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DEXTERITY IN RESEARCH AND WRITING: INTERPRETING DESIGN STUDIO AS A RESEARCH SPACE

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ABSTRACT

Designers are often blamed for producing socially irresponsible products. Their inability to formulate a decision-making process that involves end-users was observed as *a* reason. Design studio teaching urges students to fine-tune a thinking process but students are not convinced if their thinking is duly weighed in grading or recognized by prospective employers. They incline to follow popular trends or their studio tutors rather than fine-tuning a rational thinking process that will generate a unique solution for the task in hand. They practice assembling solutions and excelling presentation techniques in the design studio. By devising twelve design studios where design was interpreted as research to inculcate design thinking, we exposed students to research methods that can integrate end-users in their design solutions. They showed signs of acquiring knowledge in investigation and analysis of in-depth data required for creating end-user empathetic design solutions. After learning academic writing, students started becoming less descriptive, less precedent-dependent, or less tutor-dependent. We found that they preferred qualitative research methods over quantitative methods in developing a design process.

Keywords: Design studio pedagogy, end user, knowledge construction, qualitative research methods.

INTRODUCTION

Research dexterity is critical in any academic setup to rationally frame knowledge construction required for a task in hand. In other words, ability to research makes an academic not only to be realistic, ethical, but also be equipped with tools to self-assess their decision-making process. As such, research dexterity guides them to avoid random decision making. Design pedagogy seldom demand students to develop a substantial investigation method to collect and rationally analyze in-depth data. Design students conduct precedent studies, observe, survey and interview potential users as well as conduct contextual analysis to collect tangible data such as climatic, traffic, etc. when a design assignment is introduced. They often limit these attempts to the preliminary stages of their assignment and hardly document intangible data such as cultural values, concepts, etc. More crucially, students are not guided to use collected data in their design decision-making. They often use collected data to defend a design solution that may have been shaped after a popular trend, style, ism, or a reputed designer. This has resulted in making socially irresponsible design products that fail to satisfy the needs of end-users in a particular context. The lack of orientation to improve strengthen students' rational thinking result in stereotyped solutions too.

Students produce new knowledge while engaging in their studio projects, but their reticence to develop the craft of writing makes this knowledge redundant. They leave a little proof about the appropriateness or reusability of these approaches. This rupture is mostly caused by the misconception that research and writing are not useful in creative industries such as design. This misconception may have emerged from the misunderstanding of what research is as well as what design is. If design is conceived as a creative solution to an existing problem, we can argue that

research is the way to investigate that problem in-depth (Munasinghe 2007). Design studio, being the most tested tool to teach design or to guide students to develop a design process, is the most fitting site to break this gridlock and improve students' research dexterity. If studio projects are reinterpreted as research tasks, design teachers can guide students towards rational decision making, and to make their products more empathetic to end-users (Dermikan and Hasirci 2009). Once their ability to investigate and examine data is strengthened, they may venture into finding more design-conducive methods to fine-tune a design process rather than trying to construct an argument to convince their tutors, examiners, clients or end-users. Research dexterity will help students understand the cyclic nature of design process better, collection and analysis of relevant data throughout the design process, and the significance of learning a design process over an end solution.

Designers argue that their products communicate with end-users, who are not interested in knowing the process of its conception or production and claim that their clients do not pay for research but for end-products (Munasinghe 2008). Students know that their prospective employers test their communication skills and not research abilities. They fail to recognize the significance of research dexterity as an essential skill to develop as a designer, and their design thinking hardly improves. Design studio should not focus on end-products but on teaching a thinking process to sustain its creativity and empathy to end-users (Munasinghe 2020; Crowther 2013). Another reason for students' random decision making is the lack of orientation to compile their decision-making process. Design students as well as practicing designers hardly document their investigation process, method of analysis, or the validity of discovered data. Developing the craft of writing could help them to self-assess their decision-making and design products. Therefore, research dexterity should be entailed by academic writing to explain how designers could integrate end-users and their expectations. Research dexterity and academic writing may make a designer better accomplished and their designs empathetic. Students may be explained that these skills are required to improve their design thinking.

Our proposition is if research dexterity is inculcated, students will be in a better position to frame a rational design process. If they learn a research-based design thinking process, students can adopt it as per the circumstances. At the same time, if the laborious work in fine-tuning a product is documented along with the methods used to investigate and analyze, designers do not need to reinvent the wheel for each assignment but further their thinking process. Research dexterity supported with academic writing will assist students not only to scientifically collect and analyze data but also to inform what is being focused on, why it is focused, how it is investigated, the results and the scope and limitations of an investigation. This, making a designer a better human being (Pallasmaa 2019), would help them to integrate end-users in the decision-making process. We also intend to propose that academic writing will make designers more responsible for their products.

This paper presents the results of integrating research in twelve design studios that exposed students to qualitative research methods and to the writing format IMRaD (Introduction, Method, Results, and Discussion). We involved urban design students to design an urban space, architecture students to design a modest public building, interior design students to design a public interior space, and product design students to design furniture in an interior of a public building. They worked in teams, sometimes within their field and sometimes crossing boundaries. Observation and interviews of students and studio tutors were used to collect data. A few employers who usually train students during their practicums were also interviewed. Having provided clues to improve pedagogical practices in studio teaching and assessing, we asked studio critics to assess how their design thinking became more intelligent, focused, and intensive especially when they had to present their thinking in writing (Cikis and Ek 2010). Research ability was emphasized as a requirement to learn systematic investigation as well as critical and creative thinking. In studios, students were coached to systematically collect and analyze data, to rationally construct results, and to coherently present their decision with a self-assessment. They understood the need to check the validity of their methods and findings and how writing directed them to deconstruct the entire thinking process. We also documented their engagement in studio learning to assess the consequences of research dexterity and academic writing.

Our paper also aims at introducing research methods and writing to design students so that they can acquire research and writing dexterity.

RESEARCH DEXTERITY IN DESIGN STUDIO

Research entails an in-depth investigation to create new knowledge based on empirical evidence. It is a way of discovery, a way of developing analytical skills and inquiry-based skills, a way of developing thoughtfulness, and a way of making rational judgements. (Adams et.al 2007). Research dexterity in design means ability to practice in-depth

investigation and rational decision-making. Designers should produce socially acceptable solutions rather than demanding the society to change its lifestyles to use what was produced. Hence, it is imperative for schools to teach strategies and methods of empirical research that examine the requirements of a society. Design schools included in our study teach research methods to formulate study plans with defined problems, aims, and methods within inherent scopes and limitations, thus enabling students to evaluate various artefacts. Yet over 50% of their studios do not persuade students to apply such methods in their design studios. There, students' data collection is limited to the preliminary stages of the design process. Teaching to develop a competent research plan in design studio could guide students to fine-tune a rational design thinking process thus avoiding stereotype design products.

A research plan contains a means of planning, executing, monitoring a task, and comprehending results (Lukenchuk and Kolich 2013). A plan, creating the most relevant knowledge in a focused phenomenon, could help formulating a substantial design approach. In our experimental studios, students were first guided to compile data through literature surveys and precedent studies and then to make initial observations to assess the validity of research strategies in terms of their coherent nature, aptness to the task in hand, feasibility, and contextual and ethical limitations. The collected secondary data helped determining the valid primary data to fine-tune a preliminary design concept by testing their initial observations. They were urged to continuously test their concepts and initial solutions with potential end-users thus emphasizing the importance of a cyclic design process. Their research focus changed depending on the task in hand. Our studios exposed students to ethnographic analysis, grounded theory, and phenomenological analysis to assess social contexts through targeted lectures and facilitated them to apply those in several design exercises. They used observation and in-depth-interviews to collect data, complemented with surveys, questionnaires, experiments, and simulations. Our initial discussions with students revealed that they prefer qualitative research methods.

Ethnographic analysis (EA) describes social groups, cultural systems, and sub-cultures (Whitehead 2005). Designers can use EA to assess the needs of end-users. *Holistic school* of ethnography stresses empathy to a focus group, if researchers avoid preconceptions that may limit their capacity to the extent of restricting the insight of that group. *Semiotic school* helps one to develop skills to read signs, symbols, and their signification. Students used this to get insights into the communication between a designed product and end-users. This inductive method does not start with a hypothesis but producing one as a study progress. It is important to be open-minded to understand social groups from the perspective of their members. Students were exposed to the *Critical school* to study beyond symbolic forms to explore the power structures of subordination that lie beneath them. Students used interviews and observations to collect data, and to document them in field notes to find how decisive intermingling with potential end-users is in fine-tuning their design products.

Grounded Theory (GT) is a bottom-up strategy that strives to develop theories by analysing empirical data (Glaser and Straus 1967). GT does not start with a hypothesis but generates an analytical model with data collected from a site, and as such fits a scenario that has no existing theory to analyze a phenomenon. GT insists that empirical data is the point of departure, and theoretical tools that may emerge through analysis could be grounded with collected data. Researchers must not ignore existing theories but should not allow their thinking to be entrapped in those. Students have been using similar strategies to conduct initial context studies but required guidance to focus on more intangible data of socio-cultural contexts and then to integrate them throughout the design process. GT could help students to be exploratory if they do not have established theories or approaches to frame decision-making. The scope of design projects and time constraints limited students' involvement to stop at reading a context.

Students were trained to collect data without preconceptions through studies of intricate relationships within phenomena. They, converting collected data to concept formulation, developed fresh insights into those relationships. The nature of GT to generate samples gradually during the process of a study was useful for students as they start their projects by collecting and analysing data on users, events, programs, contexts, etc., and then developing alternative concepts. In our studios, students developed their research abilities to view beyond representative objects to further illuminate or extend concepts and categories that had been constructed in previous studies. They selected objects and compared them to others already analysed, thereby further shaping a partial theory that they had refined. The sampling was informed by the analysis of empirical data, and sampling, data collection and analysis proceeded iteratively. GT dexterity helped them to understand end-users better.

Studio projects guided students to collect data, adding objects to provide new insights to user groups, and to examine them

in their own contexts to find the formation of groups and structures. In using GT, this continues until the sampling reached the point of *theoretical* saturation, when additional data did not extend but only confirmed what had been established. After collecting data, students categorized them through coding: for example, interviews of end-users about their experiences of a prototype were coded to categorize them. They shaped their products using known perceptions, attitudes, emotions, and other factors expressed in data. The portions of codes produced excerpts, and one or more codes were assigned to each excerpt. This *open coding* describes empirical data by slicing it up and labelling the pieces. Students then categorized codes and related them to others through *axial coding*. Finally, they selected the most central codes and suggested categories under which the codes could be grouped to produce *selective coding,* to focus on main ideas to identify relations between them. Based on the results from three levels of coding types, students noted the core concepts of inter-relationships in the domain they studied, especially the social implications of design. They modelled a theoretical framework to explain phenomena in the domain. Students were advised not to acquire knowledge on a domain before starting a study to avoid preconceptions that could prejudice their work thus impeding their work to identify valuable knowledge.

Phenomenological analysis (PA), as a strategy, focuses on the perceptions and experiences of people and their feelings. Students were familiar with the concept of phenomenology as a way of depicting an experience of a place (Heidegger 1967) and have been using the concept of *genius loci* that evolved with PA (Norberg-Schulz 1979). The key notion in PA is how one senses a space, pre-reflectively without objectifying, classifying, abstracting, and sensing. These may not essentially be tangible, and therefore PA has been criticized for the lack of scientific rigour and as descriptive rather than analytical. This quality can be considered as a strength in PA too.

Students used PA to reveal links between people and places, or how they continuously are involved in place-making. PA dexterity could help them to note that social structures are not given from above and neither are the people robots that follow such given scripts. Social structures continuously evolve as members collectively give meanings to their lived experiences. Students know that they could not exert a design from the above but to facilitate one that fits evolving social structures. They used unstructured interviews, in which respondents could tell their own story without being unduly influenced by the researcher, were used to collect primary form of data. The respondents brought up new topics that were important to them, but were not foreseen by students, who regularly checked if the respondents were understood correctly. In addition, students observed the behaviour of groups by participating in their context to expose more information. It was vital to observe their behaviour during interviews to understand possible attitude changes of behaviour and reasons for them. The improved dexterity in PA made them feel confident in their work.

Qualitative research methods in design studio

Students were exposed to research methods such as interviews, focus groups, observation, case studies, surveys, experiments, action research, and simulations to collect and analyze data.

In-Depth interviews*,* as a qualitative research technique, are effective in collecting complex and sensitive data in different contexts. In the studio, students practiced how to communicate with their interviewees while controlling an agenda. They enjoyed *feeling like sociologists* and gaining confidence in knowing what an end-user would expect. The strength of interviews to elicit emotions, attitudes, experiences, opinions, or privileged information depends on questions and how the questions are presented to respondents. Students learned *structured interviews*, framed with a fixed question to follow a predefined protocol to address predetermined responses; *semi-structured interviews*, based on questions to promote a flexible discussion; and *unstructured interview*, in which the interviewer is as inconspicuous as possible thus letting respondents talk freely. Students did not favour the third option as the absence of specific questions resulted in irrelevant information and they had a limited timeframe. *Structured interviews* have the advantage of being carried out faster as there is no requirement to interpret answers (Zadkowska, et.al. 2022) this did not reveal some data. Students preferred *semi-structured interviews* to investigate complex issues as respondents expressed their ideas and feelings with less restrictions. They practiced using them to conduct *in-depth interviews* in their studios and schools to gain experience. They became confident to identify a credible respondent and to conduct interviews for an extended period whenever they found such a respondent.

Students noted how the venue, interview schedule and how a respondent perceives an interviewer impacted the responses when sensitive issues were discussed. The students practiced mixing closed and open questions to prompt, probe, or check; prompting to nudge the respondent to speak up, probing to find details, and to check if the respondents were

accurately understood to overcome this. They recorded responses with respondents' permission, transcribed them later as a group to interpret them. Conducting interviews at various stages during a design project resulted in continuous collecting and analysing data in-depth. Students shared their interpretation with other cohorts to crosscheck if there were any biases of interviewers or respondents to ensure the reliability of data.

Focus Groups (FG) is an interview type in which a group of respondents participate in a discussion. FG helps to understand and interpret a topic from the perspective of participants as a member of a group. Some participants were inspirational in pursuing a topic in greater depth when they were comfortable in the group. Students noted how participants encouraged each other to discuss freely and fruitfully, sometimes dominating the discussion too. They learned to play two roles as an interviewer: first as a moderator and then as a note-taker. The moderator inspires the participants to contribute actively to the dialog while guarding the group's focus, and the note-taker writes field notes of the discussion with activities or movements that were not captured by audio/ video recording. Some groups placed a cohort in their FGs to ensure the focus of the interview and later to crosscheck interpretations, but some were unable to do so as their products were meant for a group that knew each other.

Strengthening skills in FG allowed students to study a conversation and thought pattern of people in a more natural way than in one-to-one interviews. Students noted FG as a better fit for studio projects for being cost-effective and less time consuming with many participating in one session. They noted that FG could be observer dependent and subjective as some participants swayed the others during sessions and drove the discussion in a direction they favour thus glossing over other's views. Knowing the drawbacks, students found to be objective in using FG throughout their design process. Their ability to discuss design projects with the potential end-users significantly improved.

Observation or collecting data through observing a phenomenon can be done at the initial stage of a study and then later to confirm what was observed earlier (Dean 2019). Qualitative researchers use *systematic observation* and *participatory observation*: former to collect reliable data and the latter to reveal intricate relationships in a phenomenon by becoming an active participant. The most significant advantage of participation is that the researcher observes what people may do rather than what they may say by being in immediate contact with them. Students did not passively record observations like a camera, but inevitably interpreted them thus sometimes resulting in various discrepancies. The damage control was done by asking a few of them to observe the same phenomenon to share their thoughts. Systematic observation can be objective if it uses *observation schedules* to structure an observation. A schedule structures data collection, thereby making them more legible and useable, and helped students to focus on what is being observed thus saving time. Students developed schedules using the priorities in their design tasks.

Students used participatory observation to build a deeper familiarity with a context and observe it within its natural settings. By producing context-sensitive results, dexterity in observation helped them studying a phenomenon without the restrictions of schedules or other protocols that could limit the scope of an observation. This technique is vastly dependent on the ability and experience of the researcher. The strength of a researcher remaining covert is preserving the naturalness of the setting (Barley and Kunda 2001). The researcher should not become a spy to deceive the focus group. Urban design students inserted their cohorts in groups that were invited to participate in design charades and respondent meetings to understand how their products would be received by the assembled group. This exercise was successful as groups expressed their ideas freely, and students could self-assess their designs constructively. As a result, their designs became empathetic and creative.

Case Study focuses on one instance of a phenomenon that is being investigated. Its strength is offering an in-depth insight of that instance. Students had been using case studies to justify their design solutions rather than as way of investigation, sometimes even manipulating case studies to convince their critiques. A case study could reveal multiple factors, events, and relationships that occur in a real-world situation by focusing on one instance in a natural setting. It must be stressed that the instance had existed before, and the researcher should study it within its own context to understand the inherent processes of that instance. The researcher should determine the required type of a case study: *exploratory, descriptive,* or *explanatory* to refine research questions and/or to test hypotheses. Students practiced several case studies to deduct results.

Questionnaires are inexpensive and appropriate for gathering simplified and standardised data. Students were familiar with questionnaires and knew how to formulate questions to collect straightforward data that is brief and unambiguous. They found age, gender, cultural roots, incomes of various

groups, etc. by using questionnaires. Yet, their questionnaires were found to be incomplete for lacking background information about researchers, their affiliations, or detailed instructions to respond. They were exposed to samples of open and closed questions: a closed question with researcher determined set of permissible answers in advance, and respondents can answer yes or no, whereas an open question is one without predefined answers. Open questions allow the respondents to present their own views. Closed questions bring answers quickly and can be analyzed with statistical methods. They do not allow for nuances in the answers as the respondent only can answer by choosing from predefined alternatives. Open questions allow for more elaborate and creative answers, but answering and analysing those answers are time-consuming. A questionnaire that includes both, closed questions for collecting basic data and open questions for gathering subtle and complex data, was more fruitful. Both types were incorporated in the design process. Closed questions carry the risk of getting researcher biased responses as the available answer-options are predetermined. It was difficult to predict an acceptable response rate, as some respondents ignored to complete questionnaires.

Students were coached to carefully formulate questions to be brief, relevant, specific, unambiguous, and objective (Peterson 2000). Pilot studies were conducted at studios before distributing the real questionnaires, using a small number of test subjects to represent the actual respondents to determine if the given instructions were adequate, questions were clear and unambiguous, predefined answers were exhaustive, and if the questionnaire could be completed in a reasonable amount of time. Students used the internet to administer questionnaires, using web-based tools to design, distribute, and analyse them.

Experiments as a research strategy can investigate cause and effect relationships. Students were first reluctant to this type as it reminded them of laboratory experiments. They said that their designs cannot be tested in labs. It was demonstrated how experiments could establish a relationship between a factor and outcomes to formulate a hypothesis by using the notions of dependent and/or independent variables. They compared hypothesis to initial images and found how an independent variable corresponded to a cause and a dependent variable corresponded to the outcome after practicing them in the studio. An independent variable may affect more than one dependent variable in some cases, or the independent variable has a causal effect on the dependent variable, so the latter is dependent upon the former. Students tested more than one variable in developing a design project thus reiterating the fact that design thinking is a cyclic process. They noted how this method could be used to introduce, remove, or change the value of an independent variable, but experiments cannot prove if a hypothetical product would be acceptable in a social context though they can manage links with intended user groups.

Students were requested to conduct experiments that start from a naturally occurring situation and a hypothetical solution for the identified problem: for example, urban design students designed an in-fill in an urban setting and used virtual reality to test if there was a cause-and-effect relationship in terms of aesthetics. Experimental method necessarily involves a social group, and hence can be useful in assessing the social implications of design (Pattern 2017). The advantage of external validity of field experiments such as their potentials of generalizing results was stressed in our studios. Students found their relevance in the final stages to fine-tune a design hypothesis.

Surveying sampling is a method that maps a context, and thus has a broader coverage and provides an overall view of an area of interest (Denscombe 2014). It is useful in collecting primary data such as examining group activities, beliefs, attitudes, etc. at the initial stages of a study. Its success depends on how best a researcher collects data on a narrow and well-defined topic. Surveys are less suitable for studying complex phenomena in-depth. Students used survey to find out the responses on a design product but could not establish the reasons for those responses. They conducted surveys by telephone, internet, email, and social media. The selected strategies restricted the social group. Students, who conducted face-to-face surveys, found that some respondents did not always reveal required data as they got distracted. An *observational survey* was introduced as a more complex means to view people as participants. Students were requested to assess the interaction of social groups and design products in different contexts. They underlined *literature surveys* as a sound step to initiate their studio projects, leading towards formulating an observational survey, and noted identifying samples and determining the number of samples to see if findings can be applied to a larger group. Using both *representative samples* and *exploratory samples;* first to reflect a mirror image of the population and second not to represent its population but to gather information to explore a new area, students found the second option as more conducive. They confessed to using that strategy to determine the appropriateness of their designs in a social setting.

Action Research (AR) was introduced to students to address practical problems appear in real-world settings. It strives not only to generate new scientific knowledge but also to solve problems that people face in their practices. This, focussing on a practice and its possible changes, could stimulate active participation of practitioners. AR allows one to reflect on research completed, especially the results for a local practice in addition to generating new knowledge to decide whether to carry out a new action research cycle. Doing research is intertwined with making changes in action research and this can happen simultaneously. Practitioners may even initiate and sponsor action research as their knowledge and actions are essential resources for a design. This strategy can make distinctions between technical, practical, and emancipatory studies: technical aiming at functional improvements; practical to improve practitioners' know-how of themselves and their work; and emancipatory while including the purposes of technical and practical strategies also aims to help people to critically evaluate and reflect upon their practice within its social and organisational context. Students found its strength in self-education, self-reflection, and self-assessment as conducive to their learning. They identified *emancipatory action research* as a more complete option for their tasks. They realized the challenge of using AR to generalise their results, which were found to be closely tied to one or a few local practices. Students discussed the disparities, which resulted because both the participants and researchers failed to remain impartial. Our aim to practice this method with prospective employers did not bring sufficient results due to their time constraints. Yet, students confessed to developing their ability to conduct AR profitably.

Students used virtual reality to practice *Simulation* as a research method within their school premises. Since simulations can study an imitation of a real situation or imitation of the behaviour of a real-world process or system, they invited potentials users of their products while some used cohorts from other programs. Simulations are used to train professionals when the real-world process can be expensive or hazardous. In our case, it was used for analysing and making predictions by reproducing situations to assess the behaviour of people. As the sophistication of computers increases, more complex simulations can be carried out remotely. Students preferred virtual reality as a practical means to run their studies and uploaded their simulations in the forms of games to attract a wider response. They documented the methods rather than the results for future uses.

Academic writing in design studio

Greek philosophers noted three stages in composition: invention, disposition, and style, or in other words, prewriting, drafting, and revising. Design process that students learn in studio contains these three steps. They are given studio projects to find solutions to a defined problem as a way of learning a design process (Hettithanthri, Hanse and Munasinghe 2022). Each exercise has a problem that deserves in-depth research into its purpose and context (Dizdar 2015). It is therefore a research assignment that is required to be methodically conducted, with a defined problem. Designing a chair for a waiting lobby of a theater requires exploring who would use it, under what circumstances, what time and for how long. Obviously, the expected comfort from this chair is different from one at the waiting lobby of a hospital or an office. Students develop their ability to find the most significant aspects of a product and end-users' thinking to employ the most corresponding method to reveal the focused aspect of a design problem, so that their solution would be empathetic and unique. Designer could use methods to test the conjectured solutions by engaging the intended users to complete a more rationalized solution. This journey to find a design solution has countless obstacles or cul-de-sacs. Documentation helps students to avoid and overcome such obstacles in the future. Design schools require students to compile design reports to demonstrate their design thinking, but students feel that their examiners or employers hardly read those reports. Some schools adopt fixed formats for design reports thus making students' input more like filling the blanks. Those reports hardly include research methods or results but technical data. They do not include data, claim, and warrant, the three items of an argument in their design process (Toulmin 1958). Their training has been to swiftly move towards a design concept and then to collect information to fine-tune that concept.

Academic writing is non-technical writing intended for a wider audience. Writing in the studio should not be limited to designers since others may also be interested in reading. The key characteristic of scientific writing, which is a two-way communication, is clarity. It should be noted that research is not complete until the results have been discussed and communicated to an intended audience. The audience should be able to perceive the validity of what is written. Studio projects are not scientific experiments that need to be communicated to a larger audience. The knowledge a designer produces by engaging in the design process should not be devalued and wasted. Design solutions may address

end-users, but they hardly communicate the obscured constructed knowledge to an audience beyond those users.

Communication through writing has been occurring for centuries. The first journals may have been published over 100 years ago, and the widely practiced IMRaD format used for scientific writing has been adjusted for decades (Day 1994). Scientists of the past used to write and publish more descriptively than analytically before this format got their attention. Among the disadvantages of descriptive writing was the difficulty of assessing what had been used as methods were not explicitly discussed. Today, most journals and academic institutions use IMRaD like formats. Students can adopt this as soon as they start their design process, or the collection of data. Their defining a design problem in relation to the potential user or the program to be facilitated in the design or the context in which the design would be used, could be included in the introduction. They could scrutinize several methods to investigate and collect data before selecting the most appropriate method of study. Also, documenting the reasons for this selection could be extremely useful, so that they could self-assess their design process. The result in their study could be a sketch diagram or a mock-up that would be further tested using other methods. Studio teaching includes interim critiques as continuous assessments to test the progress of students. Those critiques could assess their writing too. Finally, students could compile a discussion based on their constructed knowledge when they intend to communicate through writing. Design studios urge students to conduct precedent studies on products, contexts, and literature reviews as the point of departure. Our studios guided students to document those stages to observe the change of their attitudes to design studio learning.

RESEARCH FINDINGS

Improved student engagement and their enthusiasm to learn an empathetic design thinking approach was the most significant finding by studio teachers. We also noted students collaborating with other students crossing the boundaries of their studios, especially when they were part of the same school. Studio critics noted that research dexterity made students consider themselves as socially responsible professionals. Their opportunity to work with real-world helped them understand the needs of end-users and how to integrate those needs. At the same time, they became more analytical and keener on producing a rationally constructed product over one that is stylistic or esthetically pleasing. Research dexterity strengthened their knowledge base and as such made them more accomplished in producing unique design solutions. It was important to note that more than 80% of students preferred observation and interviews to collect data while over 50% were involved in participatory observation and conducting in-depth interviews. More notably, students used their investigation at different stages of a design task thus continuously involving end-users. Writing dexterity reinforced their design thinking further as their self-assessment became stronger and they did not want to make any vague statements.

Urban design students noted Ethnographic analysis as a germane strategy to study the value system of end-users as it provides with opportunities to working closely with them. They, becoming aware of the challenge of being objective in observing a culture, practiced strategies to respond to those who may perceive a researcher in such a way that prevents from disclosing information. Students shaped ways of perceiving or interpreting information without being tainted by their own values. In studios, they were asked to write about their backgrounds, gender, beliefs, and values, and then to look at others' independent of their own. Students engaged in those exercises to develop their ability to be open-minded in studying end-users, and preferred the critical school for strengthening design approach by evolving a critical attitude to reveal unstated assumptions that are taken for granted in a culture (Van de Lindern et.al. 2016). Design studio teachers and critics noted a clear indication of involving empathy in students' design thinking due to EA dexterity. Students, having noted the extensive time required for EA, made attempts to develop their own techniques by sharing data or using ICT tools to save time. Most notably, urban design students found more in-depth data by using simulations in small samples.

The increasing collaboration among different student groups was a positive sign of research dexterity. Interior design and product design students using Grounded Theory (GT) for small-scale projects and dealing with end-users more closely, used observation and focus group interviews extensively. Product design students also used surveys and prototypes to an extent permitted by their time constraint. Students noted that GT dexterity helping them to fine-tune design thinking to develop a unique product empathetic to end-users, especially when they collaborated with other groups. They developed exercises to work with real-world people outside their confined studios and used unstructured questionnaires to support data collection. Studio critics found that the improved knowledge in categorizing end-users, helped students to produce empathetic designs. Their improved enthusiasm in collaborating and sharing data resulted in considering interior design and product design as an extension of building design.

Architecture students, having already been exposed to Pheromenological Analysis (PA), were eager to learn this method further. They comprehended the evolving patterns of contextual meanings by shedding their own preconceptions, common sense, everyday beliefs, and theoretical assumptions to grasp other's lived experience. PA dexterity generated results that were legible and applicable to a larger audience. Students found that PA's ability to be free from theories allowing them to be empathetic and creative, and noted parallels between EA and PA in focusing on individual meanings and identity within a social setting and enjoyed mingling with potential end-users of their products. Their dexterity facilitated them to combine different methods and using observation and interviews as well as simulations at various stages thus showing improved enthusiasm and collaboration of other students.

Students found that collaborating across their fields was important to understand end-users. They noted how different groups concluded the needs of end-users, depending on their expertise and focus. They also enjoyed going out of their confined studios and working with real-world people and contexts. They agreed that research dexterity gave them confidence to go out and work with end-users. They, as a group, understood the significance of practicing the methods used to collect in-depth data, and mostly used observation and focus group interviews.

We found that students started revisiting their knowledge construction process and decisions, paving a way to make more rational and thoughtful products after they were encouraged to write their decision-making process. They were inclined to claim final design products as their own and not something guided by their teachers. The aim of design education is to facilitate students developing a design thinking process of their own. This was largely supported by writing. Some students acclaimed that the design process they developed was more important than the products they presented at the end of a design assignment. They emphasized that their cyclic design process could help them designing any product in any context. Studio teachers noted focused design thinking while studio critics, who assessed the design process along with the product, found a marked improvement in students' design capacity. Both teachers and critics noted that research and writing dexterity helping students to fine-tune a design process that they can claim as theirs.

DISCUSSION

Our study aimed at integrating research in studio teaching to enhance its pedagogy. We also intended to introduce basic concepts of research methods, data collection and analysis to design studios. We emphasized research dexterity as a way of improving students' ability to self-assess their design process and to empathize with end-users. Having selected twelve design studios from programs of architecture, interior design, product design, and urban design, students were exposed to qualitative research methods as their design thinking approaches should include societies and humans (Creswell 2009). We placed priorities on the introduction of research methods while making attempts to convince students to learn academic writing to compile their constructed knowledge. Having documented their investigations and results, students found that it is a useful exercise to improve design thinking. Most importantly, studio teachers found that there is much potential to grow design thinking knowledge if studio teaching were more scientific. Interpreting studio projects as research tasks made students understand the scope and limitations of research space. The vastness, diversity, complexity, and variability of a context, in which students would engage, demanded due diligence to produce unique products, thus needing research. Our studios exposed design students to qualitative research methods as strategies to collect and analyze data. Students were informed of the significance of continuing their data collection and analysis through out the design process to produce more empathetic designs.

The relatively low uptake of methods makes it important to communicate to the society how to judge the quality of research through evaluative criteria commensurate with interpretive research. Without explicit articulation of criterion and descriptions of how a study meets these evaluations, there is a risk of being held to standards underpinned by other scientific presuppositions. Students noted challenges and limitations when conducting their research. These challenges included the degree of detail and time it takes to gain institutional human ethics approval, gaining access to an appropriate work site for prolonged durations, the substantial time investment for students collecting data in the field, and developing rapport and trust with participants.

As the contexts in which students produce designs is complex, there were logistical and physical constraints on when to observe or where to be located while observing. Due to the scope of this paper, those challenges and limitations have not been expanded upon. Other topics of interest aligned to observational research that also have not been unpacked in this paper, including commensurate theoretical frameworks and approaches to analysis or ethical considerations. The aim was to discuss observational research as a potential method. Students found examining a phenomenon in context through research unlocking their thinking and scientific writing providing them with an opportunity to formulate a cyclic design process. Their organizational culture, work practices, learning habits, pedagogical spaces, and motivation changed, resulting in focused insights to technologies, materials, events, or processes.

Convincing schools, studio teachers and studio critics to assess writing was difficult as they had been practicing a conventional way of training students to become practitioners rather than thinkers. A few schools turned down our request to run experimental studios as they did not see the usefulness of research dexterity in design pedagogy and did not have time to deviate from their set curricular. Some argued that if students carry a portfolio of written works rather than drawings, illustrations, models, etc., for interviews, their future employers would not be convinced. Our study did not cover prospective employers extensively but a few. More than 30% of them were prepared to read about students' design thinking process. They agreed that design dexterity is essential for students and writing completes students' design process, yet preferred employees with drawing skills and software skills as their practices would have to deal with clients.

Throughout this study, we tried to find how pronouncing a studio project as a qualitative research task could propel students to ask different questions from their end-users or to investigate hidden links in social phenomena within which their products are positioned. It was noted that qualitative research methods that promoted students intermingling with their end-users was a successful way of encouraging their learning.

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