Design and Technology Education: An International Journal

22.2

All aboard online

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2017 and Volume 22 saw our Journal move totally online – paper copies will no longer be published. Moving online has the advantages of streamlining all processes of creating and publishing the journal and for Issue 22.2 this also means a fresh new look as the Open Source Journal (OJS) repository, hosted by Loughborough University, has undertaken a major upgrade of the system. This should mean that the website not only looks cleaner and fresher, but is also easier to navigate. With this new upgrade, the Editorial team have decided to move nearly all parts of the 'workflow' process online, from submission to review, to editing, to publishing.

For those who just enjoy reading the journal, apart from the new look, you should find that the reader interface has been improved meaning that the website is easier to read on tablets, for example. It is also more straightforward and quicker to register. For authors the shift means that all submissions can now only be submitted on line, with the advantages that authors can now easily upload multiple files and track the progress of their submission. In addition, feedback from reviewers and editors will also be provided online, with email alerts to signify when new information is available.

The shift has resulted in a new url for the Journal (https://ojs.lboro.ac.uk/DATE/index) – so bookmarks will need updating. As with any major upgrade, we would be foolish to imagine there won't be some teething problems, and if problems are encountered, please let us know.

We would also encourage anyone who does interact with the journal to sign up for New Issue alerts, which you will find under Announcements.

But now to what you can find in this issue. As usual, we start with a refection piece in which Richard Kimbell reflects back on Decisions by Design, research he conducted some years ago that highlighted the core value of developing designerly thinking and action. The research focused on the impact of this on school managers, but his broader point is the value for all people, whatever their age. This is followed by six research articles representing research across age groups from as young as five and six year olds, to undergraduate students. The articles also represent a broad geographical spread, drawing from Canada, England, USA, Turkey, Iceland and Nigeria. While the contexts of the articles are quite different, the combined lessons that can be learnt have broad relevance.

The first research article, A Model of Framing in Design Teams, comes from Mithra Zahedi and Lorna Heaton (University of Montreal, Canada). Based on a case study of a team of four second year industrial design students, the paper explores a major research question of how design ideas develop in collaborative design projects. The students worked as a team to design a pop-up shop. Drawing on Schön's work on naming, framing and re-framing through processes of reflection in action, a collaborative, project based learning activity was created that would allow the researchers

to explore the students' thinking and actions as articulated through their interactions. Taken together with the 'traces' of the project (drawings, presentations etc.) the authors identified a set of designerly action themes used to analyse the students' activity, enabling the creation of a model of how processes of framing, deframing and reframing emerge in a collaborative design project. The authors present their model as a new approach to "analysing design communication in social settings.".

The second article moves us to a case study of very young fledgling designers – five and six year olds. In Traditional tales and imaginary contexts in primary design and technology: a case study, Matt McLain, Mike Martin (Liverpool John Moores), Mel McLain and Jess Tsai (St. Michaels in the Hamlet Community Primary School) and Dawne Bell, David Wooff (Edge Hill University), provide insights into the value of working from imaginary contexts in design and technology to develop design thinking, dialogue and critique. Drawing on concepts such as speculative design, science fiction and design fiction, they highlight the potential for such development when working in a fictional realm. They take the tradition story of Three Billy Goats Gruff as a starting point, and show how the young children were drawn into the context by receiving a letter requesting help from the billy goats, who effectively became the clients for the children. Design ideas were sent back to the billy goats who returned comment as the projects developed. Through interviews with the teachers involved and analysis of the children's work, a rich picture of design learning emerged. This showed how young children focused on "the social and affective aspects of the 'problem', rather than fixate on the practical aspects", with teachers scaffolding learning in relation to technical making when needed. In line with conclusions of the authors, it is easy to see how those working with older learners could also benefit with building such approaches into learning and teaching in D&T.

The third article also focuses on critique, taking an innovative approach to assessment, working with undergraduate graphic design students. In Visualizing the critique: Integrating quantitative reasoning with the design process, Kathryn Weinstein (Queens College, City University of New York) focuses on the impact of linking using data analytics and visualisation strategies with the critique of design assignments. In a case study of students undertaking an Information Design course Weinstein describes how, at the end of the course, an anonymous survey replaced a more traditional group critique. The data from the survey was then given back to the students as the basis of an assignment to create visualisations of the information and to support understanding of Quantitative Reasoning (QR). In advance of the visualisation assignment, group discussions on the data itself prompted responses including students saying they gave more honest responses in the survey and that both students and teachers could benefit from the results of the survey. Following the development and presentation of the visualisation of the data, a verbal group critique revealed both the learning benefits in terms of QR (for example the students having more 'at homeness with numbers') but also a shift in the students' approaches to critique, such as focusing more on coherence and accuracy than aesthetics, the development of reflection skills and how assessment feedback can be used for personal development.

The article that follows stays with undergraduate students, in this instance architecture students. In Searching creativity: (N)On Place design workshop, Gökçe Ketizmen Önal (Eskişehir Osmangazi University, Turkey) presents a highly focused exploratory study of a design workshop using paper folding techniques and modelling with architecture students in an exploration of developing

creativity. The study explores the value of informal workshops and the impact on creativity of folding as a technique to explore spatial and organisational pattern. The methodology for the workshop draws on literature on creativity, including approaches to stimulate creativity within design processes, and Rhodes' "4Ps of creativity (person, product, press and process). For data collection, the author has drawn on retrospective protocol analysis and structured interviews with eight architecture students. The focus of the workshop was designing a city structure and ran over two days. The detailed analysis of the models created and the thoughts expressed by the students to explain development indicated the value of having initial explorations in 3D modelling with paper, for example in the holistic ways the students conceptualised ideas, the ways they used the approach to consider user issues and interactions, such as psychological impacts on space and place and the ways students were enabled to "perceive the interactions of spatial, conceptual and volume at the moment of creation". The informal nature of the workshop also highlighted benefits, for example social-cultural aspects.

The penultimate research article shifts more directly to approaches to teaching. In Examining Teaching Practices in Design and Craft Education in Iceland, Gisli Thorsteinsson (University of Iceland) and Brynjar Olafsson (University College of Southeast Norway) report on research aimed at gaining insight into the current situation of Design and Craft (D&C) teaching in Iceland elementary schools. The particular areas of focus were the most common teaching methods, how the Icelandic National Curriculum is used and how teaching could better meet the individual needs of learners. The article begins by providing some background to the development of D&C teaching in Iceland, starting with influences from Scandinavian sloid. It then provides insights into the development of the Icelandic National Curriculum that includes the subject D&C, first developed as school industry (craft) that has been mandatory since 1936, the term Design and Craft, with an emphasis on technology, being introduced in 1999. Throughout this time an underlying sloyd pedagogy was the basis for learning and teaching. Previous research has identified some common approaches, such as outdoor education, collaborative learning, direct instruction and the use of workbooks. Based on a questionnaire to which 101 teachers responded, the authors explored the current situation. Findings indicated that the majority of teachers used mainly traditional teaching methods, most commonly direct instruction, that most teachers used the National Curriculum to structure their teaching, although some used it only occasionally. The majority of teachers based teaching on student's individual needs, but it was the younger teachers who focused more on individual differences and the teachers who had a degree level teaching qualification (as opposed to a vocational qualification) who allowed more flexibility in design decisions. The authors conclude that improving teachers' practices, possibly by in-service courses, could improve the quality of teaching and status of the subject.

The final article is Influence of cognitive styles on technical drawing students' achievements in senior secondary school in federal capital territory, Abuja, by A. Samuel Owodunni, (Federal University of Technology, Minna Niger State) Sanni & T. Abdulramam (University of Ilorin, Kwara State), Joy Nwokolo-Ojo (Benue State University, Makurdi) and C. Obeta Igwe (Federal University of Technology, Minna Niger State). It presents a study that explores the relationship between cognitive style and technical drawing skill and relates this to the impact understandings could have on learning, teaching and achievement. The context for the study is Nigeria and a concern that Nigerian students be scientifically and technologically literate. The authors raise concerns about poor

achievement in technical drawing, poor teaching in the subject and a lack of students pursuing a career in related fields. The article provides an underpinning of the nature and significance of cognitive style for learning and reports on a study with senior secondary school students in the Federal Capital Territory, based on a Group Embedded Figure Test. Students first undertook an assessment that allowed researchers to identity three different cognitive styles and the research then tested a null hypothesis that "cognitive styles have no significance on the mean achievement scores of students in Technical Drawing". Their findings indicated that performance across the three groups was significantly different and that poor teaching, based on teachers' inability to see difference in cognitive style could contribute to underperformance. On the basis of the findings they suggest that teachers should use cognitive styles to facilitate their teaching and that pre and in-service teacher education should address this.

Finally, we move to reviews, and for the first time include an extended Review Essay by Steve Keirl (Goldsmiths, University of London). In Reframing the status quo in design education: it's not a rehearsal Keirl presents a review of Elizabeth Resnick's new book Developing Citizen Designers and then provides a developed critique of the book that creates an extended essay, drawing on a range of issues and further literature. We conclude the issue with a more traditional review of Technology Education Today: International Perspectives by Marc de Vries, Stefan Fletcher, Stefan Kruse, Peter Labudde, Martin Lang, Ingelore Mammes, Charles Max, Dieter Münk, Bill Nicholl, Johannes Strobel and Mark Winterbottom. This book is the first in a series to be published by a new collaborative international research association, The Centre of Excellence for Technology Education (CETE).

We hope that you find this current issue valuable, useful, interesting and enjoyable. If you have any feedback, please let us and the authors know.

Decisions by Design

Prof Richard Kimbell, Goldsmiths University of London

There is no denying that design & technology is under a bit of pressure at the moment, with the EBacc; GCSE courses being reduced; timetable time under pressure; and even whole departments disappearing. In response to these troubling times, my friend and colleague David Barlex (with others) has published a manifesto for 'Rebuilding design & technology'. Whilst I don't agree with all of it, I applaud them for providing teachers and schools with some ammunition with which to counter the current difficulties. Their 're-building' argues for four kinds of validity for design & technology: an economic argument (about jobs); a personal argument (about satisfaction); a social argument (about social justice in a technological world); and a cultural argument (about the designed world). All of this seems to me to be entirely sound. But I think they have missed the validity argument that – for me – is the core justification for design & technology.

Some years ago, the Design Council was worried about undergraduate design courses. Having looked at the numbers of graduates and the number of design jobs, the Design Council feared that (i) only a small percentage of those graduating could expect to be employed in the design industry and that (ii) this might bring design degrees into disrepute at least to the extent that they are regarded as vocational preparation. So they asked us in TERU at Goldsmiths to address ourselves to the question … 'What are designers good at if they don't do design?' Essentially we were to explore the transferable value of designing. Thus was born the project that led to our report 'Decisions by Design.' (TERU Goldsmiths 1997)

It is important to understand the methodology we used to dig out the qualities that make designing such a valuable learning experience. We started with a group of senior managers in primary and secondary schools. There were 8 of them and they were typically deputy heads in the London area (for logistic reasons). Each school undertook to provide 20 days throughout a year for the 'teacher-fellows' to spend with us at Goldsmiths. The focus of our enquiry was 'decision-making', and we began by asking them each to create a case study of an important decision that had recently been taken in their school. We asked that the case study should include the background to the decision; the steps that had been involved in making the decision; the mechanism of taking the decision; the mode of implementation of it, and the aftermath of that implementation. All sorts of fascinating decisions emerged and were exhaustively analysed, including implementing a one-way system to overcrowded stairways and corridors; re-organising lunch-time queuing and seating arrangements; and re-organising playground security and access. All were driven by the dissatisfaction of the schools with their previous arrangements and the desire to eliminate problem areas and ensure more harmonious and safer experiences for students and teachers. The case studies were shared in round-table seminar sessions and were all agreed to represent decision-making practice in relation to key features of life in schools. The accounts were then filed and (for about 10 months) forgotten.

We have at Goldsmiths a series of undergraduate and postgraduate design programmes running throughout the year. We were able to place pairs of the teacher-fellows into several studio environments as interacting observers of what our design students were doing. In each case they

were able to observe at least one project from start to completion (typically one ten-week term), as well as being part of other structured design experiences managed by design tutors. Their brief was to note the practices that they observed and particularly when they saw anything that surprised them or had what appeared to be significant impact on the design students. Being regular members of the design groups over many weeks – the teacher-fellows inevitably developed good working relationships with the students. At points through the year, we convened teacher-fellow feedback days in which they shared some of their experiences. And at the end of the process, they were asked to produce a collective, summary report of the features of design practice that they thought had been particularly beneficial to the students, and/or that had particularly surprised the teacher-fellows, and/or that they could see as valuable in any decision-making setting. This was compiled by the teacher-fellows alone – and then shared in a round-table seminar with the TERU team.

It is important to remember that the teacher-fellows were not designers. Rather they were intelligent observers, looking in upon a set of designing experiences to tease out some of its uniqueness. Whilst our subsequent report dealt fully with all the strategies that were identified, for the purposes of this piece I will mention just five that were seen to be crucial.

Un-packing tasks: Students were frequently engaged on tasks with no obvious outcome. They were complex, multi-dimensional and messy. We know the literature talks of 'wicked tasks'. The teacher-fellows were impressed by the students' repeated un-packing of the elements of this messiness to clarify what (and who) is involved.

Playing with reality: We are familiar with the depiction of design as 'goal-directed play'. This was new to the teacher-fellows – but obvious in practice as students allowed their imagination to operate. "Being able to move in perception and thought away from the concrete given on 'what is' to 'what was', 'what could have been', 'what one could try for', 'what might happen' " (Singer and Singer 1990)

Optimising values: Design is about improvement, and the concept of improvement is essentially value-laden. A playground security system has stakeholders that include teachers, parents, pupils, governors, and support staff as well as external players like the police and fire service. It is inconceivable that the members of these groups would share a single set of values for the proposed product. They will not. They never do. Accordingly most of the dispute about whether a new design is an 'improvement', will in reality be a dispute about values. The teacher-fellows were amazed at the young designers' insistence on 'seeing through the eyes of others'.

Modelling futures: Designers continually model their concepts of the future to explore them, to experience them vicariously and thereby make informed judgments about them. The teacher-fellows saw two sides of this. First that modeling provides very direct feedback about the quality of the thinking. But – even more important – that this enables the designer to manage the risks that are naturally attendant upon the new and the innovative. Risks can be taken in the thinking and development because modeling allows the designer to mitigate and offset the risk in advance of coming to a resolution.

Making thinking explicit: It is too often the case that our thinking processes remain locked in the inner recesses of our minds. But one of the defining features of designerly thinking is that it is out in the open with all kinds of externalisations that take the designers thinking out of the mind and

express it in the public world. When thinking is in the public domain, it can be shared, examined by others, and thereby refined.

At the end of this process, the teacher-fellows were re-acquainted with their case studies and invited to see them through the eyes of a designer. And invariably the reaction was embarrassment, since almost none of the processes that they had identified as being such powerful aids to decision-making were at all evident within those accounts. No modeling of one-way systems; no recognition and optimizing of value positions with the playground; no playful exploration of possibilities for queuing & seating; and never was their thinking made explicit. Typically, obvious solutions had been implemented … 'lock the gates' … creating other (sometimes profoundly) difficult results.

As with many of the projects we have undertaken in TERU, there is always an ostensible purpose; a purpose on the surface that the funding agency can feel confident about. But there is also often an underlying purpose that has to do with some of the fundamental beliefs that inform our commitment to design & technology. 'Decisions by Design' was one such project with a purpose that went beyond the demands of the funding agency. We deliberately chose to focus the project on decision-making rather than (say) 'employability' because decision-making is such a fundamental human quality. It goes to the heart of the intellectual argument for validity that I believe is the real justification for design & technology. A good design & technology experience might help you get a job, or enable you to better understand the made world, or give you personal satisfaction, but more important than all of that it will empower you to think better and make better decisions.

Education ought to be about enriching our ability to make good decisions. John Dewey believed that intelligent decision-making was a fundamental pillar of a strong democracy, but Bronowski went further than that. If our civilization is to survive and flourish (he argued in 1973 in The Ascent of Man) we need a 'democracy of the intellect' in which each student is empowered to make good decisions to inform the 'un-ending adventure at the edge of uncertainty'.

We tend to assume that educated and well-placed people (like our teacher-fellows) are smart enough to make good decisions. But they demonstrated for us – and to themselves - that their performance was not so smart and that to start thinking as a designer would seriously have enriched their decision-making. I believe that this applies in all walks of life and in all professions. And not least in politics, where a few decisions-by-design would be a very welcome innovation.

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A Model of Framing in Design Teams

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Abstract

How do ideas evolve in the context of collaborative design? This research explores the framing strategies and tools involved in the co-construction of a shared understanding in the early stages of a design project. We observed a team of four industrial design students working to design a popup shop. We found that, while the key design elements of the solution were present from the early stages of discussion, they were continually framed and reframed through intense verbal discussion supported by sketching reflection-in-action (individual or collective) that help each team member make sense about the popup shop branding, user experience, visibility, structure, etc. The design ideas were crystallized at the end of the fourth working session. The research identifies patterns of framing, deframing and reframing of ideas that emerged from different symbolic elements associated with a brand, allowing students to design customized, non-standard, impressive and complex forms. Linking these patterns with specific 'designerly actions' led us to develop an empirically grounded model of the framing cycle. This model extends previous work of Schôn and Dorst and Valkenburg to specifically take into account collaborative design situations. In such situations, discussion among team members plays a vital role in clarifying, explaining, and interpreting as well as in encouraging reflection and critique.

Keywords

framing, knowledge co-construction, collaborative design, object-world, designerly actions, co-reflective practice

Introduction

For many years, we have been involved in teaching design to undergraduate students. Our pedagogy is based on constructivist and experiential learning ideas (Piaget 1967) and learning-by-doing (Dewey 1938/1997), and giving feedback to project-based episodes of design. We noticed that when students work collaboratively on a project, their learning experience is enriched: they better understand the complexity of the design project, they challenge each other, they learn to explain their ideas and refine their arguments to defend them, they develop their critical thinking skills, and they co-construct new understanding of the project. Nevertheless, collaborative design is rarely fully understood by students. Rather than co-constructing understanding and designing together, students' activity is more akin to cooperation. Kvan (2000) explains that collaboration is "achieved when we have accomplished something in a group which could not be accomplished by an individual". To collaborate, the group understands the interdependencies of the members and attempts to find solutions that are satisfactory for all group members, whereas cooperation is "characterized by informal relationships that exist without a commonly defined mission, structure or

effort" (Kvan, 2000). Team members divide tasks and information is shared as needed. Also, when people cooperate, the intent and degrees of participation in activities varies.

Students don't distinguish between these two types of dynamic easily. The creative aspect of collaboration that is achieved by co-construction of ideas during the design process is not well understood. In many situations students divide the project into tasks at the beginning and they assemble their work at the end. This gap of understanding encouraged us to set up design projects where collaboration as we will define it later, is central.

Understanding what design students need in order to develop and refine their abilities to collaborate with others is all the more important, given the increasing complexity of design projects as a result of economic, social, environmental and technological challenges of today's world. To meet this reality, practitioners need to work in teams of various experts. To prepare industrial design students to work within this collaborative context, workshops based on project scenarios very similar to real design situations are often part of educational programs.

Other design researchers have already drawn attention to this issue in the design education community. For example, in their seminal article "Observations of teamwork and social processes in design", Cross and Cross (1995) considered design activity as social process and studied the teamwork of three designers working together on a project. They focused on different aspects of the team's activity including roles and relationships of the team members, gathering and sharing of information within the team, ways of understanding the problem, and ways of developing design concepts. They concluded that "the social process of design interacts significantly with the technical and the cognitive processes of design" (Cross and Cross, 1995:143) and that design research has to address the design process as an integration of technical, cognitive and social processes. Considering design as a social process has been the focus of others (Bucciarelli, 1988, Carrara et al., 2009) and our study on a human centred-design approach (Zahedi, 2011).

This paper is based on observations of a team of four students in their second year of an industrial design program. The theme of the project was the design of a temporary installation (a popup shop) for a particular brand during a special event (more details are presented in section 3). The students worked together for seven weeks to design the popup shop and communicated their final concept through different means including drawings, photography, technical plans and mock-ups. This article focuses on the first two weeks of their work: the discussions about the characteristics of the project and generation of early ideas.

Our focus was on the following research question: "How do ideas evolve in the context of collaborative design among students in the context of a complex design project?" In other words, the research objective was to better understand the framing strategies and tools employed by a team in the early stages of the design process. We analyse our observations using the concept of framing (Goffman, 1974; Dewulf et al., 2009, 2012; Putnam & Holmer, 1992; Spielvogel, 2005; Hey et al., 2007) and mobilize the idea of designerly actions (Heaton et al., 2015).

This research project is part of a larger research program that focuses on the framing stage (framing, de-framing and re-framing) of complex and interdisciplinary design projects. The research activity studies in situ professionals as well as students in collaborative design situations. Our ambition is to understand HOW framing, and particularly reframing, takes place collaboratively.

A brief examination of literature and conceptual background

Design projects are characterized as wicked, multifaceted and complex (Rittel and Webber, 1984; Schön, 1985). Design practitioners are facing not only the complexity of the projects, but also situations that are unique, uncertain, and full of value conflicts (Schön, 1983). Even in the initial stages, designers typically move back and forth between the project's initial needs and goals, clarification of intentions, and crystallization of main ideas. Design education insists on teaching student the process of 'problem-setting' and consideration of the context of the project. Thus, through the process of problem-setting, students develop a global view of the situation at hand (identify users, contexts, activities, limits, priorities, etc.) and see the interaction between elements that shape the project. However, in our experience, students are still uncomfortable with the fuzziness and uncertainties of the problem-setting phase and prefer to be given a straightforward brief of the problem to solve. With a 'given' problem, students are unaware of the need to construct a frame, consider the context or see the project holistically. Ideally, by accepting ambiguity, design students become aware of the frames and limitations of projects, see the possibility of alternative frames and tackle the project through cycles of problem-setting. For Schön, design knowledge is knowledge-in-action, that is mainly tacit and revealed during the act of designing, structuring design situations (1983, 1992). He approaches designing as a 'reflective conversation with the situation' which refers to construction and reconstruction of objects and relations by the designer who is dealing with the situation and wants to determine 'what is there for purposes of design'. For him, designers subjectively interpret the design task, interact with a design situation and set the problem. "In real-world practice, problems do not present themselves to the practitioner as givens. They must be constructed from the materials of problematic situations which are puzzling, troubling, and uncertain" (Schön, 1983:39-40). Designers make choices and decisions to solve a problem by selecting the possibilities best suited to the goal among the available means. The cyclic process of problem-setting is defined as a "process in which, interactively, we name the things to which we will attend and frame the context in which we will attend to them." (Schön, 1983:40). In other words, designers' reflection-in-action can lead them to restructure their strategies, or ways of framing problems (Valkenburg, 2000 – referring to Schön, 1983). Schön's model of the process is *naming, framing, moving*, and *evaluating*.

For Schön (1983), framing is an activity that enables sensemaking based on previous experience. He proposes that reframing is the result of a process of reflection in action when designers realize that their repertory of responses is insufficient to deal with a given situation, which impels them to reconfigure their understanding of the situation. Explained by Visser (2010), designers, through reflective conversations with design situations, 'frame' and 'reframe' problems. With such conversations "the practitioner's effort to solve the reframed problem yields new discoveries which call for new reflection-in-action. Initially defined by Goffman (1974), frames are basic schemas that help place a situation with respect to past experience, and so to build interpretations and determine what is important for actors in a given context. Frames allows individuals to selectively foreground certain elements of experience among the continuous flow of events and activities going on around them, and to relegate others to the background, at least temporarily (Putnam and Holmer, 1992;

Weick, 1995; Valkenburg, 1998). A frame repertory is thus a structured set of aspects of experience, continually formed and reformed in interaction (Czarniawska, 2006).

Increasingly, design is a group activity. Collaborative design refers to activities that lead to framing and reframing criteria of a project, and lead the team to develop innovative solutions using an interdisciplinary and iterative approach (Valkenburg and Dorst, 1998; Kleinsmann and Valkenburg, 2008). Finally, for Kvan (2000:410) "Design collaboration requires a higher sense of working together in order to achieve a holistic creative result. It is a far more demanding activity, more difficult to establish and sustain, than simply completing a project as a team".

Like a number of other researchers (Bucciarelli, 1988, 2002; Cross, 1984; Cross and Cross, 1995; Schön, 1992; Valkenburg, 1998), we view design situations as collaborative social processes. Developing shared framing is recognized as an important factor in collaborative design (Dorst and Cross, 2001; Paton and Dorst, 2010, 2011; Schön, 1983; Hey et al., 2007; Hey et al., 2008; Kleinsmann and Valkenburg, 2008; Whelton, 2004; Dorst, 2011), but strategies leading to frame co-construction in collaborative design are underexplored (Badke-Schaub et al., 2007). Valkenburg and Dorst (1998) identify problems of synchronising understandings and activities as limiting collaborative design. They use Schön's —naming, framing, moving, evaluating— (reflective conversation with the situation theory) to study design teams and their relations that they called 'mechanism of reflective practice'. Based on an understanding of the process of reflection-in-action and problem-setting as a set of cyclic activities, where "designers work by naming the relevant factors in the design situation, framing this situation in a certain way, making (experimental) moves toward a solution and reflecting on those moves" (Valkenburg, 2000:72), Valkenburg and Dorst propose a model (Figure 1) in which Schön's 'evaluating' is replaced by 'reflecting' (Valkenburg and Dorst 1998:254).

This model seeks to be a more visual representation of design activities. Valkenburg (2000:72) explains, "In this scheme, the *naming-, moving-*, and *reflecting* activities are represented as separate images. For the *framing*, we are not only interested in framing activity, but also in the result: the *frame* that will guide further activities." She goes on to explain, "the frame is represented by a box, in which other activities can occur", and that reflection is a "conscious and rational activity that can lead to *reframing* the problem, the making of a new *moves*, or attending to new issues."

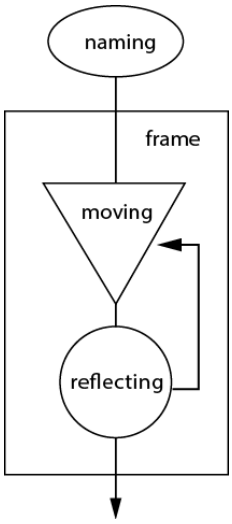


Figure 1. The mechanism of reflective practice: the four design activities and their interplay.

The model suggests that boundaries (framing) are created after naming, and reframing happens through cycles of 'moving' and 'reflecting'. "Reflection is a conscious and rational action that can lead to reframing the problem (when the frame is not satisfactory), the making of new moves, or attending to new issues (naming, when the reflection leads to satisfaction)." (Valkenburg and Dorst, 1998:254).

Bucciarelli (1988) argues that, although different team members, with different competencies, skills, responsibilities and interests, may be working on the same design, they see it differently. In order to explain how they harmonize their claims and proposals during the design process, he focuses specifically on design discourse, which he divides into three stages: constraining, moving, deciding. "The first is about the setting of performance specification early on in the design of the system. […] The second is about naming, which is a design phenomenon that crystallizes images of parts and functions of the design in the minds of participants. The third is about decision-making." (Bucciarelli, 1988:164).

In a later paper, Bucciarelli (2002) expands on his notion of 'object worlds' as agents for structuring design. An 'object world' is "a world of a variety of things particular and specialized modes of representation. Object worlds have their own unique instruments, reference texts, prototypical bits of hardware, tools, suppliers' catalogues, codes and unwritten rules. There are exemplars, standard models of the way things work from the disciplinary perspective of the particular world and particular metaphors which enlighten and enliven the efforts of inhabitants" (Bucciarelli, 2002:222). The concept thus includes discursive elements, such as specialized technical 'dialects,' models and symbol systems, but also particular ways of thinking and using specific instruments or artifacts.

For Schön, "doing and thinking are complementary. Doing extends thinking in the tests, moves, and probes of experimental action, and reflection feeds on doing and its results. Each feeds the other, and each sets boundaries for the other. It is the surprising result of action that triggers reflection, and it is the production of a satisfactory move that brings reflection temporarily to close." (1983:280) This is called 'reflection-in-action'. Design knowing-in-action consists of seeing-drawing (moving)-seeing, involving doing and thinking. Not only do designers register information, they also

construct its meaning through actions. This understanding led us to identify a series of 'designerly actions' (Heaton et al., 2015), used in the analysis that follows.

In his recent book, *Frame innovation*, Dorst (2015) characterizes problems of contemporary life as open, complex and networked. He mentions that frame creation that allows radical innovation is developed originally in the practices of practitioners. For him, expert designers are known for 'solving the unsolvable', which means that they create solutions and find new opportunities where less expert designers see only problems. He calls this approach to problematic situations 'frame creation'. This view of Dorst captures the motivation of this study and its focus on understanding 'framing'. How can 'frame creation' be developed as design students working collaboratively?

Methodology

In the context of a design workshop —project based learning— on events and communication, second-year design students were asked to design a popup shop for a particular brand during a special event related to thirst. The objectives of this design project were firstly to bring students to understand diverse interconnected aspects related to the design of a temporary installation: functional, visual, structural, installation and take-down conditions, location, footprint, etc.; particularities of a brand; use of the brand particularities for reinforcing the design; and the desired interaction of the public with the popup shop (user experience). Secondly, we wanted to put students in a collaborative design situation, believing that this would enable them to explore ideas and develop more refined design solutions. Students received a 'client brief', which included some information about the brand (eska, a natural spring water). The client brief also included the marketing objectives of the popup shop and services offered, as well as specifications, such as the location and duration of the event and the footprint of the installation.

Students worked through four phases: 1) research: to better understand temporary constructions, branding, event related issues; 2) ideation: to explore collaboratively without yet considering design criteria. Students started by sharing their individual understanding of the project brief. They were asked to sketch 40 ideas to explore possibilities. Tutors gave feedback and highlighted the sketches that held interesting ideas for the next phase; 3) three preliminary concepts based on identified design criteria such as the size and the shape of the space, the brand and the user experience; and 4) development of a final concept.

Data collection

Since we consider design to be a situated activity, it must be seen in context. This requires a qualitative methodology (Anadon, 2006; Denzin and Lincoln, 2000, Charmaz, 2004). Specifically, we wanted to focus on the actual practice of collaborative working (Nicolini, 2009). We relied principally on focused observation, taking a particular situation delimited in time and space as the object of inquiry. Frequently used in the field of education for assessment and evaluation, focused observation limits "snap judgments" that may subsequently affect appreciations (Duke and Prickett, 1987) by requiring that observers attend to specific elements rather than the whole picture. Distributed among a number of observers, it also allows for a variety of perspectives and better capturing the multiplicity of what is naturally occurring in a given situation. A descriptive method,

observation does not provide insight into actors' interpretations of their actions, as interviews might (Denzin and Lincoln, 2000; Savoie-Zajc, 2010). Since students were working in groups, their conversations provided evidence of their process and thinking. We analysed their conversations since "through talk, the creativity and constrains of design are continually being managed and performed by participants in practice" (Oak, 2010:214).

As mentioned earlier, the main research objective was to better understand strategies and tools that the team used to tackle the project in the early stages of the process. The research team observed one group of four students (two males and two females) working together. Although these students had known each other for two academic years, this project was the first time they decided to team up together. Although the entire workshop was seven weeks in length, observations focused on the first two weeks of the activity – phases 2 and 3. Direct observations were made at four different moments during the creative process, each time for about two hours. Five members of the research team were present at each session and noted their observations in the way ethnographers might look at a phenomenon. One observer focused specifically on the way students used different tools (for example, sketches, searching on the internet for images, pointing at something and other gestures), and another on emotional (nonverbal) interactions between students (for example head movements as a gesture to agree or disagree). Other observers took notes of general sense-making discussions and gestures that seemed significant. In addition, four segments, each about 45 minutes in length, were recorded on audio and video. The final observation was followed by a discussion between the research team and the students. The traces produced during the design activity (drawings, presentations, mock-ups) were also collected and were used to inform our analysis.

Analysis of data

The research team conducted collaborative analysis sessions, in the tradition of grounded theory (Glaser and Strauss, 1967; Charmaz, 2014). Our analytic method consisted of continually going back and forth between our research question and our corpus, questioning our data to check whether our emerging claims were supported and, conversely, whether the theory helped us understand our empirical material (Yanow and Schwartz-Shea, 2006). Morse (1994) describes this oscillation between the conceptual and the concrete in terms of four decisive cognitive moments: understanding, reducing, abstracting and recontextualising. Charmaz (2014) sees this approach as a heuristic device for learning about the world that one is researching and analysing.

Combining our multiple sources of information in order to analyse them was a challenge. First, the observers' notes were compiled into a single document, organized chronologically for each observation. This produced a synthesis of the activity. Figure 2 is an example of the layout of such pages. Two researchers then segmented this chronology, signalling a break each time there was a change (such as a change of subject, modification of concept, addition of an element, questioning a concept, etc.) The episodes identified in this way were then examined one by one, and their transcriptions coded using a categorization of 'designerly actions.' We noticed that one of the sessions we observed was not significant for the problem-setting phase and didn't contribute to the concept. That session was eliminated.

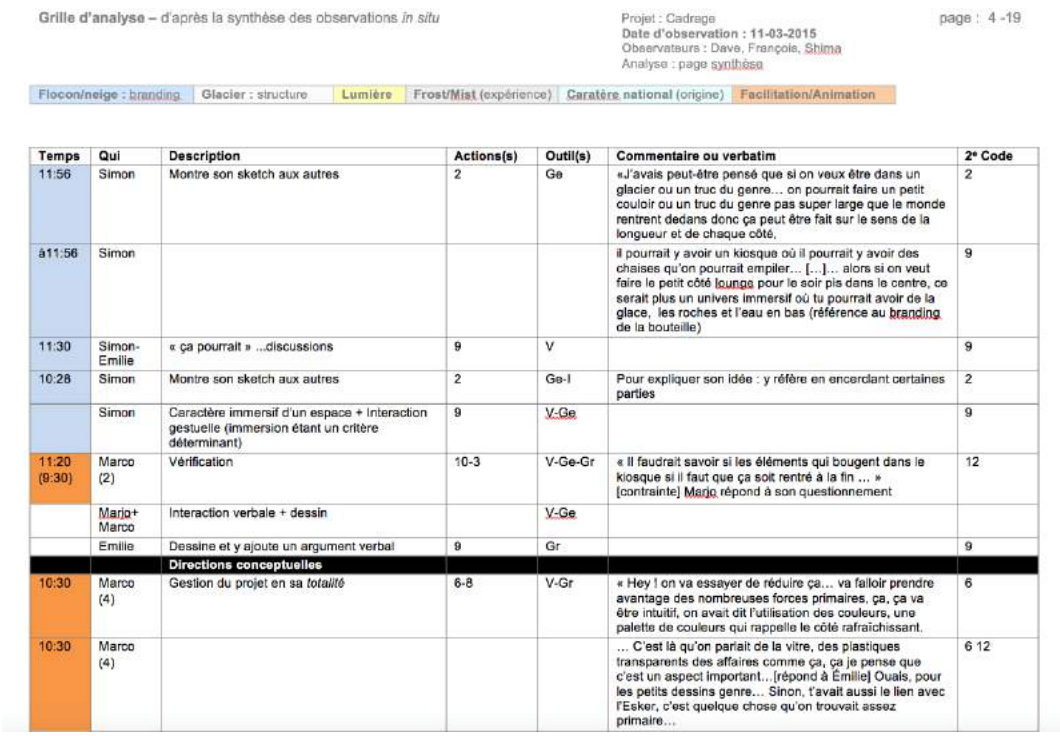
The list of designerly actions was developed in our previous work (Heaton et al., 2015) as a composite of activities found in both theoretical (Archer, Zeisel, Cross, Buchanan, Lawson) and more

applied (Sun Sigma Framework, Garrett) models of the design process. We added one new action to the 13 previously identified (see Table 1). This last action (private thinking while collaborating) was identified during our observations.

Designerly Actions	Code No.
Informing (giving information)	1
Facilitating understanding	2
Questioning / requesting for justification	3
Referring to past experience or known elements	4
Identifying needs / desires	5
Presenting a synthetize view	6
Fixing a goal	7
Fixing priorities	8
Proposing ideas	9
Proposing a process	10
Determining role / task	11
Taking a position	12
Making decision	13
Private thinking (Private reflection)	14

Table 1. List of designerly actions developed by authors (Heaton et al., 2015).

We also associated the actions with the type of tool (cognitive, interactional, graphic, gestural or technological) that generated or supported the action, as shown in Figure 2. Conversations were coded line by line, although the segment in which the line appears was also considered in order to best determine 'what was going on.' Table 2 (in the results section) is an example of a conversation transcript, coded with designerly actions. Figure 2 below shows our composite observation document. The black row shows the segmentation, which was added by researchers. The layout of the observation grid includes two sets of coding according to designerly actions: the first coding was done by individual researchers and the second coding is the result of discussions among the research team. The column 'Outil(s)' identifies tools used during the action (C for cognitive, Ge for gesture, V for visual, Gr for graphic, I for interactional). The grid was enriched with color-coding in the first column (legend across the top) related to five design elements that researchers identified during data interpretation, with an additional colour for facilitation and animation of the discussion.



Grille d'analyse – d'après la synthèse des observations *in situ*

Projet : Cadrage
Date d'observation : 11-03-2015
Observateurs : Dave, François, Shima
Analyse : page synthèse

page : 4 -19

Flocon/neige : branding | Glacier : structure | Lumière | Frost/Mist (expérience) | Caractère national (origine) | Facilitation/Animation

Temps	Qui	Description	Actions(s)	Outil(s)	Commentaire ou verbatim	2e Code
11:56	Simon	Montre son sketch aux autres	2	Ge	«J'avais peut-être pensé que si on veux être dans un glacier ou un truc du genre… on pourrait faire un petit couloir ou un truc du genre pas super large que le monde rentrent dedans donc ça peut être fait sur le sens de la longueur et de chaque côté.	2
à11:56	Simon				il pourrait y avoir un kiosque où il pourrait y avoir des chaises qu'on pourrait empiler… […]… alors si on veut faire le petit côté lounge pour le soir pis dans le centre, ce serait plus un univers immersif où tu pourrait avoir de la glace, les roches et l'eau en bas (référence au branding de la bouteille)	9
11:30	Simon-Emilie	« ça pourrait » ...discussions	9	V		9
10:28	Simon	Montre son sketch aux autres	2	Ge-I	Pour expliquer son idée : y réfère en encerclant certaines parties	2
	Simon	Caractère immersif d'un espace + interaction gestuelle (immersion étant un critère déterminant)	9	V-Ge		9
11:20 (9:30)	Marco (2)	Vérification	10-3	V-Ge-Gr	« Il faudrait savoir si les éléments qui bougent dans le kiosque si il faut que ça soit rentré à la fin … » [contrainte] Marjo répond à son questionnement	12
	Marjo+ Marco	Interaction verbale + dessin		V-Ge		
	Emilie	Dessine et y ajoute un argument verbal	9	Gr		9
		Directions conceptuelles				
10:30	Marco (4)	Gestion du projet en sa *totalité*	6-8	V-Gr	« Hey ! on va essayer de réduire ça… va falloir prendre avantage des nombreuses forces primaires, ça, ça va être intuitif, on avait dit l'utilisation des couleurs, une palette de couleurs qui rappelle le côté rafraîchissant.	6
10:30	Marco (4)				… C'est là qu'on parlait de la vitre, des plastiques transparents des affaires comme ça, ça je pense que c'est un aspect important…[répond à Émilie] Ouais, pour les petits dessins genre… Sinon, t'avait aussi le lien avec l'Esker, c'est quelque chose qu'on trouvait assez primaire…	6 12

Figure 2. Example showing columns and rows of the observation document organized chronologically.

Results and discussion

Five visual/structural elements emerged from students' collaborative design sessions: glacier, snowflake, mist, image projection and national identity of the brand. These elements were identified and developed early in the design process and structured talk during phases 2 and 3 of the design process. They were modified and enriched, and were carried through to the final version of the project. The alteration and improvement of these visual/structural elements happened through discussion, sketches, cardboard mock-ups and gestures: "Broken lines, like ice breaking …"; "I see an ice cube … that's how I imagined it to start with. It could be more like an iceberg, but I saw a giant ice cube – I think we need to think conceptually, not too literally…" These elements also helped students negotiate priorities and make decisions. Talk around and about these elements and the artifacts representing them, often in the form of "if we do this (move, add, place, etc.) then …", helped students to conjecture and imagine various possibilities for of the object of design and/or the next steps in their process. As Bucciarelli (2002:230) notes, "In this way, through the construction and use of these varied things, participants in design [design students] extend their language competencies. Their building and manipulation of these artifacts brings insight and robust meaning to their analyses and trials within an object-world."

4.1 In search of patterns

The process of framing is central in our research. As explained above, transcripts were coded according to the designerly actions being undertaken. Table 2 is an example of discussions between the team members, along with their designerly action codes. The detailed coding of talk as it was

performed shows that design practice required team members to "clarify, explain, interpret, assess, argue, and engage in interactive levels of reflection and critique," as mentioned by Oak (2010:229). We noticed that certain actions seemed to go hand in hand with others, so for many lines more than one code is attributed to capture the meaning of the actions.

Table 2. A segment of conversation coded with designerly actions (the original conversation was in French and has been translated by the authors).

M:	*Finally, what are our design criteria?*	5
MJ:	*Shall we take criteria one by one and generate ideas for each?*	10, 3
E:	*Or, do we just select three objectives?*	10, 3
S:	*Yes! it is true, he [the tutor] suggested that. […] I just want to say that when we presented, we offered three interesting options: closed space, half closed, and open. We should decide what we want to do with these options.*	4, 1, 10
M:	*Within our 40 sketches, do we want to explore the three options?*	2
MJ:	*Yeah, our three options are interesting. But when we talked, it really seemed that we wanted to create something impressive.*	12
M:	*Wait, let me write down what we are saying.*	6, 1
M:	*Related to the three options, are we focusing on 'space'?*	1, 5
MJ:	*We can start by deciding on all the dimensions.*	5, 9, 10
[...]		
M:	*I think that – we only have 6 square meters… when it's open, so that's the thing – you lose a lot of space when you do something that's on an angle…*	2
S:	*If we want to do something a lot more immersive, it gets a bit strange – we thought of something like a cave concept [...] you enter, it creates an atmosphere. But with a length of 2,40 m the potential is limited. We need to rethink that a bit.*	2, 3, 12
E:	*I like the idea of roundness …*	12
M:	*For sure, with the product [takes the eska bottle] and with all our research, we're moving more towards curves rather than walls in square shapes.*	4, 9
MJ:	*But it depends, because since the idea of…*	3, 4
S:	*It has been squarer and it could resemble an iceberg.*	2
MJ:	*Yeah, yeah, there was, like, a transparent space...*	1
M:	*I think we can achieve what we want with straight lines.*	12, 10
M:	*OK, so shall we check the design criteria just to be sure that we have everything we need to present today?*	10, 8
[...]		

MJ:	*We keep coming back to roundness … It could be a drop of water, a snowflake.*	9, 4
S:	*We could design three small kiosks – drop, snowflake, rock … It's a bit like the eska logo*	9, 4
M:	*We could design a tall kiosk that is visible from far away… Give the illusion that it's ice that's producing the water.*	9
[...]		
M:	*You can integrate the aspect air conditioning I was talking about earlier. It gives a feeling of freshness to attract people.*	8, 9
E:	*You can put mist inside [mimes]*	9
M:	*We could almost do that, [to MJ]: «your mist»*	4, 9
E:	*Ohh, that's good! [satisfaction on faces]*	7
M:	*What would be really interesting I think is the cold aspect. Like an air-conditioned mist in a partly closed circle, and that's where you make your sale.*	12, 9
S:	*Like in the passageway?*	2
M:	*It would be like an aisle but you would still have quite a lot of space [points to the drawing on blackboard] Yeah, where people are walking. You would use the outside to do I don't know what yet.*	2, 9

Following this, we looked for patterns of framing, deframing and reframing in the design sessions, and used the following definitions to eventually demystify the team design activities.

Constraining is defined as setting the performance specifications of the project. It depends on the culture, traditions, values, etc. of participants, including External constraints (what is imposed through the brief) and Internal constraints (criteria defined by the designer or the design team). Naming refers to identifying relevant issues in design situations. It is created through conversation 'alone' with the situation and with others, mediated with tools: drawing, pointing, body language, etc. *Naming* is also when a team member highlights elements relevant to the design problem. *Framing* involves setting boundaries and determining the features and priorities that the design will attempt to impose on the situation. Designers perform by 'doing and reflecting' alone or through conversations with others, mediated with tools. They select particular elements and criteria for attention in relation to the situation, features and order, looking for a coherence that can guide next moves. "The process spirals through stages of appreciation, action, and reappreciation. The unique and uncertain situation comes to be understood through the attempt to change it, and changed through the attempt to understand it" (Schön, 1983:132). Furthermore, the practitioners' moves also produce unintended changes which give the situation new meanings. "Through the unintended effects of actions, the situation talks back. The practitioner, reflecting on this back-talk, may find new meanings in the situation which lead him to a new reframing" (Schön, 1983:135). Within the framing, deframing and reframing cycle, *moving* refers to designers' actions (doing and thinking) inside the problem space that they have constructed to attempt to find solutions. It involves a change in configuration. It is testing a hypothesis within a frame (Schön, 1983). It refers to

development of a possible solution that fits with the context. 'Moving' is experimental and happens through a chain of seeing-moving-seeing episodes. To better understand 'moving' it is important to define 'seeing'. Schön (1983) presents two meanings for 'seeing': the first is 'what is there', whereas the second 'seeing' conveys a judgment about what was seen (the first meaning). During the 'moving' activity, the design team tries to solve the problem but "at the same time also explores the suitability of the frame" (Valkenburg and Dorst, 1998). *Reflecting*, evaluating and moving are intertwined. *Reflecting* and *evaluating* are the mechanisms that bring the team of designers back to moving and reframing. We consider that 'reflecting' is 'private thinking' (a designerly action) that uses reasoning alone for structuring thoughts. Reflection is then expressed and shared with the team (through talk, sketches, giving/showing examples etc.), and contributes to evaluation of the move. Thus, evaluating can be either an individual or a group activity. Because they have incomplete information, designers cannot predict in advance the consequences of a given move. But the multiple, sequential episodes of seeing-moving-seeing, and the evaluation of these episodes enable them to deal with this complexity.

Finally, *negotiating* is defined as a "special type of social interaction – one distinguished by goals, relationships and normative practices (Putnam and Roloff, 1992:2-3). In the model, it is the general situation within which these constraining, naming and framing activities take place. It is specific to collaborative design, since it involves interaction among members of the design team (although one could argue that the individual designer negotiates with his or her own understandings and the constraints of the situation, this is not the predominant meaning we give it in the model).

Framing model

Based on analyses of our data and the theories explained earlier —Schön's naming, framing, moving, evaluating (1983), Bucciarelli's constraining, moving, deciding (1988), and Dorst and Valkenburg's model (1998 - see Figure 1)—, we proposed a model (Figure 3) that formalizes our findings. The model is accompanied with a coding system for the designerly actions (Table 4), presented below.

The model shows the cycle of framing as constructed by moving, reflecting and evaluating. We find these stages more global, whereas naming (and negotiating within design teams) are closely linked to constraining.

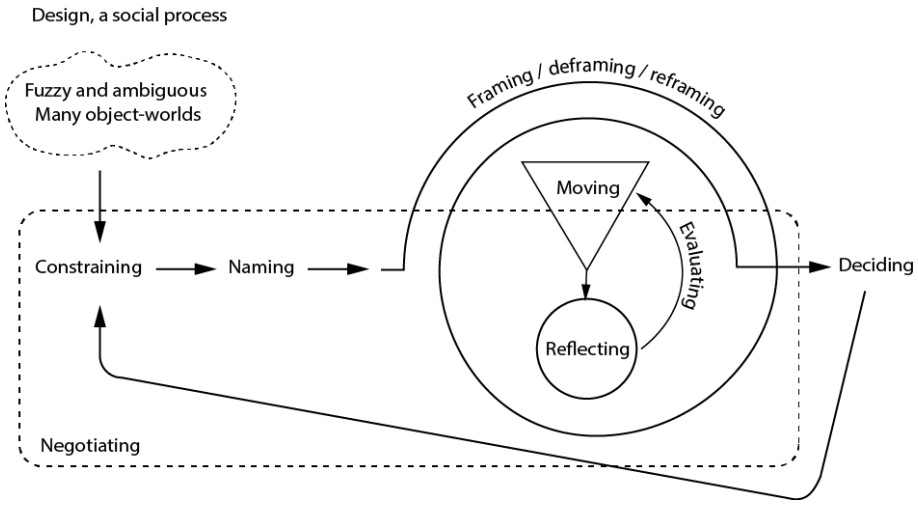


Figure 3. Model depicting the mechanism of 'co-reflective practice' of designers. The concept of co-reflective practice was introduced in an earlier work (Zahedi, 2011).

We used the model to reinterpret our data. Analyzing the design process in a fine manner (using designerly actions) combined with the regrouping of the actions (using the model) helps us to make our understanding of designing more concrete. We hope that the model can be useful not only in design education but also in professional settings and be operationalized for the development of projects. Table 4 presents how the model can be used in relation with designerly actions.

Elements of the 'co-reflective practice' model	Definition	Designerly action codes
Constraining *External and Internal*	*Ex.: project brief*	
	Int.: setting of performance specification	1, 5, 6
Naming	*Identifying relevant issues* *Elements of design phenomenon*	1,2, 4, 5
Negotiating	*Proposing, questioning, explaining, approving*	2, 3, 12, 14
Cycle of framing, deframing, reframing	*Leading to new boundaries*	
Moving	*Propose change, explain a tentative solution*	9, 10, 11
Reflecting	*Consider 'moving' in situation. Listening to situation 'talk back'*	6, 7, 8, 14
Evaluating	*Judge potential / evaluating fitness within situation context*	3, 12, 14
Deciding *External and Internal*	*Int.: overlay of interests within the team*	13
	Ex.: client / tutor instruction	

Table 4. Elements of the model and related designerly actions.

A synthetized definition (in terms of action) is added for each element of the model to make the model operational for research, in educational settings and professional projects. We consider two types of 'Constraining' and 'Deciding': External constraining refers to imposed restrictions (by client, regulations, etc.) and cannot be changed. Internal constraining refers to criteria and specifications defined by the design team as fundamental performance specifications for the project. Internal deciding refers to decisions made by the design team to crystalize a concept or a direction whereas external deciding is about suggested (or even imposed) direction by tutors or clients (Zahedi and Sharlin, 2013).

More about collaborative design

Many issues and conditions influence collaborative design: knowledge, expertise and skills of team members; the nature of different design tasks; available time; influencing external conditions including organizational why of functioning; team's implication and availability; etc. (Badke-Schaub and Frankenberger, 2002; Goldschmidt and Badke-Schaub, 2011; Kleinsmann and Valkenburg, 2008).

In the situation observed, object worlds served an essential function: "they enable negotiations among participants with different responsibilities and technical interests" (Bucciarelli, 2002: 230). We also noticed that one of the students took on the role of facilitator. This was agreed upon informally and without discussion within the team. He kept track of what was agreed upon and constantly recentred the team negotiation on the agreed-upon criteria.

Conclusion and further studies

Our goal in this exploratory study was to find answers to the question presented earlier: on how ideas evolve in the context of collaborative design among students, and develop tools and guidelines in order to assist students in collaborative design. We explored the framing, de-framing and re-framing process within a team of industrial design students who worked collaboratively on a design project. We used a set of designerly actions to explore our data in depth and interpret our observations. The detailed coding of talk as it was performed over the whole observation period points to the vital role of discussion among team members in clarifying, explaining, and interpreting as well as in encouraging reflection and critique. The interpretation led us formalize a model that is inspired by Schön's naming, framing, moving, evaluating model (1983), Bucciarelli's constraining, moving, deciding model (1988), and Dorst & Valkenburg's model (1998). The model, combined with designerly actions, is part of the contribution of this paper, a new approach to analysing design communication in social settings. This case study is the third in a series of case studies that the research team has conducted in both educational and professional situations. The case has its limits: on the one hand, although the research team observed design activities during critical periods, the entire process was not recorded and it is possible that significant developments occurred outside the observation periods. In addition, we do not have a way of knowing how the lecturers' actions, such as providing advice and instructions, influenced the process. Thus, one of the questions that will be considered in future studies is "to what extent would the resulting model remain the same with or without lecturers' intervention?"

Further studies are planned to allow us validate the applicability of the model to other design situations involving talk, gestures and the use of artifacts during early phases of design, and to improve it.

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22.2

Traditional Tales and Imaginary Contexts in Primary Design and Technology: A case study

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Abstract

Working with contexts is a key component to design and technology activity and education. The most recent iteration of the national curriculum programme of study for design and technology, in England, sets out that children between the ages of 5 and 7 "should work in a range of relevant contexts" (DfE, 2013, p.193); suggested contexts including "home and school, gardens and playgrounds, the local community, industry and the wider environment". Whilst these are real world and familiar contexts, fictional contexts also provide opportunities for developing "creative spaces" in which to speculate and discuss. This intrinsic case study explores the work of two primary teachers' development of a design and technology activity, where traditional tales provide the context. Children explore design problems and opportunities through the eyes of the *Billy Goats Gruff*, as they seek assistance to cross the river. Data was gathered through semi-structured interviews and document analysis of children's design work. The case study reveals how multidisciplinary and imaginative approaches to teaching and learning in the primary classroom stimulate and nurture design thinking, dialogue and critique.

Key words

creativity; design; primary design and technology; traditional tales; design fiction

Introduction

The national curriculum for design and technology (DfE, 2013), in England, states that pupils in key stage 1 (5 to 7 year olds) are expected to:

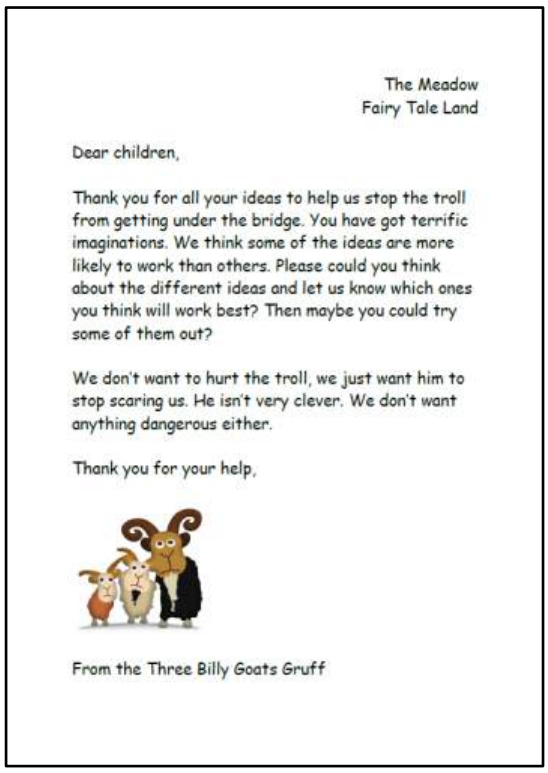
> "… be taught the knowledge, understanding and skills needed to engage in an iterative process of designing and making… [and] should work in a range of relevant contexts (or example, the home and school, gardens and playgrounds, the local community, industry and the wider environment)."

(DfE, 2013, p.2)

This study outlines a project with Year 1 (5 to 6 year old) pupils adopting an alternative approach to the realworld contexts suggested in the national curriculum programme of study. The project grew out of a discussion between the authors exploring novel approaches to teaching pupils about structures, which was considered to be a dry topic to teach. This perceived dryness may, in part, be due to the nature of structures and 'what works', along with the perceived need to focus on structural elements such as stability and reinforcement, or shell and frame structures; rather than creative application of knowledge.

As an alternative to frontloading teaching about technical structures at the beginning of the project, an approach was adopted in this study with the starting point being a context and the initial focus on developing imaginative solutions. In other words, the teaching and learning was frontloaded with contextual and design thinking, rather than technical knowledge. The emphasis was on designing and discursive activity, mediated by a traditional tale as the context, leading onto modelling.

The teachers considered that the previous year's structures unit of work was unimaginative, and a proposal was made to start with a design problem or context. The pupils had been working on traditional tales as a creative curriculum theme, and ultimately the story of the *Billy Goats Gruff* (Wikipedia, 2016) was chosen as the context for the project.



The Meadow
Fairy Tale Land

Dear children,

Thank you for all your ideas to help us stop the troll from getting under the bridge. You have got terrific imaginations. We think some of the ideas are more likely to work than others. Please could you think about the different ideas and let us know which ones you think will work best? Then maybe you could try some of them out?

We don't want to hurt the troll, we just want him to stop scaring us. He isn't very clever. We don't want anything dangerous either.

Thank you for your help,

From the Three Billy Goats Gruff

Figure 1

In the tradiational tale, three young goats attempt to cross the troll bridge to get to the grass on the other side. The first two, younger, goats persuade the troll that their older sibling will be more gratifying; and the third goat challenges the troll, knocking him into the river.

At the beginning of the unit, the teachers presented the pupils with a letter from the three goats, asking them to solve the problem of "the scary troll hiding under the bridge"; followed up by a second responding to the pupils' initial ideas (Figure 1). As the project progressed further letters were received from the goats, as clients, such as a letter explaining that a sign would not be effective(although inexpensive and straightforward), as suggested by one pupil, as the troll could not read.

Literature Review

The intention of this brief review of literature is to put this study in context and provide a rationale for the use of fictional contexts as a valid starting point for design thinking and activity.

In the opening chapter of 'Speculative Everything: Design, Fiction and Social Dreaming' Dunne and Raby (2014) challenge the notion that design is solely "about problem solving" (p.1) and highlighted issues with "[d]esign's inherent optimism", which can lead to an attempt to solve unsolvable problems, such as climate change. Although they acknowledge the important, and positive, role of optimism in design, they propose that some problems can only be addressed by changing "the ideas and attitudes inside our heads" (p.1). They call this *speculative design* – imagining how things might be. The aim of this speculative design is to facilitate and provoke discourse, rather than predict the future (pp.2-3). Fictional scenarios are used to encourage participants to "suspend their disbelief and allow their imaginations to wander" (p.3) rather than to focus on the future as an end in itself. Approaches include a range of philosophical tools, such as fictional worlds and cautionary tales.

Stables (1992), discussing the role of fantasy in design and technology activity, and how make believe comes naturally to children. This is related to the speculative nature of design in taking thinking from the concrete reality of "what is" to "what might be" (p.111). Stables goes on to caution that superficial handling of so called realworld contexts can resemble fantasy, providing an example of a rain forest. In this scenario, the context provides opportunity to empathise, although drawing on stereotypes somewhat limits the scope of designing, leading to a focus on technical rather than human concerns. The paper closes echoing Baynes (1986) of further investigation of designerly play.

Martin and Riggs (1999) noted that by the mid 1990s there had been a shift away from context in the Design and Technology national curriculum in England. Commenting on the emphasis on the product as opposed to values, reflecting an apparent narrowing of the interpretation and understanding of technology. The interim report for the Department of Education and Science and Welsh Office (1988), which preceded the launch of the national curriculum, commented on the purposefulness of design and technology activity, which differed from science education and "takes place within a context of specific constraints and depends upon value judgements" (p.4). However, Martin and Riggs suggest that more than a decade after its first teaching the role of contexts and values had somewhat diminished.

The current design and technology programme of study (DfE, 2013) reintroduced the idea of contexts for design, following its relative absence since the first orders in the 1990s (NCC, 1990). The

examples provided are real situations, such as "the home and school, gardens and playgrounds, the local community, industry and the wider environment" (DfE, 2013, p.2) in key stage 1. However, the Design and Technology Association's (D&TA) clickable framework, developed with the Expert Subject Advisory Group (ESAG) for design and technology, suggests that key stage 1 pupils could work in an imaginary context, such as "[t]raditional stories, fairy tales or nursery rhymes with a design problem to be solved [as] appropriate contexts for children's designing and making" (D&TA and ESAG, 2016, p.7). Hope and Parkinson (2011) and Bjurulf and Kilbrink (2012) have also written about the use of traditional tales in design and technology, and Antonopoulou (2011) about story-making, and the role of fiction in design. Although Dunne and Raby have "little interest" in what they call the "zone of fantasy", which go beyond speculation on possible futures that, whilst not scientifically proven, are conceivable (2014, p.4).

The relationship between science fiction and design has also been explored by Stirling (2005), de Vries (2007) and Antonopoulou (2011). The attribution of science in popular fiction could be argued to be more accurately understood as *technology*, considering Mitcham's (1994) ways of looking at technology as object, knowledge, activity and volition. Stirling talks about "design fiction" as being similar to science fiction, although to some extent it "sacrifices some sense of the miraculous"; on the other hand it lends itself to the "technosocial" (p.30). In a discourse on the nature of design and technology de Vries (2007, pp.21-27) explores how the imagined and future cultures of science fiction franchise Star Trek can be used to reflect on aspects of technology, including how technological artefacts are understood; as objects with physical and functional properties. Stirling and de Vries suggest an ability to consider problems through the eyes of another is a valuable tool for design thinking, which includes imagined, future and fictional worlds.

This case study describes how a fictional context, in the form of a traditional tale, was used to creatively introduce pupils to technical design and technology knowledge.

Research Design

This study is presented as an intrinsic case study (Stake, 1995) as practitioner enquiry (BERA/RSA, 2014). Case studies are a long-established method of documenting phenomena, across a range of disciplines, although there are associated difficulties and criticisms, including the wide variety of definitions (Flyvbjerg, 2011, p.302). Strengths of case studies as a technique to describe an in-depth "bounded system" (p.301) include developing an "understanding of context", generating new ideas or understanding and exploring relationships between phenomena (p.314). The choice of a 'case' involves "selection bias [which] may overstate or understate relationships" and the research may be unable to demonstrate statistical significance that larger scale statistical method can afford (p.314). However, the very nature of a case study, as an intensive analysis of developmental factors in relation to their environment, makes it an appropriate approach for developing conceptual understanding.

As sociomaterial research (Fenwick, Edwards and Sawchuk, 2011, pp.2-6), is concerned with conceptual (wants and needs of a client) and physical (modelling materials) artefacts as "cultural entities" (classroom dialogue, mediated by a traditional tale), taking the view that pupils and teachers engage with what Engeström calls an "object-orientedness of action" (2009, p.54); and that artefacts can be viewed as physical objects, knowledge or ideas (Wartofsky, 1979). The research

paradigm is qualitative and interpretive, adopting a relativist ontological perspective in terms of nature of realities for individuals, which are multiple, in relation to social and technological activity (McLain, 2012; Flyvbjerg, 2011; Guba, 1990; Guba, 1981).

Working within a social constructivist framework (Santino, Daniels & Gutiérrez 2009), the epistemological position is subjectivist, recognising the role of the researchers as a co-constructers of theory and knowledge with the actors (pupils) in the study. The approach to knowledge and experience is pragmatic and does not deny objective truth or reality, but acknowledges that we perceive and share conceptual constructs with physical and cultural artefacts, in this case traditional tale, mediating interactions in the classroom (Engeström, 2009, p.54).

The primary research method employed was a semi-structured interview with the lead teacher for the project. Kvale and Brinkmann describe qualitative interviews as a conversation with both structure and purpose (2009, p.3). Unlike normal everyday conversations, the interview is not an exchange between equal partners. The impact of "power asymmetry" (p.33-34) was addressed by adopting a collaborative approach, encouraging co-construction of knowledge through joint questioning and interpretation; informed by samples of pupils' and teachers' work for the project, as documentary evidence (Bowen, 2009; Wharton, 2006; Stake, 1995) of the activity undertaken in the classroom and evidence of the dialogue between teacher and pupil. These documents act as artefacts to facilitate and mediate interviews, in addition to providing and insight into the dialogue between teacher and pupil, for analysis and interpretation, as "social facts" (Atkinson and Coffey, 1997, cited in Bowen, 2009).

Findings

Description of context:

Prior to outlining the data gathered through document review and semi-structured interview, an outline of the context of this intrinsic case study will benefit the reader to allow them to envisage the operational context in which the study was carried out (Stake, 1995, p.64). The site of the study was a large primary school (2 form entry – approximately 60 per year), situated in the suburbs of a city in the North West of England, with pupils coming from mixed socioeconomic backgrounds, including historically working class families who have lived in the area for generations, families with young professional/middle class parents and non-nuclear family units. The school is comprised of separate infant (nursery to Year 2; age 4 to 7) and junior (Year 4 to 6; age 7 to 11) departments, sited in separate buildings across the school yard from each other; reflecting their previous existence as separate institutions.

The school has been described as fostering a culture of support and care, through leadership, teachers and teaching assistants; and that pupils' attitude to learning is described as outstanding (Ofsted, 2014). The curriculum includes a wide range of activities both within and outside of the classroom. The number of pupils receiving free school meals is above average, as is the number with identified special educational needs; although the proportion from minority ethnic backgrounds and with English as an additional language is below the national average. Overall the school was deemed to meet the expectations for pupils' attainment by the age of 11 (Year 6), at the end of Key Stage 2.

The case study is based on the work of the two Year 1 teachers with their classes in a 6-week unit of work, undertaken in January and February. The theme was chosen to align with a creative curriculum topic 'Once upon a time…' which facilitated cross curricular teaching.

Transcript of interview with the lead teacher:

Interviewer: "How did you come up with the idea for the project?"

Teacher: "The design brief arose following conversations between [colleague], [researcher] and myself."

Interviewer: "What were your aims?"

Teacher: "The initial aim was to promote the children's ability to generate solutions, without them feeling that they had to produce perfect drawings for each idea. We demonstrated this by our own rapid sketching."

Interviewer: "How did the learners respond?"

Teacher: "The children responded with great enthusiasm and imagination, generating a range of solutions, some more practical than others! Every child was able to successfully access the learning and generate some solutions; their developing writing skills were supported by teacher annotation, if necessary. We were struck by the conversations going on between the children, they listened to each other and developed and modified each other's ideas as they chose to work collaboratively. However, it was noticeable that, at this initial stage, no idea was immediately dismissed by the children. This meant that even less confident children suggested at least three solutions, without worrying if they were 'the right answer'."

Interviewer: "How did you manage the conversations that arose?"

Teacher: "Further letters from the goats refined the brief and closed the parameters, enabling teachers to stay in control of the solutions that could be safely and practically investigated. During each session the children reacted by great enthusiasm, recalling previous learning and predicting and explaining carefully and logically."

Interviewer: "How did the learners link the context with the subject content of structures?"

Teacher: "We saw more children choosing to use modelling kits during child initiated activities, including some who would not normally chose this area of continuous provision. The use of kits was also more focused, and, at one point, children competed to bridge the greatest gap, working together to make their structures stronger. Photos of different bridges and structures were available for the children to use as reference."

Interviewer: "Was there anything that emerged that was unexpected?"

Teacher: "The children introduced an ethical dimension into their investigations themselves. They made links to rivers bursting their banks and flooding, issues that some had seen on the news. They independently introduced their concerns for creatures living in the river, and suggested this as one of the success criteria for the final design."

Interviewer: "What impact did the project have on learners?"

Teacher: "The project was mentioned by some children when writing their review for the 'Child's Comment' section of their annual report, and has been repeated with a similar degree of enthusiasm and success in following years."

Document analysis:

Analysing the client brief and follow up letter (Figure 1) as a mediating artefact, using Engeström's (2009) human activity system, the subject could be considered to be the design problem and the object the design solution. The brief outlined the problem as including to "stop the troll from getting under the bridge", although the traditional Norwegian story of the *Billy Goats Gruff* outlines the imminent threat of being eaten! However, in this case, the goats set the children parameters (or rules), which included the instruction that the troll must not be harmed and primes them to be imaginative. The ethical dimension is played out through pupils' responses (see below) and the teacher-pupil dialogue. The community surrounding the activity has three dimensions: firstly, teachers through their planning; secondly the classroom where each teacher and their class engage with the task; thirdly, there is the wider community facilitated by the story itself and its cultural and historical influence. The brief also sets the task in the context of a pupil-led activity, with the teachers as facilitators (or mediators), which can be seen in both the annotations and feedback from the teachers (Figure 2 and Figure 3) and the teachers' reproductions of selected ideas (Figure 4). A sample of two pupils' work (Figure 2 and Figure 3) was selected by the lead teacher to exemplify pupil outcomes, illustrate the discussion between pupils and the teacher, and the aforementioned teacher facilitation.

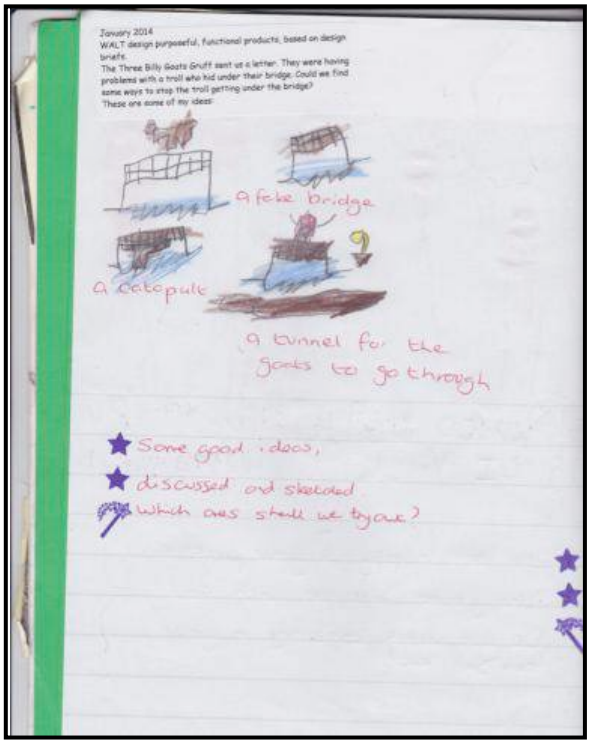


Figure 2

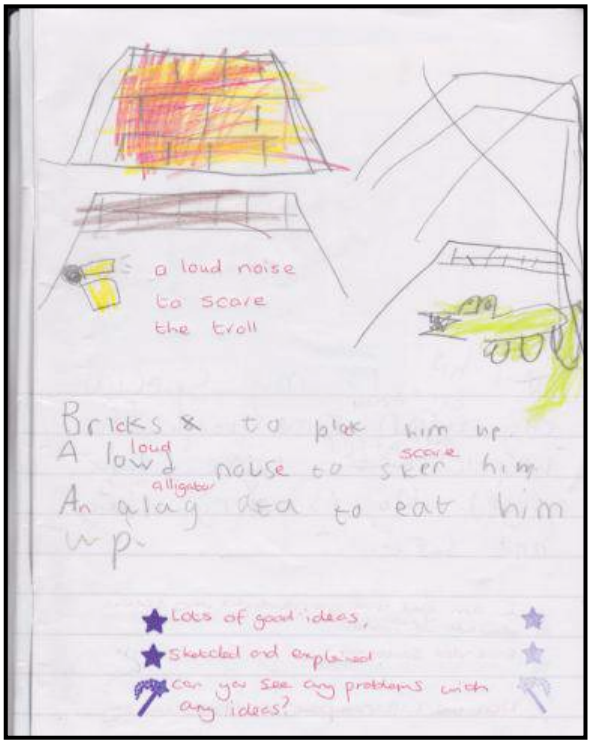


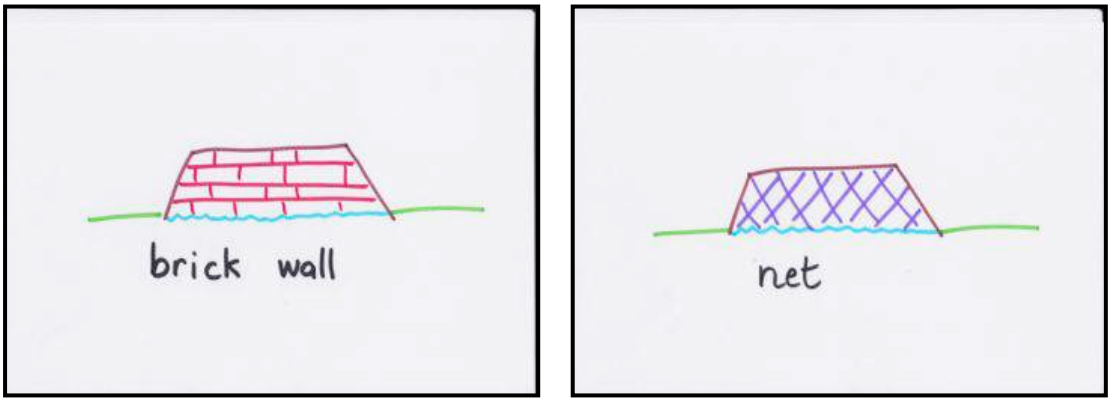
Figure 3

The lesson from which these documents originate involved the setting of the context, leading to teacher to pupil, pupil to pupil, and pupil to teacher dialogue. The teachers' discussed initial ideas with pupils, mediated by their sketches, with the teacher feedback and assessment including annotations, such as highlighting that the design solution could include "a fake bridge" to confuse the troll (Figure 2) or "a loud noise to scare the troll" (Figure 3).

Other ideas included a *flamethrower* and an *alligator* under the bridge (Figure 3), which prompted the second letter (Figure 1) and led to discussions about ethical and moral design solutions in a following lesson. Another pupil commented on the catapult idea (see Figure 2): "*You can use a catapult to make the troll go away and go to his mummy. He will go 'wa wa wa wa wa wa wa wa'. Or you can use a gigantic mouse trap.*"

After the lesson where pupils had worked on initial ideas, the teachers selected a number of ideas, representing the range of proposed solutions, to be discussed with the group in the following lesson. These ideas were then redrawn, by the teacher (Figure 4), and used as prompt cards. With the aid of these cards, the teachers modelled an iterative design process (DfE, 2013: 2) as a discursive activity with quality of ideas being the focus, rather than presentation.

The pupils went on to discuss practical and ethical implications of their ideas, identified other issues such as the impact of some of their early solutions on fish in the river, the wider environment and flooding (which was in the national news headlines at the time) – the idea to use a net (Figure 4) was to stop the trolls getting under the bridge, and allow the fish to pass through. The teachers reported that much of the work by the pupils was independent, at this stage in the process. The discourse around values revealed how the young learners' empathy and imagination provided a platform for them to critique the goats' needs and wants, considering different factors and perspectives.



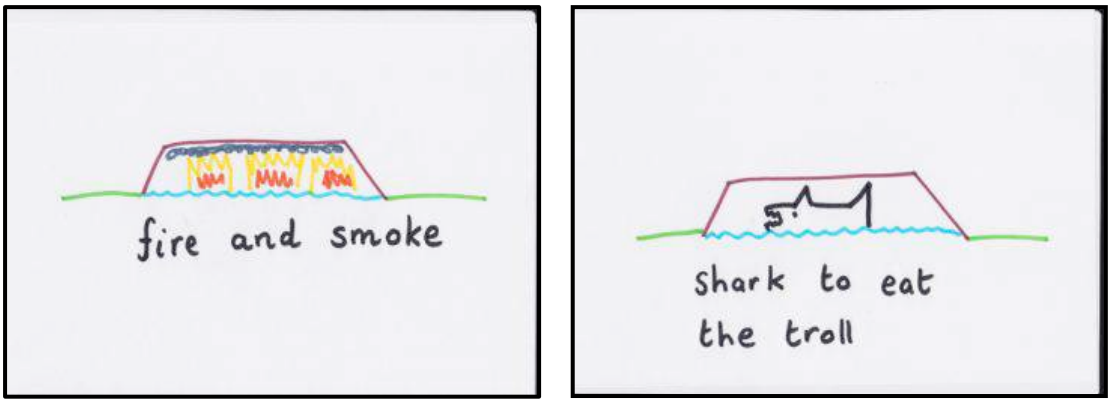


Figure 4

The opportunity for the children to use tablet computers to video themselves reflecting on their ideas supported this discussion and recording of design ideas, although this has not been evaluated as part of this study. Following on from the activity described above, the pupils used of construction kits, the Internet and large outside play equipment to further develop their technical knowledge and understanding of structures, as they explored “how [structures] can be made stronger, stiffer and more stable" (DfE, 2013).

Discussion

As described in the findings, the initial solutions included unfiltered and imaginative ideas that you might expect in a creative activity where judgement is postponed (Csikszentmihalyi, 1988). These ideas allow pupils to engage with a discourse and make value judgements, which the teachers acting as facilitators. In design and technology education, problem solving is a frequently used term to describe creative and design activity. Within psychological discourses around creativity, problem finding is also included as distinct, but “functionally interchangeable” (Csikszentmihalyi,1988, p.162) and assessable (Chand and Runco, 1993, p.156) process, but is not frequently referred to within design and technology (McLain, 2012). The open-ended dialogue between pupils, the story (context) and the teacher demonstrates both problem finding and problem solving.

Through the use of a fictional context, the pupils in this study were encouraged to focus on the social and affective aspects of the ‘problem’, rather than fixate on the practical aspects of bridge design or one initial idea (Nicholl and McLellan, 2007), which might have happened had the teachers frontloaded the teaching with technical knowledge of structures. This can be further articulated as enabling the the pupils to concentrate on the human (albeit anthropomorphised) needs and wants emerging from the task, not on the technical requirements to span the gap between once side of the river and the other, in the first instance.

Sequentially, the pupils progressed to modelling activities as their next stage of design, where they had the opportunity to learn and apply technical knowledge, but the introduction of this knowledge was staged, or scaffolded, by the teachers. As similar to the teaching method adopted in a study by Winn and Banks (2012) to teach 3D Computer Aided Design (CAD) concepts to 11-14 year olds, using an imaginary world context, where pupils drew castles and wizards rather than technical objects,

common to many CAD tutorials. An aim of this study was to encourage pupils to use "novel solutions to problems, to take risks and make links" (p.488), to focus on strategic rather than command knowledge (p.489). Winn and Banks' study differs in its methodology as some technical knowledge had to be imparted throughout the process in order for pupils to realise their ideas by using the software. However, both approaches are similar in that they privilege information about social aspects of a problem and control the introduction of, and focus on, technical knowledge; a principle that can be used to plan creative learning opportunities, as illustrated in Figure 5 (below) as a continuum for 'sociotechnical' issues (Petrina, 2003).

Figure 5

In this study the approach inverted the focus of sociotechnical learning activities, which appeared to defer or delay early decision making on practical and technical aspects of a solution.

> "… a creative person is able to delay closure: she avoids jumping to conclusions, and waits for the new idea to mature instead of forcing it prematurely into the shape of an already existing one." (Csikszentmihalyi, 1988, p.168)

Although Dunne and Raby (2014) do not favour fictional contexts within their conception of speculative design, the use of imaginary scenarios in design and technology has potential as a technique to address 'wicked problems' (Buchanan, 1995; Rittel and Weber,1974) through a dialogic approach to the subject. In recent years, there has been discussion within the design and technology community regarding the nature of design and technology activity, and this case study illustrates an approach to what has been described as a mainly designing or design without make approach (Barlex and Trebell, 2008; Barlex, 2005).

Conclusion

The approach adopted in this case study illustrates how imaginary and story-based contexts can provide suitable opportunities for key stage 1 pupils to work creativity as a means of solving problems in design and technology. This approach could be adapted as a platform from which to introduce pupils to potentially dry topics as a standalone activity or evolving into a modelling, a mainly designing or a design, make and evaluate activity. In essence, it challenges the notion that the starting point for a design and technology activity is knowledge of materials or systems, and presents a discursive and contextual approach. In this case the approach enabled pupils to initiate dialogue around ethical issues, under the guidance of their teachers, which gave rise to pupils making value judgements and considering wider contextual and contemporary issues which the teachers had not foreseen.

In addition to the role of the teacher to guide and facilitate child initiated learning, creating the environment for and sensitive interactions with pupils, the story of the Billy Goats Gruff plays a key mediating role in setting aside preconceived notions of teacher and pupil. Had a realworld scenario, as outlined in the national curriculum programme of study, have been adopted for this activity, the dialogue around the ethical implications may not have occurred as naturally – be it the impact of restricting of the flow of the river on the fish or the impact of a sign or a flamethrower on the trolls themselves. Both teacher and story play a crucial role in the activity, which created a memorable experience for pupils and teachers. This study illustrates how young children are capable of engaging with complex social and ethical issues with the support of the teacher to guide and direct dialogue emerging from the implementation of an innovative pedagogical practice.

The study celebrates, and highlights, how primary teachers, through their innovative use of pedagogical approaches, can challenge and develop design and technology education. At a time when the notion of contexts is receiving greater focus in design and technology in both the primary and secondary sectors. Colleagues working in education outside of the primary phase would be advised to consider this albeit under-researched, approach and consider implementing it in their own practice should it be deemed suitable.

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22.2

Visualizing the critique: Integrating quantitative reasoning with the design process

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Abstract

In the age of "Big Data," information is often quantitative in nature. The ability to analyze information through the sifting of data has been identified as a core competency for success in navigating daily life and participation in the contemporary workforce. This skill, known as Quantitative Reasoning (QR), is characterized by the ability to integrate arithmetic, statistics, visualizations and models for the analysis and interpretation of information. For students of graphic design, QR competencies are essential for the design of effective visual displays of information.

This case study provides design educators with an assignment that introduces data analytics and visualization strategies to the design critique. The study describes how, in two sections of an undergraduate Information Design course, the traditional delivery of feedback through verbal dialogue was replaced with an anonymous survey. Responses were collated, stripped of identifiers, and distributed to the class with directions to create data visualizations of the critique. Students employed various mapping strategies in their visualizations and successful projects demonstrate acquisition of skills related to the analysis and interpretation of data.

Additionally, the assignment clarifies the criteria of success of design assignments and delivers focused feedback on student work.

Keywords

Quantitative Reasoning; information design; graphic design; pedagogy; data visualization; design critique; feedback; assessment.

Introduction

> All (students) should be able to use simple math tools to reason—to understand, interpret, critique, debunk, challenge, explicate, and draw conclusions. In short, college graduates should be able to evaluate the crush of quantitative data modern life throws at all literate citizens. (Simpson, 1999, p. 2)

This paper presents a case study of a modified critique process that was introduced in an Information Design course (Fall 2013 and Spring 2015) taught in an undergraduate graphic design program. For the final critique of a midterm project, an anonymous survey replaced the traditional verbal group critique. Data from the surveys were collated into sets for each student project, stripped of identifiers and distributed to the class with instructions to create data visualizations of

the survey results. *Visualizing the Critique* is an assignment that design educators can utilize to facilitate student understanding of Quantitative Reasoning (QR) though the collection, analysis, and visualization of data.

Additionally, the survey assignment elucidates information about the criteria for success of a particular project and documents the evaluation process, activities that may be lost or glossed over the traditional verbal critique, and integrates student feedback into the design process. The resulting visualizations have the potential to serve as student-designed assessment tools, providing teacher and student a means to quickly identify learning gaps for an individual student or those encountered by the entire class.

Background

Research has documented a widespread quantitative literacy gap throughout the United States (Kutner, Mark et al., 2007), resulting in leading educational associations and policy-makers identifying QR as a primary learning outcome for 21st century undergraduate education (Association of American Colleges and Universities, 2007; Elrod, 2014). Quantitative Reasoning, also referred to as Quantitative Literacy or Quantitative Fluency, is characterized by the ability to integrate arithmetic, statistics, visualizations and models (formulas, graphs, tables and schematics) in the analysis and interpretation of quantitative information (Mathematics Association of America, 2015).

Quantification, a process that requires conceptualization and reconceptualization in relation to the object (or phenomenon) being quantified, is a leap from the tangible to the abstract and back to the tangible, or from context to determination of equations and back to context (Thompson, 2012). QR is characterized by two attributes applied to the quantification process: first, a comfort level with numbers that enables an individual to cope with the practical demands of life; and second, some appreciation and understanding of information which is presented in mathematical terms (Cockcroft, 1992). Applications may be as mundane as calculating a tip as a percentage of a bill or as sophisticated as the ability to draw conclusions about race and poverty from tables of unemployment rates.

QR has no specific locus in college degree programs and often is mistakenly assumed to fall within the discipline of mathematics. In fact, undergraduate introductory courses in mathematics tend to focus on abstractness and specialized language whereas QR, by definition, is a broad set of practical skills (Davidson & McKinney, 2001) and anchored in real-world data within a specific context (Steen, 2009).

Graphic design programs, often presumed to be a safe haven for math-phobic students, may prove to be one pedagogic space for the development and refinement of QR skills at the undergraduate level. Graphic designers, specifically information designers, are charged with the task of giving visual form to data to produce visualizations of statistical data to reveal patterns and relationships that would not be easily ascertained without the aid of visual representation (Meirelles, 2013). Reducing frustration and promoting the understanding of complex information is the ultimate goal of information design. The challenge of translating data to a new visual language, often employing metaphor and semiotics in the process, requires designers to possess a degree of fluency with numeracy.

Context

Queens College is one of the senior colleges of the City University of New York. The college offers a Bachelor of Science degree in Graphic Design, with upwards of 300 declared majors (QC at a Glance, 2015). Information Design, an upper-division design elective offered every third semester, explores the display of information and introduces strategies for designing effective visual communications appropriate for various users, audiences, and platforms. The course integrates lectures and exercises designed specifically to build QR competencies, including: review of mathematical equations for the calculation of fractions and percentages; an overview of statistical literacy; retrieval and analysis of data tables; and graphing and mapping methodologies.

Fourteen students were enrolled in Information Design, Fall 2013 and 16 were enrolled Spring 2015. A diagnostic quiz (See APPENDIX A) to gauge student abilities to calculate fractions, percentages and basic graphing techniques was administered on the first day of class. Only 13 percent of the students (2 of the 15 enrolled) from the Fall 2013 and 30 percent of students (5 of the 17 enrolled) from Spring 2015 could successfully answer all of the diagnostic quiz questions, indicating the majority of students enrolled in the course lacked basic competencies in QR skills.

The Design Critique

The design critique is a widely used assessment tool in design studio classes and arguably the single most consistently employed classroom activity students encounter in an undergraduate design program. Traditionally, the critique consists of project presentations at various stages of completion, and the subsequent verbal feedback is provided through peers, teachers, and invited guest critics. A basic tenet of the critique is that the individual and the group benefit from the process; students demonstrate an understanding of design principles and strategies through their work and through the questions, comments, and ensuing dialogue. The objective of the process is to create a collaborative environment that facilitates the development of design and presentation skills, and provides a means to gauge success for a particular project.

Schrand and Eliason's (2012) research indicates that the design critique does not always allow all types of students to participate, and students who are not confident enough to ask questions are left behind. Barrett (2000) and Percy (2004) cite frustration, alienation, and lack of student participation as outcomes of the traditional design critique. Further research yields a list of factors that may impede student learning, including the size (Blair, 2006) and dynamics of the group (Gray, 2013); language and cultural competencies (Lasserre, 2010; Wong 2011); and perceived self-efficacy (Gaffney, 2011).

Building upon Davies' (1996) observations that the traditional design critique tends to encourage surface learning by the emphasis of the designed artifact rather than the process of learning, the integration of alternative forms of assessment into design course work has been explored as a means to create transparency of the evaluation process, encourage peer interaction and foster a deeper approach towards learning (Giloit & du Toit, 2013). Research on peer assessment has focused on written and verbal interventions (Ehman 2005; Ellmers, Foley & Bennett, 2008), whereas *Visualizing the Critique* utilizes data collection and interpretation to integrate assessment with the design process.

The Assignment: Visualizing the Critique

For the third and final critique of a midterm project, the traditional critique was replaced with a nonverbal assessment and developed into a fourth class assignment, *Visualizing the Critique*. Like a traditional critique, the activity began with students pinning their work to the display board for the group to assess. A survey with questions regarding research, originality of topic and solution, and the relative success of each project was distributed for the review of students' projects. Students were encouraged to ask questions to clarify the survey questions, but were instructed to refrain from verbally commenting on the projects or leaving any identifying information on the surveys. After the completion and collection of a set of surveys, the group repeated the process for each student project.

The teacher collected and collated the sets of surveys, generating a numbering system to identify the projects to minimize the possibility of identification of individuals with survey responses.

Data sets for the collated surveys were distributed to students the following week with a group discussion on the method of collection, and assessment of the quality of the data and a short lecture on normal (Gaussian) distribution. The next step required students to create a data visualization of the collected data. Projects were presented to the class and critiqued in the traditional manner of verbal exchange within a group setting. Upon completion of the assignment, students were privately informed of which data set was associated with each of their midterm projects.

Results and Discussion

Table 1 records the responses of 13 students to the 9 midterm projects presented Fall 2013. Nine questions were listed on the survey and the options for response were: (Y), no (N), or no answer (NA). Table 2 records the survey responses of 12 students to the 12 midterm projects presented Spring 2015. Three questions were added to the second survey to distinguish the use of color, typography and development of hierarchy in the projects.

	Q1 Y(N)NA	**Q2**	**Q3** Y(N)NA	**Q4** Y(N)NA	**Q5** Y(N)NA	**Q6** Y(N)NA	**Q7** Y(N)NA	**Q8** Y(N)NA	**Q9** Y(N)NA
P1	3(7)3	5(3)5	10(-)3	9(1)3	1(7)5	2(6)5	4(7)3	6(5)2	2(7)4
P2	9(3)2	6(5)2	10(1)2	7(3)3	3(6)4	6(4)3	3(10) -	9(2)2	4(7)2
P3	6(6)1	3(9)1	10(1)2	9(3) -	3(9)-	- (10)3	6(5)2	10(2)1	4(8)1
P4	11(2)1	7(4)2	13(-) -	11(1)1	2(7)3	6(5)2	8(4)1	12(1) -	4(8)1
P5	6(7) -	- (12)1	10(2)1	4(8)1	2(11) -	9(3)1	- (12)1	4(9) -	3(8)2
P6	8(2)3	6(4)3	10(1)2	9(1)3	3(4)6	5(6)2	7(2)4	9(1)3	6(3)4
P7	6(6)1	2(9)2	10(1)2	9(3) -	3(10) -	1(10)2	6(5)2	10(2)1	4(8)1
P8	13(-) -	11(2) -	12(1) -	12(1) -	6(7) -	5(5)3	7(4)2	13(-) -	12(1) -
P9	13(-) -	12(1) -	13(-) -	13(-) -	6(4)3	10(2)1	11(3) -	10(2)1	10(2)1

Table 1. Survey Responses, Fall 2013

P=Project; Q=Question; Y=Yes; (N=No); NA=No Answer

Source: Survey responses collected during critique of midterm project (Information Design, Spring 2015).

9 midterm projects were presented and 13 students completed surveys.

Questions of the Survey: *Q1. Is the topic original? Q2. Is the project ambitious? Q3. Is the designer interested in the project? Q4. Did the designer research the project? Q5. Did the designer explore multiple solutions? Q6. Is the solution original? Q7. Is the project well designed (consider use of color, typography, hierarchy)? Q8. Does the project capture your interest? Q9. Does the project require you to think?*

	Q1 Y(N)NA	**Q2** Y(N)NA	**Q3** Y(N)NA	**Q4** Y(N)NA	**Q5** Y(N)NA	**Q6** Y(N)NA	**Q7** Y(N)NA	**Q8** Y(N)NA	**Q9**	**Q10** Y(N)NA	**Q11** Y(N)NA
P1	9(2)1	2(8)2	9(2)1	9(2)1	1(9)2	4(7)1	10(1)1	6(4)2	*	8(3)1	5(6)1
P2	4(7)1	9(2)1	10(1)1	11(0)1	8(3)1	9(2)1	7(4)1	8(3)1	*	10(1)1	11(0)1
P3	2(9)1	10(1)1	11(0)1	11(0)1	8(3)1	9(2)1	10(1)1	11(0)1	*	11(0)1	7(4)1
P4	5(6)1	1(10)1	8(3)1	3(8)1	0(10)2	7(4)1	9(2)1	6(5)1	*	2(9)1	3(8)1
P5	12(0)0	6(6)0	12(0)0	2(10)0	3(9)0	8(4)0	12(0)0	11(0)1	*	10(2)0	3(9)0
P6	7(5)0	6(6)0	8(4)0	12(0)0	6(6)0	5(7)0	9(3)0	9(3)0	*	7(5)0	8(4)0
P7	6(5)1	3(8)1	8(3)1	11(0)1	1(10)1	3(8)1	8(3)1	5(6)1	*	4(7)1	11(0)1
P8	7(5)0	7(5)0	10(2)0	9(3)0	5(6)1	8(3)1	7(4)1	*	*	9(3)0	4(8)0
P9	8(4)0	8(4)0	11(1)0	2(10)0	3(8)1	7(5)0	0(12)0	10(0)2	*	10(2)0	6(6)0
P10	8(4)0	5(7)0	9(3)0	5(7)0	6(6)0	8(4)0	8(4)0	4(8)0	*	6(6)0	6(6)0
P11	10(1)1	8(3)1	11(0)1	3(7)2	7(3)2	8(3)1	4(7)1	6(5)1	*	9(2)1	9(2)1
P12	10(2)0	9(3)9	12(0)0	12(0)0	9(3)0	8(3)1	12(0)0	11(1)0	*	11(1)0	5(7)0

Table 2. Survey Responses, Spring 2015

P=Project; Q=Question; Y=Yes; (N=No); NA=No Answer; * Responses removed due to recording error.

Source: Survey responses collected during critique of midterm project (Information Design, Spring 2015).

12 midterm projects presented, 12 students completed surveys.

Questions of the Survey: *Q1. Is the topic original? Q2. Is the project ambitious? Q3. Is the designer interested in the project? Q4. Did the designer research the project? Q5. Did the designer explore multiple solutions? Q6. Is the solution original? Q7. Effective use of hierarchy (clarity of information)? Q8. Is the typography effective and appropriate to project? Q9. Effective use of color? Q10. Does the project capture your interest? Q11. Does the project require you to think?*

Class discussions on the quality of the data, possible anomalies and the impact of sample size accompanied the distribution of the survey results. When asked if the survey exercise prompted a more honest evaluation of student work, both classes unanimously agreed that their responses on the survey were more honest than their personal verbal feedback delivered in a traditional critique. Students raised questions on the possible interpretations of no answer responses and concluded

that this was not an error in data collection, but reflected a response that differed from a yes or no, and should be included in the data visualizations.

As a group discussion, the data was assessed to determine what type of information might be gleaned from the data sets, and how the data might be viewed to gauge relative success of a project by an individual or as a group. Students found that reading across the rows shows the results of the survey per student project. As shown in Table 1, consensus of success (P8) or needed improvement (P5) was reached on some projects, but most received mixed feedback—success in some areas and needed improvement in other areas. When the class was asked if they believed the survey results would personally help them in their own design efforts, students tended to agree that the results may help pinpoint areas of needed improvement, but pointed out that the traditional critique was of enormous benefit for the specific suggestions on how to improve work. From student comments, it appeared that students might look to critiques for concrete direction for a particular project rather than a greater understanding of their personal design process— an observation that supports Davies' (1996) claim that the traditional design critique tends to emphasize of the designed artifact rather than the process of learning.

The class discussions turned to how a teacher might benefit from the results of the survey by reading down the columns and identifying gaps in student progress. For example, reading down the columns in Table 1 reveals that while the majority of students found that most projects demonstrated interest by the designer (Q3. *Is the designer interested in the project?*), most projects did not demonstrate enough exploration of solutions (Q5*. Did the designer explore multiple solutions?*). These responses could be interpreted as the teacher having successfully developed assignments to pique student interest, but highlighted the need for the teacher to emphasize multiple solutions as a priority in the design process of an assignment.

The responses of Spring 2015 survey (Table 2) and the ensuing class discussion parallel the observations of the Fall 2013 cohort, but with a greater emphasis on the possible meanings of mixed positive and negative responses per project. This class discussed whether mixed responses were reflective of survey-takers inclination of responding to questions in a positive or negative manner, rather than a neutral evaluation of the quality of student projects. Students agreed that some projects received a majority of yes responses (P3 and P12) or *no* responses (P4 and P8) and concluded that the survey responses were not arbitrary, the variation evidenced in the data and the consensus reached on particular projects demonstrated responses were based on responses to the work displayed. One student observed that the survey results began to parallel the grading system of evaluation, as the number of *yes* answers could be equated as points achieved for a particular project. For example, projects (P3 and P12) with the greatest percentage of yes responses were deemed successful and should receive the highest grades, all other projects required varying degrees of improvement and could be graded based on the percentage of yes responses to the survey. Students seemed to agree that the survey was a good indicator of how their own work might be received by the public-at-large or by a potential employer, and concluded that mixed results were an indication that a project should not be included in a portfolio.

Students were assigned to create a data visualization of the collected data without any restrictions to format or media. As shown in Figures 1-5, the projects created for the assignment demonstrate a wide range of solutions and a variety of lenses through which the data may be assessed. Since the

introductory diagnostic quiz of the first class, students demonstrated an increased 'at homeness with numbers' as evidenced by student ease in the reading of tables; calculation of fractions and percentages; and the development of mapping and graphing strategies. Through the integration of QR skills and those associated with graphic design - choice of color, typography, development of hierarchy through scale, and use of positive and negative space - student projects translate data to visualizations that effectively reveal relationships and patterns found within survey results.

Most students tended to initiate the project through a direct interpretation of the results utilizing color and shapes to correspond to every survey response, but many developed visualizations that incorporated arithmetic calculations and graphing techniques to create richer content, establishing visual comparisons of the class performance by question or by project. Figure 1 shows a literal interpretation of the survey results with a circle representing every response and color used to distinguish the types of responses. Information is organized and a clear hierarchy is established through use of typography and scale creating an accessible design and connoting credibility; however, the amount information communicated is limited due to the lack of computation or analysis. At best, a viewer can scan the visualization and estimate, or manually count, which projects received a greater number of yes or no responses through the color-coding of responses.

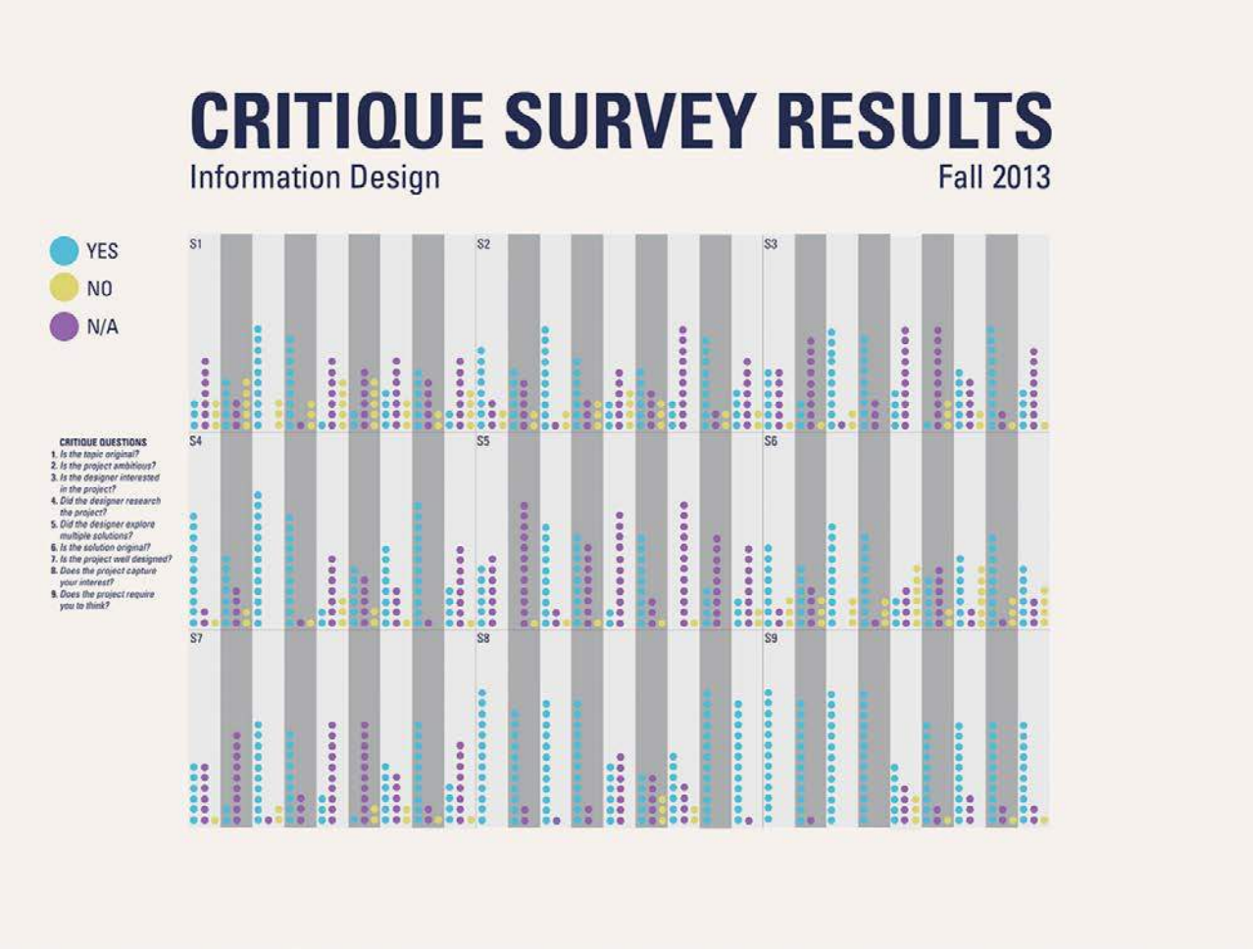

Figure 1. Madison Chajon, Fall 2013.

Figure 2 shows a minimal approach to the mapping of the responses with the use of a series of vertical lines. The vertical sweep of the lines moves the eye down the page and upon inspection; each line is composed of discrete units displaying a literal interpretation of the survey results per project and per question. Results per question can be read by reading down the page and project results can be determined by reading across. Adding additional information to the visualization, a summation of the results of the entire class is depicted by a stacked bar graph. The size and placement of the bar graph, invites the eye to travel across the page, and the list of questions beneath the bar graph anchors the design.

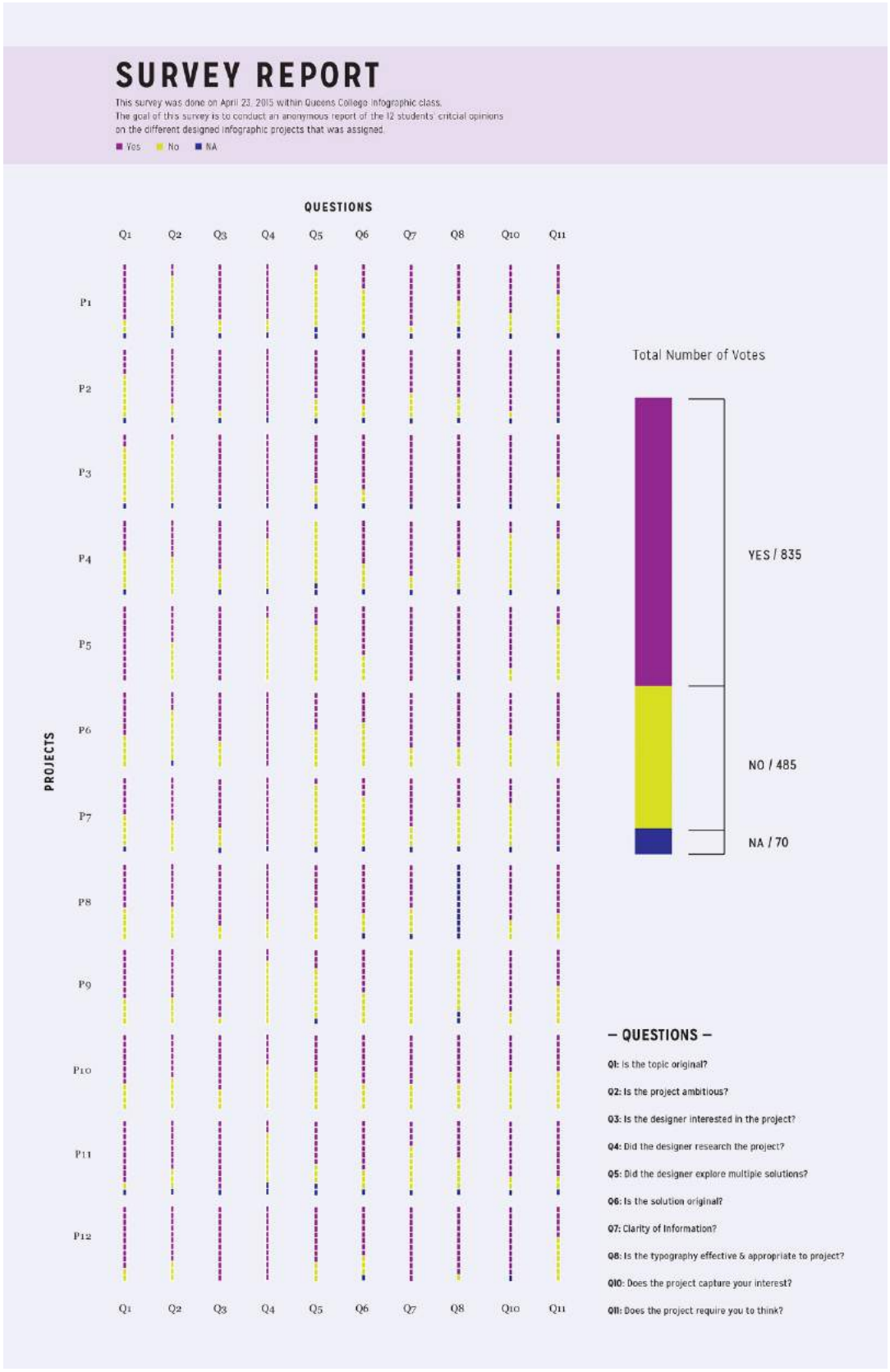

Figure 2. Qiong Lee, Spring 2015.

Figure 3 shows a project that uses area; similar to the use of area in a horizontal stacked bar graph, to communicate percentages of yes, no or no answer responses. Each graph includes the numeric values color-coded to the graphs, substantiating the visual depiction of the results. Reading across, a viewer can determine the results per project for each category of question and reading down the viewer can view the results of each question per project. Separated by space and the introduction of a new color, the bottom row and last column displays the cumulative results of questions and projects; facilitating comparisons of individual projects with class results.

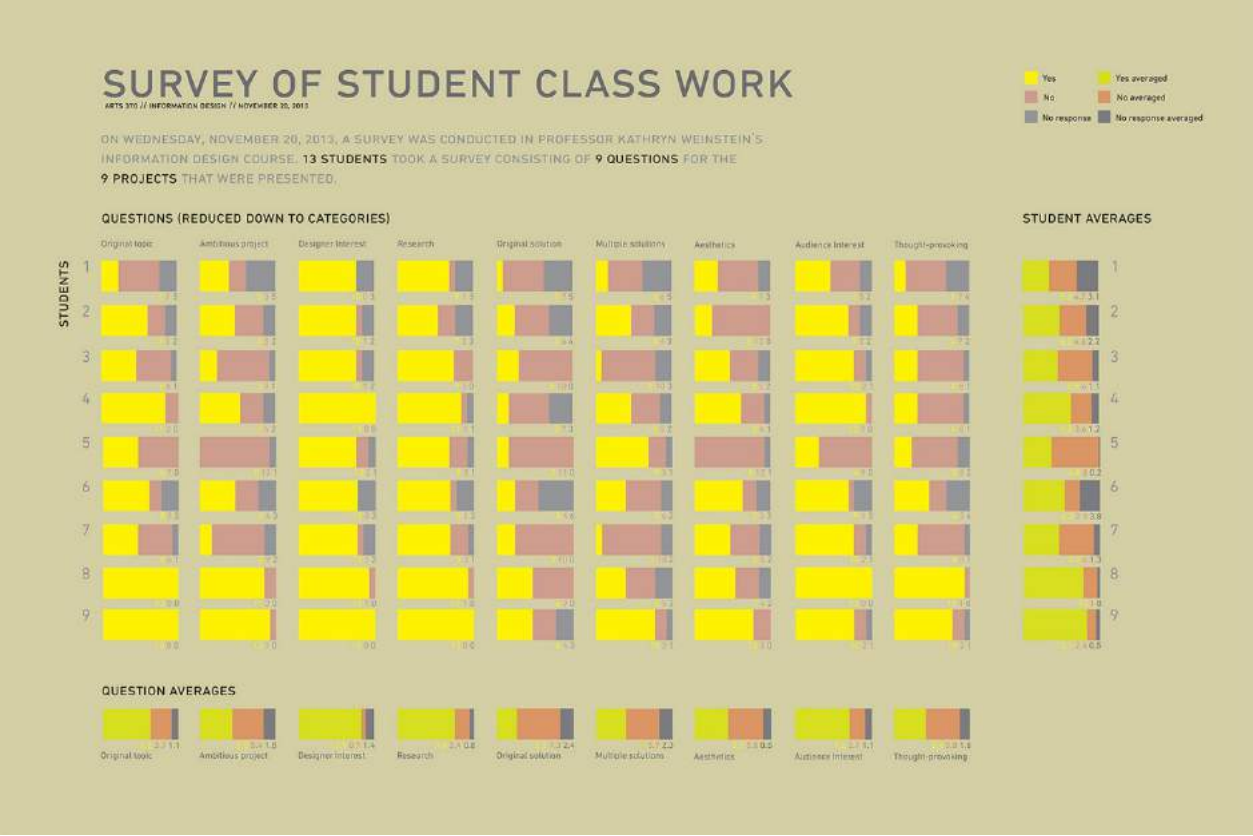

Figure 3. Praveena Persuad, Fall 2013.

The project shown in Figure 4 utilizes three graphing techniques to represent different types of information and the design leads the viewer from an overview to specifics. An area graph at the top creates a snapshot of the responses for the entire class and below is a series of stacked bar graphs paired with donut graphs to represent all responses per question per project as well as an overview of each project. Although the graphs represent different types of information, the consistent use of color for each response facilitates the reading of each type of graph and the text contributes a secondary level of information that contextualizes the graphs.

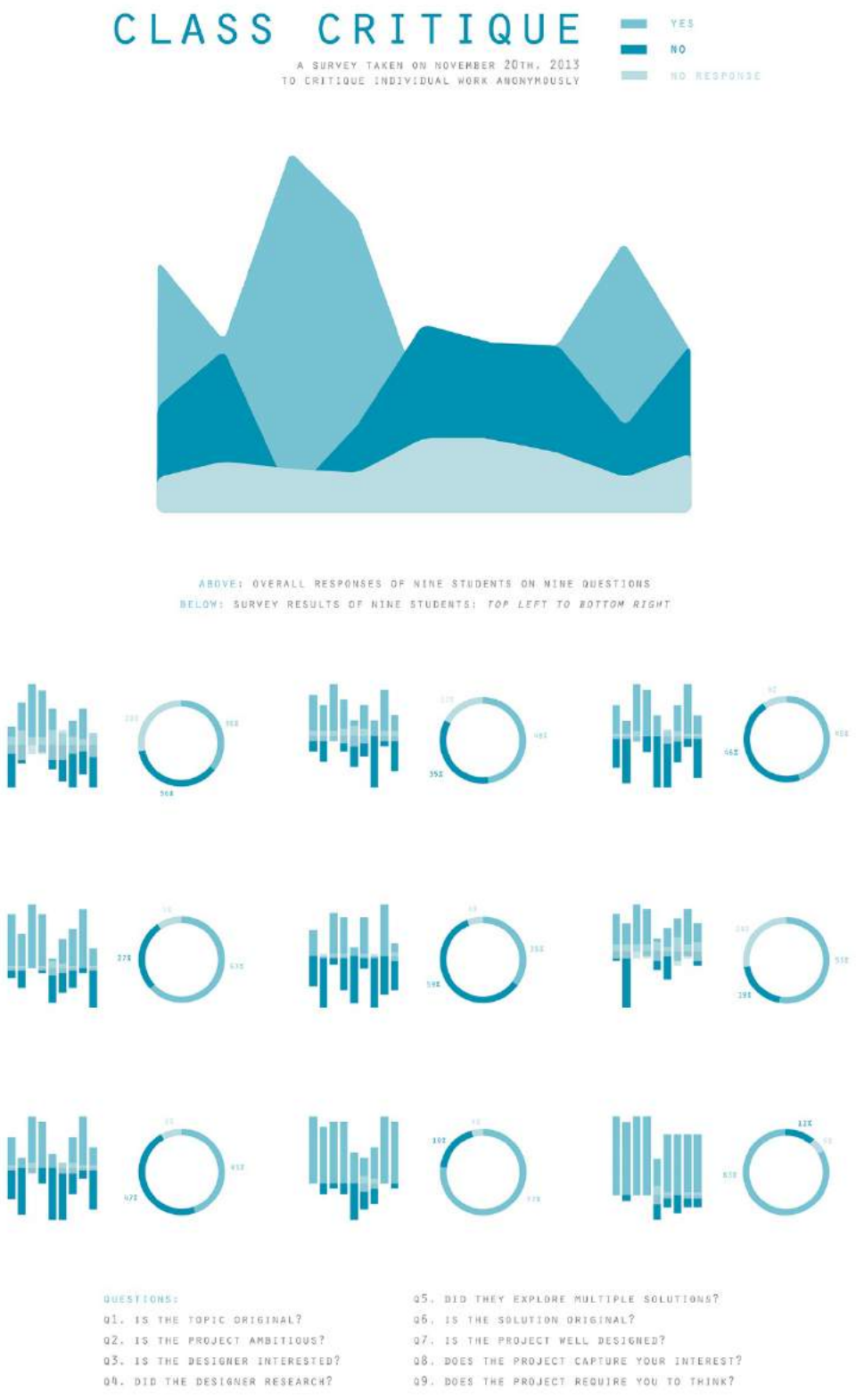

Figure 4. Serom Lee, Fall 2013.

The project in Figure 5 resembles a polar-area diagram with the entire class results represented as a circle. Like a cross-sectioned orange, the circle is composed of 14 sections with 12 projects of equal area and two smaller sections that identify questions listed below the graph. The circle is divided the questions that radiate outwards from the center creating one graph that displays the entire class results, and simultaneously presents each project with specific responses to each question.

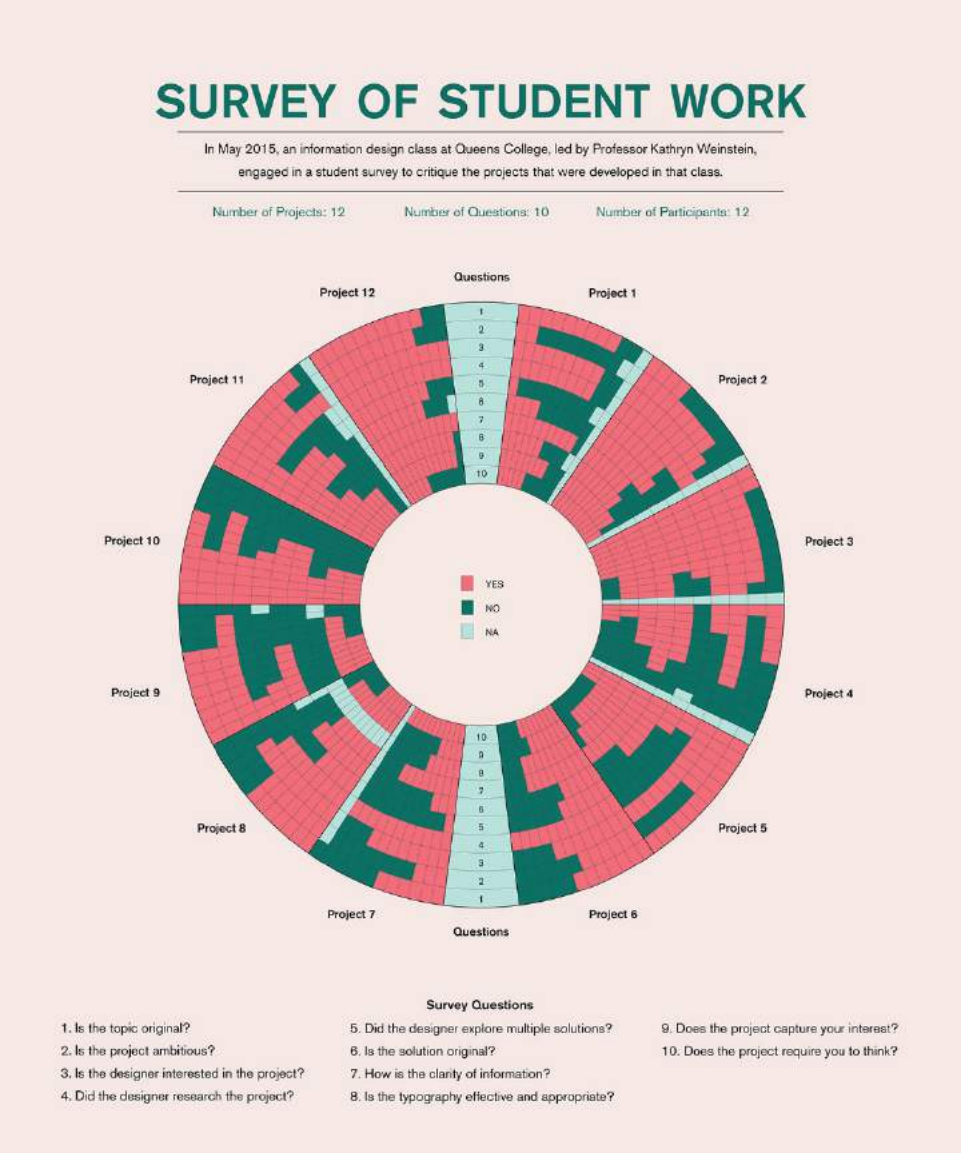

Figure 5. Samiah Meah, Spring 2015.

The verbal critique during project presentations revealed a shifting of priorities by students when evaluating work, placing coherence and accuracy over aesthetics. Students were quick to point out flaws in equations or mapping techniques and equally quick to praise effective and innovative approaches to the displays of information.

Visualizing the Critique provides teachers with a tool to democratize the critique process. In addition to the traditional forms of design critique, the survey provides a venue for students who typically

refrain from verbal exchange in a group setting to express their opinions. All opinions are recorded and carry equal weight, fostering a sense of contribution and participation. The student work and the ensuing critiques throughout the remainder of the semester seemed to be energized by the survey experiment, as demonstrated by a greater degree of verbal participation from all students without prompting and a greater range of opinions confidently expressed, than experienced in earlier classes.

Conclusion

The assignment, *Visualizing the Critique*, introduces students to data collection and analysis in an area in which all students possess a degree of authority: critiquing one another's projects. The assignment provides an opportunity for students to participate in the collection of data and question the methodology and integrity of the data collected, and then proceed to work with collected data and decide how best to visually represent the information. This process requires students to navigate from the tangible (survey results) to the abstract (determination of equations) and back to a tangible (visual presentation of the data). Through the use of calculations and graphing techniques explored throughout the course, students created information-rich visualizations with the potential to serve as an assessment tool by classmates and teacher. In short, *Visualizing the Critique* provides an opportunity for students to scaffold skills learned from previous exercises within the course and provides a format for students to demonstrate the refinement of QR skills.

Further, *Visualizing the Critique* provides teachers with a tool to expand and enhance the traditional forms of feedback through the verbal design critique, and creates a platform that documents and values all student opinions equally. The assignment engenders student reflection of assessment and fosters inquiry about the various types of assessments students encounter within their design studies and how to best utilize feedback for personal development. Further research is recommended to assess whether the experience of the assignment fosters a sense of inclusiveness for design students who are typically left out of traditional critiques, and whether this newly found engagement is sustained in new classroom environments.

Hattie & Timperly (2007) note that most assessments are in effect "accountability thermometers" based on recall and providing little feedback; whereas, feedback devices that are integrated into the teaching and learning process, promote enhanced and consolidated learning by teachers and students. *Visualizing the Critique* integrates feedback into several activities to clarify and strengthen the design process: the introduction and participation in a survey that elucidates criteria of success for a particular project, the challenge of designing visualizations of the feedback, and finally, the presentation and discussion of classmates' visualizations. The final artifact is of potential value to students and teachers as a tool to highlight the areas of success or needed improvement per student, or as a group. Further research is recommended to assess whether students utilize the feedback from the visualizations and apply the knowledge to future design projects.

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APPENDIX A

Diagnostic Quiz Distributed to Students of Information Design on the First Day of Class

1. If ¼" =.25", 1/8" = ?
2. If 18 out of 22 students have brown eyes, what is the percentage of brown-eyed students in the class? What is the percentage of non-brown-eyed students?
3. Create a graph of last week's temperatures (F): Mon (!0); Tues (15); Wed (15); Thur (15); Fri (25); Sat (15); Sun (10).
4. Create a graph of last week's range of temperatures (F): Mon (5, 15); Tues (10, 20); Wed (-5,10); Thur (10, 20); Fri (10, 30); Sat (5, 20); Sun (5,15).
5. Create a graph that shows Company ABC's profits (in millions) from 2007-2010. 2007 (5); 2008 (2.5); 2009 (-2); 2010 (3)

6. Create a graph that compares Company XYX's profits (in millions) with Company ABC's profits from 2007-2010. Company XYZ Profits from 2007-2010 2007 (2.5); 2008 (5); 2009 (1); 2010 (5).

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22.2

Searching Creativity: (N)On Place Design Workshop

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Abstract

This study is mainly about developing an approach for fostering creativity in design education through analyzing the interactions among creative dimensions resembling spatial and organizational pattern of folding as a technique and also by the help of cognitive action of designers: workshop participants. In order to make an assessment, a case study is structured, intended to refine and integrate the creativity with the characteristics and principles of design. Herein, two methods; retrospective protocol, and spatial- structural organizational analysis methods, are generated by the help of an informal education medium; '(N)On Place-2' architectural design workshop, which was conducted at "Eskisehir Osmangazi University Design Festival 2013" with the theme "Folding in Architecture".

Keywords

creativity; architectural design education; folding in architecture; protocol analyses method, spatial-structural organizational analysis method

Introduction

> *`I have never let my schooling interfere with my education. `Mark Twain (Samuel Langhorne Clemens)*

Mark Twain, a well-known American writer, thinks that one should isolate his/her informal education from the formal one. He implies that only informal learning can become one's experience (Ciravoglu, 2002). Beginning with but departing from this statement the aim of this study is not to discuss the validity of formal architectural design education, but to evaluate the positive effects of informal architectural design education on fostering creativity.

Education has been defined as formal, informal, and non-formal in much of the literature (Vadeboncoeur, 2006). Research studies show increasing interest in other forms of education besides formal because formal education does not account for all the learning of a lifetime (Erktin & Soygenis, 2014). An informal education approach has gained more and more acceptance in the world. It includes the acquisition of knowledge and skills through experience, reading, social contact, etc. (Turgut & Canturk, 2015). The role of the design workshops in architectural education has been very limited throughout design education's past, and thus has gone largely unnoticed by the educators of design. The drivers of this change in design education and practice; and changing student demographics brought some inevitable changes to design studio practices. The introduction of workshops, aid not only developing and sharpening design skills in a short period of time, but also

help to construct new approaches in architectural education. Many schools of architecture have taken steps to consider workshops as the part of informal education (Turgut & Canturk, 2015). As evidence to support this idea, it is possible to point out the BDA (Bachelor of Design in Architecture Program) program in University of Minnesota, which is constructed by a diverse series of workshops. The BDA workshops are organized to develop an essential, experimental, collaborative and critical discourse within the School of Architecture. It is declared that workshops encourage students and faculty to step outside the rigors of the very precise discipline of architecture in order to research specific issues, test professional boundaries, and experiment with emerging practices. (Bachelor of Design in Architecture Program Overview, 2016).

According to Eigbeonan (2013) many writers on architectural education have observed that the architectural design studio teaching is failing to meet the yearnings and needs of the users, societies, cultures, environments and technological developments. The general consensus is that creativity should and continue to be the main force in teaching the arch-design studio. These various authors stress, argue and support the concept and ideas of creativity in teaching the design studio to bridge this gap and agree that it is an important venture (Bala, 2010; Kowaltowski, Bianchi & Paiva, 2010; Parashar, 2010; Demirkan & Afacan, 2012; Dorst & Cross, 2001).

This study is mainly about developing an approach for fostering creativity in design education by defining creative design through the spatial and organizational pattern of folding as a technique and as a powerful design concept and also by the help of cognitive action of designers: workshop participants. This analyzing process is performed by the help of the (N)On Place-2 design workshop as being a free, flexible and dynamic informal medium, conducted in 2013 at the Design Festival in Eskisehir Osmangazi University at Turkey.

An overview of creativity and creative methods in the design context

According to Runco (2004, p.672) “creativity is often defined as the development of original ideas that are useful or influential”. In this point of view, creativity is not only a reaction to but also a contribution to change and evolution. He also asserts that creativity thus underlies problem solving and problem finding; it plays a role in reactions (e.g., adaptations and solutions) but it is also often proactive. According to Kahvecioglu (2007) early historical approaches to creativity defined it as centering in the creative person, process and product, which are also known as the "three Ps". This view has dominated research across disciplines. Also, Kahvecioglu (2007) declared that most theories of creativity have focused on the individual level of analysis, with the goal of describing the nature of creative minds (MacKinnon, 1962; Torrence, 1988). Individual characteristics such as personality (Barron & Harrington, 1981), cognitive abilities (Hayes, 1989; Finke, Ward & Smith, 1992), and intelligence (Guilford, 1967; Gardner, 1993; Sternberg & Lubart, 1999) have all been linked to creativity (cited in Kahvecioglu, 2007).

Beside many diverse explanations about creativity, it is absolute that it cannot be assessed only as a product or a process. As it is firstly mentioned in literature by Rhodes (1961) it is all about: person (personality characteristics or traits of creative people); process (elements of motivation, perception, learning, thinking, and communicating); product (ideas translated into tangible forms); and press (the relationship between human beings and their environment). It is an alliterative scheme that divides creative studies (and findings) into these 4 categories. Although discussed

individually, creative behavior nearly always arises from a combination of two or more of these facets. The 4P's helped designers to structure their thinking on design creativity in solving these not well defined problems (Karakaya & Demirkan, 2015). The present study aims to approach creativity on this four-facet point of view.

According to Asasoglu, Gur and Erol (2010) creativity, with all its social and physical connotations and implications, should be the guiding concept in the revision of architectural education. Some educational philosophers might argue that creativity is congenital, and that it cannot, therefore, be taught. According to authors it may be true that talent, inclination, intention and determination help to realize creativity at an early age, but through conducive and eliciting teaching methods anyone can be sensitized towards a rich variety of ideas, outside influences, knowledge and creativity at a proper age.

In several academic fields, one of the most investigated subjects related to creativity research conducted in design education, is the analysis of design activity, since the basis of creativity in design can be solved by the help of the analysis of design actions. Demirkan and Afacan (2012) informed that Casakin and Kreitler (2008) focused on the correspondences and divergences between instructors and students for assessing creativity in the design studio. Later, they tested the validity of self-perceived creativity as the measure of creativity.

According to Wong and Siu (2012) there are diverse suggestions in the literature for fostering students' creativity in design education. Authors recommended that any activities that aim at fostering students' creativity should reduce the frequency of repeating the creative thinking processes at each stage of the creative design process, and sharing the burden of repeating the creative thinking processes in brain capacity with other classmates in the design process.

Kowaltowski et al (2010) present an exhaustive research on creative methods and techniques related to their potential for being tested in the building design context and the architecture studio environment. Some of those methods are: Analogies; Attribute Listing; Axiomatic design method; Bio-Mimicry; Brainstorming; Mind Mapping; Other Peoples Viewpoints, TRIZ; Think Tank; Using Crazy Ideas; Using Experts; Visual Brainstorming; Working with Dreams and Images. (Kowaltowski et al, 2010). Like Kowaltowski et al (2010), Eigbeonan (2013) also analyzed the creative methods in litereature which are fostering or stimulating creative thinking in teaching the arch-design studio, and presents a list of them as shown in table 1.

Creative process phase	**Methods**
Problem definition	Assumption Busting; Assumption
	Surfacing; Backwards Forwards Planning Boundary Examination; CATWOE; Chunking; Six W's and Hs; Multiple Redefinition; Other Peoples View Points/Definitions; Paraphrasing Key Words; Why Why Why?

Idea generation	Analogy; Attribute Listing; Biomimicry; Mind Mapping;
	Morphological Analysis; Nominal Group Technique; Pictures as Idea Triggers; Pin Cards; Random Stimuli; Talking Pictures; TRIZ, Metaphor, Brainstorming.
Idea selection	Advantages, Limitations/Restrictions and Unique Qualities; Anonymous
	Voting; Consensus Mapping; Idea Advocate; NAF; Plusses Potentials and Concerns; Sticking Dots; Unique Qualities.
Idea verification	PDCA; QFD; Six sigma.

Table 1. Table of classification of various methods that may stimulate creativity in relation to phases of the creative process (Clegg & Birch, 2007; Mycoted, 2007; cited in Eigbeonan, 2013)

These methods are traditionally part of the design process and cover idea generation, selection and verification with problem definition. According to Kowaltowski et al. (2010) these methods are singled out since they are especially useful in the visualization of ideas of design processes. In creative literature, common properties of all creative methods rely on conceptualization. There are not proper or directly associated approaches focusing on the relation of issue, concept and form that are the basic domains of architectural design, where concepts are fundamental to design thinking, since they operate on an ideational level. All architectural design is about the connection of these three basic domains (Oxman, 2004).

As cited in Eigbeonan (2013), Koutsoumpos (2007) recalls that architectural design education is expected to teach creativity. Creativity, with all its social and physical connotations, should therefore be the guiding concept in the revision of architectural education. Therefore, creativity must be fostered in teaching in the arch-design studio because it takes care of designs that work (serve functional requirements, satisfactory, buildable, etc.).

Aiming to develop a creative approach in architectural design, a creative approach or a model needed to be determined. The creative approach in this study is based on Rhodes 4P`s of creativity model - design creativity defined as the component of 4 domains: person: student, product: design artifact and press: informal (design workshop) and process: architectural design practice (idea generation + form making). With the purpose to construct a creative assessment in architectural design, two analysis techniques: retrospective protocol analyses and spatial, structural-organizational diagram are generated by the help of a short-term design workshop: (N) On Place-2' Design workshop. The intention is to explore the interaction among the artifact creativity, the spatial elements of design, and design concepts by the help of two creativity assessment tools: retrospective protocol, and spatial, structural-organizational diagram analyses using the theme `folding`.

The selection of the theme of the design problem plays a crucial role in this study because the evaluation criteria's two analysis techniques are structured around the concept of folding, which has a special architectonic language. The theme has its roots in Origami, the ancient Japanese art of

paper folding. It is important to be willing to accept Deleuze's theory of the fold to fully realize its potential in an architectural discourse. The fold, not as a technical device, but ontology of becoming, of multiplicity, of a differentiation while maintaining continuity and it is more important for the development of an individual architectonic form (Vyzoviti, 2004). Fold is more important for the development of methods to achieve a new architecture, and for the development of an individual architectural form. As Vyzoviti (2004) points out, folding produces a language of architecture: The first folds must thus be viewed as sounds that only much later become words. It is a new language at least for the student, which must be learned (Vyzoviti, 2004).

As mentioned above, in architecture, folding is a way to produce individual insight and architectonic language. It is not a metric or dimensional change, but one that could operate as a degree of development and variance. Folding is a challenge with great individual possibilities. Opening a fold in a surface creates spaces, which in our minds are filled with volumes, thus, the technique of folding makes it possible to re-appraise every step (Vyzoviti, 2004).

Nowadays this technique is considered as a design approach in so many architectural projects (Folding Architecture, 2016). Also, this technique became well accepted in architectural design education. In literature, there are many different kinds of design studios that focus on folding as a design approach. The most remarkable example is the studies of "D10: Het Lab-Proeftuin voor Ontwerpenen Nieuwe Theorieen" instructed by Sophia Vyzoviti at Faculty of Architecture in Delft University in 2004. D10 design studio consists of photographical documentation of working models in all phases of the studio process. Studio project is an example of an architectural design process with a circular nature in contrast to a linear process. It allows one to encircle a problem, understand and confront it in all its relationships (Vyzoviti, 2004).

In addition to Sophia Vyzoviti, Pablo de Souza instructed a studio titled ` Folding in Architecture` in the spring semester of 2011-2012 academic year at the Department of Architecture in University of Thessaly, Greece (Vyzoviti and Souza , 2012). The design objective of that course was the creation of an architectural shell that integrates folding criteria of pliancy, diversity and the ability to integrate heterogeneous contexts in a continuum. The design ontology of the assignment interwove historic precedents of folded plate structures with recent models of single surface architecture. Special emphasis was given to the fusion of dynamic computational models with material studies.

The common objectives of all these workshops are to teach students how to create three-dimensional structures or objects, and dynamic computational models by using folding techniques. Additionally, this technique provided an opportunity for the students to get acquainted with folding strategy, and also aimed to teach them the potential of folding criteria of diversity. This technique seems to provide diverse design approaches. So, it could be claimed that folding techniques have advantages to create diverse designs in a short period of time, which helps trigger creativity.

As architectural design process includes many different domains, this study also deals with this diversity. First of all, the study attempted to develop an approach in architectural design process that could be utilised in an educational medium, which aims to foster creativity. Secondly, two analysis methods are utilised in order to itemise the dimension of creativity and its relation to elements of architectural design. Hence a powerful concept / design issue, folding, was chosen to achieve this goal.

The design activity (process) assessment is accomplished by the help of the retrospective protocol analysis technique, used to understand the designer's cognitive activities and track the changes of design activities during the design process. The design artifact (in terms of product) assessment is structured with the help of the spatial structural-organizational diagram analysis method, developed with the help of D10 studio work instructed by Sophia Vyzoviti.

Methodology

This study examines the dimensions of creativity by analyzing the interactions among its dimensions. The `(N)On Place-2' Design workshop, selected as a case study that was built on the framework of observation, documentation and analysis of design process and products with the help of the theme/design issue `folding`. Workshop was held on October 10-11, 2013 with the title "Folding in Architecture" which was announced as part of the Bademlik 2013 National Design Festival Program (Bademlik Tasarim Festivali, 2013). The aim of the workshop was to encourage creative thinking in a short period of time, and highlight the importance of conceptual thinking. The methodology of study focused mainly on the interaction of design activity (in terms of process) and design artifact (in terms of product), where press (design workshop) and person (students attended to the workshop); are the other supportive domains. The methodology relies on the analysis of design process and products with the help of `folding` theme that helps enable the production of the architectural space and concept in a short period of time, which has the potential to create a dialect of architecture. To test the introduction of methods that may enhance creativity in the design-studio an exploratory study, as a structured interview, was conducted with eight architecture students.

The design task

The present study examines eight different products of `(N) On Place-2' workshop participants who are BArch students (6 females, 2 males) from different Architectural Departments in Turkey. They are sophomore or junior students, who are able to cope with architectural design problems. The design problem of `(N) On Place-2' workshop is "designing a city structure" where students asked to prepare a model of a design idea by utilising folding techniques, which they experienced on the first day of the workshop. On the first day, a power point presentation about the history and theory of fold was introduced and the aim /scope of the workshop and examples of buildings designed by folding techniques was presented. Series of movies about "folding in architecture" was screened. The movies were chosen from Paul Jackson's "Folding Techniques for Designers: From Sheet to Form" book cd. The book explains the key techniques of folding, such as pleated surfaces, curved folding and crumpling. It is a practical handbook about step-by-step drawings, crease pattern drawings, and specially commissioned photography (Jackson, 2011). The task was to extensively explore transformations of a single paper surface into a volume. After watching each movie, students were asked to make the exact folding techniques using paper (Photo 1).

Photo 1. First day of workshop. Learning and experiencing folding techniques (Author's archive, 2013)

Photo 2. Second day of workshop: Design by folding. (Author's archive, 2013)

In the second day, students started to think about "designing a city structure" in which they were asked to elaborate on their own programme. During the working process students were asked to design the structure following these steps:

- Think about basic concepts about city structure, and produce concepts that will lead the design process. They were reminded not to forget to design the structure by using folding techniques.
- Produce a model that will represent your idea.

The aim of presenting such steps during the design process was to be able to perform a clear observation of all movements and design concepts of each student. During the process, students developed certain concepts and a programme on their design.

Before the commencement of this experimental study, two assessment methods were developed in order to assess design creativity in the workshop (see Table 2). Retrospective protocol analysis method was utilised in the first assessment process called design activity. The aim of this assessment is to expose content aspects of the design activity by using recorded verbal protocols of the students at the end of design process and also pre-model studies of their design products. All interviews are conducted after the whole design process, and recorded design session interviews utilised as cues during retrospection to assist in the recall of the design activity. The aim of the utilisation of this method is to observe the cognitive aspects of the design processes by the help of two information categories: perceptual and conceptual.

Design creativity dimension	Method	Measurement items	Scope of assessment
Design activity	Retrospective protocol analysis method	Verbal protocols of students Pre-model studies of the design artifact	observe the cognitive aspects of the design processes with the help of two information categories; perceptual *and conceptual*
Artifact creativity	Spatial structural-organizational Diagram Analysis Method	Spatial structural-organizational diagram patterns of folding technique: *(continuity*, *connectivity*, *stratification*, *serial variation: spiral*, *loop and crossing*, *entanglement*, *enclosure*, *interlacement: strips)*	perceive and configure the space between the folds as an actual space and find out the design concept for each artifact.

Table 2. Design creativity assessment tool dimensions and related items

The second assessment method, called artifact creativity, included the spatial structural-organizational diagram analysis method that was proposed by Vyzoviti (2004). The aim for the utilisation of this method is to find out the design knowledge of each design artifact.

Design activity assessment: Retrospective protocol analysis method

The design activity assessment process focused on the coding of design principles, concepts and cognitive aspects (perceptual-conceptual features) of design processes. As shown in Table 2, the aim of design activity assessment is to observe the cognitive aspects of the design processes with the help of retrospective protocol analysis method that covers two information categories of perceptual and conceptual. Many systems for describing and analyzing design protocols have been developed over the recent years (Dorst & Dijkhuis, 1995; Suwa & Tversky, 1997; Gero & McNeill, 1998; Suwa et al, 1998; Bilda & Demirkan, 2003; Tang & Gero, 2000). The retrospective protocol analysis method developed in this study adapted from the analysis method proposed by Suwa and Tversky (1997). They conducted an experiment that consisted of two design and report tasks. In the design task, each student worked on a design problem through successive sketches, and in report task student's reports lagged behind the videotape and they were allowed to stop the tape until reporting all that they remembered about the current topic. Here, in this study these two same steps were implemented, but in a distinctive way. In the design task, through the workshop process, students did not use sketches; instead they utilized conceptual 3D models, in order to express their design thoughts. Here in this folding technique, the creative process begins with 3D modeling. Hence this technique remains its uniqueness as thinking starts with a three dimensional focus.

In their study, Suwa and Tversky (1997) used four different information categories (see Table 3). First category, 'emergent properties', possesses explicit shapes and sizes, but sometimes they are embedded as partial elements or implicit objects and emerge to the viewer's eyes only when he/she discovers a new way of restructuring the whole configuration that includes those elements.

'Spatial relations' are inherently visual features in the sense that architects/designers could see them in their own sketches. Functional relations in this domain denote interactions among spaces, things, people visiting or using them, and/or environments. Unlike emergent properties and spatial relations, functional relations are inherently non-visual aspects of architectural designs. The past history of studies in cognitive science has indicated that every cognitive task performed by human beings is mediated by background knowledge about the domain to which the task belongs (Suwa & Tversky, 1997).

A new protocol analysis approach is generated in this study based on the context of the design and report tasks of the workshop process. All these relations are evaluated and a new coding scheme is developed. (see Table 4). As depicted in Table 4, basically two main cognitive dimensions; perceptual and conceptual were considered as the main cognitive aspects of design activity. Perceptual refers actions of attending to visuo-spatial features of depicted elements on external representations. It covers all the emergent, spatial and functional relations of a design artifact.

Major category	Subclasses	Examples of phrases in protocols as evidence
Emergent properties	Spaces	"Areas", "places"
	Things	Descriptions or names of something
	Shapes/angles	"Round", "prolonged", "wavy line", "too sharp a comer"
Spatial relations	Sizes	"Big", "tiny", "narrow"
	Local relation	"Adjacent", "far", "connected", "lined up"
	Global relation	"Symmetrical", "configuration", "axis"
Functional relations	Practical roles	"A ticket office should be close to an entrance."
	Abstract features/reactions	"Waves/forces (from this shape)", "good show to visitors"
	Views	"View line", "the appearance (of this building)"
	Lights	"(This place is always) bright, having sunshine"
	Circulation of people/cars	"People meander through (this narrow space)"
Background knowledge	-	"Post/beam structures",
		"An important thing in an urban setting is..."

Table 3. Information categories and subclasses (Suwa & Tversky, 1997: 388)

As Suwa and Tversky (1997) stated for the domain of architectural design, abstract relations typically correspond to functional relations. In the light of the above-mentioned description of perception, all visual and abstract content of design, which are the indications of emergent properties, can be evaluated as the perceptual level of design.

Therefore, the perceptual level of the coding scheme consists of (a) emergent properties: emergent spaces and visual features, such as areas, places and creation of or attention to a new relation(P1-P2) (b) spatial relations such as organizational or comparison elements, and emphasising the meaning of spaces (P3-P4) (c) functional relations, which can be interpreted as a consideration of psychological reactions and abstraction of features and reactions, such as assigning non-visual information or meanings to visual depictions or perceptions, and exploring the issues of interactions between artifacts and conditions of the people/nature. (P5-P6). Besides the perceptual features, the conceptual category refers to cognitive actions that are not directly suggested by physical depictions

or visuo-spatial features of elements. There are two types of actions. The first type is the goal of a designer that covers the decisions on the positions, arrangements and design requirements. (C1) The second type is the knowledge about the relevance and influence of the architectural designs (C2). This structure distinguishes itself by its focus on the cognitive aspects of the designer behavior, and on the conceptual and perceptual aspects of the design process. (see Table 4). Students' statements that occur during the retrospection are transcribed into text word by word (see Table 5).

Major Category	Levels	Content	Code	Actions /Descriptions
Perceptual	Emergent properties	`Emergent spaces`	**P1**	"Areas", "places"
		`Visual features `	**P2**	Create or attend to a new relation
	Spatial Relations	`Spatial Relationships`	**P3**	Organize or compare elements
			P4	Emphasize meaning of spaces
	Functional Relations	`Consider psychological reactions `	**P5**	Assigning non-visual information or meanings to visual depictions or perceptions
		`Abstract features/reactions`	**P6**	Explore interaction issues between artifacts and conditions of people/nature
Conceptual	Esthetic Evaluations	`Make preferential and aesthetic evaluations`	**C1**	Deciding the positions, arrangements and design requirements
	Set up goals		**C2**	` Knowledge about the relevance and influence of the architectural designs `

Table 4. Coding scheme of design activities (adapted from Suwa and Tversky, 1997)

In the assessment process of design activities, each eight student's verbal protocols are recorded and all protocols are decoded. Then the entire protocol is separated into small units and segments by interpreting the way in which concepts shifted in the designer's mind. Sometimes the sequence of the retrospective protocol has been rearranged according to the behaviors and intentions of the designer. Table 5 shows the structure of frames with various slots, into which the contents of designer's actions in a single segment are coded. Actions of each student for all segments were coded in table 6 respectively. The entire structure of segments consists of two major action categories and each is in turn divided into the subcategories that are presented in Table 6. Each row under each of the main or sub-categories is a frame corresponding to a single action.

Students	Retrospective Reports of Students
Student 1 (S1)	*"I am thinking about a city structure which has no limits. People can live wherever they desire. There are no limits. The goal of this structure is to ensure free living spaces for its occupants. If I need to state a concept it can be: `infinity`". I think this technique is so helpful. I will use it in my project at school."*
Student 2(S2)	*"I try to design a space which has so many directions. I want people to feel different in every space of structure. People will experience different feelings in every part of this space. I was thinking it might be exciting and playful place for its occupants. I think asymmetry is the best concept for this kind of space. This kind of designing is really fast "*
Student 3 (S3)	*"Yesterday while I was experiencing folding techniques, I noticed that technique has so many advantages. I also detected that I can design spaces with triangular surfaces. I explore many triangular spaces and I decide to design a city structure that has different layers, and surfaces and also I like to design them in order.*
Student 4 (S4)	*"It is exciting to fold the papers and I think it is one of the best ways of designing. You can make so many different designs. I folded papers in so many ways and I think that spiral is the best pattern. I thought that spiral is the best shape for gathering people and I think that spiral has an esthetic value. I found out that rhythm is the best word for this kind of design. I cannot believe I did it in two days! "*
Student 5 (S5)	*"I am trying to design a space with so many different forms. I tried many forms but I decided to make curves and also I could design floors between these curves. So the occupants of this space can experience different layers and surfaces. This technique helps me a lot to see the potentials of paper. A paper can be a space. It is sofunn.."*
Student 6 (S6)	*" I decided to design with curves. I think in a public space curved walls will be so interesting. But also I want to make different curves with different dimensions and in different directions. Curves will provide different kinds of experiences for people. This comes up now. It is really fast! I wish I could be fast also in my design studio at school. But I am not."*
Student 7 (S7)	*" I try to fold the papers distinctly. It is the first time that I am trying to design this way. It is amazing. I crease papers, then open them and I put them together. Is this a method in folding? I am not sure, but it seems so exiting. I also want to use colors in order to explain the main area in color red) in the whole design, which I suppose will be found interesting by its occupants. I think people will be lead into there. It is the focus point of design."*
Student 8 (S8)	*`I cut the papers and start to join them. I recognize that there exists so many different kinds of spaces. So I continue to join them and realize a big chaos in there. I like it so much. I think complexity is the core of my design idea.*

Table 5. Retrospective Reports of Students

The interpretation of the first student's segments and codes are conducted in the following way: Her words `*People can live wherever they desire. There are no physical limits*` suggest the emergent spaces of design and also that she is considering the psychological reactions of its occupants. (P1 and P5). Besides she is also emphasising the meaning of spaces by her words '*I am thinking about a city structure which has no limits*' (P4). Additionally, she is also deciding about the arrangements and design requirements (C1). The design of this city structure also happened to be an example of `exploring the issues of interactions between people and physical spaces (P6) `with the help of the statement: '*People can live wherever they desire*.' She also set up the goal of her design by `*the goal of this structure is to ensure free living spaces for its occupants*`, which refers to the conceptual code C2.

The present coding scheme has two benefits. First, it could be easily declared that the definitions of primitive design actions can be driven in a systematic way. Consequently, design behaviors of a designer in each segment can be represented as a structure consisting of those defined actions, as illustrated in Table 5. This would provide the basis for dissecting the structures out of a designer's cognitive processes.

Additionally, it is determined that students feel creative during the design process. Each one emphasized that folding techniques were inspiring. They were mostly exciting during the production of creative ideas for their projects. Each student represented in Table 4 that folding techniques provided them with a way to produce several kinds of architectural space concepts. They mostly declared that the technique was useful to design the project in a short period of time. As a result, we could argue that folding techniques have a power to provide diverse conceptual meanings in a short period of time, and also help produce different kinds of architectural spaces.

DESIGN ACTIVITY ASSESSMENT					
Students	**PERCEPTUAL LEVELS**			**CONCEPTUAL (BACKGROUND KNOWLEDGE) LEVELS**	
Codes	**Emergent Spaces**	**Spatial relations**	**Functional relations**	**Set up goals**	**Esthetic Evaluations**
S1	*`People can live wherever they desire. There is no physical limits`*	*"I am thinking about a city structure which has no limits.`*	*``People can live wherever they desire.`*	*` the goal of this structure is to ensure free living spaces for its occupants.`*	*"I am thinking about a city structure which has no limits.`*
CODE	**action**: P1/P5	**action**: P4/P5	**action**: P6	**action**: C2	**action:** C1
S 2	*I try to design a space which has so many directions.*	*`People will experience different feelings in every part of this space.`*		-	*` I was thinking it might be exciting and playful place for its occupants. `*
CODE	**action**: P1	**action**: P4	**action:** P5	-	**action:** C1
S3	*`... I can design spaces with triangular surfaces.`*	*....and also I like to design them in order. `*	*`I decide to design a city structure that has different layers and surfaces `*		-
CODE	**action**: P1	**action**: P3/P2	**action:** P6	**action:**C1	-
S4	*` I folded papers in so many ways and I think that spiral is the best pattern. `*		*`I thought that spiral is the best shape for gathering people.`*	-	*`I think that spiral has an esthetic value. `*
CODE	**action**: P2	**action**: P3	**action:** P6/P5	-	**action:** C2
S5	*"I am trying to design a space with so many different forms. `*	*`I decide to make curves and also I can design floors between these curves. `*	*So the occupants of this space can experience different layers and surfaces`*	-	**-**
CODE	**action**: P1/P3	**action**: P3/P2	**action:** P5/P6	-	**-**
S6	*" I decide to design with curves.*	*`I think in a public space curved walls will be so interesting.`*	*Curves will provide different kinds of experiences for people.*	*`But also I want to make different curves with different dimensions and in different directions.`*	*I think in a public space curved walls will be so interesting.*
CODE	**action**: P1	**action**: P4	**action:** P5/P6	**action:**C1	**action:** C2
S7	*I crease the papers, then open them and put them together.*	*I also want to use colors in order to explain the main area (in color red) in the whole design, which I suppose will be found interesting by its occupants.*		*I think people will bel lead into there. It is the focus point of design*	*.... which I suppose will be found interesting by its occupants.*
CODE	**action**: P1	**action**: P4/ P6/P5		**action:**C1/C2	**action:** C2

S8	*`I cut the papers and start to join them.`*	*`I recognize that there exist so many different kinds of spaces. So I continue to join them and realize a big chaos in there`*		*`So I continue to join them and realize a big chaos in there`*
CODE	**action**: P1/P2	**action**: P4/P5	**action:** C1	**action:** C2

Table 6. Design activity assessment: The coding of segments shown in table 5

Artifact creativity assessment: Spatial structural-organizational diagram analysis Method

As is depicted above, an artifact creativity assessment tool is implemented with the help of the four phase transitions introduced by D10 studio work as instructed by Sophia Vyzoviti, 2004. The spatial-structural-organizational diagram of folding is chosen as the design patterns for the artifact creativity assessment tool: continuity, connectivity, stratification, serial variation: spiral, loop and crossing, entanglement, enclosure, and interlacement: strips. All these patterns are an integral part of the folding process where they manage the complexity of disparate elements into a continuous system. The aim of utilisation of this method is to perceive and construct the space between the folds, and to find out the design decisions made through the creation process for each artifact.

All eight spatial, structural and organizational diagram patterns (continuity, connectivity, stratification, serial variation: spiral, loop and crossing, entanglement, enclosure, and interlacement: strips) in folding are specified at the beginning of this study. All conceptual decisions of design artifacts were evaluated in the light of these patterns. (see Table 7). During this analysis, retrospective interview analysis results were also considered. The aim of making this comparison is to investigate the relationships between spatial, structural, and organizational diagram patterns of folding techniques and conceptual meaning of architectural space. With the help of the comparison diagram, it was determined that architectural space configurations are 3D reflections of the concepts that students declared during the design process.

ARTIFACT CREATIVITY ASSESSMENT

Students	Verbal Protocols	Design Concepts	Spatial, structural and organizational diagram patterns in folding	Design Artifacts
S1	*If I need to state a concept it can be: `infinity`".*	infinity	**Continuity**	
S2	*`. I think asymmetry is the best concept for this kind of space*	asymmetry	**Connectivity**	
S3	*`I decide to design a city structure that has different layers, and surfaces and also I like to design them in order.`*	order	**Stratification**	
S4	*`I find out that rhythm is the best concept for this kind of design.`*	rhythm	**Serial variation: spiral**	
S5	*`I am trying to design a space with so many different forms`*	differentiation	**Loop and crossing**	
S6	*`I want to make different curves with different dimensions and directions`*	multi directional spaces	**Entanglement**	
S7	*`...occupants. I think people will lead to there. It is the focus point of design."*	concentric	**Enclosure**	
S8	*`I think complexity is the core of my design idea.`*	conflict	**Interlacement: Strips**	

Table 7. Artifact creativity assessment: Spatial structural-organizational diagram analysis

Results and Discussion

Table 8 displays the results of the two assessments; the total number of cognitive codes in the design activity, and the design concepts related to spatial, structural, and organizational diagram patterns in the students' folding.

Design Creativity Dimensions	**Measurement Items**	
Design Activity Assessment	**Total Numbers of Conceptual Codes**	**Total Numbers of Perceptual Codes**
	6 C1 6 C2	7 P1 4 P2 4 P3 5 P4 8 P5 6 P6
Artifact Creativity Assessment	**Spatial, structural and organizational diagram patterns in folding**	**Related Design Concepts**
	• Continuity • Connectivity • Stratification • Serial variation: spiral • Loop and crossing • Entanglement • Enclosure • Interlacement: Strips	• infinity • asymmetry • order • rhythm • differentiation • multi directional spaces • concentric • conflict

Table 8. Design creativity assessment tool dimensions and related items

These results can be summarized by the following insights:

- The findings in the design activity assessment showed that the predominant cognitive actions are emergent properties and functional relations.
- The highest number of codes are indicated as `as a consideration of psychological reactions,` which is described as assigning non-visual information or meanings to visual depictions or perceptions(P5). This result shows that design decisions made through the creation process is mostly dependent on conceptual meanings.
- Students particularly paid attention to the psychological features of spaces, and they tried to find out their physical appearance. This could be interpreted as mapping the paper fold as a spatial diagram, which requires an abstraction of spatial relations.

- One of the most employed perceptual code of design is `areas and places,` which is the subcategory of emergent properties (P1). This is the explanation for the fact that the students gave particular importance to the form-function relationship in design.
- All design artifacts symbolized a whole physical system, which could be interpreted as the students acknowledging the design as a whole not a partial system. They intended to create uncertainty between boundaries, instead of defined boundaries of separation.
- Moreover, the `abstract features-reactions` functional code has the highest number of utilisations (P6). Students generally focused on the exploration of the issues of interactions between spaces and their occupants. They mostly tried to connect the physical dimensions of the spaces to their occupants. This result illustrated that students expressed regard to the scale and proportion.
- During this stage of cognitive action, students also emphasized the meaning of spaces (P4). They defined the spaces related to their abstract meaning. They used conceptual cognitive actions as guidance for their designs. This result shows the considerable amount of utilisation of the conceptual codes (C1 and C2).
- As the last perceptual actions (P1 and P2); organizations and comparisons among more than one element, such as grouping of elements, and the similarity/uniformity and the difference/contrast of the visual features of the elements were the least used codes. These actions were inherently dependent on physical actions, which constitute the basic actions for all cognitive stages.
- All spatial and organizational diagram patterns have conceptual response in design. By the help of verbal protocols of the students, design concepts for each artifact revealed, and matched to the related spatial, structural and organizational patterns:
    - Continuity as a pattern of spatial diagram is related to the concept of infinity. It is obvious that infinite space signifies continuity.
    - But some other examples like asymmetry and connectivity do not have the same relation in the way that continuity and infinity do. The design product designed with an asymmetry concept was assessed as a connected space. It is interpreted that the architectural space either has an asymmetric or a connected character.
    - Alike with `asymmetry and connectivity ` relation; the pattern `stratification` is matched with the design concept `order`. As being the act of dividing things into different groups or layers, stratification is approved as the explanation of concept `order` in form-concept relation.
    - In the other example, namely the serial variation; spiral and rhythm also have the same relationship with the former case. A serial variation folding technique might supply several different space options for the design process. But, during retrospective interviews it was observed that the students mainly focused on the rhythm concept and regularly utilised spiral folding.
    - The word differentiate interpreted as the conceptual reflection of `loop and crossing` design patterns where they have competency to design dissimilar space forms.

- Entanglement; meaning of being confused or intertwined is admitted as the formal reflection of multi -directional spaces. This relation is approved based on the design concept of sixth student, that covers design act of creating different dimensions and directions with multi-curved spaces.
- The concept concentric is interpreted as the explanation of creating centrality in design. And this design relation states confined space that signify the term enclosure as a design pattern.
- The last concept conflict, approved as the conceptual meaning of interlaced spaces where design artifact completely designed by the help of strips that interlaced with each other as the reflection of complexity in space.

Assessments of Design Creativity Dimensions and Potentials of Folding Techniques as Fostering Creativity in Architectural Design Education

As formerly discussed, there are several approaches and models in literature about fostering and stimulating creativity in architectural design education. Most of them are about concept development (like brainstorming) or emphasizing visualization of ideas (like bio-mimicry). There is not enough study directly focused on the morphologic or conceptual relation between concept and architectural design elements (form, spatial, structural and organizational diagram patterns). This creative design approach has the power to fill this gap in design education.

The most important feature of all these investigations and observations, creative design process in folding, starts with form making before conceptual thinking. Conventionally; a design process starts with abstraction then concrete definition (3D models) of design is stimulated, as in a decision-making model where a design problem is first analysed and defined at varying levels of abstraction, then synthesized in a way that adds to the designer's knowledge of successive and hence more concrete-levels of understanding (Kirk and Spreckelmeyer, 1988: 40). The folding technique displays a new perspective. As it is mentioned in the findings, students first started to make a model and then developed concepts that seem related to the actual fold spaces. The process then turned into spatial arrangements and organization. Hence, this approach seems inspiring for students to develop morphologic and theoretical relations between design issues (as in the design problem itself), form and concept.

Conceptual knowledge, the ideational basis of design, constitutes one of the most significant forms of knowledge in design. Concepts are fundamental to design thinking, since they operate on an ideational level. They are the fundamental material of design thinking. And developing a conceptual knowledge related to architectural space for design students is one of the most complicated phenomenon. At the early stages of architectural education, students have difficulty to produce forms. Students, during the design process, comfortably use basic geometrical elements one by one. However, they are not able to diversify them by transformation because of the fact that students are not capable enough to transform basic geometrical forms in accordance with arithmetical operations and geometrical transformation (Yavuz and Akcay, 2012). Hence by the help of the folding technique it is quite easy to help students to produce form-concept relations by initially creating topological geometric forms.

As Vyzoviti (2004) claims, folding is a challenge with great individual possibilities. Opening a fold in a surface creates spaces, which in our minds are filled with volumes; thus, all architectonics like space, organizational and structural patterns emerged during the process. As it was also mentioned in the retrospective and spatial analysis results, students decided on their design concepts after choosing the best folding form. And all patterns have the power to create conceptual meaning of an architectural space. Students developed the design concept after or while making the 3D models. It is obvious that in folding process, design product is not the a priori target to be achieved. Besides, all products were different from each other. And they could not be repeated again. It is clear that folding is a strong theme, which displays diverse individual architectonic form. There is no doubt the folding project is unique in the end results created.

Conclusion

Creativity has been explored for more than a century and during this time it has been recast from a mysterious ability of humans to a more cognitive and practical ability, which can be taught and learnt. But teaching and learning to be creative is still an area that needs to be examined. One would expect creativity to be taught in architectural design education since in the design studio students are supposed not merely to learn how to form space or how to shape places. It also involves helping students become independent thinkers, proficient at self-regulated thinking. It is needed to make them think innovatively, to have a fresh view of the built environment. Architectural design is also an exploration of creating the finest forms for the settings of human activities. Because of the complexity of the design process there are no exact and fixed formulas that bring together form, function, concept and technology. In order to ensure creativity is fostered in architectural design education, there are some creative methods that could be proposed to achieve these goals, which are mostly focused on idea generation, problem definition, idea selection and verification. These methods are accepted as a guide to thinking creatively in design processes. But creative thinking in architecture design not only deals with conceptualization but also with components or elements of a structure or system and unifies them into a coherent and functional whole, according to a particular approach. Architectural design is essentially about the conceptions, configurations, connections, shape, and orientations of physical forms.

This paper discusses folding techniques as a creative design approach that should come to the forefront in design studio education. The result of this study indicates that folding is a unique technique that offers a new perspective in architectural design processes. Contrary to conventional approaches design starts and ends with 3D models. In conventional architectural design, drawings are the primary form of representation; they carry a design from conception to construction. But this study shows that design thinking starts with 3D modeling; conceptualisation can occur afterwards or in the course of process. This helps designers to comprehend the spatial and conceptual relations of architectural form instantaneously. This technique is therefore unique as it helps students, especially beginners, deal more easily with issue-concept-form relations in design. It is also vital not to forget the effect of the medium that the experiment was performed in. Informal education mediums like design workshops are believed to have an effective role in allowing students to free their minds and help them to create novel artifacts. So, in order to enhance creativity in design

studios, the social-cultural aspect of the medium also should be considered as an effective tool in learning and teaching design.

As a contribution to these debates, this technique has many aspects that can help to facilitate flexible thinking in design, and it has more potential in spatial comprehension than conventional architectural conception. Although this study presents strong evidence to challenge the conventional way of design: “creative design can start with 3D representation”. It is a creative way of thinking that enables designers to perceive the interactions of spatial, conceptual and volume at the moment of creation. It is a creative way of starting with 3D form representations.

Design disciplines dealing with issue-concept-form relations should find innovative ways such as the folding technique. This kind of approach could be adapted as an educational pedagogy in other design disciplines such as urban design, landscape design, or interior design.

This study thus fills a gap in the literature about design approaches that foster creativity in design education, by proposing a logical and practical way of understanding architectural design processes specifically for design students who are at the beginning of their education. This study is a starting point for future studies about developing new and unconventional creative approaches in architectural design education.

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22.2

Examining Teaching Practices in Design and Craft Education in Iceland

Abstract

This article reports a survey which aimed to examine the present situation in Design and Craft Education (D&C) in Iceland in terms of teachers' general standing and their teaching inside the Icelandic elementary schools. A questionnaire was sent to 170 D&C teachers in Icelandic elementary schools. The questionnaire was completed by 101 teachers, and the response rate was 59.4%. The main research questions were:

1. What are the most common methods for teaching D&C?
2. How do D&C teachers utilise the Icelandic National Curriculum?
3. How *could the teaching better meet students' individual needs?*

Data were collected using an online questionnaire that was distributed to D&C teachers in all elementary schools in Iceland. Findings showed that D&C teachers base their teaching mainly on traditional teaching methods such as direct instruction, verbal explanation, practical demonstration and discussion with students during their work. The teachers were quite satisfied with their methods of teaching and were not willing to make dramatic changes. Nevertheless, they were interested in improving outdoor education, field trips and the use of information and communication technology (ICT) in their classrooms. Most of the teachers used the national curriculum for planning their teaching, but generally only at the start of the school year. The majority of the teachers based their teaching on student's individual needs in agreement with the present national curricula. The research indicates the importance of improving the teachers' practices in order to strengthen the subject's status inside the Icelandic school system. This could be done via in-service teachers' courses and seminars with teachers discussing the outcomes of the research.

Keywords

Design and Craft, online survey, pedagogy, educational research, enhancement

Examining Teaching Practices in Design and Craft Education in Iceland

The subject of Icelandic craft was established in 1890 as a result of influences from the Danish Sloyd model (Mikkelsen, 1891; Thorarinsson, 1891). Different curriculum for craft were developed in Iceland from 1936 until 1999, when craft was re-established as a new technological subject under the name Design and Craft (D&C). D&C is based on a specific rationale for craft education, technological literacy and innovation and design, and its main aim is to develop technological literacy and ideation skills in students (Menntamalaraduneytid, 1999).

However, little research has been conducted in the area of D&C in Iceland. Therefore, research is needed to examine its current situation in order to gain information about the status of the subject in such areas as, how the subject is taught and the congruency between the teaching practice and the national curriculum for D&C. This research could enable both practicing teachers

and teacher educators to improve their work and subsequently support the subject's existence in schools (Thorsteinsson & Olafsson, 2009).

First, this article briefly reports on the background of the Icelandic D&C subject and describes the Icelandic National Curriculum for D&C. Subsequently, the aim and the objectives of the research project and the research questions are stated and the research methods described. Finally, the findings are re-examined and discussed in light of the literature, and conclusions are drawn.

Background

Iceland provides a good standard of education (OECD, 2015). Every child has the opportunity to obtain an education regardless of gender, religion, disability, handicap, economic status, residential location or social background. The Iceland Ministry of Education (2014) is largely responsible for the provision of education in Iceland. However, local authorities are responsible for the operation of primary and lower secondary schools. The government maintains upper secondary schools and higher education institutions.

The Icelandic school system comprises four levels of education: pre-school education, compulsory education, upper secondary education and higher education. There are also specialised schools. Children attend pre-school and nursery from the age of twelve months to six years, with pre-school being the first level of the educational system. The majority of Icelandic children attend pre-school, and their fees are usually paid by local councils.

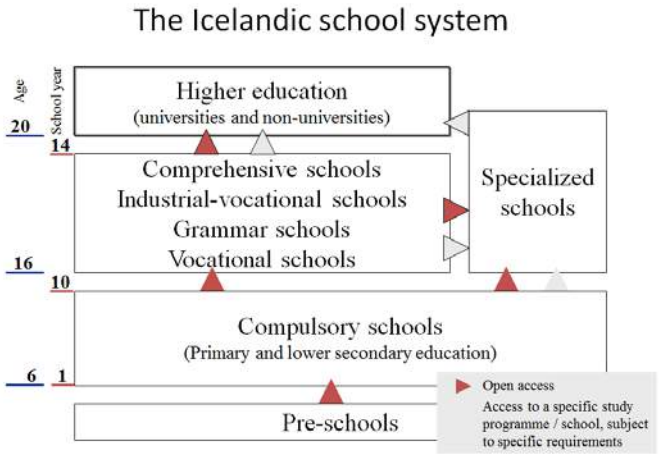

Figure 1. The Icel

Icelandic law states that education is compulsory for children from the ages of six to sixteen (The Icelandic Ministry of Education, 2014). As a result, the literacy rate is high in Iceland and has been so since the end of the eighteenth century.

D&C was introduced as a craft subject in Iceland in 1890 by the first educational director, Jon Thorarinsson (1891) under the influence of Scandinavian Sloyd pedagogy (Olafsson & Thorsteinsson, 2009). To fully comprehend the subject's role and significance in the context of this research, it is therefore necessary to give a brief description of the historical and pedagogical background of craft education in Iceland, now named Design and Craft (Menntamalaraduneytid, 1999).

At the time of the introduction of craft education in Iceland, the country was a Danish colony, and Icelandic scholars were, therefore, influenced by the Danish culture. This new Icelandic subject was first based on a system for Danish schools called Sloyd, which was developed by Axel Mikkelsen in his handicraft school in Copenhagen, Denmark. Mikkelsen established Sloyd as a

general subject in Danish public schools in 1883 under the influence of Cygnaeus, the originator of the Sloyd pedagogy in Finland, and the Swedish educationalist Salomon (Borg, 2006). The Danish Sloyd model was focused on bringing physical work into harmony with spiritual aspects (Thane, 1914) with the development of the potential of the whole child being the central focus.

The term *Sloyd* is related to the old Icelandic word *slægur,* with the original meaning being connected etymologically with the English word *sleight* (as in 'sleight of hand'), meaning cunning, artful, smart, crafty and clever (Borg, 2006; Den Danske Ordbog, 2003–2005; Nudansk Ordbog, 1990). Sloyd comprises school activities that use craft to produce useful and decorative objects. It is a pedagogical system of manual training that seeks to aid the general development of the child through the learning of technical skills in woodworking, sewing, knitting, and the making of useful objects by hand (Borg, 2006; Salomon, 1893).

The Development of the Icelandic National Curriculum for D&C

The national curriculum for craft education in Iceland have been based on various laws for general education. In the first public school laws, established by the Icelandic parliament in 1907, craft (school industry) was not included, but it was taught in many schools. Moreover, when the first national curriculum for the education of children was published in 1929, craft or school industry was still not mentioned. However, when a new law for children's education was passed in 1936, the subject was given a mandatory status (Eliasson, 1944).

Craft was first established as a subject in 1948. Instruction was gender-based with craft for boys and textiles for girls (Fraedslumalastjornin, 1948). The first integrated national curriculum for compulsory education was published in 1960. It was gender-specific, but it emphasised the general pedagogical values of the subject. Based on the above law, a new national curriculum was published in 1976–1977 (Menntamalaraduneytid, 1977). In this curriculum, *Art and Handicraft* was established as a new area for craft education. This included art, textiles and craft. For the first time, all the subjects were compulsory for both boys and girls. This curriculum was slightly revised in 1989.

Craft education in Iceland was re-established as a new technological subject in 1999 and renamed Design and Craft (Menntamalaraduneytid, 1999). The new subject was based on a rationale for technological literacy, innovation and design (Thorsteinsson, 2002; Thorsteinsson & Denton, 2003). The emphasis was on technologically-focused craft, based on innovation and design. These undertakings were expanded from an earlier curriculum with traditional aspects from technology education. It was also recommended to support the students' process of idea generation and the creation of artefacts with relevant knowledge.

Figure 2: Shows the emphasis of the D&C curriculum.

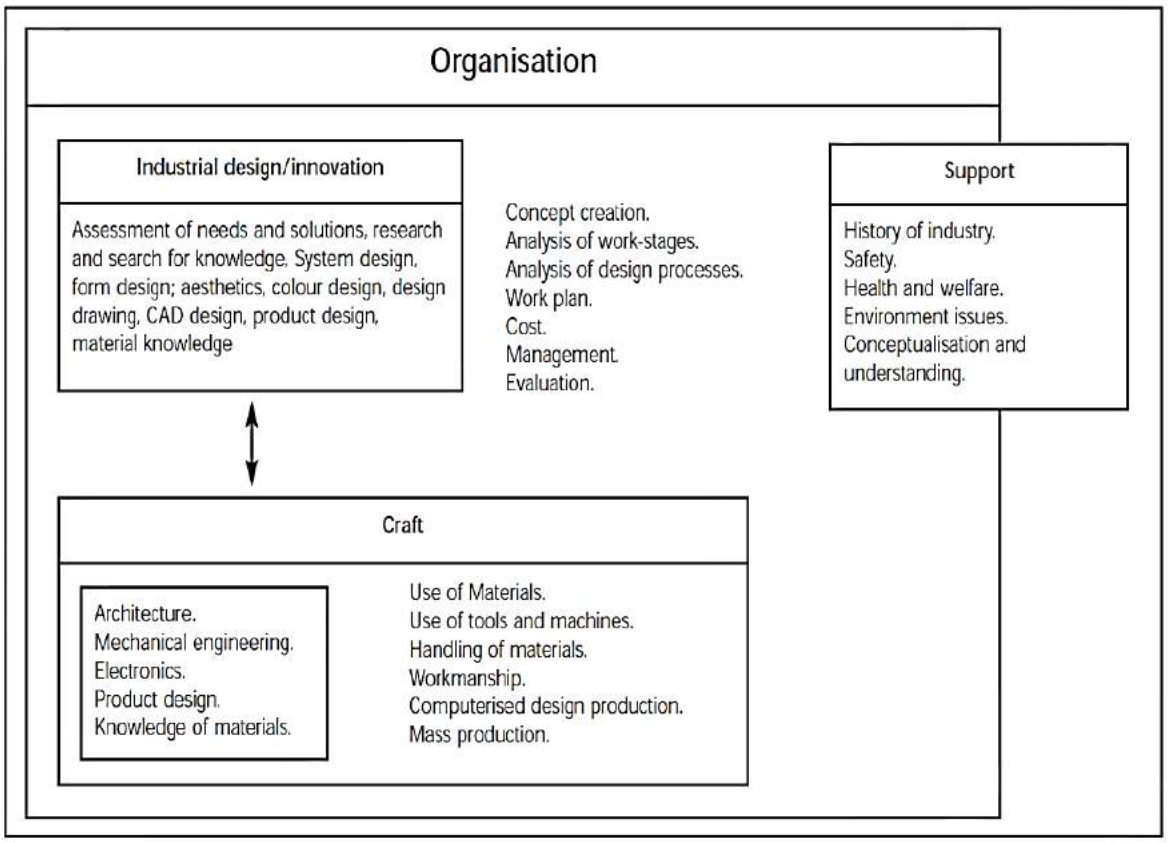

Figure 2: The infrastructure of D&C in Iceland (Olafsson &Thorsteinsson, 2013).

D&C is, at present, an independent subject in the national curriculum, and it resides within the area of vocational and technical subjects. The focus is on technologically-based D&C and innovation, both of which were expanded from earlier curriculum. The curriculum supports the students' process of idea generation and the creation of artefacts with relevant knowledge, such as knowledge concerning sustainable design, the history of industry and health and safety. Also, training students to organise their work is important. In addition, new components have been added, including outdoor education and green woodwork, sustainable design and health and safety. Individualised learning and flexible instruction are recommended in the present curriculum. The old Sloyd values have been revisited and can be seen once again in the rationale.

According to the present national curriculum, teachers have more freedom to construct the school curriculum and manage their teaching. The major emphases are listed in Table 1 (Menntamalaraduneytid, 2007).

1. Design and invention
2. Technical literacy
3. Technical skills and workshop management
4. Handicraft and organizing the work

5. Focus on individuals
6. Outdoor education and green woodwork
7. Sustainable design
8. Health and safety
9. Emphasis on craft-based tasks

Table 1: Main Emphases in the Present Icelandic National Curriculum for D&C

Teachers' Pedagogy, Teaching Practices and Curriculum Knowledge

The term pedagogy refers to teachers' practices; it is a complex concept and not easily defined. Watkins and Mortimer (1999, p. 3) define pedagogy as 'any conscious activity by one person designed to enhance the learning of another'. Alexander (2003, p. 3), however, argues that pedagogy requires discourse: Pedagogy is the act of teaching together with its attendant discourse. It is what one needs to know, and the skills one needs to command in order to make and justify the many different kinds of decisions of which teaching is constituted. McNamara (1991, p. 3), Brown and McIntyre (1993), Black et al. (2002), Ireson, Mortimer & Hallam (1999), and Bruner (1999) argue that it is difficult to understand teachers' pedagogy and that there are many factors which affect practice. Teachers have to take more into account than the latest government thinking about how they should teach in the classroom. Their work may be influenced by many factors, such as the school environment, their position in the school, their experience of learning and their training.

Knowledge plays important roles in the teaching profession. It involves how teachers apply their knowledge to make decisions, for example, about lesson design or making on the spot judgements in the classroom. Curriculum knowledge, according to Shulman (1987), requires understanding children's learning abilities, national syllabuses, school planning documents and yearly group plans. In addition, any examination syllabuses must be considered along with local requests from the individual school.

Because no research had been carried out to determine the current status of D&C, this research project was concerned with examining teachers' use of the D&C curriculum. Therefore, it was relevant to study the congruency between the national curriculum and their teaching practices and to determine if they were aware of what should be taught to a particular group of pupils.

Over the past 20 years, the national curriculum for D&C has changed considerably in Iceland (Menntamalaraduneytid, 2007). The curriculum prescribe what shall be taught, but do not dictate which teaching methods should be used. However, the general part of the national curriculum (Menntamalaraduneytid, 2007) advises teachers to select appropriate teaching methods to meet pupils' needs in order to support their education and development. The curriculum underline the importance of meeting individual students' expectations and requirements to give them positive experiences and increase their interest in the subject so they gain pleasure from their work. The teaching must be based on equality, and the teacher has to avoid discrimination because of gender, residence, origin, race, disability, religion, sexual orientation or social status (Menntamalaraduneytid, 2007).

Common Teaching Methods for Teaching D&C

Initial craft education in Iceland was influenced by Swedish and Danish Sloyds. The Danish Sloyd was built on classroom instruction (Kananoja, 1989). Students were given exercises to train them in the use of tools. All classes began by making models using a saw. Files and sandpaper were forbidden because they could hide faults. Lesson plans had to be flexible to meet the varying needs of individual pupils. Woodwork was the only course offered because the school time allocated to Sloyd was very limited (Bennett, 1937).

Teaching methods used in Swedish Sloyd were well-organised (Bennett, 1926). The individual student became the centre of the system, and the facilitation of the holistic development of the student's capabilities was placed at the forefront of learning. The importance of teaching the fundamentals and building the skills of the student, from the very first stage of his or her education, were underlined (Herrera, 1999; Herrera & Yokoyama, 2002). The Swedish Sloyd system was based on individualised instructions adapted to the abilities of each student. Three fundamental points characterised this method: (1) the creation of useful objects, (2) the analysis of work processes, and (3) the teaching method employed (Bennett, 1926). The training system was structured around the transition from simple exercises to more complex ones. Following the exercises, students were required to build objects or models in a particular order (Thorbjornsson, 1990).

As time went by, the teaching methods became more varied and more individualised (Menntamalaraduneytid, 2007). There are now differing opinions about the value of using these methods. However, good teachers will be successful with any lesson plans, including direct instruction. According to the research, the following teaching methods are used by D&C teachers.

Direct instruction with or without discussion. Direct instruction is the most common type of instruction used by teachers. It relies on formal lesson plans and lectures and does not normally include activities such as discussion, recitation, seminars, workshops, case studies or internships. The role of the teacher during direct instruction is to organize and control the lesson as the expert. When using direct instruction, the teacher presents a general principle or rule that students must base their work on. Then, the teacher can see from the students' work if the principle has been applied.

Critics argue that direct instruction is nothing but canned teaching involving little personalization. Supporters of direct instruction consider it helpful in developing students' deductive reasoning and delivering large amounts of information in a timely manner. Moreover, as the method is teacher-directed, it lends itself to designing instruction that is developmentally appropriate to pupils' ages and stages (*Engelmann* & *Carnine, 1991*).

Discussion. Discussion methods are a variety of forums for an open-ended, collaborative exchange of ideas among a teacher and students or among students for the purpose of furthering students' thinking, learning, problem solving, understanding or literary appreciation. Participants present multiple points of view, respond to the ideas of others and reflect on their own ideas in an effort to build their knowledge, understanding or interpretation of the matter at hand. Discussions may occur among members of a dyad, small group, or whole class and be teacher-led or student-led. In D&C, discussion often focuses on the teacher's brief or a technical problem in order to help students to establish their design. Other terms for discussions used for pedagogical purposes are *instructional conversations* (Tharp & Gallimore, 1988) and *substantive conversations* (Newmann, 1990).

Workbooks. Workbooks are often used in D&C, especially for younger students. They are ideal because students can work directly in their books, both at school and at home. This can, for example, be descriptions and drawings of students' designs. Workbooks have an advantage because they are usually smaller and lighter than textbooks, which equates to less trouble when the students bring the book home to complete their design (Kerr, 1947).

Giving the brief with discussions. D&C teachers normally start their classes by giving students a brief or a design task. This often includes the use of written assignments that can be used to explore the background of the design and to make sketches later at home. Often, the teacher gives the students photocopies showing several drawings or photos of possible outcomes. Normally, this includes discussions between students and the teacher, in order to increase their understanding, and brainstorming sessions about possible designs (Menntamalaraduneytid, 1999).

Group work and collaborative learning. Collaborative learning is based on the view that knowledge is a social construct. Collaborative activities are most often based on four principles:

- The learner or student is the primary focus of the instruction.
- Interaction and *doing* are of primary importance.
- Working in groups is an important mode of learning.
- Structured approaches to developing solutions to real-world problems are incorporated into learning.

Collaborative learning can occur peer-to-peer or in larger groups. Peer learning, or peer instruction, is a type of collaborative learning that involves students working in pairs or small groups to discuss concepts or find solutions to problems. This often occurs in a class session after students are introduced to the design task or technical problem to be solved.

Group projects can help students develop a host of skills that are increasingly important in the professional world (Caruso & Woolley, 2008; Mannix & Neale, 2005). Positive group experiences, moreover, have been shown to contribute to student learning, retention and overall college success (Astin, 1993; National Survey of Student Engagement, 2006; Tinto, 1987).

Outdoor Education. Outdoor education in D&C describes school curriculum learning in a way other than with a class of students in a room with a teacher. Outdoor education spans the three domains of self, others and the natural world. The most common task in D&C is using local wood to whittle and to learn about how to maintain and utilise it for craft. It encompasses biology field trips and searching for insects in the school garden, as well as indoor activities such as observing stock control in a local shop or visiting a museum.

Despite evidence showing the benefits of outdoor learning, there are a number of obstacles in the way. One obstacle is risk aversion amongst teachers, parents and others, which raises reluctance to such diverse and physical tasks (Olafsson & Thorsteinsson, 2014).

Use of ICT. In recent years there has been an interest in how the use of computers and the Internet can best be harnessed to improve the efficiency and effectiveness of D&C education, both in formal and informal settings. The national curriculum underline the importance of teachers utilising this modern technology in all subjects (Menntamalaraduneytid, 2012) as it can support D&C students in many ways, such as using computer-aided design (CAD) for drawing and accessing information sources on the Internet that support students in their design work (Sigurgeirsson, 1999).

Earlier Research Projects on Teaching Methods and Classroom Settings

Very few earlier research projects have been carried out to examine teaching methods used in the D&C field. However, several research projects have been carried out in other areas.

The research project entitled *Teaching and Learning in the 21st Century* (Oskarsdottir, 2014) focused on teaching art and craft in the Icelandic elementary schools. The project was carried out from 2008 to 2013 in 20 Icelandic elementary schools. The research examined seven different art and craft subjects. Questionnaires were sent to 860 teachers, 2,100 students in grades 7–10 and to 5,000 parents. Subsequently, follow-up interviews were conducted with seven groups of teachers in seven schools. Moreover, the researchers did observations during 135 lessons.

The research concluded that 58% of the art and craft teachers were using the national curriculum to prepare their teaching for whole year, but 7% used it only a little or not at all. By comparing the art and craft teachers with teachers from other subjects, the researchers found out that the art and craft teachers were using the national curriculum less than other teachers, both in the context of their daily preparation and for preparing for each term or for the whole winter (Oskarsdottir et al., 2014).

The questionnaire included questions about teaching methods. The majority, 74%, used direct teaching with discussions on a daily basis or more often, 66% used lectures every day or more often and 65% used practical demonstrations on a daily basis or more often. A large percentage, 78%, never, or seldom, used computers during their lessons (Oskarsdottir et al., 2014). Multiple tasks were more common in art and craft than in other subjects, and the teachers considered these subjects more able to meet individual students' needs than other subjects (Oskarsdottir et al., 2014).

In Thorsteinsson and Olafsson's (2011) research on design decisions in D&C inside the Icelandic elementary schools, they found that some teachers held the view that, as students' progress, they should be given more decision-making opportunities. However, most of the teachers did not offer any kind of formal instruction on decision-making techniques to their students as a part of their teaching methods. According to the teachers, the majority of students rarely searched for information outside of the classroom before taking their design decisions. The main source of information for the students was their teacher, and on some occasions, they used the Internet as an information source for making their design decisions (Thorsteinsson & Olafsson, 2011). The study concluded that the national curriculum in Iceland include many opportunities for decision-making in D&C education. However, many teachers indicated that some of the requirements of the curriculum were not achievable, and they therefore selected the goals and aims they found feasible to attain (Thorsteinsson & Olafsson, 2011).

In his research from 1987–1988, Sigurgeirsson (1998) analysed extensive data from 20 primary classrooms. The research showed that traditional teaching methods and classroom setup dominated. This appeared in passive individual seatwork, rote-learning, recitation, drill and various forms of textbook teaching. A follow-up survey, several years later with teachers in 80 additional schools, gave similar results (Sigurgeirsson, 1992). In 1994, Sigurgeirsson interviewed 200 head teachers from Icelandic elementary schools. The results also showed that traditional teaching methods dominated.

Jonsdottir's (2003) research showed that traditional teaching methods were dominating in the elementary school youth level. However, at the same time, the schools aimed at individualised teaching. Nevertheless, just 27% of the teachers in theoretical subjects based their class activities on individualised teaching. At the same time, 50% of teachers in the areas of art and craft focused on

individualised teaching. The art and craft teachers encouraged their students to make their own decisions more often than teachers of theoretical subjects did.

Similarly, Karlsson's (2009) research on teaching methods in Icelandic and Finnish schools concluded that traditional teaching methods dominated in Icelandic schools. The classrooms were, for example, set up in the traditional manner to teach groups, and this limited the students' freedom and independence. Little flexibility was given for individual work, and students were working on the same projects. Karlsson (2009), however, concluded that Icelandic teachers have to use various teaching methods in order to support the ideology of individualised learning. Birgisdottir's (2004) research in the elementary schools concluded that teachers, in general, believed they were using traditional methods for teaching classes, but thought their classroom settings were flexible for students. Her research also showed that teachers of younger students were focused more on individual differences.

In Sigurgeirsson and Kaldalons (2006) research on discipline problems in Reykjavik schools, three of the interviewees stated that the art and craft subjects were important support for problematic students and that they should have a greater weight inside the elementary schools. One school administrator stated that discipline problems decreased significantly when students were given more time in art and craft classes.

The Research Methodology

The aim of the survey was to examine the present situation in Icelandic D&C in terms of the teachers' general standing and their teaching inside the Icelandic elementary schools. The research questions were the following:

1. What are the most common methods for teaching D&C?
2. How do D&C teachers utilise the Icelandic National Curriculum?
3. How *could D&C teachers better meet students' individual needs?*

The research was undertaken in the autumn of 2014. Data were collected by an online questionnaire using the entire population of D&C teachers in Iceland (Cohen, Manion, & Morrison, 2005).

An online questionnaire was designed on the basis of the Icelandic National Curriculum for D&C. LimeSurvey, a web-based survey tool, was used to conduct the survey. It allowed the authors to create the online questionnaire and give respondents access to it via email and to then export the results which were subsequently analysed using the Statistical Package for Social Sciences software (SPSS, Chicago, IL, USA). The survey was anonymous and untraceable.

A survey has several unique characteristics and represents several advantages. Typically, a survey is used to scan a wide field of issues in order to measure or describe any generalized features. It usually relies on large scale data gathered from a wide population, which can then be processed statistically in order to enable generalizations to be made about given factors or variables (Cohen et al., 2005). According to Morrison (1993, pp. 38–40) a survey normally gathers data on a one-shot basis and is therefore economical and efficient. It represents a wide target population, generates numerical data, provides descriptive, inferential and explanatory information, manipulates key

factors and variables to derive frequencies and gathers standardized information (Bryman & Bell, 2007).

The questionnaire served four basic purposes: to (1) collect the appropriate data, (2) make data comparable and amenable to analysis, (3) minimize bias in formulating and asking questions and (4) make questions engaging and varied.

The questionnaire included 28 questions and was sent to 170 elementary schools. The questions were designed to extract general and specific information about teaching D&C. The specific questions concerned the following:

- Teaching methods,
- School curriculum,
- Teachers' backgrounds, and
- How teachers' want to improve their work.

The response rate was 59.4%, as 101 teachers responded to the questionnaire. A numerical analysis was performed using the SPSS software, which provided total averages, median, standard deviation and averages for different classes of questions.

According to Icelandic law, the survey was reported to Personuvernd, the Icelandic Data Protection Authority (Personuvernd, 2011). No personal information was collected in the survey, and it was not possible to connect responses with specific individuals.

Results of the Survey

None of the participants who answered the questionnaire were younger than 30 years of age, and only 17% were from 30–39 years of age as seen in Figure 3. About half of the teachers were located at schools in the capital area, and the other half were located at schools in rural areas.

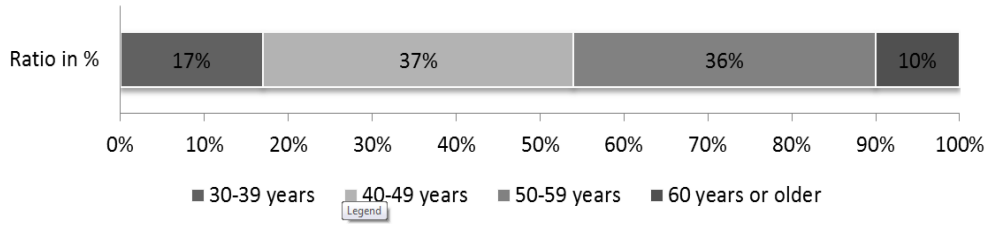

Figure 3: Age of participants.

The majority of the participants (39%) were professional D&C teachers, as shown in Table 2. Of the teachers, 19% had vocational backgrounds with a teaching licence, and 14% had general teacher education qualifications without being professional D&C teachers. Of the total, 40% of the teachers taught only D&C, and 60% taught additional subjects.

Table 2: Participants' Education

Education	Percentage
B.Ed. specialised in D&C	39%
B.Ed. specialised in other subjects	14%
Vocational training with teaching licence	19%
Vocational training without teaching licence	5%
Other education with teaching licence	6%
In university	1%
Other education	16%
Total	**100%**

Table 3: Period of Employment in Teaching

Years of teaching	Percentage
In first year	2%
1–5	18%
6–10	25%
11–15	20%
16–20	12%
21–30	14%
30–40	8%
40 or more	1%
Total	100%

The national curriculum states how much time each subject is allotted. According to the 2007 National Curriculum (Menntamalaraduneytid, 2007), D&C is to be taught from first through eighth grades. It is not compulsory to teach D&C in ninth and tenth grades, but some schools chose to use unallocated hours for subjects within art and craft. Of the survey participants, 60% stated that D&C was an elective subject in eighth grade, 80% in ninth grade and 79% in tenth grade (Table 4).

Table 4: Grades That Were Not Given D&C Lessons

Class	Percentage
1	24%
2	8%
3	3%
4	2%
5	1%
6	1%
7	1%
8	6%

9	12%
10	14%

According to the national curriculum (2015), all teachers are obliged to follow the national curriculum, and schools are further obliged to create specific school curriculums for each subject based on the national curriculum. Of the participants, 3% stated that they did not use the school curriculum to prepare for teaching. However, 74% of the participants used the school curriculum in the autumn when preparing for the whole winter, 47% used it in the beginning of each school term, 13% used it every week or every month and 7% used it for daily preparation.

When the teachers were asked about their teaching practices, 64% stated that they were encouraged by school administrators to use various teaching methods. As seen in Table 5, the most common teaching methods were direct teaching with discussions with students and direct teaching with the teacher assigning tasks and giving direct information to the students. Only 12% of the participants used workbooks on a daily basis, and 28% never used textbooks. Of the participants, 29% never utilised student computers during their lessons.

Table 5: Teaching Methods

	Daily	**1 - 4 times a week**	**Fewer than 3 times a month**	**Never**
Direct teaching for all students	52%	31%	16%	1%
Direct teaching with discussions	62%	24%	13%	1%
Workbooks	12%	12%	48%	28%
Other written tasks	6%	13%	55%	26%
Group work in classes	21%	22%	52%	5%
Discussions in groups and oral presentations	8%	18%	55%	5%
Outdoor education and field trips	0%	6%	74%	20%
Students use of computers	6%	11%	54%	29%

There was a correlation between the participant's educational background and whether he or she used written tasks. Of the participants, 66.7% of those who had a B.Ed. degree and were professional D&C teachers sometimes used written tasks, while 35.7% of those who had a B.Ed. degree without specialisation in D&C used written tasks ($\chi 2$ [36, N = 100] = 55.1, $p < 0.05$).

The participant's answers to the question as to whether or not they wanted to use the listed teaching methods, and to what degree, are shown in Table 6. Most of the participants wanted to do more outdoor education (51%) and use computers more (49%).

Table 6: Teaching Methods

	Use more	Same as present	Use less	Do not know
Direct teaching for all students	10%	81%	5%	3%
Direct teaching with discussions	14%	78%	5%	2%
Workbooks	20%	51%	14%	14%
Other written projects	20%	47%	16%	16%
Group work in classes	29%	57%	7%	6%
Discussions in groups and oral presentations	41%	45%	5%	8%
Outdoor education and field trips	51%	33%	4%	11%
Using computers	49%	35%	3%	12%

Of the participants, 83% stated that students were very often or always given individually-based tasks. Only 11% stated that students were seldom or never given individually-based tasks. Of the participants, 58% said that students were almost always permitted to make their own designs and that 29% were very often permitted to make their own designs. Only 6% of participants expressed that their students could almost always make their own design choice, and 27% said they were very often able to make their own design choice.

There was a correlation between the participant's education and whether students were allowed to make their own design decisions. Of those who had a B.Ed. degree and were professional D&C teachers, 69.2% stated that students were almost always allowed to make their own design decisions, as did 57.1% of those who had a B.Ed. degree without a specialisation in D&C and 42.1% of those who had vocational training with a teaching licence ($\chi 2$ [37, N = 100] = 24.1, $p < 0.05$).

Participants were also asked about their attitude towards students' behaviour. Half (50%) of the teachers agreed that students with attitude problems should get more time in art and craft, 25% did not agree and 25% did not answer. However, 86% of the teachers considered D&C helpful, particularly helpful for students with learning difficulties, and felt that students should receive more time in D&C.

Participants were asked what could help them to better meet the needs of individual students. As seen in Table 7, 72.2% stated that an assistant in the classroom would be somewhat or very much helpful, 71.1% considered smaller classes would be somewhat or very much helpful and

77.3% believed that better equipment and technical inventory would be somewhat or very much helpful. Only 32.9% stated that more flexibility would be somewhat or very much helpful, and 35.1% felt that that advice from experts would be somewhat or very much helpful.

Table 7: What Would Be Helpful in Meeting the Needs of Individual Students?

	Somewhat or very much	**Neutral**	**Not much or very little**
Extra assistant in class	72.2%	15.4%	12.4%
More time for preparation	62.9%	30.9%	6.2%
Smaller classes	71.1%	18.6%	10.3%
Advice from experts in preparation	35.1%	36.1%	28.8%
Courses in new teaching methods	59.8%	28.8%	11.4%
More encouragement from leaders	31.9%	50.5%	17.6%
More flexible timetable and possibilities for longer hours	32.9%	39.2%	27.8%
More equipment and technical inventory	77.3%	17.5%	5.1%
Increased cooperation with other teachers	56.7%	34%	9.3%

There was a correlation between the participants' education and their answers to the questions about what would help teachers meet the needs of individual students. Of the professional D&C teachers, 48.7% stated that smaller classes would help them, but only 35.7% of those who were qualified teachers but not specialised in D&C agreed about smaller classes, while 36.8% of those who had vocational training with a teaching licence agreed ($\chi 2$ [55, N = 100] = 37.1, $p < 0.01$).

Discussion and Conclusion

The Icelandic National Curriculum for D&C does not define how teachers should teach, nor does it recommend the use of certain teaching methods. Nevertheless, the general part of the national curriculum (Menntamalaraduneytid, 2012) advises teachers to select advantageous teaching methods to support the development of individual students. This means that the teachers' work depends on their professionalism and ability to use various teaching methods to meet different needs of students.

When teachers were asked about teaching practices, the majority stated they were encouraged by school administrators to use various teaching methods to meet the demands of the

national curriculum. Nevertheless, earlier research projects showed that most of the teachers used traditional, old-fashioned teaching methods, such as direct instruction (Birgisdottir, 2004; Jonsdottir, 2003; Karlsson, 2009; Sigurgeirsson, 1998, 1992; Sigurgeirsson & Kaldalons, 2006). As Oskarsdottir's (2014) research concluded, very few of the teachers used computers for students, went on field trips or were involved in outdoor educational activities. However, many of the teachers were interested in using computers in support of ideation. Most probably, they were interested in diversifying their teaching to meet the national curriculum's new requirement of increasing students' ICT skills by using computers in all subjects (Menntamalaraduneytid, 2012).

It was found that teachers and students were not using textbooks a great deal in order to allow students to determine their own tasks because most of the teachers considered it better to select suitable projects for students' on different levels. Moreover, general D&C is based on hands-on work supported mutually by instructions and demonstrations, and the common textbook, by its nature, is not seen as supportive for students. Furthermore, the fundamental ideology behind the subject is to support students' development using handicraft in general education; therefore, it might be more effective to focus more on handicraft activities than on planning and students' ideation (Mikkelsen, 1891; Thorarinsson, 1891; Thorsteinsson & Olafsson, 2009).

The majority of the participants were professional D&C teachers who became used to certain teaching methods as students during their own education in the subject area. Consequently, their work was affected by their earlier experiences as students.

All of the teachers were more than 30 years of age, and 17% were from 30–39 years of age. This could possibly have affected their interest for using certain methods in their teaching; perhaps, their teacher training was different from that of younger teachers. There might also have been differences between teachers located at schools in the capital area and those in rural areas because of closeness to the economy live in the rural areas.

Some of the teachers wanted to focus more on group work. D&C education in Iceland is more individual-based than in most other subjects and, therefore, better equipped to meet the curriculum's demand for supporting the development of individual students by using appropriate teaching methods (Menntamalaraduneytid, 2012).

Many of the teachers were more interested in outdoor education, field trips and the use of computers as these are new emphases in the national curriculum for D&C. Yet, it is probable there is a lack of time to engage in these, or perhaps teachers do not have the opportunity or facilities to currently support such activities.

The national curriculum dictates (Menntamalaraduneytid, 2012) how much time each subject is given. However, according to the survey, classes 1–2 and 9–10 get fewer D&C lessons than other classes. This might affect the selection of teaching methods in some of the schools as students have weaker skills and knowledge if they start later, say in class 3, and therefore receive a more basic teaching. If students are taught earlier, they become more skilled and more capable of working individually, which also means they are more capable of making their own design decisions.

All teachers are obliged to follow the national curriculum when planning the school term. Moreover, schools are obliged to develop a school curriculum for each subject based on the national curriculum. Most of the participants used the national curriculum when preparing for the whole year, but some used it when planning each school term. This means that most of D&C teaching is based on the national curriculum. However, Oskarsdottir et al.'s research (2014) showed that art and craft teachers used the national curriculum less when preparing for the school term than teachers of

other subjects. This could indicate that D&C teachers base their teaching more on their own experience and skill. Thorsteinsson and Olafsson's research (2011), moreover, shows that D&C teachers are not all content with the demands of the national curriculum as they think that the time is too limited to fulfil its requirements for individual learning and that it is better to use the time for augmenting students' skills and knowledge.

Most of the teachers had been teaching for six or more years. Because of their long experience, they had probably already established their way of working. Also, some of the teaching methods they were asked about are more appropriate for teaching theoretical subjects rather than craft and would thus reduce students' handout work in lessons. For example, only 12% of the teachers used workbooks daily. Sigurgeirsson's (1998) research found traditional didactics were overwhelmingly dominated by passive individual seatwork and various forms of textbook teaching. However, the nature of the more practical subjects can demand other types of teaching methods.

There was a correlation between participants' educational backgrounds and whether they gave students written tasks. The majority (66.7%) who had a B.Ed. degree and were professional D&C teachers sometimes used written tasks, while some (35.7%) of the teachers who had a B.Ed. degree without specialisation in D&C used written tasks. Educated D&C teachers gain training and knowledge in D&C didactics in their teacher education. Therefore, they should be able to base their practices on their didactic knowledge. They should also be able to reflect on their own teaching experiences and analyse their successes and failures when attempting to teach. They should, moreover, be able to examine the conceptions and assumptions implicit in their teaching and consciously develop their own theories of education though the analysis, evaluation and reconstruction of their understanding of teaching the subject and what it means to learn D&C (Thorsteinsson and Olafsson, 2015).

Teacher education in D&C is important as, most likely, it supports teachers' understanding and ability to use handicraft as a systematic method for teaching and learning. This also gives teachers the ability to gain a deeper understanding in teaching their subject by connecting handout activities and theoretical knowledge when teaching D&C.

Most (83%) of the participants stated that students were working with individualised projects always or very often, and a small number (11%) stated that students seldom or never were given individual tasks. The importance of individualised learning was underlined in the beginning of D&C education in Iceland (Thorarinsson, 1891) and is still practiced in schools. The initiators of the pedagogy for using craft as a teaching method in public education also recommended this teaching method to enable students' individualised learning. Today, D&C is still used to support individual development, which is the main aim of teaching the subject (Thorsteinsson and Olafsson, 2015).

The D&C possibilities and methods for individualised learning could be supportive in general education, and they could serve as guides for many other subjects taught via general education in Iceland. Karlsson's (2009) research on teaching methods in Iceland concluded that traditional teaching methods are dominant in Icelandic schools. The classrooms are, for example, set up in a traditional manner to teach groups, and that limits students' freedom and independence. Little flexibility is given for individual work, and students work on the same projects. Karlsson (2009) believes that Icelandic teachers have to use various teaching methods to support the ideology concerning individualised learning. Jonsdottir's (2003) research also showed that traditional teaching methods were dominating in the elementary school youth level; however, at the same time, the schools focused on individualised teaching. Nevertheless, just 27% of teachers in theoretical subjects

based their class activities on individualised teaching. At the same time, 50% of teachers in the area of art and craft were focused on individualised teaching. The art and craft teachers encouraged their students to make their own decisions more than teachers of theoretical subjects did. Birgisdóttir's (2004) research found out that teachers, in general, believed they were using traditional methods for teaching classes. However, teachers in art and craft used traditional methods more, and teachers of younger students were more focused on individual differences.

The teachers' background and education were important in the context of students making their design decisions. There was a correlation between a participant's education and whether students were allowed to make their own design choices. Teachers who had a B.Ed. degree stated that students were almost always allowed to make their own designs, but fewer were able to in classes of those who had a vocational training background and a teaching licence. In Thorsteinsson and Olafsson's (2011) research on design decisions in D&C in elementary schools, they found that teachers held the view that children should be given more decision-making opportunities as they progress. However, most of the teachers did not offer any kind of formal instruction on decision-making techniques. According to the nature of the study, it was concluded that the national curriculum for D&C in Iceland includes many opportunities for independent decision-making (Thorsteinsson & Olafsson, 2011).

The participants were asked about their attitude toward students' behaviour. Half of the teachers were in agreement with the statement that students with attitude problems should receive more time in art and craft classes. Most of the teachers also stated that D&C was helpful for students with learning difficulties. This is in accordance with Sigurgeirsson and Kaldalons (2006) research in Reykjavik schools that stressed that art and craft subjects were important for students with discipline problems and that it should be given more space in the schools' timetables.

Answering the research questions

To clarify the outcome of the study the authors attempted to encapsulate the answers to the research questions set out at the beginning of the survey, in the light of the research results and the discussions and conclusions above.

1. *What are the most common methods for teaching D&C?*

The teachers used mostly traditional teaching methods in order to fulfil the aims of the national curriculum. The most common teaching methods were; direct teaching for all students, direct teaching with discussions and group work in classes. Nevertheless, some of them had included outdoor education and ICT in their teaching to meet the demands of the latest national curricula and to support ideation. Lack of time and facilities limited teacher's possibilities to use different teaching methods.

2. *How do D&C teachers utilise the Icelandic National Curriculum?*

Most of the teachers were using the national curriculum when planning the school term. This included mainly, selection of teaching methods, flexibility for individual learning, student's freedom of making design decisions and different undertakings. Consequently, the D&C teaching in

schools is generally based on the national curriculum. 3% of the teachers stated they were not using the school curriculum to prepare for teaching.

3. How *could D&C teachers better meet students' individual needs?*

83% of the teachers based their teaching always or very often on student's individual needs. This is in agreement with the initial pedagogy of the D&C subject and the aims of the present national curricula. However, teachers of younger students were more focused on individual differences. Teachers with a B.Ed. degree gave students more often flexibility to make their own design decisions than teachers with vocational training background. Most of the teachers also stated that D&C was helpful for students with learning difficulties.

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22.2

Influence Of Cognitive Styles On Technical Drawing Students' Achievements In Senior Secondary School In Federal Capital Territory, Abuja

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Abstract

There are different cognitive strategies for processing information which in turn influence students' academic achievement. This paper reports an investigation of cognitive styles and achievement scores of secondary school students. In the study, the standardised Group Embedded Figures Test was used to determine the influence of student's cognitive styles on Technical Drawing students' achievement in Senior Secondary Schools in Federal Capital Territory (FCT), Abuja. A research question and null hypothesis tested at 0.05 level of significance guided the study. The design of the study was a causal comparative or (expost-facto) design. The sample for the study consisted of 87 Senior Secondary School Two (SSSII) Technical Drawing students drawn from the three sampled schools in three Area Councils of FCT. The students were categorized into three groups based on Group embedded figure test (GEFT). The instrument used for data collection was Technical Drawing Achievement test (TDAT). The instrument was face and content validated by three Technical Drawing Lecturers and two experts in Measurement and Evaluation. The reliability coefficient of Basic Electricity Achievement Test (BEAT) was established using Kuder- Richardson formula 20 (K-R20) and this yielded an index of 0.69. Data were analyzed with mean, standard deviation and analysis of variance (ANOVA). Results of the study revealed that cognitive style significantly influenced students' achievements in Technical Drawing. Recommendations made among others were that students' cognitive styles be adopted for effective teaching of Technical Drawing in Secondary Schools.

Keywords

cognitive styles, technical drawing, achievement and group embedded figure test

Introduction

Nigeria is moving through an era of development in gearing towards becoming a developed nation. As part of its effort, education is indeed considered as a vital aspect in achieving the goal. The National Policy on Education clearly states that individual potential development should be

emphasized throughout the learning process. Education in Nigeria is an on-going effort towards developing the potential of individuals in appropriate skills, mental, physical and social abilities and competencies to empower the individual to live and contribute positively to the society. Such an effort is designed to inculcate in Nigerian citizens respect for the worth and dignity of the individual, faith in human's ability to make rational decisions, moral and spiritual principles in inter-personal relations, shared responsibility for the common good of human, promotion of the physical, emotional and development of all children and acquisition of functional skills and competencies for self- reliance (Federal Government of Nigeria, 2013).

Based on this philosophy, individuals' development must be addressed. It also can be clearly seen that the objective of Nigerian National Policy on science, technology and innovation, is to produce students who can initiate, support and strengthen strategic bilateral and multilateral co-operations in scientific, technological and innovation activities across all sectors of the economy (Federal Republic of Nigeria, 2012). Thus, to produce such individuals, students should not only be science and technology literate but be able to think critically and creatively as well.

In this research, focus will be on the difference in cognitive styles among Technical Drawing students. The implication of this is that educators should always be aware of their significant roles to ensure the national aspirations are achieved. Thus, the focus and objectives of teaching and learning should be on the development of the students' potential. Cognitive abilities for instance, have a significant impact on the way teaching and learning processes are conducted. Students with high cognitive ability are assumed to be able to engage in learning, especially in a highly skill tasks. Therefore, their cognitive development should be emphasized in terms of enabling them to do specific tasks, such as problem solving, creative and innovative thinking.

Cognitive style is a psychological construct which is concerned with how an individual learns, thinks, solve problems, remembers and relates to others (Hall, 2000). Cognitive style is an individual characteristic mode of perceiving, and processing information in the environment (Governor, 1998). An individual is either Field-independent (Fl) or Field- dependent (FD) (Witkin, 1977; Hall, 2000). A Field independent (Fl) cognitive style learner is described as analytic, competitive, individualistic, task-oriented, internally referent, intrinsically motivated (self-study), self-structuring, detail oriented and visually perceptive, prefers individual project work and has poor social skills, while a field dependent (FD) cognitive style learner is described as global (holistic), group-oriented sensitive to social interactions and criticisms, externally motivated, externally referential, not visually perceptive, a non-verbal and passive learner who prefers external information and group projects (Hall, 2000).

Cognitive processing styles affect how one stores knowledge and retrieves it, when it is needed (Tinajero and Paramo, 2000). The students' cognitive styles may hinder or facilitate the acquisition of knowledge in science and technology subjects (Okwo and Otuba, 2007). There is a need to investigate how students' cognitive styles may influence achievement in Technical Drawing. This is because the knowledge of student cognitive style is very useful in teaching him or her (Bahar and Hansell, 2000). Students' learning outcome in a subject is associated with their cognitive styles. This helps to measure teacher effectiveness and learning outcome (Kalu, 2004).

The performance of students with different cognitive styles in a given tasks will determine how effective the teacher is in delivering instruction that are related to the tasks and whether the objective of the learning is achieved or not.

Studies have shown that thinking skills are related to the students' cognitive styles and thus, will affect their achievement in learning (Hall, 2000; Okwo and Otuba, 2007). Teachers should therefore identify their students' cognitive styles so as to improvise their teaching technique to match the students' cognitive styles. In the study presented here are of cognitive styles, whether it has a significant impact on the students' learning styles and their thinking ability. It is necessary then to determine whether the students' cognitive processing styles affect their achievement in Technical Drawing. The result will enable the researcher to determine whether the use of students' cognitive styles could improve their achievement in Technical Drawing. Therefore, this study is aimed at investigating the influence of students' cognitive styles on achievement in Technical Drawing in senior secondary schools in Federal Capital Territory, Abuja.

Statement of the Problem

Technical Drawing is a popular science and technology subject offered by both science and technology oriented students in Senior Secondary School Certificate Examination (SSSCE). Students continue to enroll yearly in SSCE Technical drawing, but each year students achieve poorly in the examination. Literature has however revealed that students' underachievement in science and technology subjects such as Technical Drawing is linked to the inability of the students to think properly and also the inability of teachers to assist students to think when faced with problems in technical drawing and solve the problems. The persistent poor performance coupled with poor classroom practices has resulted in few students choosing Technical drawing related courses as career. The yearly poor performance in Technical Drawing has therefore created an educational gap of students not continuing their studies in Technical Drawing at tertiary level. This gap can be filled by devising a more effective strategy for improving the situation in order to meet the needs of the students and the society at large. It is therefore certain that without using an effective remedial strategy, Technical Drawing teaching and learning may continue to be poor in our schools.

In view of this situation, adequate knowledge of students' cognitive styles may be useful in teaching Technical Drawing in order to improve the students' poor performance in the subject. The problem of this study posed as a question therefore is: What influence do students' cognitive styles have on their achievement in Technical Drawing in Senior Secondary Schools in Federal Capital Territory (FCT)?

Methodology

Design of the Study

The study was a causal comparative or (expost facto) design, where the independent variables among subjects cannot be manipulated or controlled. The subjects are studied in the natural settings without any behaviour modifications introduced by the researcher.

Population and Sample of the Study

The population of the study consisted of all Senior Secondary School two (SSSII) Technical Drawing students numbering 148 students in government-owned secondary schools in Gwagwalada, Abaji and Kwali Area Council of FCT (Education Resource Centre, 2015). The sample of the study consisted of 87 Senior Secondary School Two (SSSII) Technical Drawing students drawn from the three sampled schools in Gwagwalada, Abaji and Kwali Area Councils of FCT through simple random sampling technique. One intact Technical Drawing class of SSSII was randomly drawn from each school. The three sampled schools were assessed each with Group Embedded Figure Test (GEFT).

Instrument for Data Collection

The Technical Drawing Achievement Test (TDAT), constructed by the researcher, was the only instrument used for data collection in this study. TDAT is a multiple-choice objective test. Each item has 5 options lettered A — E. The test was based on the units of study in SSSII Technical Drawing curriculum used for the study. The researcher initially constructed 100 multiple-choice items before face validation. The items measured the six objectives in the cognitive domain of Bloom's taxonomy of educational objectives. A table of specification was used in constructing the TDAT objectives items. The weighting for the objective levels were based on the proportion of the low and high order performance objectives in the unit of study. The TDAT, which was constructed by the researcher, was validated by three Technical Drawing Lecturers from Department of Industrial and Technology Education, Federal University of Technology Minna and two Technical Drawing Teachers from Government Secondary School Minna, all in Niger State. The face validation involved checking the items of the instruments for arrangement and logical sequence. Based on the experts' suggestions, a revision was carried out on the instruments. The items that remained after face validation were trial-tested on 20 students in a Senior Secondary School outside the area of the study. The result of the trial-testing was used for item analysis. The item difficulty and discriminations indices, were calculated for each item, consideration for including an item in the final version of TDAT was based on the item satisfying the psychometric qualities of having:

(i) An item difficulty facility level of between 0.30 and 0.70 and

(ii) Any item that the discrimination index falls within +0.30 and +1.0 were selected.

At the end of the analysis, 40 multiple items were selected and other items were dropped because they did not fall within the required range.

The TDAT reliability coefficient was determined with Kuder-Richardson 20 (K — R20) methods. The reliability index was found to be 0.69. The TDAT items being dichotomously scored meant that the K-20 method used was, appropriate. The high scores 0.69 signifies a large degree of coherence in

interpretation and answers by the students. Any correct answer in TDAT was awarded one mark, giving a maximum of 40 marks. The total score of each student was calculated and recorded.

Training Programme of Research Assistant

The researcher briefly trained two research assistants for two hours each day for three days on the concepts of cognitive styles. The research assistants were taught how to make use of Group embedded figure test (GEFT) to classify learners into different categories of learning. The relevance was to assist in meeting the learners' needs during teaching/learning processes. They were also taught the various categorizations using a Group Embedded Figure Test (GEFT) into Field-dependent (FD3), Field Intermediate (FInt) and Field-independent (FI). The need to use a categorization test in teaching/learning situation was emphasized.

Categorization Procedure or Grouping

The group embedded figure test (GEFT) developed by Witkin, Oltman, Raskin & Karp (1971) was adopted and used for categorising students into FD, FInt and FI. The test is used to test the ability of students to find a simple form when it is hidden within a complex pattern. GEFT consists of simple forms of large complex figures (i.e extracting the embedded figure from a field figure). The test instrument consists of three sections within 25 items. The first section was given for practice purposes and included 7 items. Both the second and third sections contained 9 items each. The second and third sections of the GEFT, which are complex figures, contained ten items each for scoring. The simple figures (each identified by a letter) and cannot be viewed at the same time as the complex design. The GEFT has a score range of 0 to 18, a student that scored 0 to 6 was classified as Field-dependent (FD) while 7 to 12 was classified as Field Intermediate (FInt) and 13 to 18 was classified as Field-independent (FI) cognitive style. This took a total of 40 minutes to be solved. The GEFT provides a guideline to categorize learners into different types of cognitive styles. During the administration of the GEFT, the exact procedures set out in the technical manual (Witkin, et al., 1971) regarding time limits and directions were closely followed.

Finally, the TDAT instrument was administered to each of the students in the sampled schools. The scripts from students were marked and recorded using the marking guide. The scores collected were used for data analysis.

Method of Data Analysis

The research question was answered with mean and standard deviation. While Analysis of Variance (ANOVA) was used to test the null hypothesis at 0.05 level of significance, ANOVA was used to determine whether there is any significant different between two or more mean at a selected probability. To determine the direction of the difference for significant mean, post-hoc multiple comparison tests were conducted, using the Scheffe method. This provided a guideline to identify different type of cognitive styles in a classroom.

Results and Discussion

The results of this study are presented in accordance with the research question and hypothesis that guided the study.

Research Question

What is the influence of students' cognitive styles on the mean achievement scores in Technical Drawing?

Table 1: Mean Achievement scores and Standard Deviation of Students' Cognitive Styles in Technical Drawing.

Groups	Students' Cognitive Styles	N	Mean	Standard deviation
COG Style 1	Field Dependent (FD)	22	22.51	6.80
COG Style 2	Field Intermediate (FInt)	29	24.50	5.94
COG Style 3	Field Independent (FI)	36	27.19	6.04
	Total	**87**		

Data on table 1 reveals that field independent (FI) students had the highest mean score of 26.18, followed by students with field intermediate (FInt) cognitive style which has mean achievement score of 24.50. The students with field dependent (FD) cognitive style had the lowest mean achievement scores of 22.51. With this result, students with field independent (FI) cognitive style achieved more in Technical drawing than any other cognitive style. The standard deviation also revealed that the student scores are not far from the mean.

The relative effectiveness of students' cognitive styles influencing mean achievement scores in Technical Drawing could be due to the personality characteristics associated with field-dependent (FD) and field independent (FI) characteristics that are quite different. Cognitive style is an individual characteristic mode of perceiving, organizing information and using the acquired knowledge (Brenner, 1997). Luk (1998), added that cognitive style reflects an individual's preferred way of actively processing, and transforming information, categorizing new knowledge, and integrating it within the memory structure. This result is in line with the finding of Hall (2000) that reported field-independent individuals as self-reliant, unaware of social stimulus value, inner-directed and individualist. They have a greater aptitude for cognitive restructuring and functioning autonomously (Tinajero and Paramo, 1998). The field-independent learners set goals for themselves, relying on intrinsic reinforcement to devise their own strategies for learning (Raynor and Riding 1997). This makes their achievement scores differ significantly to others.

On the other hand, field independent individuals have a greater aptitude for interpersonal skills (Raynor and Riding, 1997). They also have the tendency to relate well with others and are often characterized as warm, affective, and accommodating (Tinajero and Paramo, 1998). However, Hall (2000) observed field-dependent individuals as socially dependent, eager to make a good

impression, conforming and sensitive to the social surroundings. These qualities cause Field-dependent learners to prefer to work in small groups and have stated goals and structured activities. As a result of interaction with peers and teachers, field-dependent learners receive extrinsic reinforcement which influences their learning experiences (Raynor and Riding, 1997). These personality traits may have made their mean achievement scores in Technical Drawing to differ significantly. This result is also in line with Richardson and Turner (2000) findings, that reported differences in the approaches taken by field-independent and field-dependent individuals in selective encoding (which involves sifting out relevant from irrelevant information), selecting compiling (which is the task of compiling new knowledge with the aim to create an integrated whole) and selecting comparing (which takes new knowledge and relates it to the "old knowledge to form a connected whole"). These differences in approaches lead to qualitative and quantitative differences in their preferences for choosing certain cues and ignoring others (Richardson & Turner, 2000).

Besides, field-independent learners have a greater ability to structure information, solve problems and think reflectively on concept cues (Brenner, 1997). They tend to have greater intellectual curiosity as they express desires to investigate new ideas and seek for additional information (Raynor and Riding, 1997). All these qualities may cause their mean achievement scores to differ significantly from others. Field-independent subjects tend to be better at analytic activities. They can solve complex problems, recall information, isolate facts and separate the relevant from the irrelevant (Felder, 1993). They can perceive an item as discrete from its background, and impose structure when it is lacking content, quickly and accurately (Richardson and Turner, 2000; Tinajero and Paramo, 1998). This may be the reason why they performed better than other groups. However, field-dependent learners, tend to be global or wholistic in the analysis of learning situations. They have difficulty in breaking information into isolated parts (Tinajero, and Paramo, 1998; Rayner and Riding, 1997). They cannot perceive or have difficulty in an item as discrete from its background nor can they impose structure when it is lacking in content (Richards, Sullivan and Gillespie, 1997). The field- dependent learners may prefer more direct instruction or definition of the material in situation that involve restructuring abilities (Kahtz and Kling, 1999).

Pithers (2002) reported that field dependent individuals were more strongly influenced by the immediate social context and more inclined to attend to and learn about social aspects of their environments. They seem to be incidental learners in social contexts and have difficulty in initiating a task. (Richardson and Turner, 2000). Incidental learning is unintentional or unplanned learning that results from other activities. It can happen through observation, repetition, social interaction, and problem solving from implicit meanings in classroom or workplace policies or expectations by watching or talking to colleagues or a teacher about tasks (Cahoon 1995; Rogers1997; Leroux and Lafleur 1995) This natural way of learning (Rogers 1997) has characteristics of what is considered most effective in formal learning situations: it is situated, contextual, and social. Initiation is the ability to begin a given task without undue procrastination, in a timely way. A student that has difficulty in using initiation does not easily know how to get started on a task and sustaining the attention and effort levels needed to complete the task. The student often 'just often sits there' when the other students have started working, often the student can complete the task successfully, once they get going. This finding is in agreement with that of Hall, 2000, Richardson and Turner, 2000.

Hypothesis

HO_1: Cognitive styles have no significance influence on the mean achievement scores of students in Technical Drawing.

To test this hypothesis a one-way Analysis of Variance was done.

Table 2: One-way Analysis of Variance (ANOVA) on Mean Achievement Scores of Students' Cognitive Styles in Technical Drawing

Source	Df	Sum of Squares	Mean Squares	F	Sig	Decision
Between Groups	2	1027.8763	513.9383	13.2188	.0000	S
Within Groups	85	10186.3878	38.8793			
Total	**87**	**11214.2642**				

The Data presented in table 2 reveals that the mean achievement scores of students' cognitive styles in Technical Drawing differed significantly from each other. This is shown by the calculated F-value of 13.2188, which is significant at .0000, but is not significant at 0.05 level of probability. Therefore, the null hypothesis of no significant influence of students' cognitive styles on mean achievement scores in Technical Drawing is rejected. This suggests that there is a significant influence of students' cognitive styles on mean achievement scores in Technical Drawing.

To find out the direction of difference a Scheffe post hoc multiple comparison test between two means, at 0.05 level of significance was carried out and presented in table 3.

Table 3: Scheffe Post-hoc multiple Comparison test between two mean scores of Students' Cognitive Styles at 0.05 Level of Significance.

The differences between two means is significant if Mean (1) — Mean (3) > = 2.3745 *RANGE *

Group	Mean	Mean Score comparison	Mean Score difference	Range	Decision
1	22.51	1 and 2	1.99		Not Significantly Different
2*	24.50	1 and 3	4.68	> = 2.3745	Significantly Different
3*	27.19	2 and 3	2.69		Significantly Different

(*) indicates group significant difference at 0.05 level of significance.

The result as shown in table 3 revealed that students' mean achievement scores in each cognitive style group differed significantly from each other. The field-independent (FI) group 3, performed better than field intermediate (FInt) group 2 with a mean score difference of 2.69, and the Field intermediate group 2, performed better than field dependent (FD) group 1 with a mean difference of 4.68 in Technical Drawing achievement test. Therefore, cognitive styles had a significant influence on students' mean achievement scores in Technical Drawing.

The finding that students' mean achievements scores in Technical Drawing were significantly influenced by students' cognitive styles is in agreement with the findings of Bahar and Hansel (2000), that field-independent students could readily sort "signal" (relevant) information from "noise" (incidental) information. Also, those field-independent students have a higher working memory capacity than those who are field-dependent. The result also agrees with Achor, (2001) and Anyigbo (2004) that the three groups of cognitive styles significantly differed in academic achievement in physics.

However, the finding does not support the study of Ahiakwo, (2000) that found no significant difference in the achievement of both field-dependent and field-independent on problem-solving ability in chemistry. The result is in agreement with Okwo and Iliya (2006) that the effect of modes of Pictorial adjusts and cognitive styles were significant with field- independent learners performing better in a Technical Drawing objective test than the field-dependent ones. Thus, the Busari (1998) study conforms with the finding that there is a moderate relationship between the performance of field independent and field-dependent learners in chemistry. As a result of the relationships in the findings of other studies which were used as support to the finding of this study, the finding that cognitive styles significantly influenced students' academic achievement in Technical Drawing is not misleading.

Conclusion

From the results of this study, it is clear that persistent poor students' achievement in Technical Drawing (WAEC, Chief examiner's reports 2015) and other researchers (Gambari, Yusufand & Balogun, 2014; Oviawe, Ezeji, & Uwameiye, 2015) could be attributed to teachers' inability to look at students' cognitive styles in classifying learners' ability. It is hoped that mass adoption of cognitive styles in classifying learners during teaching would bring about the much-desired improvement in achievement in Technical Drawing in Nigeria. It is a known fact that curriculum change is a gradual process which needs the input of experts in order to improve achievement in a given subject. After identifying the cognitive styles of the students, Technical Drawing teachers are encouraged to teach the students using teaching styles that will match their cognitive styles. This will enable students with poor achievement as a result of an inability of teachers to match the teaching styles with cognitive style to do better. As stated by Sternberg (1997), teachers must take into account that they teach according to a specific style. However, they should design their teaching style to takes into account the diversity of learning styles. This must be done to enrich and at the same time favour all the students. As we know, a compatible learning style with the teaching style of a course instructor enables the students to retain the information much longer, apply it more efficiently and effectively and have more positive post-course attitudes toward the subject than their counterparts who experience learning/teaching styles mismatches (Felder, 1993). If students can be enabled to be more aware of themselves and the ways in which they are likely to have better achievement in Technical Drawing, they can be encouraged to develop more effective and more flexible learning styles.

Recommendations

Based on the findings of this study, the following recommendations are made:

1. It is evident that since the adoption of cognitive styles was found to be effective in improving students' achievement in Technical Drawing, teachers should use classroom cognitive styles to facilitate their Technical Drawing teaching.
2. The curriculum of teacher education in the country should include the use of cognitive styles in identifying learners' learning problem in order to popularize their effectiveness in teaching Technical Drawing.
3. In-service training, workshops and symposia should be organized and made compulsory for practicing teachers to embrace the skills of cognitive styles for effective implementation in teaching and learning process.
4. Schools should organize workshops and seminars internally which will enable teachers and students to share ideas on the skills of cognitive styles.

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22.2

Reframing the Status Quo in Design Education: it's Not a Rehearsal

Resnick, E., (2016), *Developing Citizen Designers*. New York/London, Bloomsbury Academic

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Reviewer's note: In this review, any reference appearing as a number alone, for example (227), refers to the page number in Developing Citizen Designers*. All other references are Harvard in-text system with full listing at the end.*

Developing Citizen Designers offers an engaging range of writing and illustrative work, stimulus quotations, discussion and a spectrum of the theoretical and the practical in and for design education in general and graphic design education in particular. Following its Foreword, Introduction, and Introductory essay, it is structured in three parts:

1. *Design Thinking* with sub-sections on Socially responsible design, Design activism, and Design authorship;
2. *Design Methodology* with sub-sections on Collaborative learning, Participatory design, and Service design; and,
3. *Making a Difference* with sub-sections on Getting involved and Resources.

The six sub-sections in Parts One and Two share a common framing each having an opening essay; an interview with a respected designer or design educator; and, a set of up to eight case studies. Part Three's two sub-sections together comprise eight essays; one interview; a rather brief resources list; and a reasonable bibliography. Across the sixty-seven contributions, there is a reasonable smorgasbord of offerings to engage students, educators and designers alike. Equally, the same players would no doubt offer their personal criticisms and will have wanted more of one aspect than another – but what else would we reasonably expect from the field of design? Whilst all the contributions might be considered short (at never more than a few pages each), they all have the potential to open up issues, show practices and, importantly, offer stimulus for critique and debate. Given the book's title, we would surely look for nothing less.

Resnick has done well to assemble this collection although it's a curiosity that the impression is given that she is the book's author rather than the editor of an anthology – not least as she is the author of just two of the sixty-seven entries. That said, the conception and intentions of the book are sound

enough and the title is generally well addressed by the contributors. Given the global reach of the issues that the book engages, we can be disappointed at its geo-political grounding being, as it is, largely populated by US contributors with many others from Europe. While these are still rather early days for us to talk of a global design education/practice phenomenon we do know – as the book eventually shows – that the reach of consequences from dominant Western-minority world design practices is indeed global.

Developing Citizen Designers has a distinctive graphic design positioning but mitigating this there are enough counterpoints and suggestions to remind the reader that alternatives matter. It soon becomes clear that most contributors recognise that graphic design cannot continue its poorest practices of the past in any form. In fact, the book works to show the kinds of new direction on offer to the field and the necessity of it maintaining its critical and holistic perspective. For example, in one of the book's practitioner interviews, Vulpinari, noting the abundance of online sites, agencies, and ready-made graphics templates and packages, says:

> My advice to a student studying graphic design would be to consider changing program if it's strictly designated to "Graphic design"! ...Communication designers need to quickly climb the decisional ladder and get into the strategy-defining circle where they can practice an integrated approach of strategy and creativity, across channels and disciplines. (23)

Whilst this is a reference to interdisciplinarity taking graphic design well beyond of its traditional patch, another increasingly practised school of thought presents itself – that of the inter-disciplinary potential (if not role and duty) of the encompassing field of design in general. Increasingly, leading (critical and post-disciplinary) higher education design centres resist any valorisation of either 'design disciplines' such as graphic design as they might sit under a design umbrella or, equally, they see design practice in its cross-disciplinary stance as engaging all fields of human endeavour. As Boylston notes, designers worldwide who are positioning themselves as global activists are doing so on a forty-year emergence of such fields as design for social impact, design for public interest, design for sustainability, design for social innovation and so on – fields that, he suggests, '…are earnestly redesigning design.' (294).

The book is weakened for the reader who is hoping (as is suggested in several places) to find any solid educational theory or philosophy to underpin the good practices that it espouses. Pedagogy is oft-mentioned but only in near-lay terms and, at best, in well-meaning talk of teaching-as-generally-understood with terms like assessment, aims, and collaborative learning being rather uncritically used. For a welcome theoretical input, social constructivism makes a worthy appearance and does so in both a valid and valuable way for what it is signifies. Elsewhere, as with pedagogy, *literacy* is underplayed when Myra Margolin writes of *Teaching Social Literacy* as '…teach(ing) social design students basic frameworks for "reading" the social world and understanding social issues and social problems.' (276). This, to a critical literacy theorist, would not be enough; residing as it suggests, in only the technical-practical realms of literacy. Nonetheless, she offers a stance echoing critical theory when she advocates transformative interventions through socially aware design practices.

> A transformative intervention has the explicit intent to create a fundamental shift in power dynamics. It reallocates resources or shifts the control that a particular group has over

> significant decisions impacting their lives. One cannot create transformation without shifting power. (277)

The arguments for collaborative approaches in the book are unsurprisingly greater than those connected just with learning. I say 'unsurprisingly' not only because of the book's title and mission but especially because collaboration-as-antithesis-to-competition offers clues to so many designerly strategies that can be adopted to support cooperative ventures, democratic design and design democracy, participatory design Fand participatory democracy and so on. Resisting competition and any 'race to get ahead' resonates with Armstrong's approach in her essay on *Social innovation through participatory design* (190) where she celebrates hierarchy-breaking practices that can come from designer-user collaborations. She points to the process-oriented participatory design initiatives that emerged in 1970s Scandinavia involving workers, unions, academics and political activists and, introducing the Participatory Design section of the book, notes how 'Design becomes not just a single creative act but a continuing dialogue.' (191). Here the parallels of participatory democracy and participatory design become apparent – they similarly resist hierarchy, power imbalance, marginalisation, and monocultural thinking.

It is impossible to do justice here to the forty-two case studies presented in the book. They are all articulate (though some are rather lacking in deep theoretical underpinning) and collectively well-supported by the book's 250-plus colour images. They too, have a guiding structure as a consistency-device. This risks the charge of being formulaic but they are not overly constrained by it. The collection and their groupings can be criticised positively and negatively for what they offer. Some are pedagogically strong, some designerly so. couple really made me want to challenge their inclusion but that's a reviewer's lot and belongs to another forum. As ever, what matters is how those using the book engage with it. An uncritical read will offer little stimulus. However, whether student, design educator or designer, the spectrum offers much. If, as an example of poor practice, a design educator were to simply 'take' a project from the book and apply it to their setting they would probably offer a poor educational experience as well as fail to advance the book's intentions. Taking a different pedagogical tack, there is such a qualitative variety in the case studies that collectively there is not only huge potential for comparative design studies amongst them but, also, they represent excellent source material for sensitive yet difficult ethical debate.

The case study range of topics is wide. A sample of the forty-two includes: designs for democracy and engagement with elections; projects on sexuality, sexual health and wellbeing; homelessness; food production and care including entomophagy (insect eating); school branding; domestic violence on male victims; neighbourhood environmental engagements; substance misuse; dementia support; and, a women's museum.

All of the assignment-based case studies anticipate communication in some form. As Resnick says in her introduction the studies were written by: '…an engaged group of design educators who directly address the notion that design, and design education, can illuminate a pathway to effect positive change within a social agenda.' (13). This brings us to the point that 'communication' takes many guises and that, today more than ever, communications purposes and methods must be closely scrutinised. Writing sixty years ago, Vance Packard presented his book *The Hidden Persuaders* as:

> …an attempt to explore a strange and rather exotic new area of modern life. It is about the way many of us are being influenced and manipulated – far more than we realize – in the patterns of our everyday lives. Large-scale efforts are being made, often with impressive success, to channel our unthinking habits, our purchasing decisions, and our thought processes by the use of insights gleaned from psychiatry and the social sciences. Typically, these efforts take place beneath our level of awareness; so that the appeals which move us are often, in a sense, "hidden". (Packard, 1957/1962:11)

Arguably, little has changed in sixty years. Today, much is seen to up for grabs in the arena of citizenship behaviours with concerns about the levels and quality of information available to voters and consumers, about 'fake news' and about the used and abuses to which the internet and so-called 'social' media are put. Mis- and dis-information go back much further than the post-war consumerist boom yet today, as Canniffe in his foreword to the text notes: 'People have lost faith in governments, and politicians have lost their way. Every day we are reminded that politicians are either incapable or unwilling to meet these global challenges, don't understand the relationship of local to global, and appear to only serve the needs of the few.' (8). Put otherwise, democracy (or ethical politics) is under remarkable strain as it heads towards 2020.

To this end, Ilyin's essay *What design activism is and is not: a primer for students* talks of design activists who '…work for people who do not have access to the design tools, strategic thinking, or knowledge of communication systems they need to advocate for themselves or their causes'. She positions 'design activists as propagandists' and offers the notion of 'activist as sleuth' and cautions that: 'It is impossible to become a design activist without finding yourself in many conversations about ethical choices.' (64-65). Such enlightened approaches do show up in several of the case studies, for example when students are sleuths/researchers and, significantly, when they are having to sensitively and ethically address issues that warrant change.

It could be said that the collection of cases remains grounded in the local but this would be unfair. In that they are invariably locally positioned, the whole point of this kind of educational approach is to contribute to students' capacities to empathise as well as to maintain a critique that is globally oriented. If truly global issues of exploitative capitalism, climate change, perpetual war, and famine and water shortages are to be addressed then studied and principled strategies are needed. Some would say that we can only tinker at the edges of the neo-liberal agenda of coarse capitalism while others would argue for complete re-design on many fronts - not least the political, ethical, social, and psychological. Fry (2011) for example would argue for rethought, re-designed institutionalised notions of such concepts as 'sustainablility' and 'democracy'. As he has said: 'We do not feel our unsustainability beyond occasional touches of guilt as we fill up our car's tank, look at the contents of our supermarket trolley or check-in at the airport… Certainly, few of us feel the tyranny of our human centredness.' (Fry, 2009:247)

For sure, ethical discourses can be difficult and cause much inner reflection but there are plentiful sources of encouragement and inspiration. For example, towards the end of his book, David Berman (also a graphic designer and Ethics Chair for graphic design in Canada) discusses the question: "What can one professional do?" (Berman, 2009:156-7) and he says: 'Together, it is up to us to decide what role our profession will play. Is it going to be about selling sugar water and smoke and mirrors to the

vulnerable child within every one of us… or helping to repair the world?' He urges that designers 'choose well' and 'don't just do good design, do good'. Meanwhile, on the challenges of personal efficacy and how to act ethically in times seemingly dominated by self-interest or corporate greed, the work of Peter Singer is strongly supportive. Amongst his extensive literature, his thesis of the best form of self interest being that of looking after the interests of others is presented in Singer (1995).

Victor Papanek's opening words from his 1971 text *Design for the Real World* are well known to critical design educators:

> There are professions more harmful than industrial design, but only a very few of them. And possibly only one profession is phonier. Advertising design, in persuading people to buy things they don't need, with money they don't have, in order to impress others who don't care, is probably the phoniest field in existence today. (Papanek, 1971/1974:9)

The stance resonates in the contributions of several of this book's authors, and one of the interviewed designers, Jacques Lange, was deeply impressed by it as a student:

> This statement has haunted me throughout my career – I asked myself if I am one of these 'phonies'? My answer has always been the same: "I need to do more to break this cycle." Yes it is my belief that social and ethical responsibilities should be at the center of what designers do. (142)

Heller & Vienne (2003) dedicate their edited collection *Citizen Designer: Perspectives on design responsibility* to Milton Glaser and, in the book's introduction, Steven Heller attributes to Glaser the statement: "Good design is good citizenship". Heller goes on:

> But does this mean making good design is an indispensable obligation to the society and culture in which designers are citizens? Or does in suggest that design has inherent properties that when applied in a responsible manner contribute to a well-being that enhances everyone's life as a citizen? (Heller, 2003:9).

Resnick's makes use of this quotation in her introduction in order to engage with the question 'What is design citizenship?' when she sets out her motives and agenda for the collection. She notes the need to get beyond current design orthodoxies of preoccupations with aesthetics, styles and trends and to act with social and moral responsibility to articulate a necessary change in both design education and in professional design practice.

We are all designers and consumers, citizens and users, creators and (after another of Packard's works) waste-makers. Our species (in fact, the wealthy minority of it) is responsible for a history that has now shown itself to be unsustainable. Does this mean we are committed to perpetuating the same? Most of us would not only hope not and would want actively to work to reverse the situation that corrodes the planet, lives, communities, environments and democracy alike. This would imply activism whether in our daily or professional lives but for many it is also about the notion of changing behaviours. Certainly, graphic design for its part is all of: persuader, communicator, propaganda, and profession. As Victor Margolin says in the book's introductory

essay: 'Promoting behavioral change has…become one of the greatest tasks of the graphic designer' (15).

But is this a strong enough perspective? Arguably not. Critical theoretical stances are key to the necessary change too. For example, authors such as Fry would reject the very notion of 'sustainable design'. Whether as propaganda tool, public health educator or product 'pusher', much graphic design output has to be understood as both messenger and message in relation to whatever content is seeks to advance. Graphic design enjoys a contextual temporality in that it both contemporary to the moment and the issue engaged as well as being temporary in its purposeful existence. Much the same can be said for any design practice although some have better chances of (en)durability than others. Design and designers may claim to be apart-from the message/products/propaganda (or any other creation) they bring into being but they are nonetheless culpable. As Fry says: 'What design brings into being not only influences the nature of the world we human beings inhabit but equally affects what we become as actors within that world as its makers and un-makers' (Fry, 2011:38). Designers' and design educators' roles in the bigger drama are re-envisioned when the likes of Fry see design as key to political action – when design and politics each inform the other in acting on and for the future. In his 2009 text he speaks of the need for '…displacing the 'design community' tendency to reduce design to the process, product and expression of a professional practice...' (Fry, 2009:14) but he also urges that:

> It is also important to grasp that like no other critical moment before, there are going to be unprecedented opportunities in coming decades as the world of human habitation is transformed. This is the opportunity of crisis. However, it is always ambiguous. Loss and breakdown will certainly occur and the new will come at a price, but what is certain is that design transformed will have a central role to play in the creation of any futuring process.' (Fry, 2011:xi)

I have noted that *Developing Citizen Designers* has a distinct Western lean to its content. This is an important concern when today nothing is spared from global interconnectivity nor should be spared from global scrutiny. If designers are to have a personal values framework that is 'responsible' in all the senses espoused in the text and are to situate themselves in some kind of empathetic ethic then global disposition must be a part of their consideration and their being. It is thus a welcome counterpoint in the book when first nations are cited or a report from Africa appears. However, rather than see such observations as a criticism of the book, we can reflect on the extent to which design – at least in the Western, minority-world, consumer-driven context – must carry a huge burden of responsibility (if not guilt) towards the monster that has been created. To pull back from the excesses that do not constitute ethical design is a major challenge for the Academy and for design professions alike. Clearly, Resnick and many of her contributors are onto this challenge but the circumstances of today demand a strong drive from all of us engaged in design education and design practice. It is here that quality Design and Technology education plays its powerful double role – in enhancing the general education of all students which in turn seeks to nurture appropriate values frameworks in those students who would become the new design professionals.

In his essay *Anatomy of the socially responsible designer,* Shea importantly reminds us that: 'Not all designers have a clear understanding of their personal ethics…(h)owever, socially responsible

designers know what values drive them' (20). This draws attention to how we can be victims of our own education if that education (and the social milieu of which it is a part) has been a largely uncritical one. There is no design that is not contestable nor is there any design that is anything more (or less) than a bundle of competing values – whether they be values designed into the design by the designer or values attributed post-design by the user-engager of/with that design.

And we are to be ever-cautioned by Ihde's (2006) Designer Fallacy, namely, to remember that whatever the designer's intentions, it is a fallacy to assume that the final design, once in the public or user's realm, will be used as intended. This is a caution that can temper designer arrogance and nurture a responsible humility in designers. Thus, on a note of designer humility and sensitivity, Jancer and Weinstein call for:

> …a holistic understanding of a situation, (where) citizen designers can facilitate solutions by synthesizing ideas from key stakeholders and celebrating them. The true value of design is not about personal ideas or credit, but rather about empowering the voice of others and sewing together ideas that might never have synergized without the direction and commitment of someone looking at the whole system of complex, delicately interconnected parts. (289)

If the human-designerly dispositions of all people are to harmonise with an emergent class of empathetic design professionals then a consciousness is needed towards all four of our 'realms of co-existence': *other humans*; *other species*; *the planet*; and, *technologies*. (Keirl, 2010). In parallel, the choice-making capacities and power of citizens everywhere need nurturing and educating to maintain the kinds of democratic participation and critique so keenly needed for enabling better futures. However, we should ever-remember that such languaging and configuring does not remain in the dominant Western mould.

To this end, the emergence of design anthropology in some higher education institutions has spawned new understandings, new research opportunities and new critiques of design theory and practice. Not least, this is a field that engages ethically with majority world and aboriginal peoples and brings to the attention of the Western, culturally-limited stance richer perspectives on both self and 'the Other'. Tunstall moves beyond the necessary considerations of professional and social 'responsibility' for the designer alerting her students to the problematics of 'cultural responsibility'. 'Culture demands respect, not responsibility, which sometimes means stopping the design process where it might be considered disrespectful' (278). She presents a strong critique of how dominant (e.g Euro-American) ways of being in the world work to colonise innovation by creating a 'design industry' around notions such as social responsibility. Articulating many potent methods and processes, she draws into her cogent essay Scandinavian cooperative design methodology, respectful dialogue that fully engages all who might contribute to design development, ways of working to 'shift hegemonic values systems', and… '…(the) creation of conditions of compassion among the participants in the project and in harmony with their wider environments.' (279-280).

Buck-Coleman's essay discusses *Assessment considerations for social impact design* (note here that this is not *educational* assessment) and she cautions against unrealistic ideas of fixing major problems and issues via any single design. 'Although it is highly unlikely a design project can single-handedly untangle a complex problem, social impact design can contribute to minimizing and

redirecting negative effects. With this, we need to replace the overstating verbs we have been using, such as "solve" and "eliminate", with more pliable ones, such as "contribute", "support", "minimize", and build".' (285). Such critique has been witnessed over the years in Design and Technology's pedagogical discussions around the qualitative differences amongst framing terms such as 'task', 'challenge', 'brief', and 'problem' when used in the classroom. Such nuances are key to, not apart from, the qualitative change that is sought for *Developing Citizen Designers.*

This collection amounts to neither a revolutionary manifesto nor a recipe for ready-made success. It recognises an enormous task and that, whilst the whole burden cannot be shouldered by designers and design educators, they have a moral and political responsibility to engage with and act on the task. It is honest enough in recognising that incremental local change can work, that its need is urgent, but that there is no guarantee of overnight success. As Buck-Coleman puts it: 'Climate change. Poverty. Water shortages. Drug trafficking. AIDS epidemic. Social injustice. These and other wicked problems were years in the making, and we cannot realistically expect one design problem to "solve" them. However, thoughtful, well-executed design projects can make a difference. We just need data to support it.' (286).

And here the flag of research is hoist. Design academics do their part in maintaining the status quo when they don't act to document the impact of their efforts – whether as designers or as educators. Our field is a poor research performer in the Academy and it cannot grumble about lack of recognition or respect if it cannot demonstrate what it can achieve. For those with interests in both research impact and design impact (is there a difference?) the book also offers clues for research 'capture' opportunities and challenges. Jancer and Weinstein caution us to engage in meaningful ways with all stakeholders in any design project they say, if the designers' ideas perpetuate '…a hierarchy of solution-making and values' then there is an implication (or presumption) that '…people don't know what they want or need for themselves: this is a dangerous attitude to have in making social change.' They go on:

> Operating with such considerations poses a risk of neo-colonialism in practice. Despite seemingly beneficial outcomes, negative impacts at the communities' expense often result as well. Social changefocussed designs that exclude a community's culture, norms, or values essentially serve to erase community and replace it with a "neocolony" of the creator. These negative impacts are why neo-colonialism is a force for change that is fundamentally imposing rather than empowering. (288).

If creeping and pernicious neo-colonialism and neo-liberalism are to be resisted and dissolved then, as Canniffe argues, there is a need for '…a new breed of educator, designer and student. This new breed of designer is a mix of community builder, designer, entrepreneur, and activist.' (8-9). Resnick argues from the outset that:

> As the fabric of our societies and cultures continues to unravel at an accelerated rate, there is both a compelling and crucial need for an unmitigated transformation of design education as we know it – design educators urgently need to revisit our ingrained methods and philosophies in order to review and reconsider how we will actually "steward" our future generations of young design practitioners.' (12).

Design educators in schools may be able to avoid some of the historical pitfalls addressed in this book by learning from it and by reflecting on the embedded practices that have, over the past fifty to sixty years, become the norm of a design profession in need of radical revisioning. This is the unsustainable status quo within the profession that has contributed to the status quo in the world at large. To close, I am grateful to have drawn this essay's title from a line from Steven McCarthy's introduction to the Design Authorship section of the book: '…an education in design should not merely be a dress rehearsal for the status quo.' (110).

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Design and Technology Education: An International Journal

22.2

Technology Education Today – International Perspectives

M.J.de Vries, S.Fletcher, S.Kruse, P. Labbudde, M. Lang, I. Mammes, C. Max, D. Munk, B. Nicholl, J. Strobel & M. Winterbottom (Eds.)

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Technology Education Today – International Perspectives is the first book in a series to be published by a new network, The Centre of Excellence for Technology Education (CETE) which is a collaborative international research association formed by six leading academic research institutions within the field of Technology and Engineering Education.

The book is made up of a series of ten chapters each devoted to providing the current state of International Technology Education (TE) in the selected countries of Australia; Canada; Germany; Luxembourg, the Netherlands, New Zealand, Switzerland, Ukraine, the United Kingdom and the United States of America. The book provides an excellent overview into the different approaches, structures and challenges found when implementing TE in each country at a time when the need for developing technological literacy is recognised by all as important and yet TE is struggling to meet various stakeholders' expectations.

Chapter 1: Technology Education in Germany

Ingelore Mammes, Stefan Fletcher, Martin Lang & Dieter Münk

This chapter discusses in depth the need for TE in Schools within Germany; the necessity for Technological literacy and its relationship with technological socialisation; the need for technology in Primary schools; the institutionalisation of TE on the basis of curricular; teachers professionalism as a barrier for implementing TE; the current position of TE across age phases and within different school types (Comprehensive schools; grammar schools; special schools) including present implementation models and future requirements. The chapter ends by discussing the crucial separation that exists in Germany between general education and vocational education and the challenges that this affords to those designing and providing TE.

Chapter 2: US K-12 Engineering Education History: A keyword, field, and Social Network Analysis of Trends

Johannes Strobel, Mallory D. Lancaster 7 Yi Luo

Chapter 2 concerns a piece of on-going bibliometric research regarding K-12 Engineering Education (EngE) where there are strong associations between science, technology and mathematics. A database of bibliometric records extracted from ISI Web of Science were used as a basis for the project. In the first section Strobel et al. provide a useful detailed description of their methodology in terms of using keywords, as well as field and social network analysis. In the results section the analysis indicated research into K-12 EngE curriculum was most frequently found in High Schools. The field analysis of the top ten subject categories aligned to EngE is discussed; whilst the social network analysis indicated which authors contributed to EngE Research (EngER) and which of them worked collaboratively, and with whom. The final section of the chapter discusses how the research functioned as a means of quantifying and tracking the progress of EngER research in terms of what had already been researched most and what still needed to be researched. Strobel et al. suggest that their research could be used to progress EngE and that the same methodology could be repeated using other databases to provide even more accurate and generalizable results.

Chapter 3: Technology Education in Switzerland

Stefan Kruse & Peter Labudde

In this chapter Kruse & Labudde begin by stating that there is a severe lack of comprehensive, general TE for children at all levels and in all types of schools in Switzerland. They explain that in Switzerland where without primary energy and natural resources the country depends on the technological creativity of its skilled trades-people technicians and engineers. Despite this identified need for TE they describe clearly that there has been a decline in the demand for TE within schools. They explain that neither schools or families empower students sufficiently in the area of TE. They specifically mention that girls are not encouraged to study STEM subjects. After a section describing the Swiss educational system in general and Technology in the New Curriculum 21 in particular, Kruse & Labudde discuss a series of initiatives that have supported TE. They go on to explain that TE in Switzerland has never been seen as a self-contained area of the curriculum, but part of an interactive framework of different disciplines. This discussion leads into a useful section that describes the training of TE teachers and future proposals in terms of setting up a core theme for TE in the hope of closing the recognised gaps in the subject area. The final summary section optimistically looks towards the future of TE in Switzerland.

Chapter 4: Elementary Science and Education within the Luxembourg Educational System

Charles Max

This chapter starts by emphasising the importance of elementary science and technology education in a Luxembourg context. It goes on to discuss how in 1989 along with the introduction of technical and scientific topics in fundamental education the curriculum was supported by materials for teachers, recommendations for equipping schools and learner centred courses in initial and continuous education. Max then explains how the initial enthusiasm for TE stalled, although he

believes that there has recently been a change in attitude induced by the following factors: the rising prominence of higher education and research; the diversification of the country's economy and its impact on the labour market; digitisation and connectivity in all walks of life; and the introduction of sustainable development. Each of these factors are described in detail. This is followed by a discussion concerning educating a very diverse school population and the problems this causes for teaching TE. Further sections follow concerning the relationship between Science and TE in Fundamental and Early Education. TE is then discussed in terms of its place in the four Learning Cycles especially in terms of Competency Standards. TE and Science in Secondary School and Practical activities in Science Education are also described. The effects of gender and the mixed distribution of foreign and Luxembourg students within TE and Science are explained. Finally, Max advocates ways forward in terms of further changes to Science and TE to include a new label for this combined school subject - SciTEC, along with suggestions for its syllabus content and the use of personalised learning approaches.

Chapter 5: Rise, Fall and New Perspective for Technology Education in the Netherlands

Marc J de Vries

In the first section of this chapter de Vries discusses the history of Dutch TE which, as in many other countries, started out as a craft-based subject. He also examines the effect that having a separation between general and vocational education at the age of twelve or thirteen has had upon the development of TE in the Netherlands, with two art and craft subjects taught in both types of school while a third subject, 'General Techniques' is taught only in Vocational Schools. This is followed by a description of the government lead development of 'General Techniques' and the fact that in neither type of education were pupils stimulated to acquire what would later be called 'technological literacy'. The next section details the rise of TE during the 1970s and 1980s and the reasons why the status of the subject was negatively affected towards the end of that period. The continued demise of TE during the 1990s and 2000s is then discussed, followed by a description of recent initiatives that signify 'new hope' for TE. Although as de Vries explains in the final section of the chapter this has not led to a return of the glorious past. He believes that TE can no longer survive as a separate school subject in the Netherlands explaining that the way forward is to seek alliances with science and mathematics. The chapter continues by describing these ways forward, finishing by suggesting that useful educational research investigating the political and policy processes pertinent to TE could result in strategies that could be used to safeguard TEs future survival. De Vries concludes the chapter by suggesting that the societal relevance of technology literacy as one of the prime aims of TE would justify the resources required.

Chapter 6: 'Academic Tasks' in Design and Technology Education: Past, Present and Future

Bill Nicholl & David Spendlove

In this chapter, Nicholl & Spendlove challenge the notion that D&T is characterised as a practical subject bereft of intellectual challenge and associated mainly with 'low ability' students. They draw on their extensive teaching experience and research and offer a view that D&T provides unique opportunities for learning through engagement with challenging activities and associated 'academic tasks'.

The chapter examines 'academic tasks' from a historical perspective, followed by the present location of such tasks within contemporary D&T in the UK. Finally, Nicholl & Spendlove propose that future D&T opportunities will require creative, critical and emotional dimensions to be addressed as essential features of these rich academic tasks. In the section 'Academic Tasks 1990-1990' they provide an insightful historical overview describing the procedural nature of the subject. They use examples from their own 'handicraft' experiences in the 1970's to illustrate this period. This section is followed by a discussion concerning developments during the 1980s leading to the National Curriculum in 1990 and a government initiative in 2004 emphasising designing, creativity and problem solving. Nicholl & Spendlove go on to illustrate the disconnect between policy and practice illustrating this with various examples. They then go on to speculate on possible ways forward for academic tasks in the future which they posit should be orientated around the following dimensions: Creativity; criticality; emotional. The chapter concludes with sections which detail exactly what they envisage in terms of each of these dimensions and why this direction is important for the future of D&T in the UK.

Chapter 7: Technology Education in Ukraine

Zinaida Bakum & Viktoria Tkachuk

This chapter starts by discussing the higher education system in Ukraine and teacher training preparation. With specific reference to Vocational Education, Bakum & Tkachuk discuss the detailed statistics concerning the numbers of students across the sector. They review the complexity of training used to achieve both professional and specialist subject competencies. These are described in detail; as is the detail of what students should learn in their TE provision in order to ensure the development of work culture, technical culture, practical knowledge and skills which they see as central to TE in Ukraine. Bakum & Tkachuk go on to describe the methods, means, and processes used. Whilst also discussing the results of the consequences of the knowledge, application and transformation of natural, artificial, and social environments that they believe are reflected in the study TE in Ukraine and which they deem are not provided by other areas of general education in the Ukraine.

Chapter 8: Technology Education in Australia: A case study of some good news but some serious challenges ahead.

Denise MacGregor & Howard Middleton

MacGregor & Middleton start the chapter by providing a brief historical account of the development of education in general and TE in particular in Australia. It includes a thorough description of the two distinct but related subjects of Design and Technologies and Digital Technologies that together form the Australian National Curriculum for Technologies. This is followed by a comprehensive analysis of the current position in terms of the development and implementation of TE at both primary and secondary level and how the subject is presented through two related strands of 'Knowledge and Understanding' and 'Processes and Production Skills', also how Design and Technolgies is taught through five specified contexts. This is then followed by a section that provides an analysis of where each state is both in terms of its existing curriculum and in the implementation of the National Technologies curriculum. The diversity and discrepancy in level of uptake of the new curriculum in each of the states is clearly defined. A fourth section of the chapter discusses the new directions for TE in terms of the vocational education agenda and the political pressure for teachers of Technology, Science and Mathematics to keep up-to-date with the STEM agenda. A warning is provided for D&T educators to make them aware that by adopting an integrated approach that the focus of D&T should not be lost but rather emphasised and enriched. This is followed by an overview of teacher education programmes to be found in Australian Universities, and a discussion of the current and future supporting role of the professional associations. The final section is devoted to examining the developing research culture that exists with concluding comments that draw together the themes that MacGregor & Middleton provide as pointers for future developments.

Chapter 9: Technology Education in Canada: An update

Ann Marie Hill

This chapter starts by providing an overview of Education in Canada. Because of the diverse nature of subject content in each province and territory these are separately described in great detail; providing the reader with an understanding of the differences reflected in geography, names given to TE, educators visions, their curriculum and implementation strategies. The detail indicates that some areas of Canada provide a mainly vocational pathway and others a more academic pathway but that all set out to address local needs. Hill explains that even though school technology meets these local needs there is a common pedagogical approach across Canada in terms of learning by doing, 'the joining of head and hand', that engages and motivates students and is as Hill suggests, an approach that because of its success is being adopted in other areas of the curriculum across many parts of Canada.

Chapter 10: Technology Education in New Zealand: Embedding a New Curriculum

Alister Jones & Cathy Buntting

This chapter shares some of the story of how what Jones & Buntting describe as ‘a small nation' has moved from technical education to a broader view of technological literacy and the provision of TE for all. The chapter discusses in detail the development of the New Zealand National Curriculum; the Introduction of TE as a Core Learning Area with the key driver being the role that technology is believed to play in New Zealand’s economic growth and social development. The revision of the curriculum in 2003 which led to a change of emphasis within TE is discussed in detail, as is the current position of the subject. This leads to a summary and some closing thoughts about future developments and the need for further investment if all students are to reach their potential in this important aspect of a pupil’s education.

Reviewer’s Conclusion:

As explained at the start of this review this book provides an excellent overview into the different approaches, structures and challenges found when implementing TE in Australia; Canada; Germany; Luxembourg, the Netherlands, New Zealand, Switzerland, Ukraine, the United Kingdom and the United States of America, at a time when the need for developing technological literacy is recognised by all as important and yet TE appears to be struggling to meet stakeholders’ expectations in each of these countries. These challenges and struggles are not confined to the ten countries portrayed in each chapter and I therefore believe that this book will provide food for thought for researchers, educationalists and government officials far beyond the nations represented in Technology Education Today – International Perspectives by providing pointers for the future development of a subject area that the world cannot afford to allow to decline.