” (2009, p.18).

The same rich differentiation is recognised by Schön in architectural education: “practitioners have tended themselves with a bewildering array of contending schools, each of which has a claim to architecture” (1983, p.78). He ascertains that for a student this is confusing: “Should we take them as competing definitions of the field, which entail very different concepts of professional knowledge and practice? Or as stylistic variations of a design process that is essentially the same for all schools?” (1983, p.78).

How can teachers help students in this confusing array of personal design approaches?

There are different aspects related to this question. It might help when teachers of architecture (read designers) make their design approach explicit to students and, moreover, when they could compare their design approach to that of others. For comparing the different personal design approaches, it might help to make communication clear when there is some kind of conceptual framework or vocabulary describing an underlying generic process.

Schön (1983) answers his own question by considering the design process a generic process, describing it as a reflective conversation underlying the variety of architecture schools. Also others (Cross, 2001, 2007; Darke, 1979; Lawson, 1994, 2006; Lawson & Dorst, 2009) ascertain that beyond all personal differences and approaches there are underlying elements in the design process, which are essentially the same for all designers. Based on these underlying generalities, specific for the context of architectural design education, a framework has been developed with generic elements for making the design process explicit (Van Dooren et al., 2014). Knowing by experience that expert designers (read teachers) are not used to making the design process explicit, the framework is meant for students and teachers in architecture to talk about the complex, personal, open-ended and creative design process and to give insight in the basic design activities.

The main aim of this paper is to explore whether this framework is suitable to characterise the differences between architectural designers – and consequently between teachers. Is the framework a useable tool for understanding and positioning the differences in architectural design approaches by recognizing them as personal views and expressions of generic underlying basic design elements?

To explore the feasibility of the framework in respect to making personal differences visible in relation to underlying generalities, expert designers were interviewed about their design approaches.

First the framework will be placed in the context of architectural and educational methods and approaches. Then the framework will be explained and the main research question and sub questions will be defined. In addition, information will be given about the research method. In the following section the results of the interviews are presented i.e. the personal architectural design approaches in relation to the framework of the generic elements. In the final section conclusions are drawn and the way teachers and students may benefit from the framework is discussed.

3.1.1 Context

Central in all architectural design education is the studio: students learn-by-doing, by practicing design tasks. The studio is mostly accompanied by additional courses about all kind of subjects, such as historical, compositional and technical knowledge. However, as mentioned earlier: a rich differentiation in architectural design education models can be seen. Three main perspectives or directions may be distinguished.

1. architectural vision

Architectural design education has traditionally been grounded (for almost three centuries) in an intuitive vision or idea of what architecture should be. It started with the Ecole des Beaux Arts and includes famous examples as the Ecole Polytechnique and the Bauhaus. Being professional designers, teachers come up with design assignments in the studio and a wide variety of knowledge in courses, based on the ideas they have about architecture and on how they themselves learned designing. Being designers, their focus is on the architectural content. In fact, education takes place on the level of the architectural debate. It is concerned with the cultural or personal view on 'good architecture'. As a result, these educational models and ways of tutoring take position in architecture, mostly in an implicit way.

2. scientific and cognitive point of view

Inspired by the successes in scientific disciplines, there has been (for roughly half a century) discussion, at least on a theoretical level, about the role of scientific knowledge in relation to architecture and more in particular in relation to the design process. The still ongoing debate can be summarised along two main streams, which Schön (1983) characterised as *rational technology*, related to a positivistic, objective science concept and *reflective practice*, related to a 'constructivist' world view. According to Hillier, Musgrove and O'Sullivan (1972), in the case of rational problem solving the design process proceeds by analysis and synthesis: scientific knowledge and rules should decrease the designer's reliance on intuition and rules of thumb and design methods must be systematised. In the case of reflective practice the design process proceeds by conjecture and analysis. Design problems are pre-structured by constraints and the designer's own cognitive map.

3. educational point of view

With the developments in educational science, the input from this science in architectural education has increased (for roughly the last decennia). In particular notions such as learning goals, assessment criteria, and curriculum design were used to help teachers (being professional designers) in making the design education more clearly structured and help students to understand what they should learn. Examples of general and concrete learning goals are the ability to create a design, the ability to acquire necessary information, the ability to weigh aspects, the ability to determine, structure and relate use and space, the ability to apply technical knowledge and the ability to choose and formulate criteria.

All architecture and design education models remain on the level of the architectural debate and on the level of discussions on the design product. In our opinion (Van Dooren et al., 2014), to reduce the resulting confusion a generic conceptual vocabulary might help.

Before giving a short overview of the framework or vocabulary of the five generic elements, two remarks have to be made. First, the framework is specifically meant for use in design education as a generic underlying vocabulary of the architectural design process. This means that it should be usable in all kinds of situations, such as working as an individual designer or designing in a team. Second, the research in this paper focuses on architectural design, including urban and landscape design, but for reasons of readability, regularly the shorter notions 'designing' and 'design process' are used. Although the focus is on architectural design, at the same time, research on the design process (Cross, 2001) and discussions in an interdisciplinary design education network (TU Delft) point out that the framework may be useful in other design disciplines as well.

3.1.2 Framework

The framework consists of five generic elements (see Figure 3.1).

- The design process is a process of *experimenting*, a fractal-like process of coming up with, testing and evaluating hypotheses, or a process of exploring and decision making by activities such as collecting information, analysing, abstracting, associating, comparing, evaluating, and taking distance. Designers present provisional solutions, they study all kinds of aspects in different options and they propose alternatives to compare what "fits best". After each trial, they reflect on intended and unintended consequences, in order to come up with new proposals.

- In the process of experimenting a designer needs a focus, an inspiring direction, a *guiding theme or qualities*, something to hold on to in an almost endless field of possibilities and to give character and coherence to the design. Coming up with a guiding theme, may happen at the start or later on in the process of experimenting. Usually it happens in steps, in a "train of thought".

- Designers experiment and come up with their guiding theme within and across *all levels of scale and meaning or domains*. For architecture five domains are defined: (a) space and composition, (b) material, climate and structure, (c) function and movement, (d) site, and (e) socio-cultural, historical, philosophical context.

Designers come up with statements and make choices in all these domains, and within these domains they have to deal with a lot of criteria and information: such as government rules, personal preferences, client's wishes, "universal" laws, and cultural habits.

— The process of experimenting and working with a guiding theme takes place in and with the help of *a broader context, a frame of references or library*. The knowledge about architectural designing is stored in the built environment and in theory. Designers build up a library, for unconscious and conscious use during the design process. In all domains, the knowledge is in the form of rules of thumb and in principles and patterns used, tested in the situation at hand, rejected, transformed, and so on.

— A *laboratory* is needed for experimenting. The *"designerly language" of sketching and modelling* functions as an extended working memory. By making visual and explicit, the process of "designerly" thinking, of making choices, formulating, reformulating, evaluating, exploring possibilities and discovering new insights, unfolds.

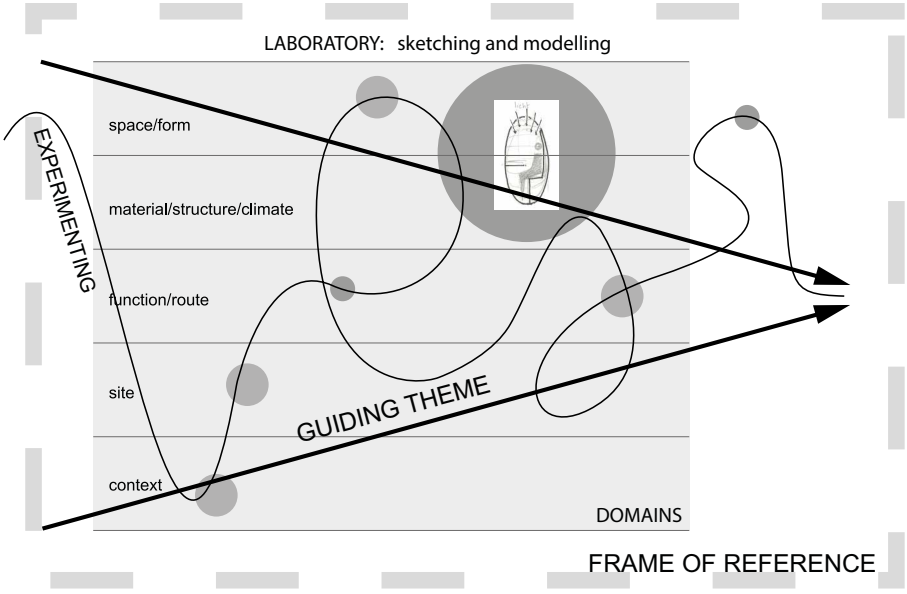

FIG. 3.1 The five generic elements in the design process: (1) experimenting, (2) guiding theme, (3) domains, (4) frame of reference and (5) laboratory (Van Dooren et al., 2014).

TOC

This paper focuses on the question: Do the generic elements form a helpful framework to compare the different architectural design approaches in relation to an underlying design process? To answer the key question four sub questions are to be answered: (1) Do professional designers recognize the generic elements in their design process and if so, which notions do they use? (2) How do they describe and interpret the elements; which features do they point out? (3) What are personal differences in each element? (4) Do they have comments on the framework as a whole?

3.2 Method: designers interviewed

The main criterion, applied in the selection of participants, was to form a group of interviewees that represent a wide variety of personal "designerly" approaches. Therefore, participants were selected because of the different content of their design work, which in some cases led to publication and discussion. Other aspects in the selection such as the extent of their involvement in different educational institutes and their different educational backgrounds (see Table 3.1) also played a role. The group includes both unknown and known designers. They were born between 1948 and 1970, mostly in the Netherlands, except for two, who were born in Italy and Portugal. The designers interviewed are architects (n = 11), urban designers (n = 2) and landscape architects (n = 2). The interviewees all work in the design practice. Many worked in different offices and they all had their own office at the time of the interview.

The interviews were semi-structured. To decrease the risk of prejudice, the focus was on the designers' stories. The elements were used as starting points for talking about the personal design process. For each element the main question was: "Do you recognize and can you tell about this element in your approach?"

Other questions arose in the context of the designer's story, to stimulate further clarification of particular aspects and to encourage further talking, all with an open mind to critique on the framework.

TABLE 3.1 Education and involvement in education per interviewee.

Designer	Education	tutor / lecturer
1	Faculty of Architecture Porto & Faculty of Architecture TU Delft	University Montevideo, Porto, TU Delft, ArtEZ in Arnhem and Zwolle, Academy of Architecture Amsterdam, Rotterdam & Groningen
2	Academy of Architecture Groningen	Academy of Architecture Groningen, TU Delft Faculty of Architecture
3	Faculty of Architecture TU Eindhoven	TU Delft Faculty of Architecture
4	Politecnico di Milano, Faculty of Architecture	TU Delft, Piet Zwart Institute, WDKA Rotterdam and Politecnico di Torino
5	Faculty of Architecture TU Delft	Faculty of Architecture TU Delft, study year Japan.
6	Faculty of Architecture TU Delft and Academy of Architecture Rotterdam	Interior architecture Academy of Fine Arts The Hague (KABK)
7	Faculty of Architecture TU Delft	Faculty of Architecture TU Delft
8	Faculty of Architecture TU Delft	Academy of Architecture Rotterdam
9	Faculty of Architecture TU Eindhoven	Nijmegen, Architectural academy Amsterdam
10	Faculty of Architecture TU Delft, Universidad Autonoma de Barcelona	no teaching
11	Faculty of Architecture TU Delft	Academy of Architecture, Groningen
12	Landscape architecture, Wageningen	Faculty of Architecture TU Delft, Hogeschool Utrecht, Wageningen University, Utrecht University, Academy of Architecture Arnhem
13	Faculty of Architecture TU Delft	TU Delft Faculty of Architecture
14	Urban planning and design Faculty of Architecture, TU Delft	TU Delft Faculty of Architecture. Active in education at several universities and academies.
15	Landscape architecture, Wageningen	Academy of architecture, Amsterdam. University of Berkeley

The interviews started with a short overall introduction (approximately 5 to 10 minutes), including the explanation of each element. Four out of the fifteen interviewees already knew or had read about the framework, but the others heard about it for the first time. The participants were interviewed by one interviewer (ED, the first author) for approximately 1 hour. The interviews took place in 2013 and 2014 in the Faculty of Architecture in Delft or in the designer's office. All interviews were in Dutch, except for one, which was conducted in English.

The interviews were recorded and verbatim transcriptions were made. The interviews were analysed in two ways: summarizing and labelling. Going deeply into the transcriptions, making, reading and rereading them, helped explore the essence and capture it in a summary, directed by the five generic elements. The designers received the summaries of their interviews and were asked to confirm the adequateness of the interpretation.

Also the transcriptions were labelled (in Atlas TI) by two persons. The process of labelling was done separately and in discussion to come up with a reliable result. In relation to the research questions the labelling focused on (1) synonyms and descriptions, the personal notions and ways designers use to describe the activities, referred to with the elements, (2) aspects or features of the architectural design process, in particular the elements, (3) differences in approach between designers and (4) extra remarks, regarding the framework of the elements.

3.3 Results

The way in which the interviewees talked about their way of working differed. Almost all designers talked about their design process, guided by the 5 generic elements. On top of that, one designer showed his design process in detail in one project he had documented. Sometimes designers referred to examples of their own work. One designer talked from the perspective of his education studio. The interview with one designer included and followed on a lecture given about the personal design process. The degree in which the interviewees stayed close to the elements, differed from quite close to telling their own story. Nine out of the 15 designers agreed on the summary they received for comments, the other six did not react.

The data of the interviews will be described from the perspective of the 5 generic elements.

For each element the results will be given, following three of the sub-questions: (1) the recognition of the element and the notions used, (2) features and further specifications of the element, (3) personal differences. Finally, remarks of the interviewees on the framework as a whole are given (sub question 4).

3.3.1 Experimenting

Using their own words and notions to talk about the process of experimenting, all designers recognise the experimental character of designing. They call it a process of trial-and-error, of analysing and evaluating different options, of constantly elaborating and changing different options within different scales: “something isn’t

right in your opinion as a designer; so you change it, you try something else". It is a process of "learning about the project by exploring alternatives and elaborating further".

Sometimes a designer has a more specific meaning for the notions used in the framework. For example, designer 1 makes a difference between testing and experimenting, respectively testing common solutions and developing new languages. In the framework both are included in the element of experimenting.

Together the interviewees come up with several features of the process of experimenting. It is a process of zooming in and out, working on all scales, on a lot of aspects (domains) and at the same time keeping a helicopter view of the work. Experimenting is a lot of work, it is working intensively and concentrated, making a lot of experiments, which often seemed to be put aside again. However, designers point out that all the hard work contributes to the final result. Within the process of experimenting, it is a matter of finding direction (guiding theme). Designers see experimenting as a process of reducing or abstracting, of returning to the essence. Designer 3 emphasises that "thinking it over and over again, you may come up with a simple and intelligent design". Experimenting implies also having confidence in yourself and the process. According to designer 14 experimenting is a process of "jumping in a pool of uncertainties, of endless, often equivalent, possibilities and solutions. You have to be confident that by jumping in, you will find the direction to climb out in the end". Experienced designers point out that they often know what issues they have to solve immediately and what they can postpone. In the words of designer 2 "It also means solving things, not going around the problems. It is about drawing a plan and, when a difficulty arises, immediately testing if it can be solved. By experience you learn to recognise the problems. When you postpone dealing with a problem, there is a risk that you will have to change the whole design." The process of experimenting is a process of doing basic work on the one hand and on the other hand being open-minded and taking nothing for granted. Designer 11 emphasises that for the larger part it is doing a lot of basic, "known" work. And designers emphasise designing being "in the first place exploring without prejudices" (2) and "It is important to keep in mind that nothing is given information" (4) and "trying to go beyond what we know" (3). The process of experimenting is both a process of being on your own and of working together, of concentration and of associating with co-workers. Two designers (2, 5) use various options also in their conversation with the client, to learn about the preferences of the client. In this way they trigger the client to find out what he wants and to form an opinion. And designer 6 sees the projects he designed also as experiments, objects of research to learn from for future projects.

The personal differences in the way designers experiment do not seem very large. In fact it seems there are only small differences in the emphasis on the aspects mentioned above. However, two aspects are more outspoken. First, designers' emphasis in regard to the process of collecting and analysing information about task and site varies from being a really important issue to being an analytical or an associative action, taking place almost in the margin of the design process. Second, the process of experimenting is carried out either well-structured or rather chaotic. One designer (10) calls it chaotic, however with the notion that "you have to finish each drawing". Another designer (2) works really well structured by questioning top left on the page what it is that he wants to explore. During sketching the focus is on this question and when finished the preliminary conclusion is written down, bottom right.

3.3.2 Guiding theme

For the guiding theme, that what gives direction to the design process, the palette of names and notions designers use seems to be the most varied. It is named a fascination, a passion, "an expression of something and not just solving problems", a vision, a way of working, exploring the "inner logic" of a project, the point where "the building takes over" and finding direction. It is also called a set of principles, an ideal to achieve, the inner compass, the handwriting, the essence, and the essential quality. It is a matter of reasons and motives in the choices made: "It is about being consistent". In most interviews the designers almost directly understand what is meant by the notion "guiding theme". In a few interviews alternative notions given by the interviewer such as "things you want to achieve with your designs" or "something that gives direction to the process" helped to explain the meaning. That seems to be related to all different notions used and to the more or less complex, plural or even mystical character of the guiding theme.

Designers experience the (working of the) guiding theme in the whole palette from clear to vague. They ascertain: (1:) "If you know what kind of end result you want, it tells you how and what you should do to reach this goal" and (4:) "I would put it ahead of everything. When considering architecture as an expression of something and not just as solving problems, the guiding theme has to be there" and (14): "It is there, it is an inner compass; you have to find a direction in all endless possibilities and solutions". At the same time designer 14 concludes that the "longing or what it was, we were searching for" becomes clear to him only when the design is almost finished. However, one way or the other, there seems to be something like a guiding theme, something that helps in keeping focus within the complex design process.

Going deeper into the features, the picture emerges that the guiding theme seems to give direction at two "levels" at least (see Figure 3.2). One level is having some kind of *project-transcending theme*. Designers take position: it is what in their opinion architecture and urban and landscape design is about. Sometimes they are clear about it, it is their fascination in designing. Sometimes they tell about it after some questioning. One designer (15) called it the way he elaborates the design project and his "handwriting, something by which others do recognise that it is my design". The other level is a *project related crystallisation point*; it emerges from the situation at hand. In most cases it seems to be a spatial diagram, a formal structure or composition. The relation between the two levels can be as complex and plural as the notion or guiding theme itself. One designer (4) describes it as: "It is the form that makes the design coherent. It is like writing a text: you understand the text because there is a relation between the topics. A building that works is a building that has this relation between the parts, the form becomes important at some point as the conclusion of a process. There is a form, that expresses a guiding theme, but probably a guiding theme doesn't express only one guiding form, that's why architects can make 20 different buildings, with the same theme."

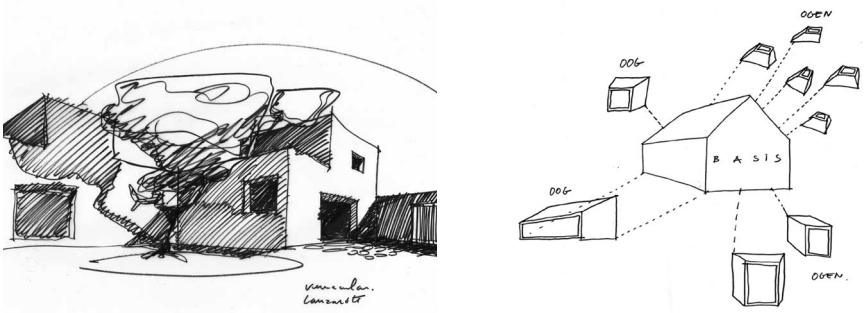

FIG. 3.2 Example project transcending (light and monolithic) and crystallisation guiding theme (monolithic and 'eyes' for light and view) (work designer 1).

The personal differences in the guiding theme seem to play an important role in the design process.

An immense rich palette of guiding themes or qualities can be seen (see Table 3.2). The guiding theme can be a handwriting, a strong fascination, such as for monolithic forms and light, a driving force like closing life circles, a set of guide lines, such as Japanese principles, or principles of ambiguity and balance.

TABLE 3.2 Fifteen interviews: fifteen personal guiding themes in the design process.

Designer	Guiding theme
1	Fascination for the monolithic and daylight.
2	A typological way of working as a kind of rational approach.
3	Inspiration from the socio-cultural, could be everything, e.g. daily habits in a particular culture.
4	Architecture is a social and political act: a service to people, including topics such as sustainability and beauty.
5	Spatial experience, more specific a fascination with Japan(ese principles).
6	Life-cycles, to give value to unused potential of different waste flows, such as scrap parts.
7	Per project: (contrasting) aspects in requirements, client's wishes and site. Sequence of "golden moments" per project. Up to the point where "the building takes over".
8	Smart technical principles, learning from nature and a spatial concept per project.
9	Complexity of the urban context; giving cultural meaning to a building within society and showing important characteristics of an area.
10	For each project a vision, expressed in an aquarelle.
11	Usually the idea of the client or government. And a transcending focus on the way people interact; the relation between private and public.
12	Coming up with the organising structure out of the qualities / the essence of the landscape, being strong enough to guide the spatial intervention.
13	Abstracting to essence and implicit values such as "democratic urbanism".
14	Ambiguity. Balance between what is there and what is changeable, between the broadness and intimacy / tactility, between past, present and future.
15	Project-related: the essence of the site and question of society, client. Overall handwriting: long lines, spaciousness and openness, fine detailing, quality material and simplicity.

3.3.3 Domains

In general designers call all aspects and domains they have to attend to by their respective content. They talk about space and form, material, structure and climate, function, urban site, socio-cultural context and all aspects within these domains such as light, texture, colour, energy, composition, and proportions. In principle, domains are related to the design discipline. However, the landscape architects and urban designers recognize the architectural domains. The differences seem to be much more a matter of scale, emphasis and interpretation per design discipline or designer.

Together the designers come up with some features of (working in) the domains. Designers ascertain that they work in and across all domains, they have to make statements and have to decide on all kinds of aspects. Working in the domains is considered a considerable part of the design work: dealing with all aspects and integrate them. One designer (8) compares working within the domains with a "one-

armed bandit slot machine": "it is about pulling the trigger, until the moment that all the icons will appear neatly in one row; all the aspects will be in harmony". At the same time, the domains consist of all kinds of aspects a designer has to take into account such as requirements and regulations, criteria, norms, and conditions. You could say that the guiding theme is the main (set of) reason(s). All other criteria, preferences and norms in the domains are of minor importance. Designer 4 describes it this way: "While working on a design you consider several domains at the same time with the guiding theme in the background. At the same time you start with a plot and the plot has regulations: you have to keep distance from the neighbour, from the road, there is noise, there is orientation. Also the historical tradition, the context and the historical context play a part. So all these elements are more practical, they intervene, and they are related to the design. It just happens that you start working with all these elements and you keep your theme in the background."

Personal differences between designers are to be found in the different emphasis on one domain or a combination of domains. Designers may emphasise the urban (12), a combination of urban and socio-cultural context (9), the material domain (4 and 8), the domain of space and form (1, 2, 5) or a combination of function and urban context (7). The emphasised domains often seem to be related to the guiding theme.

3.3.4 Frame of reference

Most designers refer to the library or frame of reference with the notion references. It is also called a toolbox and a pattern language. The references could be abstract patterns, principles and rules of thumb, but also actual images, referring to patterns and principles. They could be a personal belief or common cultural principles. A lot of these principles are part of the professional (architectural, urban or landscape design) field, but designers are also inspired by seeing and studying entirely different fields, for example literature, dance, choreography, painting and nature.

Together the interviewees come up with several features of the element "frame of reference". Developing your personal frame of reference is a lifelong process. One designer (8) observes that it may start with the images of your youth, like narrow small streets, busy avenues, a centuries-old tree, a theatre. Another designer (14) points out the role of plan analysis during his studies. It is about understanding plans, sites, cities and houses by making plan analyses. Designer 10 ascertains that designers learn from and are inspired by all kinds of ("beautiful") things that they come across in their lives. Visiting buildings and cities is one important way to develop your personal frame of reference, reading books and seeing photographs in

newspapers and magazines another. Some designers emphasize the importance of experiencing buildings by visiting and sketching (see Figure 3.3). One designer (2) said: “After sketching things tend to be better remembered than when documenting a project with photos or film”. The designers observe that they often use references unconsciously. One designer (4) says: “Only after I had made a sketch, I realized that it looked like a building that I really liked and which I saw earlier.” On a general and a personal level the frame of reference is a dynamic and developing library of knowledge and experience. Working with principles, rules of thumb and images is an open activity: they don’t provide a set of fixed rules. Designers use existing principles and patterns and transcend them by finding “new” ones. One designer (8) describes it this way: “It is about using patterns and about creating new patterns. About staying innovative, being curious about new things, finding new solutions”.

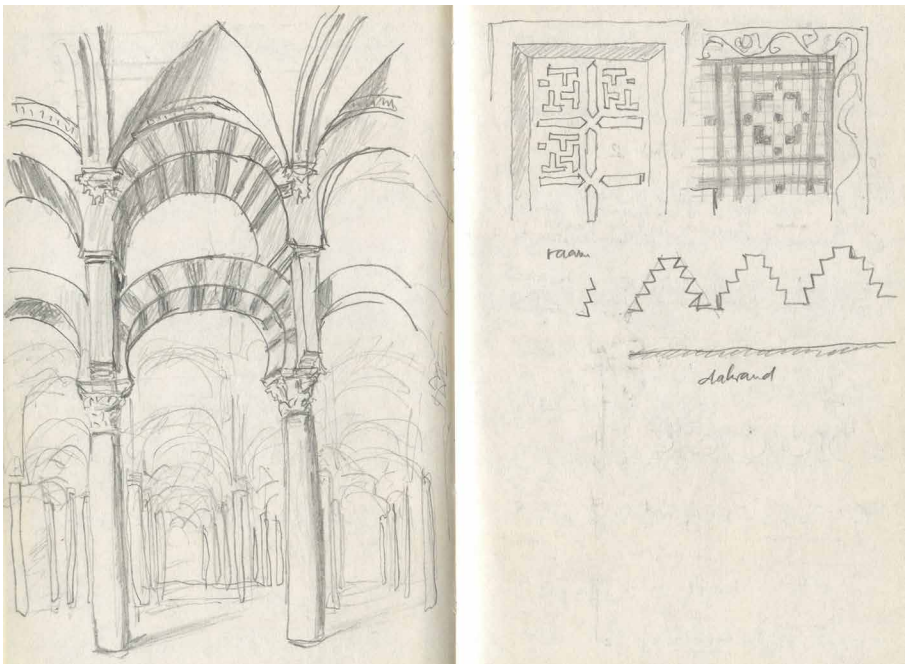

FIG. 3.3 Sketches excursion to Cordoba Spain (work designer 2).

For a part, the frame of reference consists of all kinds of common, practical and basic professional principles, patterns and rules of thumb. For example, architect 7 not having much specified information about the actual functions in advance, knows that an 8 by 10 meter grid would be suitable for designing flexibility. The urban and landscape designer 14 uses principles and patterns such as the lot measurements and drainage.

For another part, the frame of reference consists of specific principles, patterns and rules of thumb, preferred by an individual designer or a group of designers. Here the personal differences are to be found. Examples of these cultural or personally preferred principles are: (10:) “the beauty is not in making things abstract, but in that which makes it a little bit complex, for example, the dovetail in a wooden box makes the box beautiful; it shows craftsmanship” and (12:) “wanting the landscape design to look as if it hasn’t been designed at all”. There seems to be a relation between these specific, personal references and the guiding theme. For example, principles and patterns used by one designer (5) are influenced by his fascination for Japan, where he lived, studied and worked for one year. His experiences in Japan are much more than just a source of inspiration; he calls it his “second nature”.

3.3.5 Laboratory

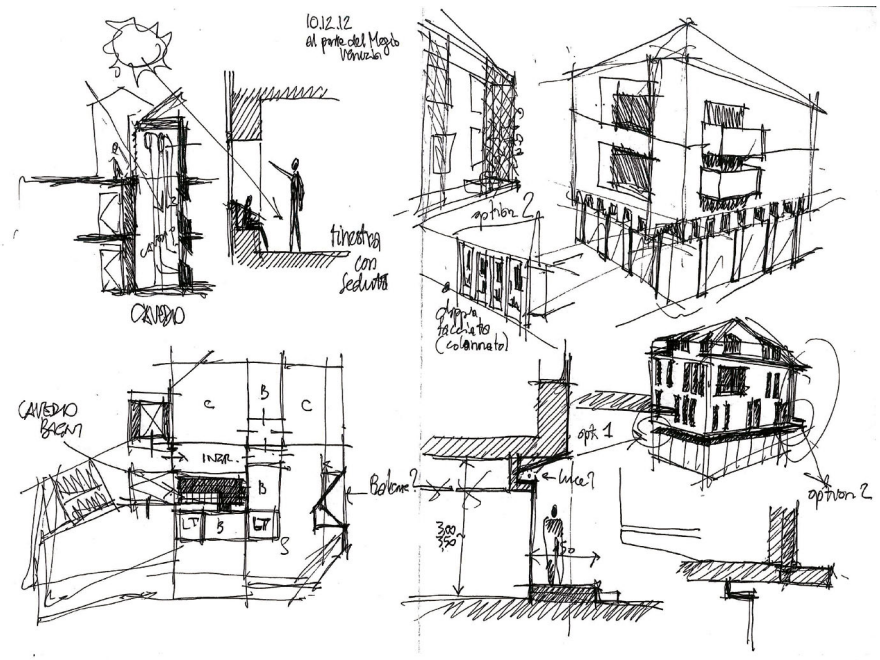

FIG. 3.4 A project on a placemat; all kind of sketches (work designer 4).

Designers refer to the laboratory with the elements involved; sketching, modelling, digital drawings, perspectives, and so on. Traditionally designers sketch and make physical models. In a time when the digital possibilities are developing rapidly, designers also work at the computer. However, the traditional means of sketching and modelling are still important. When using the computer, designers often work with programs that at least partly use the features associated with sketching.

When talking about the "laboratory", all designers, except for two, emphasize the role of sketching. They refer to features and qualities, such as working really fast and only needing pencil and paper. One of the designers (4) shows a (sketch) drawing, which he made on a placemat in a restaurant in Venice; it portrays a complete impression of a building: facades, details, perspectives and floor plans (see Figure 3.4). Two other designers (9 and 13) made sketches during the interview to express and illustrate what they meant. Also "the direct contact between brain and hand", the "physicality" and "openness" when sketching are mentioned. According to designer 14, it is about sketching "thin" and "thick" lines, "unsure" and "sure" lines in the process of analysing, discovering and trial-and-error. Working digitally has its own set of advantages: easy shifting between different scales, the possibility to immediately add textures like wood or metal, restrictions and measurements, and the possibility to "walk through" the design to get a better sense of space. The disadvantage of using the computer in the development of a design is that it can be too precise and the loss of direct contact between hand and brain. Sometimes the project at hand asks for a specific medium in the laboratory. One designer (7) used movies to develop an 800 meter long building near the highway to find out what effect the building would have on car drivers. Another designer (1) makes a model in a relatively large scale (scale 1:20) to experience the light in a design.

There seem to be no major personal differences in the way designers sketch, model and work digitally. Almost all designers experiment in sketches. Only two designers find that for them the role of sketching during the design process is minor or even not important at all. One designer (12) mentions the vocabulary also being an important laboratory for designers, besides drawing. He values the cerebral side of designing and sees himself more in the role of a thinking designer. He calls himself a rationalist who needs to develop a repeatable, verifiable line of reasoning. The other designer (11) emphasises that he visualises the building in his mind in a very early stage. He doesn't need to sketch a lot to know the design.

3.3.6 Framework

The elements are aspects or activities, distinguished to make them explicit for educational purposes, but interwoven in a complete, integrated whole. The elements are not meant to represent steps in a fixed sequence. The stories of designers confirm and emphasise this.

Four designers made remarks about the choice of the elements. One designer (9) thought it could be four elements - experimenting and laboratory being one element. One designer (11) thought it could be even two - only experimenting and guiding theme-, but he almost immediately concluded that in that case some kind of suborder would be needed within those two. One designer (7), emphasising "analysing" in his design process, missed it as a separate element.

3.4 Conclusions and discussion

3.4.1 Generic elements and differences

In regard to the first research sub-question, the results show that the elements, as proposed and defined in the framework, can be recognised in the architectural design process of all designers interviewed. They may put different emphasis on what the elements stand for in their personal process, and they may differ in naming them, however, the elements were recognisable, at least to a certain extent. In fact, the spontaneous notions and words used to describe four out of five elements, nor the content didn't seem to differ a lot. Only for the guiding theme, designers use a lot of different synonyms and descriptions. Basically, also these notions seem to mean and refer to the same thing: some kind of constant factor, emerging in and to a certain extent directing the design process. The interviewees experienced differently that what is called in the framework a guiding theme: from a clear personal fascination to a mystical existence.

In regard to the second sub-question, the way designers describe and interpret features and aspects provides a more profound and detailed understanding of the design process and more in particular the five defined elements. The most interesting

topic in this respect is –again– the guiding theme. From the start of the development of the framework, the guiding theme was referred to as a "train of thoughts" (Van Dooren et al., 2014). In the interviews, this seems to be confirmed and, moreover, it became more concrete. At least two important "centres of gravity" can be seen: an overall quality or set of qualities to be achieved by the designer, often project transcending, and a "crystallisation point", often a spatial / formal, structural sketch, specific for the project at hand.

In regard to the third sub-question personal differences can be distinguished. Designers experiment in a well-structured or rather chaotic way, they work often or seldom digitally, and the emphasis is on analysis or association. Yet, these differences seem to be relatively small. They are partly due to personal preferences, partly due to the different nature of projects. Individual differences seem to be most prominent in the guiding theme. With the guiding theme, varying from a more or less conscious choice what qualities to achieve to the experience of the emergence of a continuous factor, a designer takes position and "imposes an order" (Schön, 1987) in a particular personal way. At least for a part, directly related to the personal guiding theme is a personal library or frame of reference, a preference for certain principles, patterns and examples and regularly a certain emphasis on one or two domains.

In regard to the fourth sub-question, the elements seem to outline the basic design activities. To a certain extent, the choice of elements may always be a topic for discussion. At the same time, there might be some logic in the proposed elements, in the context of the criteria (Van Dooren et al., 2014): the elements have to be (1) generic, always present, (2) for educational purposes, to explain and train students, and (3) easy to remember, a clear overview.

Finally, in regard to the main research question the results show that the framework makes it possible to see and compare differences in personal views and approaches in relation to the underlying design process. Overall, the impression is that the framework lives up to what it was meant to be: a simple diagram of the underlying, basic, generic design activities, aimed at achieving and keeping an overview of the much more rich and nuanced design reality itself. Interesting in this respect are some spontaneous remarks. One designer (4) considered the framework to be useful to learn about his own design process. Another designer (14) – who, as a teacher, is particularly interested in exploring ways to help students in learning to design – thought the framework to be useful for education.

Looking back at the wide variety of design examples, mentioned at the start of this paper, the framework gives a deeper insight in the differences. In particular, they seem to be expressions of personal interpretations and choices of the guiding theme.

3.4.2 Limitations

Each research method has its specific strengths and limitations. In summarizing and labelling the interviews, we tried to stay close to what was said. Assuming that what was said, what was meant and what really happened in the designers' way of working are more or less directly related. On the one hand, knowing that an expert practices his or her skills mainly implicitly, a limitation of interviewing is that designers may not be able to tell everything about their design approach. Interviewees differ in their awareness of their way of working, in their ability to explain things, in the ways in which they talk about the subject, and in their 'black spots' or biases. Also the situation and the interviewer may influence the course and outcome of the interview. On the other hand, structuring the interviews by the five elements may have helped the interviewees to think of different aspects of the design process, they should have overlooked otherwise. And the fact that the interviewees often accompanied their talking with sketching and showing projects or other examples, helped to make implicit knowledge explicit.

Having an overview of the interviews, it became apparent that some interviewees had a more subjective way of talking, whereas others were more objective. Some of the designers focused on what they, in contrast to others, saw as 'good' architecture. Other designers focused on facts and features of their way of working. In fact, here we see the difference between positioning yourself within the architectural debate and describing your way of working.

Also the process of analysing and labelling may cause limitations. The process of labelling was directed by the framework of five generic elements and the questions regarding aspects and personal differences, being the main topic of the research. Although the process focused clearly on the research question, there is always a risk that this leads to a tunnel vision. To avoid this, we asked for general remarks or critique on the framework (sub question 4) and tried to stay as open minded as possible.

In the context of this research the conclusion is that interviewing designers in a semi-structured way is suitable as *a first exploration* to see if the framework is useful in mapping similarities and differences. During the interviews, the primary focus was on discovering if and in what way all the elements of the framework were recognized.

Next to that, learning about the features and about new details and connections was also aimed at. The interviews ended at the point where no new information seemed to come up. However, then new questions emerged. These may be answered by research with a different approach: structured questioning and observation. For example, an interesting topic is the relation between on the one hand being open-minded, taking nothing for granted and on the other hand doing a lot of basic, familiar work. In the interviews the former is mentioned 4 times and the latter only 1. This seems to correspond with design education where teachers often emphasize the importance of being open-minded and "forget" to tell about the basic, familiar work. Designers may be less aware of the role of this topic in their design process. Also interesting in the context of design education would be to have more detailed examples of the elements. Observing designers at work will give a more concrete and detailed insight in their way of working. It should clarify the design process and bridge the gap between the abstract and the concrete level.

3.4.3 Implications for design education

The interviews show and confirm what may to a certain extent be called a Babylonian confusion of tongues; everybody speaking a different language, from different perspectives and with different ideas about the "right" approach, but in the end about the same content, about "building the tower". In the debate and the architectural practice, it may be the way designers show their uniqueness, in design education it seems to be a gap, for students a source of confusion.

Having a first confirmation that designers recognise the elements and that the framework may help in showing differences in personal approaches in relation to underlying basic design activities, naturally, besides doing more research in this respect, the next question is whether and how the framework may be used in design education.

First, the framework may help in creating *a common educational "language" about the design process*. By using the same notions for the most important design activities or at least relating various notions with each other, the Babylonian confusion may be reduced. Regarding the second perspective in design education models mentioned above in the Introduction, the framework of generic elements makes use of and summarises what researchers have found out about the cognitive aspects of the design process. In a particular way it combines both directions: the framework is grounded in designing as a reflective practice, but it does not exclude aspects of rational problem solving.

Designers all have their own way of talking about the design process. Parallel to that, in their role of teachers they don't seem to be used at all to talk about the design process. Personal observations in design classes suggest that most of the time they seem to talk with students about 'product aspects', such as light, spatial experience, the proportion of space or mass and technique. The framework offers teachers and students in architecture a vocabulary to make the underlying design process more explicit.

Some examples will illustrate this. Teachers could and should explain more than once that designing is a matter of experimenting. Designing is a matter of questioning yourself "what if I do this?". It is a matter of coming up with alternative solutions and possibilities, reflection and decision making. It may be structured or unstructured. Opening one's mind for different solutions prevents a designer from getting stuck, helps learning about the design task and improves the quality of the design at hand. Teachers should also explain that experimenting is also for expert designers in most cases only possible by sketching and making 'quick' models. The laboratory functions as an extended memory to store all kinds of information and is necessary to discover (unexpected) implications of experimental solutions. Teachers' explanations could be accompanied by visuals. Not in a perfectly expert way, but simply by showing the students how they themselves have to experiment and sketch to find out what happens, what kind of implications (and surprises) may come up, what they see in a sketch and what they think of it. By doing so, they may illustrate what Schön (1987) calls a 'conversation with the situation' and 'reflection-in-action'.

In relation to the stages students go through from novice to master (Dreyfus & Dreyfus, 1986; Lawson & Dorst, 2009), the way in which the vocabulary could be used, may differ per stage. For example, for novices experimenting and choosing a guiding theme may be a straightforward matter, 'applying the rules'. In later stages, experimenting and working with guiding themes may be more nuanced, complex and related to the situation at hand. Then all kinds of different aspects of the elements could be involved, such as finding your personal guiding theme or ethical aspects.

Furthermore, regarding the third perspective in design education models mentioned above, the framework could also be used within the context of the educational process, by making implicit activities in the process of learning-by-doing explicit. It may help teachers in coming up with learning goals, assessment criteria and design tasks. It should help teachers make explicit which activities students should train with greater focus to internalize 'thinking designerly'. For example: sending students home with a design assignment 'to work on' or telling them to 'think out of the box' is a far cry from asking them to come up with a number of alternative ideas or to explore and experiment with different solutions and reflect on them. Examples of process oriented learning

goals are: ‘being able to come up with different ideas and solutions and reflect on them’, ‘being able to translate a vision or idea in a concrete, project related (spatial) scheme’ and ‘being able to reduce and abstract all kinds of information into the essence’.

Secondly, in particular in the context of this paper, the framework may then also work as *an anchor point, from which you can recognize and show different approaches*. Regarding the first of the three perspectives in design education models mentioned above, in a multiform society the framework is meant to go beyond the cultural and personal differences in method or approach and make them explicit to students – (1) to achieve an overview of the architectural debate and all kinds of positions in it, (2) to compare them and understand all kinds of similarities and (personal) differences, and (3) as a result, to be better equipped to develop a personal approach.

Differences in approach related to the design task at hand, could and should be explained, discussed and compared. For example, working chaotically or structured, and the balance between associative thinking and analysing, are important issues within the element of experimenting. Making these differences explicit is (again) a matter of explaining in combination with experiencing them. Students should not only follow implicitly a design teacher in his or her way of designing, but should also explicitly practice different ways of working in design tasks. For example, it may be helpful for students to be told about and experience explicitly the differences between sketching-by-hand and computer modelling and the effect they have on the outcomes of their design processes. This may improve their ability to select the most adequate way of working for the design at hand.

Apart from such smaller differences, the development of a personal view on architecture is an important issue. Students often experience confusion because teachers – being expert designers - talk about architecture from their personal angle. For example, one designer (8) considers architecture as creating a place with identity, to make the city richer, whereas another designer (9) considers architecture as using technique in a smart way and a third one (1) considers architecture as sculpturing and playing with light. With the framework, designers (read teachers) might be able to position themselves. This may help in distinguishing talking about the generic design process and showing the personal design process as an illustration. It may help separating discussions on ‘what is good architecture’ from practicing generic activities. And it may help guiding students to explore their personal way of working. Students may develop a greater ability for ‘naming and framing’ (Schön, 1983, 1987) and for positioning the different personal visions of designers and teachers in particular. By understanding and experiencing differences, they may be able to develop their own preferences in vision and approach.

In fact, in making explicit the design process, there could and should be an interesting role for what in the framework is called the guiding theme. In showing the differences in the personal design approaches, in coming up with all kinds of personal influences, the framework transcends the 'technical rational' description of common design process activities (see the second perspective in design education models mentioned above in the Introduction). The framework provides in 'objective' similarities and the open palette of 'personal' perspectives in designing the future. Here, also the door may be opened for cultural and ethical discussion as well.

With the choice of a guiding theme - being a lifelong fascination or a fascination in the context of a project - a designer takes position. Here the personal may be the most expressive. Bielefeld and El Khouli describe it this way: "Every design begins with a search for an idea or for an intuitive understanding of how an assignment should be solved. This idea is the start of a long journey on which the designer defines the idea more precisely, modifies it, adds details and repeatedly rejects results" (2007, p.7). "This design perspective is often directly related to the designers' character, and is not limited to interaction with architecture. It can be an expression of an entirely personal worldview and associated with a broader social context or philosophy, developing a design perspective is this part of an individual maturation process and cannot be forced or artificially produced" (2007, p.14). It might be helpful for students and teachers to focus as explicitly as possible on these aspects, both in the process of learning-by-doing in the studio and in lectures and other information sources around the studio. A "philosophy of the guiding theme" should be at least concerned with (1) the particular aspects of (working with) a guiding theme, also in relation to the other elements, and (2) its character, which means an almost endless number of differences in cultural and personal views and ideas.

Moreover, a "philosophy of the guiding theme" is an example of bridging the gap between theory and practice, between courses around the studio and the studio itself. Architectural design education often seems to be (implicitly) grounded in the assumption that courses give information and students have to bridge the gap by themselves. They have to comprehend all kinds of relations between courses and in particular they have to understand how to apply knowledge in practice. Students may get a better picture when the different courses and studios are related to each other. For example, courses about all kinds of knowledge could include rules of thumb and principles and patterns, being the translation between theory and practice, and could show that knowledge provides in possible experiments in designing.

In this paper the focus is on the personal design methods and approaches (of the interviewees) in relation to the underlying generic elements in the design process. However, transcending the personal approaches, cultural tendencies could be recognized in architectural methods as well (see for example, Leupen et al., 1993; Bielefeld & El Khouli, 2007; Jormakka, 2008). It is expected that cultural tendencies, often described afterwards in historical overviews, might be related to the generic elements as well. A "philosophy of the guiding theme" could be extended with these cultural tendencies. Here, guiding themes, cultural situation, architectural history and ethics may come together. For example, in a course students had to design a piece of furniture with themes that originated from historical pieces of furniture. Teachers concluded that the design process became more focused (being already 'halfway' a guiding theme) and students learned about guiding themes and architectural history also by experience.

To conclude: focusing on architectural design education from the perspective of the design process may add new views and connections. With the introduction of the framework, as a construction or perspective to study the design process and in particular the personal similarities and differences in the way of working of architectural designers, the emphasis on information that used to be implicit will give rise to a new understanding and experience but also to new questions. It is to be hoped that teachers and students will be triggered to talk more explicitly about their own and others design process, that they will learn about it and will develop a greater ability to define their personal position.

Acknowledgement

A lot of thanks to all designers for making time and for making the interviews a fascinating journey through the design process!

TOC

4 The tacit design process in architectural design education

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ABSTRACT

The purpose of the architectural design studio is that students learn to think and act like designers. However, communication between teachers and students seems to be problematic. Teachers barely seem to explain how designers work, which may be confusing for students. To learn professional reasoning processes and strategies, different teaching activities are involved, such as modelling, coaching, scaffolding, reflection, exploration and articulation. In the design studio it seems tradition that teachers only ask questions, while not articulating the design process.

This paper focuses on the research question of whether teachers in architectural design education articulate the main 'designerly' actions and skills, performed by expert designers, and if so, to what extent and in which manner? To answer these questions video-recordings of 13 tutorial sessions are analysed with the help of an educational framework of five generic elements. The framework consists of the basic design process actions and skills, and is specifically developed as a vocabulary for making the design process explicit and to train students in the design process elements. The main conclusion is that teachers refer to the design product in an implicit way. They leave it to the students to discover the structure and components of the design process more or less by themselves.

KEYWORDS

design process, generic elements, design education, design skills.

4.1 Introduction

”One of the things that really bugs me about architectural education is that a lot of things are really implicit, remain under the surface and are not talked about.” This statement, made by a student, is quoted by Donald Schön (1987, p. 98) in his case-study of education in the design studio. Schön observes what happens in the studio and concludes, among other things, that communication in the tutorial dialogue between teachers and students is problematic. For example, when Quist, the teacher in his case-study, tells the student she must ‘draw and draw’, he means that she must draw in the sense of experimenting, to discover consequences of different options. For students this might be unclear as for them drawing may refer to making a visual presentation only. Oxman (2001) refers to these phenomena in the design studio as “a neglect of attention to thinking in design as legitimate pedagogical content”.

However, the purpose of the architectural design studio is that students learn to think and act like a designer. They must acquire habits and patterns which are mostly used by experts implicitly. They have to learn ‘reasoning processes of professionals’ (Van Merriënboer and Kirschner, 2018). Collins, Brown, and Holum (1991) coined the term cognitive apprenticeship in education to emphasise the (mostly underexposed) reasoning and strategies experts employ. To learn these processes of thinking adequately, different activities are involved. They distinguish modelling, coaching, scaffolding, articulation, reflection, and exploration as teaching activities.

In this case study, the focus is particularly on articulation. Making the process of thinking explicit in the form of explaining and instructing, can help students in understanding ways to approach the design process and achieve adequate conceptualisations of the design process. For example, instead of the notion that designing is coming up with one single solution, students are confronted with the idea that designing is experimenting with different possible solutions and reflecting on them.

Our hypothesis is that teachers talk about the design process itself to only a limited extent, being traditionally not used to articulate the design process and not having an adequate vocabulary to do so. Therefore, a framework is developed based on a valuable body of design process knowledge (Van Dooren et al., 2014). The outcome of this research is ‘summarised’ into five generic elements that design processes have in common. The framework has already been tested by interviewing designers with different design approaches (Van Dooren et al. 2018) and turned out to be a generic framework of the main common basic actions and skills. This framework is

now used to investigate whether and to what extent teachers articulate the design process during design tutorials.

In the remainder of this introductory section, some thoughts behind the way students learn to design in the studio will be described. Then, briefly, the framework is introduced. The section ends with the main research question and sub-questions. The second section gives information about the research method. In a case-study, the current situation in a first-year design studio is video-recorded and analysed with the help of the framework. Then, the third section presents the results for each of the five elements, whether and to which extent they are addressed in the tutoring session. In the final and fourth section conclusions are drawn and the ways teachers may make the design process more explicit are discussed.

4.2 Design process and design education

4.2.1 Sense and myths

Why is the thinking process barely articulated in the architectural design studio? We see three at least possible explanations: (a) complex skills and actions cannot be made (completely) explicit, (b) teachers have (mis)conceptions about (design) education, and (c) it is just common use in the design studio tradition.

Firstly, regarding the possibility of making a professional set of actions and skills explicit, there is a discussion with notions such as tacit (Polanyi, 1966), implicit (Reber, 1989), knowing-in-action and reflection-in-action (Schön, 1985, 1987) at the core of it. On the one hand there is (tacit) knowledge, which people seem to be principally unable to make explicit. On the other hand, there is the conviction in at least the 'positivist' part of the world of science that all phenomena can be made explicit in an objective manner. In our work, we take the position that knowledge can be made explicit at least to a certain extent. It may vary in time and culture, but the aim should always be to derive a vocabulary as adequate as possible for describing the phenomena we experience. As Dewey argues: knowing makes us understand the relation between our actions and their consequences. A better understanding of these relations helps to focus better and act more thoughtfully, more intelligently (Logister, 2005).

Secondly, regarding the misconceptions about design education, listening to colleague teachers over the years, the first author has heard different explanatory thoughts, which seem to underlie the way teachers act in the design studio. Teachers seem to have formed a cognitive model of inconsistent pieces of information (Vosniadou & Brewer, 1992, Vosniadou,1994). Summarised in a statement of a teacher: 'teachers ask questions; they do not give answers'. Teachers know that academics and designers must be independent and critical. They must act scientifically and creatively, not taking for granted what others say, not 'following the rules'. As to learning a complex skill, teachers seem to be convinced that learning is (only) adequate if students make discoveries for themselves. On their own these thoughts are honourable theorems. However, taken into the extreme and in combination with each other, they even may be called a design education myth: you do not instruct, tell, explain or guide students. Nevertheless, making the reasoning processes explicit helps students in performing 'designerly' actions and skills and in achieving and discovering desired professional qualities such as independency, critical thinking, and creativity. There seems to be no body of educational research supporting the idea of using minimal guidance. On the contrary, research points out strong instructional guidance in the case of novice and intermediate learners, for advanced students it may be equally effective. There is even research that suggests that minimal guidance may lead to misconceptions (Kirschner, Sweller, and Clark, 2006). It seems that teachers have forgotten what it is like to be a novice designer, that they have forgotten the confusion caused by not knowing 'what and how to do'.

Thirdly, teachers may simply not know how to talk about the design process. Being experienced, expert designers, most of the time they act implicitly. Not having a professional background in education, they seem to act as they remember from their own teachers in design education and they appear to talk with students as if they would with colleagues in their offices, discussing all kinds of product-related aspects. Therefore, we assume that a vocabulary for having a rich tutorial dialogue about the design process is needed.

4.2.2 A vocabulary for design education

Design problems are by nature ill-defined. Confronted with an open, unique and vague situation at hand, designers approach this in their personal way. However, they also have basic actions and skills in common. For the last decades, researchers coined adequate terms and notions to describe aspects of the design process, such as: reflection-in-action, conducting experiments, a web of moves, imposition of an order, and naming and framing (Schön, 1983, 1985, 1987), primary generator

(Darke, 1979), a co-evolution of solution and problem spaces (Dorst and Cross, 2001, Lawson, 1994, 2006, Lawson and Dorst, 2009), and ideation and evaluation (Goldschmidt, 2014).

Nevertheless, how valuable this body of knowledge may be, it is not easy to use in design tutorials, especially in the case of novices. Therefore, to make this personal, creative, open-ended and complex process of (architectural) designing more explicit, a framework, consisting of five interwoven elements has been developed (Van Dooren et al., 2014):

- Designing is a process of *experimenting, of trial and reflection, of exploring and decision-making*. Designers play around and find their way in a series of experiments. They come up with ideas and means to express these ideas and test them in a process of reflection. In Figure 4.1 this is expressed with an erratic line with circles to symbolise the experiments.

- This process of experimenting is given direction by a *guiding theme or qualities*. It acts as a hold during the process and helps in creating in the end a coherent and significant result. In Figure 4.1 the guiding theme is symbolised by two lines coming together; experimenting with(in) theme or qualities, whilst becoming more and more defined.

- The process of experimenting takes place in different *domains*. For architecture: (a) form and space, (b) material, structure and climate, (c) physical context, site, (d) function, and (e) a broader socio-cultural, economical, historical and philosophical context. Designers have to consider all kinds of criteria and make statements concerning all these domains. Therefore, in Figure 4.1 the erratic line crosses all domains and relates these domains to each other through the act of experimenting: often a decision in one domain can be taken only in relation to the outcomes of experiments in other domains and has new implications for other domains.

- The design process is inseparably embedded within a broader context: a *personal and culturally defined frame of reference*. Designers use and test patterns and images in a design project at hand, and they transform them into new patterns. In Figure 4.1 the frame of reference is symbolised literally with a frame, the blocks representing projects, patterns and other knowledge designers are aware of.

- The process of experimenting is not possible without the help of a *physical language of images and words: a laboratory or a (visual) language*. In this laboratory the testing takes place, expected and unexpected implications of experiments can be discovered, all domains can be considered. Being directly related to the process

of experimenting, in Figure 4.1 the laboratory of sketching and modelling is also symbolised by the circles of the erratic curve.

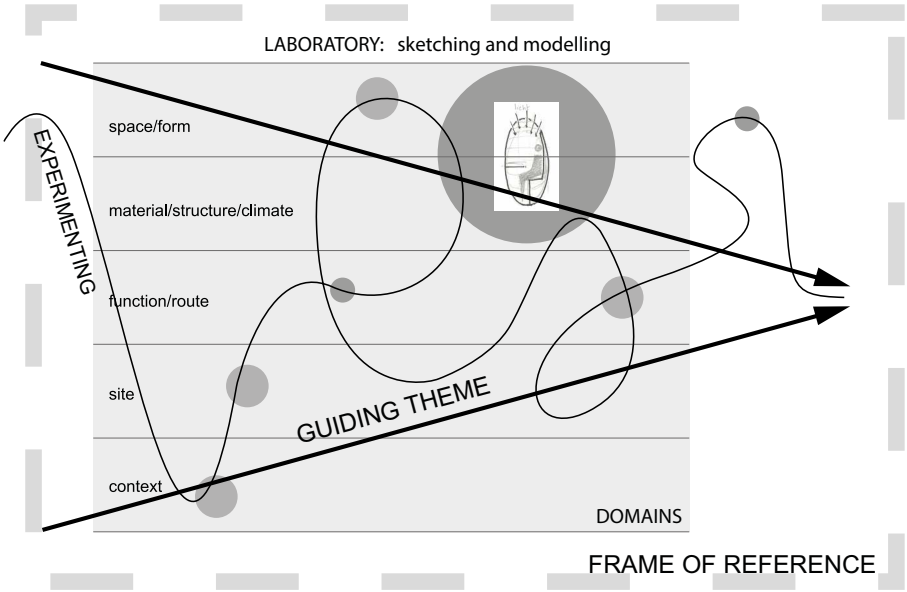

FIG. 4.1 The five generic elements in the design process: (1) experimenting, (2) guiding theme, (3) domains, (4) frame of reference, and (5) laboratory (Van Dooren et al., 2014).

The five elements are certainly not meant as an unidirectional design method. They do not form a prescription or recipe to design; they are merely meant to give insight into the 'designerly' reasoning processes and behaviours. The framework can be used in design education in different ways. The two key aims are (a) explanation of the design process in tutoring sessions in all kinds of concrete design situations at hand, and (b) organisation of design education: it may help in deriving practices to train essential design skills and actions. These main aims include all kinds of sub goals, such as working as an individual designer or in a team, and studying differences and similarities in the personal design approaches and methods of all kinds of different designers.

Because the framework is a vocabulary to articulate the 'designerly' actions and skills' performed by expert designers, in the case study presented here, it is used to analyse whether teachers in architectural design education articulate these actions and skills, and if so, to what extent and in which manner. Separately formulated in three sub-questions: (1) Do teachers articulate the generic elements when they discuss design

TOC

products with their students? (2) If so: to what extent do they articulate the elements of the design process? (3) What kind of expressions do they use?

A remark before giving more information about the research method, the research in this paper focuses on architectural design, including urban and landscape design, but for reasons of readability, regularly the shorter notions 'designing' and 'design process' are used. At the same time, being basic and elementary elements, the framework may also be useful in other design disciplines as well (Van Dooren et al., 2014).

4.3 Research method

4.3.1 Participants

All thirteen participants (nine male and four female) are teachers in the first bachelor design project at the Faculty of Architecture TU Delft, the Netherlands. They are practising expert designers and differ in educational experience, ranging from only a few design projects to more than a decade. The teachers are observed and video-recorded at work in the studio, each time tutoring one student.

4.3.2 Setting

Each year twenty or more groups of nine novice students conduct the first design project of their studies. In the studio, students work individually on a given design project. They regularly have tutoring sessions in which the project at hand is discussed with their teacher in a tutorial dialogue.

The BSc design assignment consists of designing a small house in a landscape (forest, dunes, ...). varying from a studio and house for an artist with the focus on the environment, a small neighbourhood with a public sculpture route, to a holiday home for two family members with the focus on different users (e.g. two brothers) and anchoring in a particular landscape.

Out of a larger set of recordings, thirteen tutorial dialogues of different teachers and students were chosen at random; only the sound quality of the recordings affected the choice.

4.3.3 Procedure and analysis

The (Dutch) tutorial dialogues were recorded in the studio during three academic years in the period 2012-2015. The transcriptions were analysed and coded with the help of the program ATLAS TI. Two categories of coding were used. The first category consists of notions referring to the different actions and skills of the design process: the generic elements including synonyms and aspects of the elements (see Table 4.1). The second category refers to the extent in which teachers are implicit or explicit about the design process (see Table 4.2). This category was defined beforehand and refined during the first round of coding.

The coding of each transcript was completed in two equal rounds of analysing: first, by the main researcher (first author) and a student-assistant, in the second round by a colleague teacher and another student-assistant. Only five cases (presented in the result section) were topic of discussion: the decision was taken by the main researcher (first author).

Also, extra information was collected, such as the duration and structure of a tutorial dialogue. To get insight into the structure (start, middle and end), text fragments were distinguished based on content. Each fragment consists of one or more items, being the smallest part of the text, textually belonging together, often about one aspect of the design product at hand. Fragments and items helped in deciding which notions belonged to one code. When a notion, such as 'you have to vary' was mentioned two times in connection with one item, it was coded as one.

TABLE 4.1 Notions referring to actions and skills of the design process.

generic element	notions referring to (parts of) the element
experiment	search / explore / alternatives / investigate / variants / analysing / association / decision taking / testing / reflection / looking for implications / ...
guiding theme	concept / idea / quality / focus / primary generator / design question / essence / starting points / …
domains	aspects fitting together / strengthening each other /...
frame of reference	references / examples / patterns / principles / rules of thumb / abstraction / …
laboratory	sketching / modelling / drawing / physical thinking / external memory / 'way of testing' / drawings, such as perspectives, sections, plans / ...

TABLE 4.2 Categories referring to the extent actions and skills of the design process are named.

category	description
instruction	Giving explicit instructions in terms of 'designerly' actions and skills. For example: come up with at least three different alternative concepts or ideas / come up with at least three different ways to solve this particular problem and study the (dis)advantages.
explained	Explaining the design processes, a design skill or set of activities. Clarifying how designers may approach, such as how to decide, coming up with different alternatives, and testing them. Relating the design products at hand to 'designerly' thinking. Could be about one element or the relations between elements.
mentioned	The design process is named or referred to with one or a few terms or notions (see Table 1). Could be a synonym of an element or referring to an action 'part of the element'. Often in the sense of "you should ...", "you may ..."
not mentioned	The design process is implicitly present, in talking about the product at hand, mostly in the form of product-related examples or instances. No mentioning nor referring to notions and terms of the design process.

4.4 Results

The results will be described in three sub-sections. Firstly, some common features of a tutoring session will be given, relevant to understanding the research results in their context. Secondly, the data from the observations will be described per element, based on the sub questions: (1) Do teachers articulate the generic elements when they discuss design products with their students? (2) If so: to what extent do they articulate the elements of the design process?

In the third sub section, the results regarding the third sub question are given: (3) What kind of expressions do they use?

FIG. 4.2 Dialogue between teacher and student in first year design project with models and sketches on the table.

4.4.1 Features tutorial dialogues

The observed dialogues mostly take twenty to twenty-five minutes, with some exceptions of three and forty minutes (see Figure 4.3). There seem to be no qualitative differences: discussions seem to be simply longer, consisting of more items or more time per item. On the table is the work of the student: sketches, drawings and models (see Figure 4.2). The amount differs between tutoring sessions; some students show a lot; some students show only few drawings and models. Two types of tutorial dialogues can be distinguished: (a) dialogues with a recognisable start in which the student talks about the project, ending approximately a third of the way through the tutorial in a 'turning point' from which the teacher takes over, and (b) dialogues without a recognisable start; the teacher reacts directly per item to what the student is telling. In all cases, the end of the tutoring is abrupt: it simply ends or a teacher just briefly repeats one of the discussed items.

In general, the discussion is on an 'aspect' level. Students describe the results of what they have done; they describe the product at hand. They talk about the living space, the entrance, and so on. For example, in the tutoring by teacher 3, the student starts by talking about the results of the work done in the past days. The story is descriptive, more or less about 'what is where' (see Table 4.3 - A1). Besides asking questions to understand what a student has done (see Table 4.3 - A2), teachers react on the project at hand and what the student has done with monologues and (rhetorical) questions. Parallel to the talking, some teachers sketch, showing what they mean at a visual level.

TABLE 4.3 Parts of the tutorial dialogue of teacher 03, with underlined sentences referring to the design process (translated from the original dialogue in Dutch).

The design task at hand is a house plus studio for an artist. The discussion takes 22 minutes.		label
A	START TUTORING / EXAMPLES TEXT STUDENT	
The student starts telling about changes made in the design in the past days. The story is descriptive, about 'what is where'.		
1	S: I have also thought about changing these rooms: the dining room and the living space. But that didn't work out with the kitchen. I want to have a separate kitchen. An open kitchen is good, but not functional. S: To make it quieter, I have made the living space over there. And I have made a longer wall here... S: In the living room is an opening in the wall; you can look into the studio.	
The teacher is mainly trying to understand the drawings.		
2	T: I'm lost; where are we? T: It is a beautiful drawing, but I don't know… where are we, in what direction do we look? T: I try to analyse what you do. In fact, you make a house consisting of two parts. ... In the largest part you make a staircase.	
B	MIDDLE TUTORING / EXAMPLES TEXT TEACHER	
The tutoring continues and is about the walls around the staircase and hallway downstairs and upstairs: they are not placed over each other. The teacher assumes there is a reason for it and the student explains:		
3a	S: Here, I wanted to make a kind of mini-sculpture walk, with some tables over here, with sculptures on it. T: Look, now we are talking. What next? I should think; okay, I want to know …. This means that this staircase…. what is the size now? S: 0,8 metre T: can it be wider? S: it may be also 1,0 metre T: if you want to make in fact room for exposition here. S: yes T: what does that mean? It means that the inhabitants and guests will see the art. Then there is the chance that the artist takes his visitors upstairs: 'Come, I want to show you some things'. So, it is not a hallway anymore, but it is more. Then, for me, it may have more space. What would that mean? What if you would say .. I am going to find this out. What does it mean, for your design?". S: my design? T: maybe the library would become a little bit smaller? S: Yes, but the sculptures will not be on the staircase .. T: No, but you can make the stair wider, making it more conspicuous." S: yes.	experiment, mentioning
3b	T: Making it more important. I understand that the sculptures are not on the stairs, but you may take more space […] What happens then?... Do things shift?... [...] T: What I try to say to you … that when you start designing, these small things may change your whole design. But in the end, it will be important… this is tough, because it is a lot of work to make this kind of beautiful drawings and then change them again. But… that's what being an architect is about... changing everything continuously. Until you think: this is how I want it to be.	experiment, mentioning

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TABLE 4.3 Parts of the tutorial dialogue of teacher 03, with underlined sentences referring to the design process (translated from the original dialogue in Dutch).

	The design task at hand is a house plus studio for an artist. The discussion takes 22 minutes.	label
	The tutoring dialogue continues about symmetry in relation to the rooms and the way you walk through the house. Later on, the teacher also refers to making a load bearing wall and a column.	
4	T: … that means that you have to make something like a column here. You may put it inside. So, you can make the facade the way you want it to be … but you have to do something. You should look at the house of Lina Bo Bardi again. S: Yes, but what should be the proportion of the column? T: The column may be 30 centimetres… like the walls … square or round, doesn't matter… […]	frame of reference, not mentioning
	The tutoring dialogue continues, mainly on a product level. The teacher jumps from one aspect to another, barely referring to the process, only:	
5	T: then the exploration is what you need…	experiment, mentioned
	Later on, the student asks how to explore:	
6	S: yes… in fact I don't know how to explore further… T: By drawing, drawing, drawing, … by asking yourself what you are doing?	experiment, not mentioned + laboratory, mentioned
C	END TUTORING / EXAMPLES TEXT TEACHER	
	The tutoring ends with some sentences such as:	
7	T: it is all about making choices […] so: sections. And make also a drawing of the house on the site. That is a first sketch of the garden, that is important. Okay? Good luck!	experiment, mentioned

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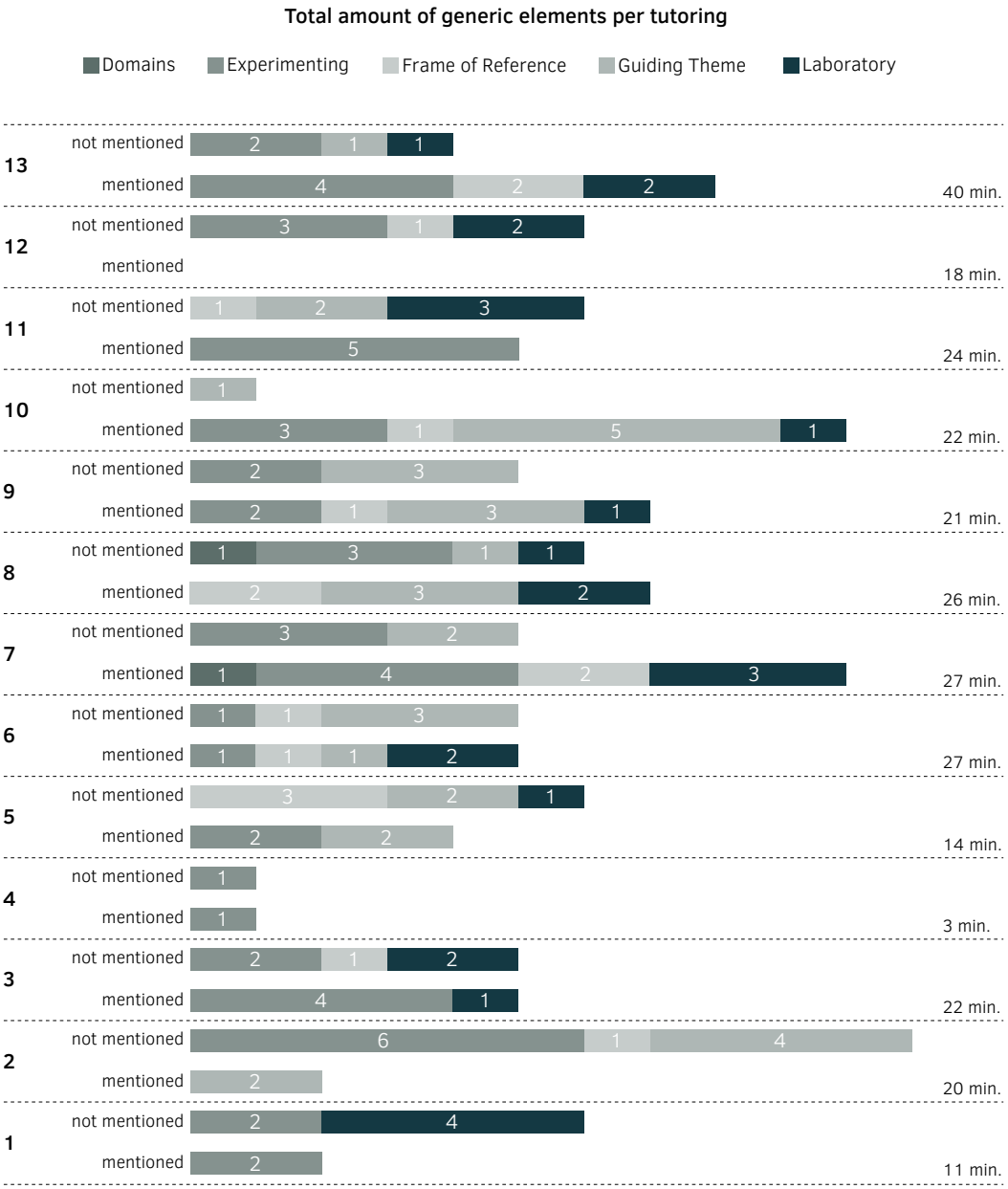

FIG. 4.3 Number of times design-process elements are referred to during tutorial dialogues and duration of tutorial dialogue in minutes per teacher.

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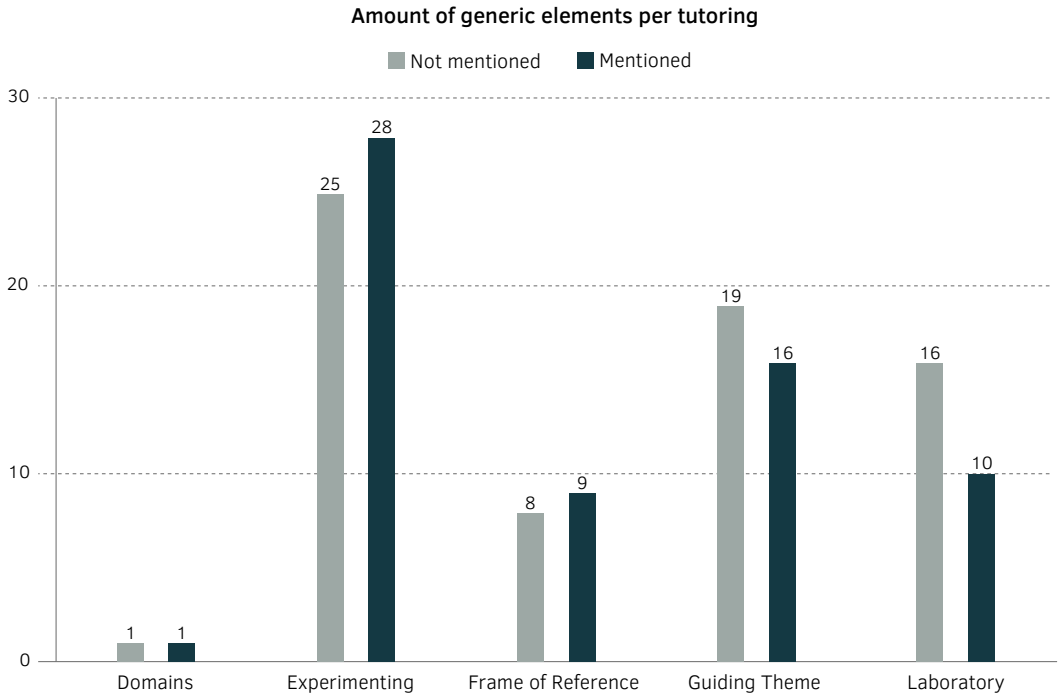

FIG. 4.4 Total number of times design-process elements are referred to during tutorial dialogues: teachers give examples (not mentioning) or refer to (mention) notions in the design process.

4.4.2 Experimenting or exploring and deciding

Of all the elements, teachers referred most to the element of experimenting: n=53/133 in thirteen tutorial dialogues (see Figure 4.3 and 4.4). However, teachers did not explain the 'how and why' of experimenting, neither did they give instruction in this respect.

Teachers showed the process of experimenting by suggesting and talking about possible solutions of the particular design problem at hand (n=25 'not mentioned'). For example, a student tells teacher 04 that concerning an issue of the previous tutorial dialogue - transporting large pieces of art to and from the studio on top of the house - he will solve this problem with a lifting platform. The teacher reacts

TOC

by saying that it is possible to use a platform "*being a large intervention […] you may make a hoisting beam at the façade […] or hire a crane each time you have to transport something […] or use the staircase*." He mentions that the last two options are not so handy. Then he simply goes on with another item without a conclusion or explanation.

Teachers also refer to the element of experimenting by using notions, such as 'different solutions', 'studying', 'alternatives', 'exploring things', 'just doing', 'testing', 'finding out' and 'choices you have to make' (n=28 'mentioned'). They use sentences almost as a kind of side-remark, while talking about the design product. See for an example, Table 4.3, part 3a.

In two quotes teachers give a glimpse of what experimenting actually means (coded as 'mentioned'). For example, see Table 4.3, part 3b.

And teacher 07 refers to testing (in combination with the element of laboratory): "*You need to test it. It is inventing or making and then testing if it is like that. (..) Testing is making or drawing. In making you may surprise yourself. …You cannot visualise everything, so your hands can do more than your mind. With a model it is the same, maybe you cut it the wrong way, but then it shows something, you may like*".

4.4.3 Guiding theme or qualities

Teachers also regularly refer to that what gives direction in the design process, a guiding theme or quality: n=35/133 in thirteen tutorial dialogues (see Figure 4.3 and 4.4). However, teachers do not explain the role of the guiding theme in relation to the product at hand, neither do they give instructions in this respect.

Teachers seem to refer to the process of giving direction by talking about possible aspects and moves regarding the particular design problem at hand (n=19 'not mentioned'). For example, teacher 11 seems to refer to how a designer may make a jump from a 'local' aspect to a theme for the entire design, without naming it: "*Instead of just using solar panels, you could consider finding out how to make the house as sustainable as possible? How can you make use of that in the architecture?*"

Teachers also refer more literally to the guiding theme, using a palette of names and notions, such as 'motives', 'starting points', 'dream images', the 'essential', that 'what gives surplus or value', 'the importance of doing something that distinguishes your

design from another', 'key-point', 'strip down to the core', the 'value' of the design, a 'story', a 'bigger story' and 'setting priorities' (n=16 mentioned). They all seem to have their personal names or notions.

Teacher 08 refers to a 'starting point': "*A contrast between an 'underground' and a 'floating' volume. That may be visible in the materialisation. That it is clear that they are different, … a contrast, being two different functions in two different elements. […] two characters… [..] That may be a starting point as well: that you have two similar things, worked out entirely differently*".

Three times a glimpse of 'the how and why' of a guiding theme is given (coded 'mentioned'). Teacher 05 refers to a bigger story: "*What I hear you saying is, I have looked at the roof, I made a variant for the roof, I know about the entrance, but those are all small solutions. […] What I miss is a bigger story. So you could take all kinds of small actions … it is all possible… but what do you want to achieve in the end? [...] Well, you are the designer. You have to say: this is what I want. It's like having a 'steppingstone', that makes it easier to take decisions"*. Teacher 09 refers to the quality in relation to making decisions: "*You may set priorities, for example, requirements that are essential for you, that may help you make decisions. If you make it all equal in value, it is hard to decide. If you say for example, it is about the dinner table, […] you may add quality by making a central space [..] Not everything has the same importance*". Teacher 10 seems to explain on a product level: "*Now you have to go to the key point, what is it that you want to achieve? So, you have to strip it down to the core, now. What is the most important?" […] I want to know what the core is. What do you want? […] Let's say you will present this to the brothers. They say they don't have the money. So you have to cut. Then it may become a slack extract of what you really wanted. So, from the start, you have to have a clear picture, so that you cannot miss what you want. […] It is not about the budget; we do not have a budget now. But it is about being aware of what you are doing*".

4.4.4 Domains

Throughout most of the tutoring sessions teachers refer to all kinds of aspects. Teachers and students talk a lot about aspects such as light, texture, colour, proportion, mass, composition, form, detail, structure, column, beam, span, experience space, function, and so on. The discussion is 'in' the domains, on a 'product-level'. However, teachers barely address the domains on the level of the design process. Only in rare occasions do teachers talk in a more abstract way about

the aspects and scales and the relation between them, about how to work in and across the domains: n=2/133 in thirteen tutorial dialogues (see Figure 4.3 and 4.4).

Both quotes refer to the relation between aspects. Teacher 08 in the form of an example (n=1 not mentioned): "*Do you want the hallway over there or over there? Do you want to be surprised? That you enter a room with its own view? But that is related to the anchoring. To the location. And a feeling of holiday*".

In the other quote (teacher 07) a first glimpse of explanation can be seen (n=1 'mentioned'): "*You can look at a building from different points of view, so from shape, function, direction of the wind, location. […] The location, the view, the function and the dynamics of eventual facade panels, that those relations… In a good design it appears at a certain moment, that your choices will strengthen each other.*"

4.4.5 Frame of reference or library of examples

Teachers refer to the frame of reference, to the professional principles and patterns designers work with: n=17/133 in 13 tutorial dialogues (see Figure 4.3 and 4.4). Teachers do not explain the role of references in the design process, nor in relation to the specific design product at hand. Neither do they give instructions how to work with references.

Teachers refer to a reference project by simply mentioning its specific name (n=8 'not mentioned'). For example, teacher 10 simply refers to being inspired by an architectural type: "*It is good that you let the treehouse inspire you.*" Teacher 08 refers to a specific item in a reference project: "*You had the teahouse of…*" (S:) "Toyo Ito" (T:) "*There is a large void, where downstairs and upstairs come together*".

Teachers also refer literally to the frame of reference, using one of two notions: 'reference' or 'example'.

Solely in two quotes more is said about the reference projects: teachers 06 and 07 refer to the analysis of a reference. They do not mention what to do with it in the design at hand.

4.4.6 Laboratory or the language of sketching & modelling

Teachers address the process of sketching and modelling: n=26/133 in 13 tutorial dialogues (see Figure 4.3 and 4.4).

Teachers do not explain the role of sketching and modelling in the design process, nor do they give more instructions.

Teachers refer to the laboratory with all kinds of sketches involved, such as drawings, sections, and plans (n=10 'not mentioned'). Teacher 03 says: "*You have to draw sections, you have drawn the facades well, now you have to draw the section"*.

Teachers also refer to the laboratory with the actions involved, such as sketching, modelling, drawing different times (n=16 'mentioned'). Teacher 01 says: "*Maybe you should think this over ... sketch what happens here" and "so, you have to sketch... different times. Roughly, as I do now. It does not have to be orderly*"'.

Because sketching and modelling are literally the laboratory for the process of experimenting, a direct relation can also be seen in the dialogues. For example, teacher 13 asks: "*Did you test that in a model?*".

4.4.7 Expressions used by the teachers

Exploring the way in which teachers talk, the open character is quite striking. Besides the obligatory statement: '*you have to ..'*, teachers let students decide what to do with what is said and how to do it. Teachers ask a lot of questions. For example, regarding the width of a staircase in relation to a place to show art (teacher 3): "*what is the size now?*, "*could it be wider?*". Furthermore they keep statements 'personal': "*What if you would say .. I am going to find this out*" (teacher 3), "*What is missing for me is a bigger story*" (teacher 05) and "*You may set priorities, for example, requirements which are essential to you, that may help you make decisions"* (teacher 09). When a student has made a choice regarding an aspect, it is regularly left open if it is a good choice or not. For example, in the example about the lifting platform mentioned earlier, new options are given when a student has come up with a solution, without discussing how to make the decision.

4.5 Conclusion and discussion

Regarding the first sub-question, in general teachers refer to elements in the design process several times in a tutoring session (see Figure 4.4). However, teachers refer to the design process (second sub-question) mainly in two ways: (1) implicit by using examples, directly related to the project at hand to show the process of designing, without mentioning or explaining the actions they 'model', and (2) literally to the design process by mentioning all kinds of notions, such as exploring, testing, variants, starting points and sketching. These notions have the character of side-remarks or footnotes, almost hidden in the discussion about the design product at hand. Teachers barely explain the design process. Only in five quotes (5 out of 133 quotes, teachers 03, 05, 07, 09, and 10), a first glimpse of making the design process more explicit can be seen. However, it is more a matter of justification than explanation. Therefore, they are labelled as 'mentioned'. None of the observed teachers gave explicit instructions. Regarding the kind of expressions (third sub-question), teachers mainly use questions and suggestions. They seem to leave the student to decide if and what to do with what the teacher has said: 'you can / may do that', 'for me, it is'. Even in the case of 'you have to', they do not explain the why and how of the mentioned action.

Answering the main question in this paper whether, to what extent and how teachers articulate the design process in architectural design education, we may conclude that it remains for a large part implicit. Overall, the tutoring is about all kinds of aspects involved in the design project at hand. Teachers talk with students about the position of the rooms, the form of the building, the position or measurements of a staircase, a view, the entrance, the composition of the facade, and all other kinds of aspects. Amongst this, teachers regularly mention design actions and skills in terms of 'you have to' or 'you may'. For example: they tell the student to explore, but they do not explain what they mean by that, how to explore in the particular situation at hand, and how it relates to ways designers generally explore.

Experienced designers may understand each other, however, for (novice) students this may be confusing. There may be a significant difference between what teachers mean and students understand, as Schön (1987) already illustrated with the 'drawing' example, mentioned above. Before discussing how teachers can make the design process explicit, first the limitations of the research will be discussed.

4.5.1 Limitations

In this paper, the articulation of the design process is literally the subject of research. However, as already mentioned in the introduction, tutoring in the studio is more than the text of the dialogue. Regularly, teachers and students refer to sketches, such as plans, sections, and models. In several cases teachers sketch parallel to their talking. Also, aspects such as body language and the atmosphere between teacher and student play a role. Together, these aspects could make the dialogue becoming more or less clear than only looking at the language and notions used.

One could justifiably argue that the design process should not be articulated in all tutorial dialogues. However, in thirteen randomly chosen observations in the first design project of the architectural design program, one may expect the design process to be explicitly articulated more often than it actually was. This should also be the case if the process is subject in other courses. Being subject in parallel courses and in the design studio, helps bridge the gap between theory and practice.

In principle the results of the case study presented here are not proof for other design school situations. However, recorded in different contexts and with different research approaches, the results presented here seem to run parallel to the results presented by Schön (1983, 1985, 1987), Dinham (1987), Uluoğlu (2000) and Goldschmidt, Hochman and Dafni (2010), which supports the generalisation of our findings.

Other limitations to the study presented here, are natural implications of the chosen research method: the process of recording and coding. Teachers may be affected by the presence of a camera. Furthermore, the number of labels per element may still be a point of discussion. However, these decisions do not interfere with the main conclusion. Only five quotes were topic of serious discussion, being on the border of being explicit. In fact, these quotes are an extensive way of mentioning, a kind of description what may happen in the design process. They do not explain the design process.

4.5.2 Making the design process explicit

In the process of analysing and labelling the framework helped in comparing what actually is said and what can be said seen from the perspective of the design process.

For example, in the dialogue about the staircase with some sculptures (see Table 3), teacher 03 starts to ask if the stair may be wider The student ('yes, 20 cm') seems to interpret it as a matter of measurement, being a first-year student without a large frame of reference. The teacher seems to 'pull' the student to the idea of a 'function exceeding staircase' and concludes about small things which may change the whole design, "that's what being an architect is about changing everything continuously. Until you think: this is how I want it to be." To avoid misinterpretations, to give an overview and to explain design process actions, it could be discussed more directly, such as: the staircase as (1) a functional staircase, (2) a staircase with room for having some pieces of art, (3) making the staircase as an art gallery, as the core of the house, or (4) making the house 'living in a loft-like art gallery'. Each with its (dis) advantages and its own specific proper means to achieve it. This way the student gains an overview and logic of architectural ideas, such as qualities or themes (e.g. house as art gallery) and architectural means, such as principles and patterns (e.g. enclosed staircase and hallway with rooms or a staircase in an open 'loft' space, each with corresponding constructional principles). The student still has to choose, but the teacher now articulates the kinds of choices and how these choices are related.

This example seems to run parallel to the way teachers mainly seem to tutor their students: reacting 'afterwards', discussing all kind of aspects of the design product at hand.

However, studio and tutorial dialogues may also be structured according to the 'designerly' actions and skills, to train students 'automatically' in the way designers think and act. First year students may be given small tasks as part of the whole design task, such as coming up with three themes or qualities next time, or coming up with alternative solutions and means to develop the preferred theme. For example; regarding the lifting platform the teacher might have given in the previous tutoring the instruction to study different methods of transporting objects vertically in reference projects, presenting them in diagrams or icons and reflecting on them in the situation at hand.

To conclude: teachers barely articulate the how and why of the design process in general, and in connection with the development of the design product at hand. They do not relate the situation at hand to the larger context of the design process. As educational practice proves, students may learn how to design simply as a result of doing design tasks and discussing the products at hand with their teachers – even when the design process stays implicit. However, making the design process explicit can significantly enrich and speed up their learning process (Kirschner, Sweller & Clark, 2006; Van Merrienboer & Kirschner, 2018). Students may experience learning-

how-to-design as less confusing, they may in the long term become better designers, they may spend their time in education more effectively, and their self-confidence may increase. With the help of a design vocabulary teachers should be able to talk about the design process and train students in a more explicit way.

Next research steps will be testing the framework in design education. Does it help teachers in being more explicit and in organising design education? And even more important, does it help students in mastering the confusion and become more successful designers?

Acknowledgement

A lot of thanks to all teachers and students, being so kind to do the tutorials before a camera.

TOC


KEYNOTES**
Thursdays 6:30 pm
Orange Room
Public Program
Spring 2020 Public Program
SHAPESHIFTERS
Transformeer je mee?
Architaste
Walking Dinner
MAANDAG
The Shape Within
The Growing Pavilion
Monday
17.02.20
Tuesday
18.02.20

5 Making the design process in design education explicit: two exploratory case studies

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ABSTRACT

The aim of design education is that students learn to think and act like designers. However, the focus in the design studio is mainly on the design product, whereas the 'why and how' of the design process are barely addressed. A risk of learning by performing real-life tasks without addressing the skills involved, that is, without receiving appropriate support and guidance, is that learners are overwhelmed by the complexity of the tasks.

To make the design process explicit, a conceptual framework is developed in earlier research. This paper reports a first evaluation how articulation of basic designerly skills with the help of a conceptual tool is perceived by students and teachers and whether it changes students' conceptions of the design process and their self-efficacy.
In two exploratory case studies, questionnaires give insight. The first is a short intervention in which students perception is measured. In the second case study the design process was addressed in the design studio. It measured changes in students conceptions and self-efficacy. Also insight is provided in teachers perception of working with the framework.

The results of these exploratory studies indicate a positive effect. The teachers involved perceived the framework as a structuring factor during the tutoring sessions, for both teacher and students. Students did perceive explanation of the design process as being helpful. A change in students' design conceptions and an increase in self-efficacy is seen.

KEYWORDS Design process, generic elements, framework, design education, architectural design.

5.1 Introduction

The aim of design education is that students learn to think and act like designers; they have to acquire the reasoning processes of professionals (Collins, Brown, & Holum, 1991; Van Merriënboer & Kirschner, 2018). For experienced professionals reasoning processes are not split up in separate steps. They constitute an undivided unity of automatic, unconscious actions based on common practice and routine, interspersed with conscious moments of reflection and exploration. For learners the complex, interwoven set of skills is (largely) unknown and unobservable. It has to be acquired by practicing while frequently doing 'whole' tasks (Van Merrienboer & Kester, 2008). To guide students in this 'journey in the unknown', it is helpful to address the design process explicitly.

However, in the architectural design studio students seem to learn mostly by practicing design tasks without explicit articulation of the actions and skills involved. Research in architectural design education (Van Dooren et al., 2019) has shown that tutoring appears to be primarily a matter of discussion on the level of the design product at hand. Teachers talk with students about all kinds of aspects involved in the design product in relatively detailed terms: such as the position of rooms, the form of the building, the view and the composition of the facade, and all other kind of aspects. If they refer to the design process, they do so almost solely as a kind of side remarks or footnotes. The 'how and why' of the basic design process are barely addressed.

A risk of learning by performing real-life tasks without addressing the skills involved, that is, without giving appropriate support and guidance, is that learners are overwhelmed by the complexity of the tasks (Van Merriënboer & Kirschner, 2018; Sweller, Van Merrienboer & Paas, 2019). Students are asked to perform skills, that are still unknown to them. In the context of a working memory with limited capacity

and a lack of adequate cognitive schemas and conceptions in their long-term memory, students tend to focus mainly on the specific design project at hand without a learning process taking place. Articulation and instruction of the professional reasoning processes, more in specifically the design process, will help students to develop effective conceptions.

Reasons for barely addressing the design process in the design studio, may be the lack of a commonly shared vocabulary and lay person conceptions on design education (Van Dooren et al., 2019). Teachers, being experts performing their skills for a large part implicit, talk with students in the same way they talk with colleagues in the design office and in the way they remember from their own education as a student. They are not used to talk about the design process and if they refer to it, they use their personal notions. Not being trained as teachers, they also seem to think that students (only) learn by discovering the designerly skills themselves (Van Dooren et al., 2019). Guidance in the form of leading questions and well-designed learning tasks regarding the skills that students are supposed to develop does not seem desirable in this view.

To be able to make the design process explicit and to have a common base for communication, a generic framework has been developed (Van Dooren et al., 2014). Five elements have been distinguished to explain the design process in relation to all kinds of design situations at hand, and to guide and train students in the development of design skills. These two main goals may include other goals, such as the comparison of personal design approaches and the articulation of the design processes in the context of teamwork.

This paper presents the results of two exploratory case studies, in which the framework is used to make the design process explicit and to guide and train students in specific essential design skills. The aim of the *first case study* is to investigate how first and third year Bachelor students perceived the articulation of the design process. The *second case study* gives insight in the results of working with the framework in two Master design studios. How did the teachers perceive the use of the framework in the tutorials and did students' conceptions of the design process and their self-efficacy change as a result of using the framework?

In the remainder of this introductory section, information about (the relation between) students' self-efficacy, their design conceptions and the way teachers articulate the design process will be given. Then, the framework is briefly introduced. The section ends with the main research question, the sub-questions and an introduction on the research method. The following two sections each present and discuss an exploratory case study. Finally, overall conclusions are drawn and discussed.

5.1.1 Self-efficacy and design-process conceptions

Students' self-efficacy, their design process conceptions and the way in which teachers make the design reasoning processes explicit and help students to acquire adequate design skills are related to each other.

The design process conceptions are the mental models and cognitive strategies, which describe how to perform tasks and how to reason. There may be large differences between effective sophisticated conceptions of professional designers and intuitive or lay person conceptions used by novices (Van Merriënboer and Kirschner, 2018). Students and lay persons tend to consider designing as a process of solving 'the problem', posed by conditions and criteria, presented by the client, site and program analysis. Observing the typical behaviour of novice design students and comparing it with their conceptual drawings of the design process, made by these students, Newstetter and McCracken (2001) concluded that the drawings were prophetic for the design behaviour of students. The design process was mainly represented in two ways: in linear flow charts and as a creative process, with an emphasis on brainstorming, intuition and imagination. These conceptions could be recognised in the behaviour characteristics they observed: (1) coming up with good ideas without evaluation, (2) coming up with solely one idea without considering alternatives, (3) working in a linear, serial process without iteration, (4) working on the idea and the component level without moving between these levels, and (5) ignoring constraints and context (environment and user). The sophisticated conceptions of professional designers include designing as an ill-defined, open-ended, complex, personal and culturally influenced process. The process unfolds in a process of experimentation. Conditions and criteria are discovered during the process of exploring and reflection. Designing is a matter of coming up with inferences and profound testing of possible solutions (Cross, 2007; Lawson, 2006; Lawson & Dorst, 2009; Schön, 1983, 1985, 1987). If teachers show and articulate their sophisticated design-process conceptions, students ability to perform the design process may increase and their self-efficacy may rise.

Self-efficacy, the perceived belief in the personal ability to perform, is caused by and affects different cognitive, motivational and affective processes. Sources of self-efficacy are mastery experiences, experiences provided by social models, social persuasion and the reduction of stress reactions (Bandura, 1994). In principle, if students are able to master challenging tasks, not too easy, but still realistic in relation to their prior knowledge and experience, their self-efficacy will increase. Their ability to perform challenging tasks will increase and their stress level may decrease. Main teaching issues to increase the ability to master challenging tasks are the behaviour and articulated way of thinking of the teachers and the way in which they help students acquire skills that enable them to deal with new tasks.

5.1.2 A framework for design education

In the past decades, research has been conducted on the reasoning processes of design experts. Researchers have used different terms to describe the different basic skills, such as conjecture and analysis (Hillier, Musgrove & O'Sullivan, 1972); primary generator (Darke, 1979); imposition of an order, naming and framing, reflection-in-action, conducting experiments, and a web of moves (Schön, 1983, 1985, 1987); a co-evolution of solution and problem spaces (Lawson, 2006; Cross, 2007; Lawson & Dorst, 2009), and ideation and evaluation (Goldschmidt, 2014). These terms are regularly overlapping each other.

To help teachers and students discuss the design process, an overview is needed which is relatively simple to remember and easily to use. Therefore, the body of knowledge is brought back to as few elements as possible, five basic design skills present in any design process. The elements are interwoven with each other. There is no fixed step-by-step sequence; the emphasis on the elements depends upon the kind of project, the designer and the design discipline. The five elements are certainly not meant as a prescription or recipe for design, they are only meant to articulate the 'designerly' reasoning processes and to help in designing adequate design courses, to guide and train students in the main design skills.

For each of the elements (see Figure 5.1) a short description is given:

- *Experimenting* is a process of *exploring and reflecting*. Exploring refers to a process of being open and alert, coming up with alternative options in a rational and associative manner. Reflection refers to the process of testing, of analysing and evaluating the possible solutions, looking for (un)intended consequences of the provisional solutions and looking for the option that best fits the design situation at hand. Experimentation is studying different options, in a fractal-like process of diverging and converging.

- *Guiding theme or quality* stands for the 'emergence' or imposition of a focus, an inspiring direction, something to hold on to in an almost endless field of possibilities and to help in creating coherence and significance in the design result. The guiding theme is the personal 'answer' of the designer, influenced by culture and profession. The qualities develop during the design process, from vague and abstract to a concrete elaborated solution fitting the situation at hand.

- *Domains* consist of all *aspects and scale levels* designers have to address in the design result, such as space, material, function, the direct context of the site, and a broader socio-cultural context. Designers have to make statements and choices and

they have to deal with a lot of knowledge and information – such as criteria, rules, preferences and cultural habits – in and across the domains. Aspects influence each other, choices in one domain can be made with knowledge about other domains.

— The *frame of references* is the common professional and personal *library of knowledge* and experience in the minds of designers, consisting of ideas and qualities and abstract and proven rules of thumb, principles and patterns. In these 'knowledge chunks' different domains come together (for example in a spatial type structural or circulation aspects are already embedded). Consciously or unconsciously, designers explore and test these 'knowledge chunks'; they use, reject and transform them in the situation at hand.

— *Laboratory* is the (visual) language designers use to experiment. The most important physical "designerly language" is *sketching and modelling*. The visual functions as an extended working memory, complementary to the language of words and notions. With the help of different visual means, the process of "designerly" thinking, of exploring and reflecting on options and discovering new insights, unfolds.

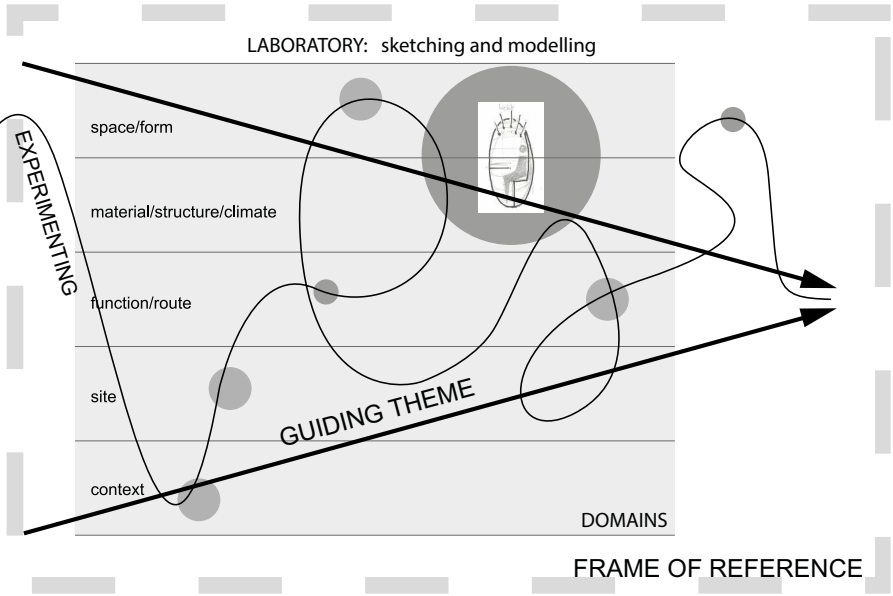


FIG. 5.1 The five generic elements in the design process: (1) experimenting, (2) guiding theme, (3) domains, (4) frame of reference and (5) laboratory (Van Dooren et al., 2014)

TOC

5.1.3 Questions and method

In the research presented here, the main question is how articulation of basic designerly skills with the help of a conceptual tool is perceived by students and teachers and if it changes students' conceptions of the design process and their self-efficacy.

To answer the main question, four sub questions will be answered in two case studies (Harland, 2014; Burke Johnson, Onwuegbuzie & Turner, 2007). The *first case study* explored the perception of students: (1) how did first and third year Bachelor students perceive the value of the framework as a conceptual instrument to gain understanding of the design process? The *second case study* focussed on students and teachers in two master design studios. This study explored the change in students' conceptions and self-efficacy: (2) Did first year Master students acquire more sophisticated conceptions? and (3) Did addressing the design process increase their self-efficacy? Finally, the teachers involved were questioned about their perceptions: (4) Do teachers perceive the framework as a supportive tool to make the design process explicit, for themselves and for their students?

Both case studies include each an intervention, a questionnaire and statistical analysis. An overview is given in Table 5.1.

In the *first case study* the perception of Bachelor students was measured. It is expected that students conceptions and self-efficacy may change if teachers address the design process intensively, more specific during a longer period in direct relation to the design process at hand. Therefore, the *second case study* included a more profound test of the framework in the design studio. Two relatively small groups of students were involved in the intervention: with a few years and almost without design experience. Also the teachers involved were asked whether the framework was perceived as useful. In addition to the research, informal anecdotal information is given from students involved in the master studios.

TABLE 5.1 Overview of the two case studies.

first case study: Bachelor	
content	lecture, text and reflection
participants	380 first year + 240 third year Bsc students
perception	survey + analysis value of making design process explicit and reflection on personal design process
second case study: Master design studios	
content	lectures, text and reflection + tutorials and training
participants	7 academy, 8 university MSc students, respectively without and with design experience + 3 teachers
perception teachers	survey: value framework for tutoring and for students
conceptions students	survey + analysis: five notions, a visual representation and imagine a house
self-efficacy students	survey + analysis: statements concerning understanding, trust,…

5.2 Case study 1: students' perception (first sub question)

5.2.1 Participants and setting

All architectural students involved participated in a first or a third year 'academic skill' course in the Spring semester of 2017. The students followed a BSc Architecture study at a Dutch university. Almost all of them came directly from high school in the Netherlands.

The first-year students (N=380) fulfilled a 'one-day' assignment, a short reflection written on the day of the lecture without further guidance. The third-year students (N=240) worked on a 'two-weeks' assignment; they were guided by 20 teachers, selected to teach research and writing and having different teaching experience in general and in these courses specifically.

The information for students and teachers consisted of an English text about the five generic elements (Van Dooren et al., 2014) and one lecture, which provided a short overview of the generic elements (by the first author). On the basis of the framework, students were asked to write a reflection on their personal design process in a parallel running design project.

The first year students' response rate was 29%, the third year students' response rate was 30%.

5.2.2 Material, procedure and analysis

Questionnaires concerning the first sub question were distributed in September 2017. Figure 5.2 shows the questions which focussed on reflection on the personal design process (1.1), and more specifically with the help of the framework (1.2 and 1.3), the value of making the design process explicit in a text and lecture (1.5), and having knowledge of the design process (1.6). The main goal was to get information on students perception. But because there seemed to be a relative large difference between the assessments given by the first and third year students, it was tested with the Mann-Whitney U test for two independent samples.

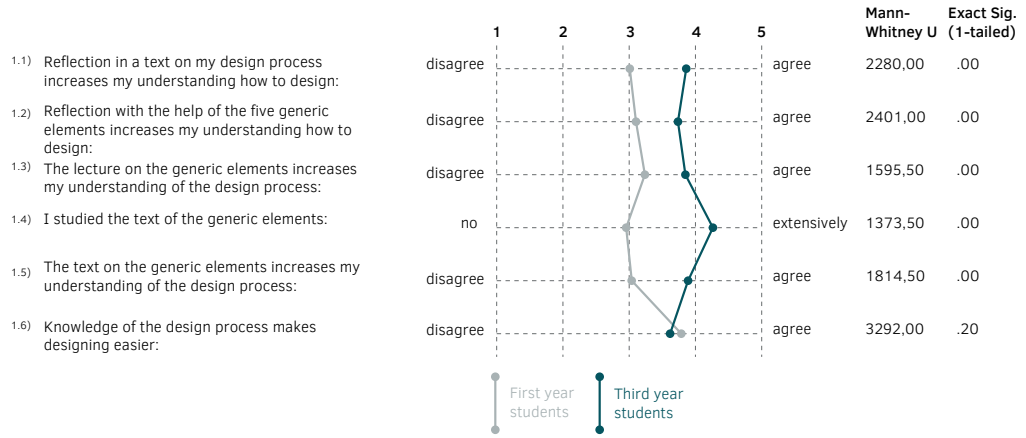


FIG. 5.2 Students' perception of making the design process explicit and Mann-Whitney U test for differences in assessment by the first / third year students

TOC

5.2.3 Results

Figure 5.1 shows the results. Five out of the six statements have been assessed significantly different by the first year and third year students ($p < .001$). Addressing the design process (in text, lecture and reflection) is perceived neutral by first year students and significantly more positive by third year students. Both groups are equally positive on 'knowledge makes the design process easier'.

5.2.4 Discussion

Making the design process explicit with the framework of the five generic elements as a conceptual tool (first sub-question) has been perceived neutral to positive.

There may be several causes for the distinction in outcomes between the first year and third year students. The most obvious reasons may be the difference in duration of the assignment (one day versus two weeks) and the difference in design experience. Third year students may be more in need of getting to grips with the design process and they had more time to study than first year students.

The *first case study* investigated the perceptions of making the design process explicit by a relatively short 'study and reflection' task in a separate course, parallel to the design studio. However, designing is learned in the design studio, during the whole design project. Therefore, the data collection for the *second case study* takes place in the design studio: the design process is made explicit in direct relation to the successive preliminary design products of the students.

5.3 Case study 2: teacher perceptions and students' change in conceptions and self-efficacy (second, third and fourth sub question)

5.3.1 Participants

All students involved studied architecture and participated in one of two Master design studios in the Fall semester of 2017. The studios were given in two different Dutch design schools, an academy and an university. The *Academy Project* is a mandatory MSc 1 studio. Eight students had started their Master with no or relative little design experience. They had different backgrounds: primarily building sciences and in a few cases civil engineering or art. This MSc 1 is the first studio in a four year part time study, in which students always work in design offices parallel to the design studios. The *University Project* is an elective MSc 2 studio, part of a two year full time MSc Architecture. Six out of seven students already completed a full time three year architectural design BSc at the same university, one student completed a building engineering BSc background. This elective MSc 2 included a ten week long apprenticeship as assistant-teacher in a first year design studio for Bachelor students. The language spoken in both the academy and university project was Dutch.

The teaching staff consisted of four teachers, including the first author. The other three were selected because they had a more than average interest in being more explicit about the design process. The teachers worked partly individually, partly in couples in the design studios. They differed in experience in teaching in general and specifically in supervising these projects.

5.3.2 Setting

In the Academy Project the students had to do one design assignment and in the University Project students had to do three relatively short design tasks. Goal of both design studios was to learn to (1) experiment by sketching and modelling as

the basic ‘designerly’ skill, (2) work with a guiding theme or qualitIes, (3) see the relations between the different architectural aspects or domains, and (4) recognise (spatial) patterns in reference projects and explore them in a project at hand (frame of references).

TABLE 5.2 Examples of leading questions and learning tasks referring to generic elements, referred to in direct relation to the design at hand.

generic element	examples of leading questions, asked by teachers	examples of learning tasks, instructions given by teachers
experiment	what happens if….? / which experiments did you have done? / what implications did you discover? / which one do you prefer? / which experiments should be done next?	come up with few different options / looking for the similarities and differences / testing an experiment in other domains
guiding theme	what kind of identity or quality do you want to achieve? / is this […] the meaning you want to give the design? / which means are related to the chosen quality?	come up with different qualities for this particular design situation / come up with alternative options and architectural means to express the chosen quality’
domains	what does this decision (e.g. a spatial order) mean for other aspects (e.g. the structure)? / in which domains(s) do you have or wish to do experiments as a next step? / what does the theme or identity mean for this aspect?’	look for implications of a choice in one domain in other domains / study the architectural means in the different domains to express the chosen theme
frame of reference	what happens if you do it like […] ? / which projects do you like and which values or qualities do they express, in specific for your design? / what does this [... e.g. spatial] pattern mean for the other aspects?	come up with the patterns in these projects / experiment in the design situation at hand with these patterns
laboratory	how do you test these possible solutions, in a sketch, model,…? / which visual mean do you need? / what did you discover by making a model?	make an abstraction / study the possible options by making different sketches and models / explore this option in plan, section and perspective

The framework was addressed in several ways. First, information on the generic elements was given in a text (Van Dooren et al., 2014) and in lectures, given by the first author in the first weeks of the projects. After an overview lecture, the elements were discussed more in depth in three other lectures. Secondly, during the design tutorials the teachers referred to and explained the basic ‘designerly’ skills as best as possible in relation to the design situation at hand. Table 5.2 shows examples of how the design process was addressed in the tutorial dialogues. Both, leading questions and learning tasks, were used during the individual dialogues and during group tutorials. Thirdly, all students had to present their design process on a poster and write a reflection about it, in the order of the elements.

5.3.3 Material and procedure

Table 5.3 shows the questions concerning the change in students' conceptions (second sub question), the change in students' self-efficacy (third sub question) and the teachers' perceptions (fourth sub question). To gain insight in the change in students' conceptions and self-efficacy, a questionnaire was handed out before, directly after, and 2-4 months after the project (pre, post and delayed post). The change in conception of the design process, was measured in three questions. The change in self-efficacy was measured with a set of 8 statements that had to be scored on a 4-point scale (completely false / barely true / somewhat true / completely true). To gain insight into the experiences of the three teachers involved(apart from the first author), they answered three open questions after the design studio.

TABLE 5.3 Questionnaires in reference to addressing the design process in the design studio: teachers' perception and students' change in conceptions and self-efficacy (pre, post and delayed post).

Subject		Questions
students' conceptions (third sub question)	**Q 1**	What are the first five notions you think of regarding the design project?
	Q 2	Make a visual representation of the design process with the help of the words from the previous question.
	Q 3	Imagine, you get the assignment to design a free standing house. Explain in short how you would approach this task (max. 100 words).
students' self-efficacy (fourth sub question)	**s 1** **s 2** **s 3** **s 4** **s 5** **s 6** **s 7** **s 8**	To what extent do you agree or disagree with the following statements at this moment: I have enough understanding of the design process to be able to design. I trust myself that to effectively approach unexpected events while designing. I have enough insight and skills to integrate different aspects in a design. While designing, I always see multiple solutions. When I get stuck in the design process, I know in most cases what to do. I know I'm able to apply generic design principles and basic skills. I know that I'm able to become an excellent designer. Although it can be difficult, I have fun in designing.
teachers' perceptions (second sub question)	**q 1**	Does the framework help in tutoring students? If so, how / why?
	q 2	Do you have the impression that it helps students? If so, how? (if possible with examples of students)
	q 3	Other remarks?

5.3.4 Analysis

The process of coding, counting and analysis of *students conceptions* is done by two researchers. The codes were defined, based on the five elements and study of the data. The final decisions were taken by the main researcher (first author).

Regarding *the first five notions you think of regarding the design project* (students perception Q 1) eight codes were distinguished. Two codes for separate aspects and actions (D1, space, form, function, and E1, exploring, deciding) and five codes for the elements as comprehensive notion: (D2, domains; E2, experimentation; G, guiding theme; R, frame of reference; L, laboratory) and one code for all other notions, regularly more personal perceptions (P; stress, complex). The differences between the codes were tested with the Cochran Q test for k-related samples with a binary variable. Before the test the scores were transformed into binary variables (0 - 1 / item named or not named).

In reference to *the visual representations of the design process* (students perception Q 2), five codes were distinguished, gradually increasing in complexity: (1) linear steps, (2) linear steps with one feedback loop or parallel lines in one step, (3) steps with several loops or parallel lines, (4) zigzag, parallel lines, network like, and (5) complex combinations of zigzag, parallel lines, including guiding theme lines.

With respect to *the descriptions given imagining a real situation* (students perception Q 3), the stories were analysed in idea units. Three codes were distinguished: (a) the number of elements mentioned in combination in one idea-unit, (b) the process as elaboration or experimentation, and (c) the emphasis on preconditions, including client, site analysis and program.

The internal consistency of the eight *self-efficacy statements* (s1-s8) is tested with Cronbach's Alpha coefficient. A reliable scale is shown for the second and third measurement (Cronbach's Alpha > 0.8); it was relatively low but still acceptable for the first measurement (Cronbach's Alpha = 0.67).

5.3.5 Results

Change in students' conceptions (second sub question)

The data collected from the questionnaires provide insight into the change in students' conceptions of the design process, seen from three different perspectives: the first five notions you think of regarding the design project (Q1), visualisation of the design process (Q2), and the imagination of a real situation (Q3).

In Table 5.4 *the notions named* (Q1) are presented in relation to the elements of the framework. Specifically, four groups of notions show a significantly different distribution of the measurements pre and post the project ($p < .05$): a decrease in separate aspects, such as space, function, site (D1) and separate actions such as exploring and investigation (E2), and an increase in the more comprehensive notions domains (D2) and frame of references (R).

TABLE 5.4 Numbers of notions named by students per measurement reflecting their conceptions on the design process and significant results on Cochran's Q tests.

	CODE	NOTIONS	Pre	Post	Delayed post	Q	df	p-value
DOMAINS	**D1**	partial notions, separate aspects, such as space, user, material, context, site, form,…	24	8	14	8	2	.02
	D2	comprehensive description, such as domains or aspects	0	7	7	9,8	2	.01
EXPERIMENT	**E1**	partial notions, specific actions, such as develop, investigate, discover, (connecting) ideas, study, analyzing, di/ converging, reflection, iterate, compare, (dis) advantages,	15	7	6	3,5	2	.27
	E2	comprehensive notions, such as experimenting.	1	13	9	18,67	2	.00
GUIDING THEME	**G**	comprehensive notions, such as concept, vision, direction, (guiding) theme	6	9	12	4,91	2	.10
REFERENCES	**R**	comprehensive notions, such as (frame of) references, case studies,	2	9	10	11,4	2	.00
LABORATORY	**L**	comprehensive notions, such as sketching, modelling, drawing, laboratory	9	9	6	0,75	2	,90
PERSONAL GENERAL, PERCEPTION	**P**	observing, input, collaboration, creative, logic, design, learning, presentation, flexible, divers, creative, designing, fail, critical and honest, keep positive, stress	18	12	11	1,56	2	.59

Table 5.5 shows *the change in the visualisation of the design process* (Q2). A shift can be seen in the number of students from naming more simple, step-by-step visualisations before the project towards criss-cross and complex visualisations after the project. The Chi-square test shows a significantly different distribution of the measurements of how students visualise the design process (chi-square=15,85, df=8, $p < .05$).

TABLE 5.5 Visualisations of the design process: a shift in the number of students from naming more simple towards more complex visualisations.

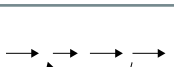
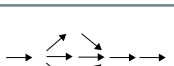
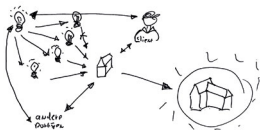
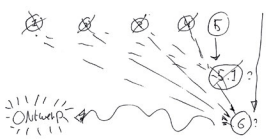
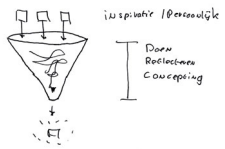
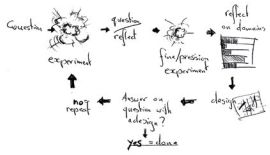
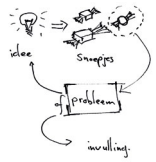
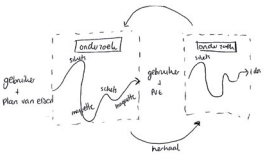
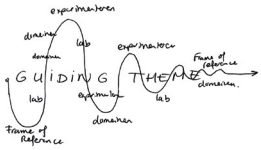
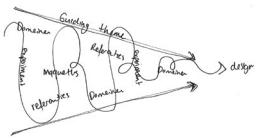
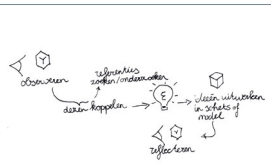
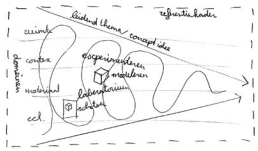
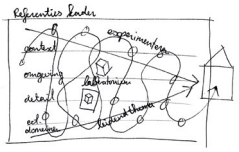
abstraction of patterns					
	1. linear steps	**2. steps / feedback loop / parallel lines**	**3. steps / more loops +/parallel lines**	**4. zigzag/ parallel lines/ network like**	**5. zigzag/ parallel lines/ network like/ incl. guiding lines**
pre	2	5	4	2	2
post	0	2	2	5	6
delayed post	0	0	3	3	9

Table 5.6 shows some examples of student visualisations. All four selected students start with a more linear sequence. The academy students A2 and A3 show in their visualisations 'having ideas' as parallel actions in one step, which then are worked out in the next steps. The visualisation of university student U6 is the most linear one, U5 is the most complex one. Post and delayed post the project almost all visualisations show higher complexity. The visualisation of student A2 shows delayed post a more criss-cross symbol. In the visualisations of student A3 the linear sequence is still there but now in an iterative loop. The visualisations of U5 and U6 are more complex and criss-cross and show more resemblance to the framework: student U6 refers almost literally and student U5 comes up with a personal interpretation of the framework.

TABLE 5.6 Examples of visualisations of the design process of four students, measured pre, post, and delayed post (Q2).

	Pre	Post	Delayed post
A2			
A3			
U5			
U6			

In reference to *the imagination of a real situation* pre, post and delayed post design studio (Q3), the stories seem to change in conception from simple towards more complex, 'from problem solving towards designing'. Table 5.7 shows examples of the same students as in Figure 5.2 (Q2). Before the project the design seems to be directed by client / program and site analysis. After the project client / program and site analysis are still important, but other actions are also mentioned such as essence, experimenting and alternatives (student A2). A second parallel tendency concerns the notion elaboration. Before the project the design process seems to be mostly a matter of elaboration (of one or more ideas), after the project refining is still mentioned but more in combination with developing a theme and testing on domains (student A3). And finally, directly after the project the idea units include more actions and skills in direct relation to each other. Student U5, for example, says: "*At the hand of references and personal ideas slowly a 'guiding theme' will emerge, or at least the start of it*". And U6: "*Also I should look into houses of buildings in reference to my guiding theme. These might be inspiration to experiment further in the different domains.*"

TABLE 5.7 Examples of descriptions imagining a real situation (question 3).

Student	Pre	Post	Delayed post
A2	"Firstly discussing with the client, based on the 'right' questions, to collect starting points. Then looking over site, context, orientation and so on. // Then discussion about the design with the client for remarks. When needed modify."	"Discussion with client to achieve 'true wishes'. //Coming up with the essence. Followed by a frame to direct the process.// Experimenting with aspects such as form, site, material and context. // Then showing alternatives to client to reflect and develop."	"Discussion with the client, to get to know him (personality, character, interests, preferences).// From here trying to come up with a guiding theme, with conditions connected to it. // Next all information trying out in different sketches and models. // Reflection together with the client."
A3	"Check my limitations: budget, environment, size. Think about primary goal(s) and list them. Think about secondary goal(s) and list them. // Sketch a number of designs. Ponder which feels to fit the goals the best (could be multiple). // Refine the design to make it practical while maintaining the essence. Finished."	"Investigate the site. What are the values. How can I use them. // Start sketching designs. See what works with your site and "ambition". // Develop a guiding theme.// Find references which work for your design. // Start testing your design on the domains and reflect. // Refine your design or alter your design accordingly. // Repeat till finished/ out of time."	"Visit the site. What kind of experience I want? // Experimenting. // Some elaborate, reflect on domains and elements. // Repeating this until time ends or project is finished."
B5	"I should start with an investigation of the site […] requirements users, looking at their living style […] From this investigation you achieve the most important design themes or improvements, together the starting points. // With these starting points, you sketch and model. // First on larger scale, but also ideas on a smaller scale can be imported. // In between you look if the provisional design fits the user. // Probably you have to make more versions. Iteration till a fitting design."	"I should start with exploring qualities in the site and task to come up with a guiding theme. // Then experimenting by sketching. Firstly, testing functionality and spatiality, e.g. in different plans. // The choice is made with the guiding theme at hand: does it fit? //References may help in generating new ideas, to experiment further.// Working in different scales, making variants, making provisional choices working in a different domain. Coming back on previous decisions. // Through the whole process the guiding theme serves as a kind of test frame, to come up with a coherent whole."	"I would start with looking into the domains: what spatial area is needed. // At the hand of references and personal ideas slowly a 'guiding theme' will emerge, or at least the start of it. // Next experimenting will provide alternatives in the five domains.// The experiments fitting the theme, atmosphere and the requirements are feasible to do further experiments. // This proceeds until the point that design and theme are a whole."

>>>

TABLE 5.7 Examples of descriptions imagining a real situation (question 3).

Student	Pre	Post	Delayed post
B6	"Starting with investigation of the site, what kind of existing materials, culture, and so on. For whom, what are the requirements or interests. // Next to that searching for other references for inspiration. /Then, mostly the first sketches will unfold. // If I get stuck, I often make a small model or repeat investigation. The sketch or model I reflect to the self-imposed requirements or starting points."	"I would start with coming up with the kind of house I want to make: atmosphere, impact,… next to that I should look for references, which direction I want to go (guiding theme). // Then I would start with sketching and making a lot of alternatives, look if they fit in the guiding theme. // Then elaborating through the different domains, until a consistent, good elaborated design is developed."	"First I should investigate the environment and the context of the site. // From here a guiding theme may rise; or a fascination could be for me the guiding theme, which I will use to experiment. // Also I should look into houses of buildings in reference to my guiding theme. These might be inspiration to experiment further in the different domains. // Finally, testing in reference to the theme a final design is worked out."

This last effect, the combinations of design elements, is also presented in Table 5.8. The overall Chi-square test over the three measurement moments shows a significant difference in combined elements just after the studio (chi-square= 16.77, df=3, $p < .01$). Also the decrease in combined elements from the second to the third measurement moment is significant (chi-square=9,25, df=3, $p < .05$). So the increase in the combined elements is only present just after the studio and does not last.

TABLE 5.8 Number of idea units with a combination of elements mentioned imagining a real situation per measurement (Q3).

	Pre	Post	Delayed post
1 element	42	25	41
2 element	13	30	16
3 element	0	5	4
4 element	0	1	0

Changes in students' self-efficacy (third sub question)

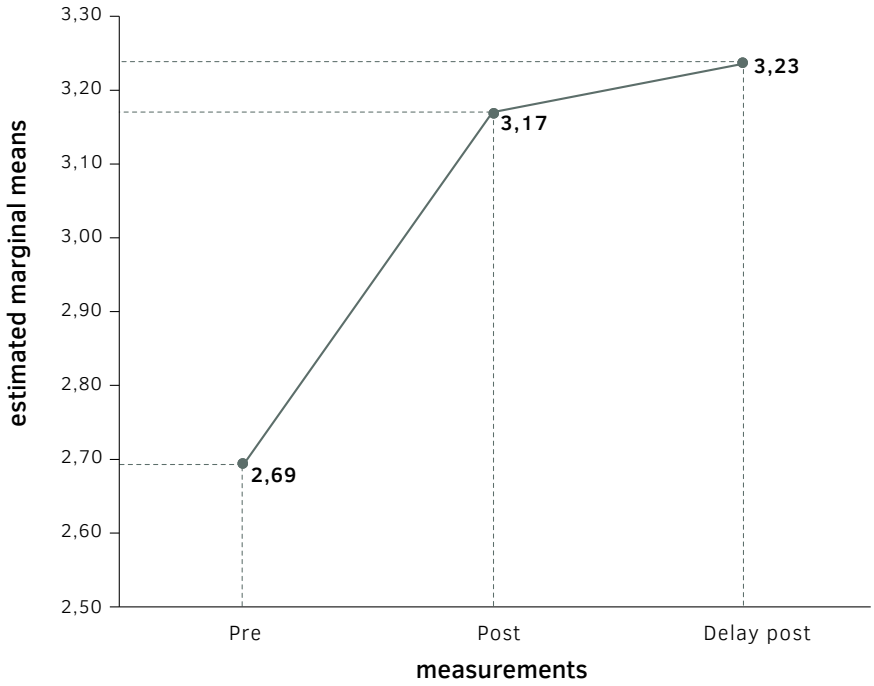


FIG. 5.3 Increase in self-efficacy students pre, post and delayed post project.

After the project the self-efficacy of the students (see Figure 5.3) has significantly increased and the effect remains till at least 2-4 months after the project. ANOVA with Repeated Measures shows significant differences between the average self-efficacy scores ($F = 21.54$; $df = 2.13$; $p < .01$). Paired t-tests showed significant differences between the first and the second measurement ($t=-4.79$, $df=14$, $p<.01$) and between the first and the third measurement ($t=-6.72$, $df=14$, $p < .01$). It is interesting to see that self-efficacy did not drop after 2-4 months (see Figure 5.3).

Teachers' perceptions of using the framework (fourth sub question)

Each three teachers involved(apart from the first author) perceived the framework elements as a structuring factor during the tutoring sessions, both for teachers and students. Teacher 2 compared the framework with a map: the discussion with the student improves if you have an overview of all areas and know which area is the discussion topic at a particular moment.

Teacher 1 mentions that it is almost a list you have in mind, with the kind of things which may be discussed with the student. When a student gets stuck, he literally goes over the list together with the student to show how you may act in situations like these. Teacher 3 asserts that it helps in formulating concrete tasks for students, such as experimentation. When a student gets stuck, he is more able to see possible reasons, such as not enough references, no clear theme, or no experimentation.

The teachers had the impression that the framework directly helped the students to decrease anxiety and uncertainty and to get to grips with the design process. Students' pleasure and understanding seemed to increase and they felt that they were allowed to make mistakes.

As extra remark teacher 1 mentioned that it helped when working with a student on a design you do not like as a teacher. He continues: "*I'm used to teachers with a judging attitude, from their opinion about right or wrong, attractive or unattractive. This method gets around this. That is clever, because as a human being you tend to the 'right or wrong' attitude very easily.*" Teacher 3 mentioned that his personal fun in designing and design tutoring has increased.

5.3.6 Spontaneous student' remarks

Not only the results of the questionnaires, also spontaneous remarks made by the students confirm the assumption of teachers that the framework may be helpful for students. In the University project some of the students used a representation of the generic framework more or less literally. Questioned why, they concluded that the scheme was very helpful, therefore they worked with it the whole studio period. And one of the students participating in the Academy Project reported similarly in an email. He wrote that he started with the wish to be an architect, but almost without understanding of what designing meant. His first design studio in the Academy project was a struggle, also with the scheme and text. After the first design studio during the next two design studios, he related most of his actions to the scheme to understand the process. In the fourth project the scheme was solely implicit somewhere at the back of his mind and his understanding of the design process had increased, which was also illustrated by his grades (from sufficient to good).

5.3.7 Discussion

The second case study indicates positive results. Regarding the *conceptions of students* (second sub-question) we see to a certain extent a move from layperson conceptions towards sophisticated conceptions of the design process. The layperson conceptions consist of (1) a linear design process, frequently with a feedback loop, (2) having ideas (without testing) or having one idea and elaboration, (3) the client as a source of feedback, and preconditions in general such as brief and site analysis as source for solutions, and (4) a relatively high number of separate aspects, such as space, site, form, and partial notions such as investigation. Students may see the design process as coming up with ideas as a kind of solutions, as 'logical' implications of the design task and its conditions, more specific of 'what the client wants'. In this conception the designer seems to solve the problem, put forward by the client. The more sophisticated conceptions consist of (1) a zigzagging, criss-cross, and parallel process, (2) more comprehensive and inclusive terms, such as experimentation, guiding theme (concept, vision), and frame of reference, and (3) naming the design actions and skills more often in relation to each other. The discussion with the client is still there, but students may see designing more as exploring and testing alternatives, working parallel and across in the diverse domains, and working with overall qualities or guiding themes.

Regarding *students self-efficacy* (third sub-question), on average an increase is shown after the design studio. Studying the design process and having more sophisticated conceptions of the design process may be related to the believe in being able to design.

Finally, the teachers involved in the design studios *perceived* working with the framework (fourth sub-question) as a structuring factor, which helps teacher and students to gain an overview and helps in cases of getting stuck. It may help in making the tutoring less dependent on personal preferences of the teacher. The teachers' perception that the framework may be helpful for students seems to run parallel with the changes in students' conceptions and self-efficacy.

5.4 General Discussion

The results of the two case studies indicate positive effects of making the design process explicit. At least a part of the students did perceive articulation of the design process as being helpful. For the teachers involved the framework works as a structuring tool. Their perception that it helps students, seems to be confirmed by the change in students' design conceptions and their increase in self-efficacy.

However, the positive results presented here should be taken with caution.

Obviously, there is no guarantee that using the framework terms more often after than before the project will lead to better understanding and improvement of design skills. Secondly, solely based on the second case study, it cannot be concluded that the moves in conceptions are more different than they might have been in a 'normal' product-oriented educational approach. Even though the fact that more or less the same kind of lay person conceptions were seen at the start of both the Academy and the University Project, indicates that there was no difference in conceptions between less and more experienced design students. Thirdly, the increase in self-efficacy may also have other causes, such as a positive encouraging studio environment. And finally, conclusions can be solely tentative because of the limited scale of the case studies.

Only a full experiment with a larger number of students, with control groups and during a longer period of time may provide more robust evidence for the effects of making the design process explicit. In a large scale experiment, especially during a longer period, it is not only expected that students self-efficacy increases and student's conceptions of the design process become more sophisticated, but also students' skills may increase and become more adequate and effective.

Yet, the positive results run parallel with the positive informal reactions of participating students and they are in line with other research. Kirschner, Sweller and Clark (2006) conclude that controlled studies support strong instructional guidance for the learning of complex skills. The results of the second case-study show the same kind of lay person conceptions of novice design students, as Newstetter and McCracken (2001) exposed. With only one exception: students do not seem to ignore the constraints and context, they seem to expect that (profound) knowledge of preconditions (site, brief, client) will lead 'automatically' to a design solution.

5.4.1 Framework

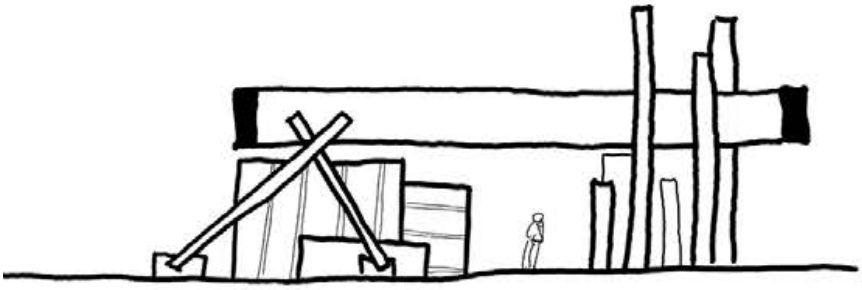
Making the design process explicit with the framework did work well in practice. In principle, the choice for the five elements may to a certain extent always remain a matter of discussion. However, the elements seem to be 'resilient'. They fulfil the requirements of being (1) generic, basic skills of the design process, (2) the main skills to be learned by novices, and (3) relatively clear and easy to remember (Van Dooren et al., 2014). They are key items in the design process, distinguishable and providing an overview for teacher and student.

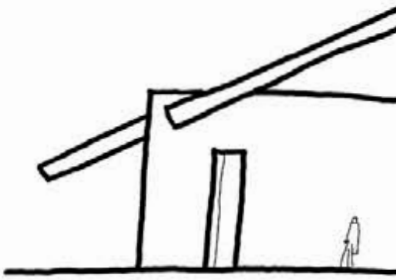
The elements also include a 'world' of notions and mutual relations, related to the nuanced and rich reality of designing, which still has to be discovered, developed and worked out. In the second case study, we experienced on a small scale that structuring learning tasks accordingly to the elements, may lead to learning to design in a 'natural' way. Especially in the first year(s) of the design study, providing experience in the form of adequate, specified learning tasks may help students to overcome the paradox formulated by Schön (1987): although students do not and cannot understand what designing means, neither can recognise what they see, they have to learn by doing it. Developing the framework more in detail may help in the set-up of the curriculum and the design studios. It should provide learning tasks that are interwoven with the design process. It may also help to 'translate' more general notions such as investigation and creativity in more concrete and specified actions and put all kind of notions such as analysis in a broader perspective.

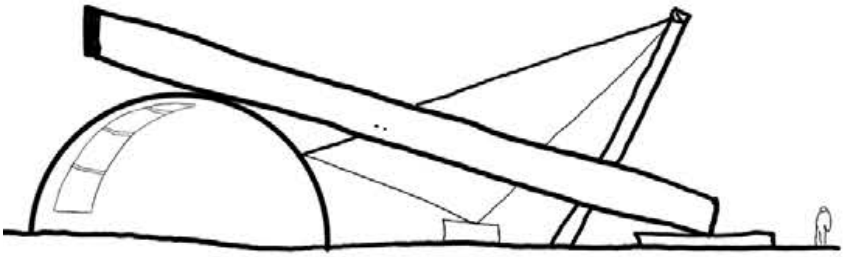
To conclude: design education, in which the design process is made explicit with the framework may have positive results. A richer understanding of the design process and a better specified training of the students may help students to learn 'the unknown'. Students may experiments more often, taking informed decisions and working with professional patterns. They may articulate, develop and explore qualities more consciously and they their ability to distinguish and compare different design methods and approaches may increase. Students may become more independent when working on a design, also when they get stuck. Their stress level may decrease and their pleasure to design may increase.

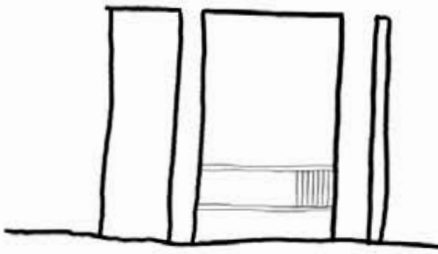
Acknowledgement

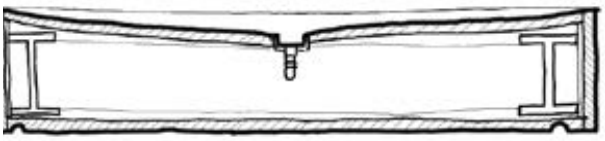
A lot of thanks to the teachers and students involved, being so kind to fill in the questionnaires, to Veerle de Vries, for helping in elaboration of the data, and to Gust Marien, for the statistical analysis.

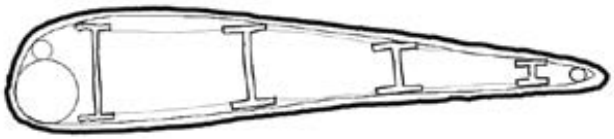


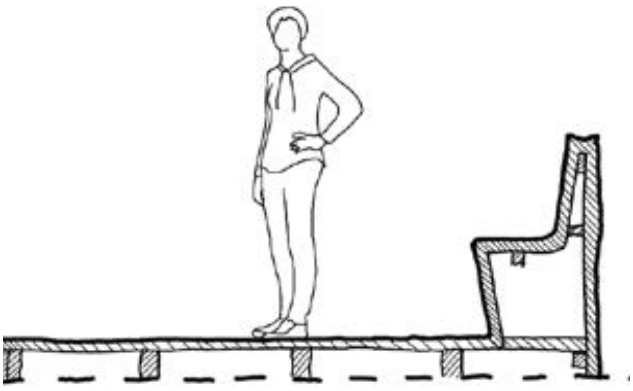


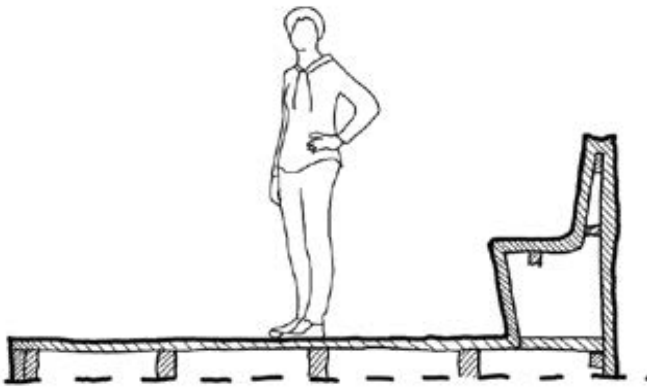


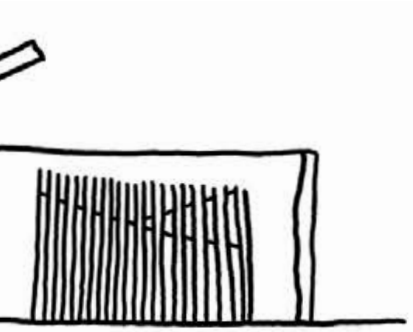


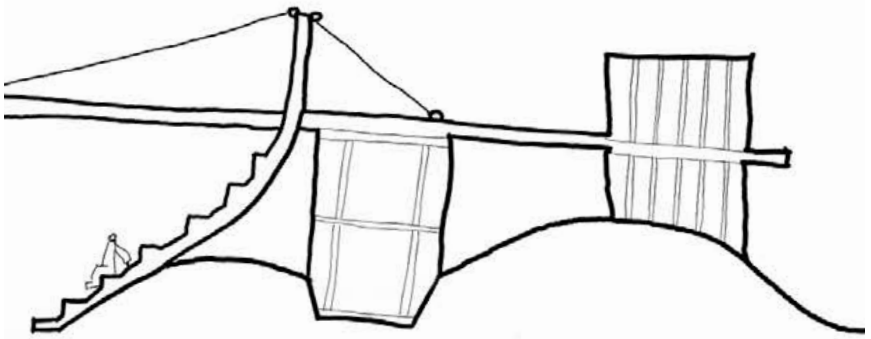


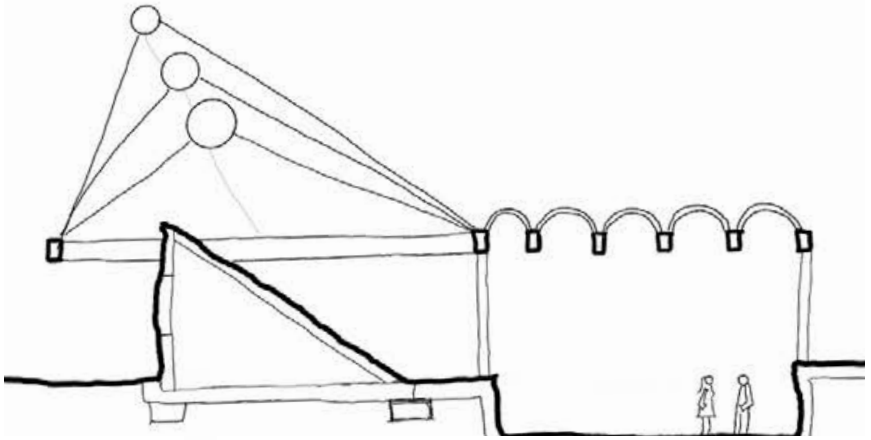


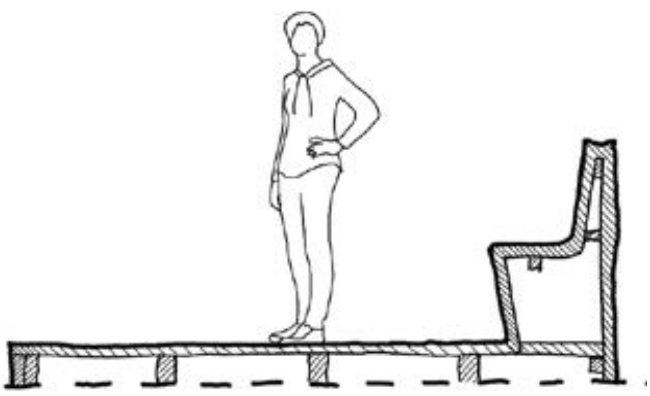


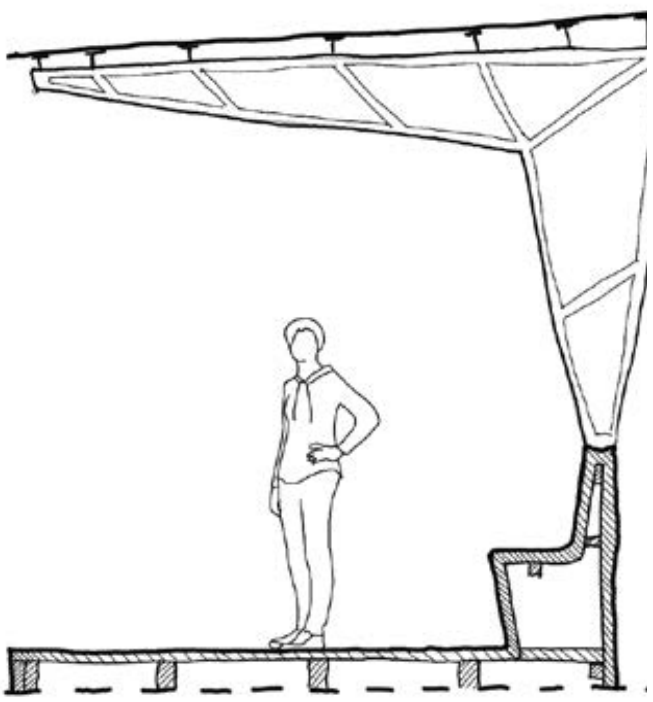










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6 General Discussion

Based on the assumptions that design teachers do not address the design process in design education nor have a vocabulary to do so, a framework has been proposed to make the design process explicit. Once the basic design skills were established as framework elements, three studies were conducted to gain insight into and evaluate the adequacy of the framework and the first underlying assumption. Basically, three questions were asked: (1) What should and might be discussed in reference to the design process? (2) Whether, and to what extent, do teachers address the design process? (3) Is learning to design less confusing for students if the design process is explicitly addressed?

For expert designers, designing is a matter of implicit knowing-in-action and reflection-in-action. In Chapter 2, five generic elements were presented to answer the first question: 'What should and might be discussed in reference to the design process?'. Based on the existing body of literature on design processes, the elements describe the essential and basic designerly skills in general terms. The identified elements do not comprise a recipe of steps, and they do not guarantee a good design outcome. They are simply meant to help distinguish and clarify the skills of the design process, which in practice are interwoven and largely implicit. To see if the elements adequately represent design practice, in Chapter 3 interviews with expert designers were reported. A variety of designers, each with their own personal style and approach, recognised the elements as basic, generic design skills. The five elements appeared to provide a generic overview in distinguishing basic skills and comparing different personal and cultural design methods and approaches.

Thus knowing what should and might be said about the design process, the second question could therefore be investigated: Whether, and to what extent, do teachers address the design process during design tutorials? In Chapter 4, observations of the dialogue between teachers and students in a first year BSc studio of the Delft University of Technology, Faculty of Architecture, showed that during tutorials, teachers mainly discussed the design product at hand. They barely made the design process explicit. They only (1) used implicit examples, directly related to the project they were discussing, without mentioning or explaining the actions they 'model', and (2) referred "between the lines" to the design process by mentioning concepts such as research, variants, and sketches. These notions mostly referred to the detailed level of the design product, such as a staircase, window, solar panels, or a view.

Finally, in Chapter 5 the third question was investigated and answered: Is learning to design less confusing for students if the design process is explicitly addressed? In two interventions in a Bachelor course (Delft University of Technology, Faculty of Architecture) and two Master design projects (Academie van Bouwkunst, Groningen and Delft University of Technology, Faculty of Architecture) positive results were found. Explanation of the design process by means of the framework was perceived as helpful by a substantial number of students, both formally (in questionnaires) and informally in spontaneous conversation. The research showed a change in students' design conceptions and an increase in self-efficacy. The teachers involved experienced the framework as a structural tool, allowing them to have an overview of the elements which should and might be addressed in tutorial dialogue, and to help students better understand the design process.

Regarding the general aim of research to find and establish a vocabulary to make the design process, at least to a certain extent, explicit in the architectural design studio and therefore decrease confusion felt by students, the conclusion is that the five elements form an adequate framework which may help both teachers and students. The generic design elements form anchor points to discuss situated, embedded and encapsulated knowledge and values.

The first experiences show that the proposed framework fills a gap in architectural design education. The five elements enable teachers and students to address the designerly attitude, making it more explicit. The way designers reason consist of: (1) *experimentation;* an experimentation-based way of thinking, how to explore and reflect, (2) *the frame of reference;* a knowledge-based way of thinking, how to work with common and proven 'professional' knowledge regarding all aspects, (3) *the guiding theme;* a value-based way of thinking, how to take a position in the design process. Next to that (4) the *laboratory* is the (visual) language or set of means designers use to think designerly and (5) the *domains* are the playing field for the designer, the product aspects s/he should address.

The framework supports learning by doing. It is a construction to make the design process explicit and train students in basic designerly skills. The first experiences show that students' understanding and self-efficacy may increase. With the framework, the focus in design education moves away from the design product towards the design process, the way in which designers think and reason. Design products are 'vehicles' that help students learn to design. They remain topic of discussion, however fulfilling the role of 'examples' helping students experience the design process in several concrete situations. The core is learning how to design. The framework elements help in unfolding the design process, helping students to come up with coherent, meaningful, adequate, elaborate and imaginative design products.

In the remainder of this General Discussion, the following will be discussed: first, the theoretical implications of the findings, secondly, the limitations, thirdly, recommendations for future research, and fourthly, practical implications for teaching and curriculum development.

6.1 Theoretical implications

First, the elements form a model or construction to make basic designerly skills explicit. Therefore, the number and content of the five elements may remain a matter of discussion. For now, however, the five elements seem to be 'resilient'. They appear to fulfil the requirements set in the second chapter. The elements represent (1) distinguishable key notions, providing an overview of generic basic skills beyond personal and cultural differences and (2) the main skills and knowledge implicitly used by expert designers and largely unknown to novices. Furthermore, (3) they are easy to remember. More elements would lead to more overlap, while fewer than five elements would lead to a loss of the basic skills teachers should address in design education.

The risk of a model is always that it is taken too literally. The elements are certainly not meant to be a simple 'one-dimensional' description of the design process. They are really meant as anchor points in design education, allowing students to practice the design process time and again in different situations and seen from diverse perspectives. Students should be able to make their own representations of the design process and architectural knowledge and transfer their experience and knowledge from one situation to the next. They should become 'cognitive flexible'. After all, learning a complex skill is a matter of learning to restructure knowledge in different ways and situations (Spiro & Jehng, 1990; Boger-Mehall, 1996).

Secondly, the five elements were initially meant to uncover the ambiguities, vagueness and complexity in the dialogue between teacher and student in the architectural design studio. But they can be used in all kinds of situations in which mutual understanding is important, such as group work, and collaboration between designers and non-designers. Group work in the architectural design studio is regularly a matter of role play (architect, urban designer, structural engineer and so on) or a matter of combined individual design processes. With the help of the framework, the design process may literally become group work, with all group members doing experiments and coming up with 'knowledge means' within the

context of a chosen guiding theme or value. In the case of collaboration between designers and non-designers, the framework may help to explain what designers do. For example, during a discussion with the client or contractor, it may help put the focus on the basic values (guiding theme) of a design. In the context of design education, it will help educational organisers understand the main content of what should be learned.

Discussions with design colleagues in disciplines other than architecture seem to indicate that the framework may be useful in those disciplines as well. It is expected that the balance between technical rationality and reflective practice may be different per discipline and that the elements will obviously differ in professional content, but the basic elements may be recognised in all forms of designerly thinking. Using the framework as a common vocabulary to investigate the differences and similarities in the design process between different design disciplines may lead to mutual understanding and learning from each other, which may in turn lead to broadening and intensifying the design processes and design education.

Thirdly, once the design process can be made explicit, the elements also form a guideline for teachers to organise education in the design studio and curriculum. The framework gives insight into typical activities to be practiced by novices and more experienced students. For example, if novice students simply have to do specific actions such as coming up with 3-5 alternative options and studying different means to achieve a specific quality, it enables them to develop adequate basic habits. In the dialogue with more experienced students, the focus might be on the specific nuances of each design situation and the vigour and personal interpretation of design values. The framework also gives insight into the development of the design curriculum. For example, in the several design studios, the variety of methods, values and themes should be explicitly addressed, thus enabling students to practice the design process from different perspectives and achieve an overview of all possible approaches.

Also, the gap between designing and knowledge could be bridged. For example, the observations in the design studio (Chapter 4) showed that although designing includes a knowledge-based attitude, the frame of reference was clearly referred to less often than all other elements. In general, professional knowledge seems to be addressed mostly in other courses, such as architectural history and theory, and building physics and mechanics. As a consequence, a gap exists between the presentation of content that helps students to construct knowledge and how students work with this knowledge. In Chapter 5, one of the three-week design tasks in the second case study directly focused on the relationship between knowledge, in the form of spatial patterns, and the design situation being discussed. However, it was too short to draw any firm conclusions.

Fourthly, although the elements form recognisable and suitable anchor points to discuss and train students in the design process, working with the elements requires a change in thinking. Basically, it requires a shift from asking, 'what and why did you do it?' (regarding the situation at hand) towards asking, 'what might it lead to in the end?' or 'what might be the next steps?'. Furthermore, the elements include a 'world' of notions and mutual relationships, related to the nuanced, rich reality of designing. Teachers need time to get used to working with the framework and learning the richness of the anchor points.

6.2 Limitations research studies

Once the framework to anchor the design process had been developed, three studies were conducted to gain insight into the usefulness of the framework and the accuracy of the underlying assumption that teachers in design education mainly address the design product. Obviously, the research presented in this thesis has its limitations. Mainly, they concern the context of architectural designers and design education in the Netherlands and applied research methods.

To learn more about the content of the framework and test it more profoundly in design practice (Chapter 3), in-depth interviews may be combined with observations. Having acquired greater information over the course of time, interviews with designers may be more detailed on specific items per element. Moreover, it may be informative to observe what expert designers actually do. In-depth interviews and observations may lead to an interesting 'library' of methods, approaches and techniques per element.

To learn more about current practice in the design studio and test the assumption that teachers barely address the design process (Chapter 4), observations of teachers and students may be conducted on a larger scale, in other design courses and schools. Extra information may be collected when observations are combined with short interviews after the observation, with questions focusing on the teacher's intentions and student's understanding. It also may be instructive to follow several tutoring sessions of the same student during the course of the design project.

To learn more about the effects on teaching and learning to design with the framework (Chapter 5), the experiment should be conducted on a large scale and in different design projects. A positive effect in students' understanding and self-

efficacy was found. However, the duration of the experiment was too short to explore whether, and to what extent, the students' skills had actually improved. In Chapter 5, it was already concluded that an experiment "with a larger number of students, with control groups and during a longer period of time may provide more robust evidence of the effects of making the design process explicit. In a large-scale experiment, especially over a longer period, it is not only expected that students' *self-efficacy* increases and their *conceptions* of the design process become more sophisticated, but also students' *skills* may increase and become more adequate and effective."

6.3 Recommendations for future research

Based on research, and more specifically, its implications and limitations, five recommendations for future research are given.

First, since the case studies (Chapter 5) were limited by the number of participants and duration, conducting further research for both Bachelor and Master students, (with a larger number of participants, including a control group, and for a substantially longer period) is recommended. The question if students' skills will improve especially needs to be addressed.

Secondly, it is recommended doing research on how architectural knowledge is cognitively processed, as well as how to guide students in this respect during the design process. Parallel to research in other disciplines (De Groot, 1965; Rikers, Schmidt & Boshuizen, 2000; Van de Wiel, Schaper, Boshuizen, & Schmidt, 1995), it is assumed that architectural knowledge is stored and applied in the form of reference projects and underlying principles and patterns. In the second case study (Chapter 5), one design task did focus on the relationship between common and proven knowledge and designing in the form of spatial patterns. However, this was too short to draw any firm conclusions.

Thirdly, conducting further research to learn if the framework can help make the design process explicit in other design disciplines is recommended. The results may lead to similarities and differences between disciplines. This may lead to mutual understanding and learning.

Fourthly, it is recommended investigating the framework as one of the factors in organising the design studio and curriculum. Moreover, it is advised to combine the framework with the complex learning model of Van Merriënboer and Kirschner (2018). This 'four-component instructional design approach' focuses on the design of courses and curricula for complex learning. It includes important aspects such as learning by doing the entire task, variation in learning tasks, and the emphasis on specific skills in the context of the complete task. In combination with this educational model, the framework specifies the content of (architectural) design, the way designers reason. For example, that students work with different qualities or themes and with different means and tools to achieve them.

Fifthly, since working with the framework requires a shift in thinking, it is recommended investing in profound teacher training (e.g. a post-master year) and means (e.g. a book and online information, such as a MOOC) to make the design process explicit in design education practice.

6.4 Practical implications

The way teachers currently teach may lead to misunderstandings amongst students. By discussing all aspects of the design product on a relatively detailed level, students may get the impression that designing is a matter of step-by-step reasoning through the domains. In each step a solution should be found for one or a few aspects. Students might understand that they need to have reasons in order to draw a solution. This misunderstanding seems to run parallel with the 'technical rationality' perspective on designing. Although working through the domains and technical rationality are part of the design process to a certain extent, the overall process is one of 'reflective thinking', experimentation with common and proven knowledge, and taking a position. Teachers have to explicitly address these elements in the design process.

To understand the design process in all kinds of situations, the elements have to be *repeatedly clarified and practiced*. Table 6.1 shows generic examples of basic notions, questions, and instructions to help teachers become aware of what is done implicitly and therefore find the words for embedded and encapsulated knowledge and values. The questions and instructions are given per element. Obviously, in the discussion the elements will be present in combinations, such as experimenting with

patterns in the context of a guiding theme, and questions and instructions should be directly related to the design situation at hand.

One of the basic aims in design education is guiding students towards a more open, curious, creative, critical and thoughtful attitude. Professional designers "know-and-reflect-in-action". They see their sketches and models and 'know' or 'feel' that it is 'still not what it could and should be'. Designers have experienced this process and have knowledge of 'what it takes to come up with a good design' and 'what it could be'. Students—especially novices—do not have that experience and knowledge yet. They often come up with one solution—'the' solution. Training them to explore and reflect (especially in their first few years) is expected to help students acquire and develop a habit for experimentation. Students can be guided (see Table 1) with questions such as: What happens if…? Which options…? Which implications…? And they can be trained with instructions to develop alternative options and then compare and reflect on them. It can be done intuitively and rationally, in a more open and associative way, in experiments by changing one or more aspects of the previous experiment or by being more structured in a scheme, such as proposed by Breedveld, Herder, and Tomiyama (2011). Note that it is not the intention to come up with the best or the most creative option. It is a matter of studying and learning, exploring and developing, of unfolding the design process in order to learn what might be a good option for the design situation being discussed.

Although it may sound paradoxical, an exploratory and creative way of thinking also includes explicit training in doing experiments with commonly proven knowledge. It includes achieving and understanding all kinds of patterns and principles and applying and playing around with them in specific situations. Questions could be: What kinds of means and tools are available to you for expressing the specific theme at hand? What happens if you apply, play with, and transform these abstract schemes in your design? Doing experiments with knowledge patterns and principles bridges the gap between knowledge and designing, and between studying existing, commonly proven knowledge and coming up with a new part of the future.

TABLE 6.1 Elements as anchor points, examples of questions and instructions.

Element		Articulation of designerly skills	Question	Instruction
Experiment	what happens if…? exploration and reflection	• being open, playful and curious, generating different options and ideas, rationally or playfully. • being critical and thoughtful, studying and evaluating options by comparing similarities and differences.	What happens if…? Within the context of the current design situation a variety of questions can be asked. Which options? Which implications? What happens if you try another option? What do these options mean in the larger context of the design? What are advantages, disadvantages, similarities and differences?	Doing 2–5 experiments, including a reflection on similarities and differences (advantages and disadvantages). Rational or intuitive. On all kind of topics and scale levels or domains.
Laboratory	physical experiment (visual) language	• exploring ideas and experiments through the use of different visual means. • testing ideas and experiments in sketches and detailed drawings.	Which visual means to do this experiment? How do you test potential solutions in a sketch, model, perspective, plan or section? What are the expected and unexpected implications? Can you make an abstraction, a scheme of your design?	Doing experiments physically. Sketching and modelling in different kinds of ways, such as plans, sections, perspectives, different scales, both visionary and vague and detailed and concrete.
Frame of reference	seeing as professional knowledge	• to explore, apply, combine, interpret and transform (abstract) commonly proven knowledge. • reflect on design experiments in regard to commonly known and proven knowledge.	What knowledge do you need for the design situation at hand? What kind of means and tools are available to express a specific theme? Which projects do you like in order to come up with values or qualities for your design? What is the essence and quality of the reference project? What happens if you explore a reference/ abstract scheme in your design?	Studying relevant reference projects. Seeing similarities and differences and recognising and ‘understanding’ the underlying abstract schemes. Experimenting with these ‘knowledge chunks’; exploring, and reflecting on (combinations of) principles and patterns in the current situation. Seeing (im)possibilities.

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TABLE 6.1 Elements as anchor points, examples of questions and instructions.

Element		Articulation of designerly skills	Question	Instruction
Guiding theme	taking position values and qualities	• exploration of guiding themes and the development of the chosen guiding theme. • reflection on the values (choice for guiding theme) and testing the elaboration of a design in relation to the guiding theme.	What kind of theme (meaning/value) do you want to achieve? Which ways to develop this theme (value)? How to summarise your design in a few words or in an abstract sketch or symbol? Do the decisions regarding aspects fit the overall idea or vision? What does the chosen quality mean for all different kinds of involved aspects (domains)?	Seeing and recognising different themes and values. Taking position and development of the theme/position. Exploring and reflecting on the different tools and means, the different ways the themes could be 'expressed' or 'shaped'.
Domains	jigsaw pieces play field	• exploration of all relevant aspects (mutual relationships given criteria, specific sites, material, socio cultural context, etc.) • testing all relevant aspects (mutual relations, given criteria, specific site, material, socio cultural context, etc.)	What does this decision mean for other domains (aspects)? Is there a domain you haven't paid attention to yet? Which domains do you want to explore next? Can the decision in this domain be based on the guiding theme? What knowledge do you need regarding this specific domain? Do the decisions fit the (given and explored) criteria?	Studying the criteria (brief and site, current design situation) as conditions. Working through the domains. Seeing relationships and implications between aspects. Seeing the relationship between guiding theme and domains. Working with professional knowledge (frame of references) in the domains.

An important source of confusion in design education is the variety of different values, paradigms, approaches and methods that exist in architectural design. For example, waiting for the camera to start, one of the interviewees (Chapter 3) heard the name of another architect. He immediately expressed his opinion that his colleague's architecture was inferior. Actually, this was a matter of debate: on differences in guiding theme and in qualities and visions in a plural world. This variety of approaches is also seen in architectural schools (Schön, 1983). Values, styles, methods and approaches seem to be mostly implicit, remaining in the background in the design studio. At best, they are addressed in separate courses, such as architectural history and theory.

With the framework and more specifically, the guiding theme, the kind of visions and approaches can be made explicit on an abstract, overview level and in direct relation to the design situations being discussed. Teachers and students can and should discuss how to deal with values and come up with adequate means to achieve them. In the context of tutoring, studio and curriculum, students should be able to study and compare themes explicitly, their importance in the context of society, and what they mean for that particular design situation.

In principle, explicit guidance on the design process elements is the difference between telling the students 'to design and asking afterwards the reason for what they have done' and telling the students 'to experiment and develop a direction (theme or qualities) and then discuss these in terms of how to proceed'.

Table 6.1 helps achieve a shift from discussing various aspects towards addressing the situation at hand *on a more abstract 'overview' level.* What should be articulated, asked or instructed depends on the situation. For example, in sketches and models, almost all relevant aspects may be there, yet it may not be coherent. The student may have an idea about the main qualities or direction, yet, without having experimented with this idea. If teachers combine their product-related comments with these kind of 'overview' conclusions, they will enable students to achieve a better understanding of designerly skills. The product aspects will still have to be discussed, but they will function as concrete examples of the designerly way of working.

The framework was intended to make the design process explicit in the dialogue between teacher and student, but in fact, it similarly helps in *the organisation of studio and curriculum*. In Table 6.2, examples are given of how the elements may help organise the curriculum—in this case, the design projects of first-year studios. In principle, in each design project all designerly skills are addressed. However, each project focuses on a theme directly related to a specific domain or combination of domains and a basic body of knowledge. This enables students to work with different positions, qualities or themes and with means to achieve them in the specific situation being discussed. For example, if the theme in the design studio is 'anchoring in the site' (see Table 6.2 C), teachers should refer to, explain, and train students in understanding and experimenting with all kinds of visions, patterns and principles. If the theme is 'sustainable materialisation,' teachers should focus on the visions, patterns and principles to achieve a sustainable design. In this way students build up a frame of reference, learning to interpret and develop a commonly proven general theme in a specific design situation.

TABLE 6.2 Examples first-year projects, based on generic elements.

	Examples Assignment:	Theme	Frame of reference	Experiment in laboratory	Domain (All involved)
A	Designing a house or an art gallery.	Personal interpretation and elaboration of the given theme: form and aesthetics.	Studying form and aesthetics in examples (art, architecture, etc.)	Different options with given material = sticks, blocks and cardboard (beam/ volume/ slab). Models.	Space, form, composition.
B	Designing an archetypal house or an art gallery.	Personal interpretation and elaboration of the given theme: spatial order and experience.	Analysing spatial patterns in reference projects. Studying relationship to other aspects.	Different options with given abstract spatial patterns. Different options regarding other domains. Sketches plan, section, façade.	Space, form, composition + function, use.
C	Designing small pavilion in urban site + in landscape.	Personal interpretation and elaboration of the given theme: anchoring in site.	Analysis means to anchor in a site: principles, patterns.	Different options with different means in the specific situation. Sketches and diagrams.	Site, environment + function, use.
D	Designing a tram or boat museum.	Personal inter-pretation and elaboration of the given theme: sustainable mate-rialisation.	Studying patterns and principles sustainability and materialisa-tion.	Different options (1) structure, (2) material, and (3) detail. Sketches and models.	Material, structure, construction, climate, detail.
E	Designing a small hotel - cafe in a specific situation.	Personal choice, interpretation and elaboration of a theme.	Which means and tools relate to the theme?	Different options with different means in regard to chosen quality.	Related to personal theme.

Once students have a basic understanding and skills regarding the design process, design tasks and design qualities may become more complex, profound, specific and personal. For instance, what might start in the first year as understanding measurements and the basic relationship between functions may later become a guiding theme in reference to sociological and psychological knowledge concerning user friendly design.

6.5 Final

Returning to the two fragments at the start of the Introduction (Chapter 1), the elements help to clarify their meaning. What in tutorial dialogues is regularly called '*investigation'* and *'drawing, drawing, drawing*' refers to a world of embedded knowledge. '*Investigation'* may refer to analysis or experimentation, which are two distinct movements. Analysis refers to learning 'what is', such as the site, brief, and an inspiring reference project.

Experimenting refers to 'what might be'. For example, 'what happens if …' regarding alternative uses or alternative compositions in a specific site, or sustainable techniques in a building. More distinct and specific use of the notions analysis and experiment is important to prevent misunderstanding. It may be the difference between the idea 'that the design should be deducted from analysed given facts, such as site and program' and the idea 'that designing is a matter of ideas and reflection within the context of analysed and given facts'.

The student's question 'how to investigate' is answered with *'drawing, drawing, drawing*', implicitly meaning that by visualising options, ideas and thoughts, they can be tested on implications and new ideas can therefore be explored. The sentences '*… instead of solar panels you could see it more as an investigation'*, '*How can you deal with this in the architecture?*' and '*there are also translucent solar panels, letting the light through*' refer to a world of commonly known and proven means in direct relation to a socio-cultural theme. More specific: means such as solar panels, glasshouse and heat pump represent a quality such as zero energy in the context of climate change.

Finally, 'in-between' sentences such as '*having reasons*', '*choices you have to make*' and '*until it is what you prefer*' illustrate the interwoven character of the five elements. They (may) refer to (1) given and analysed conditions and criteria, (2) preferences and conditions discovered during the process of experimentation, (3) all kinds of common known and proven knowledge developed within the architectural profession and other disciplines, (4) the qualities to achieve, and (5) the coherence and significance of the end result.

This research project taught us that the design process can be made explicit, at least to a larger extent than design teachers are used to doing. The research shows that the framework provides a common vocabulary to improve mutual understanding, avoiding linguistic confusion. For teachers, the framework helps them shift from teaching students about a singular product towards teaching them about the

broader design process. For educational developers, the elements help organise the design studio and design curriculum. For students, design education in which the design process is made explicit with the framework, leads to a richer understanding of the design process and an increase in self-efficacy.

This PhD ends with two sets of five rules of thumb for teaching the design process and developing design education.

6.5.1 Rules of thumb design process

Experimentation

— *Designing is exploring and reflecting on options on all relevant scale levels in the situation being discussed: what happens if…?*

Laboratory

— *Images, such as sketches and models, are the means to unfold the design process.*

Frame of reference

— *Designing is knowledge based. Designers see new situations with the eyes of commonly known proven patterns and principles.*

Guiding theme

— *Designing is value guided. Designers take a position with a method or quality, a primary generator or an imposed order, which directs the design process.*

Domains

— *Domains form the playing field of the designers. They are the jigsaw pieces that have to be addressed and which should fit together in the end.*

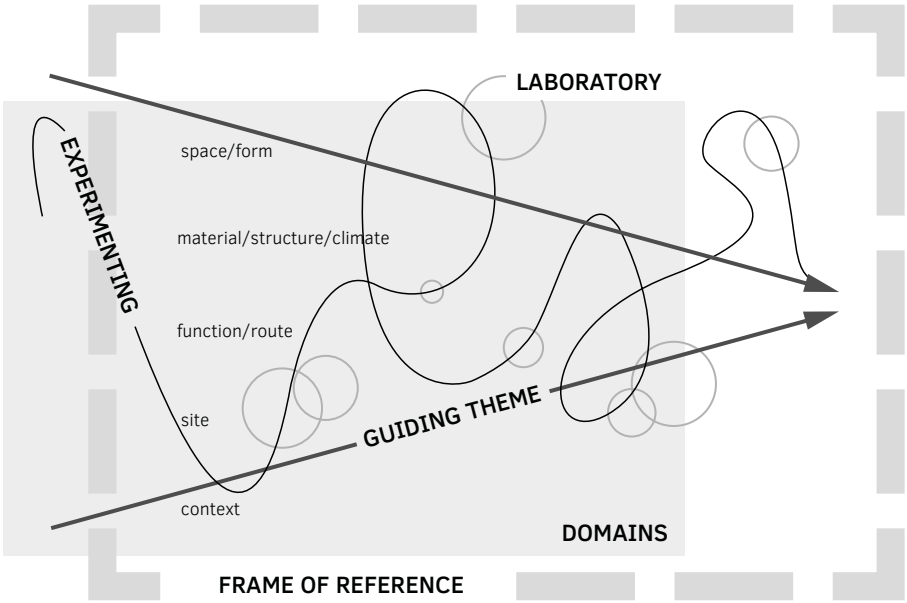

FIG. 6.1 The five generic elements in the design process: (1) experimenting, (2) guiding theme, (3) domains, (4) frame of reference and (5) laboratory [New version].

6.5.2 Rules of thumb design education

- *The way in which the design process is addressed should gradually increase in complexity, profundity, sensitivity and richness.*
- *In the dialogue, the abstract and concrete level, the design process and the situation being discussed should be combined.*
- *Design projects should differ in length, type, theme, and assignment. Always, the complete design process should be practiced.*
- *It should be clear to students if they learn a specific design method, or if they are coached by their teacher that they will also have to find their own designerly way.*
- *Designing is rooted in knowledge, therefore acquiring knowledge on subjects such as mechanics, history or modelling should be integrated in the design process.*

TOC

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TOC

About the author

After obtaining a master's degree in Architecture at the Technical University Delft, I worked for about ten years in practice, as freelancer and with a partner. Almost immediately after my studies I also started as a guest teacher at the faculty of Architecture in Delft.

Since 2000, I am a staff member at the faculty, participating in a diversity of educational projects and roles, such as teacher, coordinator, chairman of the educational board and educational developer.

Enjoying design education and being fascinated by the question how to teach, I started doing research in my free time. The result is this publication including the published journal papers. I develop courses for students and teachers about design didactics in which I am also involved as a teacher (TU Delft, Groningen, Tilburg, Technasium). Next to that I regularly do peer reviews (International Journal of Technology and Design Education)

TOC

20#17

Anchoring the design process

A framework to make the designerly way of thinking explicit in architectural design education

Elise van Dooren

This thesis proposes a framework to address the design process in design education. Building upon the assumption that teachers, being professional designers, do not discuss the design process in the architectural design studio and do not have a vocabulary to do so, five generic elements or anchor points are defined which represent the basic design skills. The validity of the framework and the assumption is tested respectively in interviews with a variety of designers and in observations of dialogues between teachers and students. In the final test the design process is addressed in the design studio: the first experiences show that students' understanding and self-efficacy may increase.

The five elements enable teachers and students to address the designerly attitude. The way designers reason consist of: (1) *experimentation*; an experimentation-based way of thinking; how to explore and reflect, (2) *the frame of reference*; a knowledge-based way of thinking; how to work with common and proven 'professional' knowledge, and (3) *the guiding theme*; a value-based way of thinking; how to take a position in the design process. Next to that, (4) *the laboratory* is the (visual) language or set of means designers use to think designerly, and (5) *the domains* are the playing field of the designer, the product aspects s/he should address.

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