Information behaviour of architecture students in creative design projects

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Abstract

Purpose - This paper reports on an exploratory study of third-year architecture students' information behaviour. It focuses on information activities, personal experience, resource usage, preferences in working individually or collaboratively, preferences for information resources inspiring creativity, physical spaces to be creative.

Design/methodology/approach - It was a mixed methods study with a strongly qualitative component and limited descriptive quantitative data. Data was collected in October 2016 at a South African university using individual self-administered questionnaires and semi-structured individual interviews; 19/60 (response rate 32%) third-year architecture students doing a design project participated.

Findings - Creativity is important in architecture projects, as is information resources in stimulating creativity. Students preferred to work individually during their design projects; at times collaboration was needed for idea generation. Information activities included: information gathering, encountering, use and sharing. A range of theoretical, technical, artistic and practical skills and knowledge must be integrated to produce creative outcomes, in addition, to information searching and information usage. Factual information is also required. Students can benefit from a supportive information rich creative space (physical or virtual).

Research limitations/implications - The study was conducted at only one institution with a small number of participants. Although generalization of findings is not possible, issues for further research can be noted.

Practical implications - Designers of physical and virtual creative spaces must take into account different facets of information behaviour and the information resources and services required during creative information-seeking activities.

Originality/value - Although there is literature on information behaviour and creativity, we could not find any that explores architecture students' information behaviour in academic spaces of creativity.

Keywords Architecture, Creativity, Information activities, Information behaviour, Spaces of creativity, Students

Paper Type Research paper

Introduction

"The whole art of teaching is only the art of awakening the natural curiosity of young minds for the purpose of satisfying it afterwards" (France, 1920). The turn of the 21st century signalled a shift in the new skillsets and technologies required by students to flourish in a rapidly advancing world (Koh and Abbas, 2015). Spaces of creativity, such as makerspaces,

became increasingly important for educational spaces to support STEAM-related studies (science, technology, engineering, arts and mathematics) (Abram, 2013; Barniskis, 2014; Burke, 2015; Hira, Joslyn and Hynes, 2014; Peppler and Bender, 2013).

Education literature reports many skills associated with creativity, such as critical thinking, imagination, holistic thinking, information literacy, problem-solving and active learning (Kostagiolas, Lavranos, Martzoukou and Papadatos, 2015; Medaille, 2010; Torun, Tekçe and Esin, 2011). Studies on academic contexts and library services and information literacy highligh the importance of creativity (Chang and Hsu, 2015; Plemmons, 2014). In academic disciplines, such as architecture, creativity is significant to set a design apart from competition (Sidawi, 2013; Tzonis, 2014). These disciplines require special supportive spaces (e.g. design studios, makerspaces) and tools for creative tasks (Dayaratne, 2013; Siestrzewitowska, 2015). According to Williams, Ostwald and Askland (2010, p. 3) creativity requires a holistic approach. So an understanding of information behaviour, based on a holistic approach including affective, cognitive, and physical components (Anderson, 2011; Case and Given, 2016; Kuhlthau, 1991, 1994; Hepworth and Walton, 2013), might better inform the design of creative spaces and information support (McCormick, 2014; Prince, 2012; Vogel, 2014).

Although many architecture studies mention the importance of creativity in academic contexts, few covered information behaviour (Campbell, 2017; Makri and Warwick, 2010). This paper therefore explores which information activities feature in architecture students' information behaviour in academic design tasks. Findings can inform the design of information rich creative spaces that can support students. The paper reports on the information behaviour of architecture students during project design phases, which by nature of architectural work, calls for creativity. The focus is on information activities, personal experiences, resource usage, preferences in working individually or collaboratively, preferences for information resources inspiring creativity, physical spaces to be creative. The full project is reported by Meyer (2016).

Clarification of concepts

Creativity

Naiman (2014) founder of Creativity at Work, explains that "creativity is characterised by the ability to perceive the world in new ways, to find hidden patterns, to make connections between seemingly unrelated phenomena, and to generate solutions".

For purposes of this study, creativity is defined as the "act of turning new and imaginative ideas into reality" by "questioning assumptions and re-interpreting facts, ideas and past experiences" (Goodman and Dingli, 2013, p. 54).

Information behaviour

According to Ingwersen and Järvelin (2005, p. 21), information behaviour refers to human behaviour dealing with generation, communication and use of information and other activities concerned with information, such as information-seeking behaviour and interactive information retrieval. Fisher and Julien (2009, p. 317) maintain that information behaviour focuses on individuals' information needs; specifically how they seek, manage, give and use information, actively and/or passively, in various roles in their daily lives, while Bates (2010, p. 2381) explains information behaviour as people's interaction with information. This paper

accepts Wilson's (1999: 249) definition of information behaviour as "those activities a person may engage in when identifying his or her own needs for information, searching for such information in any way and using or transferring that information", since it can include information activities mentioned in the other definitions.

Background

Glăveanu (2010, p. 79) explains that creativity has been hypothesised and applied throughout various domains of studies, such as *psychological and behavioural science* (Auger and Woodman, 2016; Pelaprat and Cole, 2011); *educational science* (Ergen and Akyol, 2012; Likar, Cankar and Zupan, 2015); *building science* (Dayaratne, 2013; Onsman, 2016); *health science* (Bang, 2015; Smoyak, 2015); *library and information science* (Lotts, 2015; Onuoha, Anyanwu, Ossai-onah and Amaechi, 2015); *fine arts and science* (Lavranos, *et al.*, 2015; Medaille, 2010); and *economic and management sciences* (Dean, Griffith and Calantone, 2016; Karim and Sarfraz, 2016).

Various authors argue that creativity is multidimensional (Lucas, 2016; Runco and Pritzker, 1999; Sternberg, 2005; Williams, Ostwald and Askland, 2010), consisting of various components (also known as the 4Ps of creativity) (Anderson, 2013) such as the creative individual (personal factors), creative product (design, service and system factors), creative process (cognitive factors) and creative environment (physical factors or context). Vogel (2014) added a fifth component: creative philosophy (motivational factors or ideology).

Studies regarding creativity in information behaviour mainly focus on information seeking (Hemming, 2008, 2009; Lavranos, *et al.*, 2015; Medaille, 2010; Visick, Hendrickson and Bowman, 2006; Zach, 2005) driven by inspiration, motivation (intrinsic and extrinsic) or to reach goals (Lavranos, Kostagiolas and Martzoukou, 2016; Makri and Warwick, 2010; Medaille, 2010). Torun, Tekçe and Esin (2011: 750) note that research into creativity in design education has flourished. More specifically, "the concept of creativity is very important for the architectural profession, and architecture is also sometimes used instead of creativity as meaning" (Danaci, 2015, p. 1310). Creativity is an inherent characteristic of architects' information work (Makri and Warwick, 2010, p. 1750). Alomar (2003, pp. 3, 6) indicates the significance of adequate access, use and sharing of information in working spaces during idea generation in architectural projects, and according to Shaaban, Lockley and Elkadi (2001, p. 43) "information is a critical element for architects to accomplish their tasks". Even though the importance of information for architectural design has been noted by various authors (Campbell, 2017; Shaaban, Lockley and Elkadi, 2001), there has been relatively little research on how architects search for, interpret, and use information.

The link between information behaviour and creativity has been highlighted by: Kostagiolas and co-authors (2015), Medaille (2010), and Torun, Tekçe and Esin (2011). They reported on the information behaviour of artists and designers' physical activities, cognitive processes and feelings based on personality traits (anxiety, fear, moodiness, enthusiastic, etc.). Other information activities noted are information gathering, encountering, use, sharing (communication), visualisation and avoidance (Ebrahimy, Hekmat and Jowkar, 2015; Lavranos, *et al.*, 2016; Makri and Warwick, 2010; Medaille, 2010). From the latter, connections between architecture, creativity and information behaviour are clear. Key findings

from information behaviour studies in fields of creativity such as architects, designers and artists are portrayed in Table 1.

Work role	Focus and author	Key findings reported
Architects	Therapeutic environments (Tétreault and Passini, 2003), design information seeking using memory accessibility and diagnosis (Wu, Huang and Mao, 2006), information-seeking habits of architecture faculty (Campbell, 2017), and understanding architects' information seeking and use behaviours to inform design (Makri and Warwick, 2010).	Architects prefer their own expertise and experience during design in addition to technical and functional information (Tétreault and Passini, 2003). Internet resources and personal libraries were most important for research and creative inspiration, personal communication with peers was most importance for architectural education, and plans, details, and photographs are the most important image types to trigger inspiration (Campbell, 2017). Electronic information seeking, information use (e.g. editing and recording) and communication (e.g., sharing and distributing), multimedia materials (i.e., images and drawings) are important for architectural design projects (Makri and Warwick, 2010). Architects first seek architectural information and then fit the special needs of the client to the information available to the architect (Wu, Huang and Mao, 2006).
Students (e.g. video game designers, other types of design and art)	Collecting library resources for video game design students (Miller, 2014), understanding information-seeking behaviour and library usage of students at the Hong Kong Design Institute (Lo and Chu, 2015), a comparison between arts and science undergraduate students' internet information seeking in Iran (Omidian and Seifi Maleki, 2013).	Heavy reliance on websites (Google searches), social resources (Facebook, Twitter) and visual references (ConceptArt.org, DeviantArt, Polycount) for troubleshooting assistance and to stay current about new developments or artists in the field (Miller, 2014). Students heavily rely on Facebook, Twitter and Instagram for inspiration (Lo and Chu, 2015); and blogs for reflection (Omidian and Seifi Maleki, 2013) and they find inspiration from a diverse, 'idiosyncratic' set of sources through accidental discovery (Lo and Chu, 2015).
Academics (e.g. arts, humanities, architecture scholars)	Information gathering behaviour of arts scholars in Sri Lankan universities (Ileperuma, 2002), information needs and information-seeking behaviour of arts and humanities teachers in Pakistan (Tahir, Mahmood and	Art scholars gather information for teaching, research and administration purposes, and to keep up with current developments (Ileperuma, 2002). Arts and humanities scholars have a range of information needs (i.e. teaching, research and

	Shafique, 2008).	developing competence), they rely heavily on library reference books in printed format, consultation with subject experts and conversations with colleagues (Tahir, Mahmood and Shafique, 2008). Low preference for e-books (Campbell, 2017; Tahir, Mahmood and Shafique, 2008).
Practitioners (e.g. art historians, arts administrators, emerging artists and designers)	Information-related behaviour of emerging artists and designers (Mason and Robinson, 2011), technology's impact on the information-seeking behaviour of art historians (Rose, 2002), information-seeking behaviour of arts administrators (Zach, 2006), the information-seeking and stopping behaviour of senior arts administrators (Zach, 2005)	Emerging artists and designers generally have information practices similar to established artists (Mason and Robinson, 2011). Serendipitous browsing is important for inspiration (Mason and Robinson, 2011). Emerging artists and designers rely heavily on internet and social networks, while also using traditional printed tools and libraries (Mason and Robinson, 2011). Art historians mostly consulted art librarians to assist them in tracking down resources, acquiring unusual resources (interlibrary loan), and using new electronic tools (Rose, 2002). Printed information resources such as archival materials, bibliographic materials, monographs, and image resources are preferred (Rose, 2002). Arts administrators rely heavily on direct personal experience, previous knowledge and randomly acquired information to fill their information-seeking needs (Zach, 2005, 2006) Arts administrators are "satisficers" (i.e. people who are willing to pursue a "good enough" option rather than best possible options (maximizers) when it comes to seeking information (Zach, 2005). Information seeking is seen as mission-driven and consensus-based (Zach, 2006).
Designers (e.g. software designers and aerospace engineering	Comparison of collaborative information retrieval behaviour of two design teams (Harry, Fidel, Pejtersen, Dumais, Grudin and Poltrock, 2003), understanding	Most common information seeking strategy is to ask colleagues and have meetings (Harry, Fidel, Pejtersen, Dumais, Grudin and Poltrock, 2003).

designers)	how information requests of aerospace engineering designers influence information-seeking behaviour (Aurisicchio, Bracewell and Wallace, 2010)	Information-related to design specifications is most significant (Harry, Fidel, Pejtersen, Dumais, Grudin and Poltrock, 2003). Books, research reports and websites are seldom used (Harry, Fidel, Pejtersen, Dumais, Grudin and Poltrock, 2003). Preference for sourcing knowledge and information through informal interactions with colleagues and consult databases and drawings (Aurisicchio, Bracewell and Wallace, 2010). Information acquisition and processing are main information activities to solve design problems, and face-to-face interactions is a key resource (Aurisicchio, Bracewell and Wallace, 2010).
Theatre artists	Creativity and the information-seeking behaviour of theatre artists (Medaille, 2010)	Theatre artists seek information for understanding a work's historical, cultural, and critical background; finding inspiration; learning about contemporary or historical theatre productions, artists, and events; learning technical or process information; finding performance materials; and, furthering career goals (Medaille, 2010). Collaboration was vital for idea generation (Medaille, 2010). Information is gathered from personal contacts (i.e. friends, colleagues, and mentors), private collections and professional networks, with heavy reliance on traditional print sources such as books. Images, specifically, browsing art collections at random and hoping to serendipitously find an image, are important, and the internet is used to stay abreast with the latest developments (Medaille, 2010).
Visual artists	Information-seeking behaviour of visual artists (Hemmig, 2008), and practicing visual artists (Hemmig, 2009)	Serendipitous browsing is very important; they have a wide spectrum of information needs (e.g. for inspirational technical, business information and library trends) (Hemmig, 2008). Preference for browsing information occurring in nature (e.g. biomimicry) and personal experience for inspiration (Hemmig, 2009).

		Books, periodicals and photographs are more useful as visual resources than moving-image and digital media (Hemmig, 2009). Contact with colleagues is preferred for learning about materials and techniques (Hemmig, 2009). Websites were most useful for gathering technical information (Hemmig, 2009).
Liberal artists	Interdisciplinary platform for information behaviour research in a liberal arts hobby (Hartel, 2014)	Core information activities during adult learning projects are information acquisition and expression; these were experienced as pleasurable and profound in nature (Hartel, 2014).
Musicians	Musicians information seeking behaviour for creativity (Lavranos, Kostagiolas, Martzoukou and Papadatos, 2015), use of information retrieval systems (Lee, 2010), and theoretical and applied issues faced during creative activities (Lavranos, Kostagiolas and Martzoukou, 2016)	Musicians seek information for inspiration, leisure, development of collections (e.g. for composition, performance, improvisation, listening, and analysis), for improving comprehension of musical pieces (e.g. orchestration, lyrics), and development of new ideas, musical material and other forms of musicianship (Lavranos, Kostagiolas, Martzoukou and Papadatos, 2015). Musicians mostly use information retrieval systems to seek information regarding specific works of artists, recordings or lyrics (Lee, 201). Musicians' creative activities are impacted by their personal, interpersonal (e.g., social, cultural), organizational, community and physical environment. Barriers included a lack of appropriate information literacy skills, special libraries and music information services, familiarity with computers or music software, scholarly information available on the internet, and problems with understanding of information in a foreign language (Lavranos, Kostagiolas, Martzoukou and Papadatos, 2015).

Table 1: Review on key findings from information behaviour studies in fields of creativity

For effective support of information needs, selection of information resources and planning of information services, an understanding of information behaviour is required. The study thus investigated the information behaviour of architecture students during the design phases of a project.

Problem statement and sub-questions

Based on the need shown from the literature review this study focused on all information activities of architecture students, specially information and collaboration.

Research question: How do diverse information activities feature in the information behaviour of architecture students completing a design project?

Sub-questions:
- What contextualizing factors influence the information behaviour of architecture students?
- What information activities are revealed in the information behaviour of the architecture students completing design projects?
- How can information activities affect creativity throughout the phases of architecture design projects?

Research design

Research design refers to a logical plan with processes and strategies that cover the decisions on the research method, methods of data collection, study population and data analysis (Creswell, 2014).

Research methods

The study employed a mixed methods research approach with a strong qualitative component and limited quantitative elements data. (This paper reports on findings from the qualitative component).

Sampling and target group

A purposive sampling method was used involving three groups from an architecture department situated at a South African university, namely: acting head of department[1], lecturer of Module Anonymous[2] (third-year module in architectural design), and third-year architecture students registered for Module Anonymous.

Methods of data collection

Descriptive quantitative data was collected through a self-administered online profile questionnaire via Google Forms and qualitative data through individual semi-structured interviews via face-to-face. Google Forms (online) or Skype, according to participants' preferences. The Google Form questions were open-ended and allowed participants to express their opinions in detail. Participants accessed Google Forms through a link. Responses were automatically gathered in a Google spreadsheet that was exported to Microsoft Excel. Although online interviews can consist of various rounds, the study used only one round since it was a very busy time of year. Students could however, view their responses and add additional feedback.

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[1] The acting head of department participated on behalf of the head of department.
[2] The module code and name was replaced with Module Anonymous to ensure anonymity of the participants and associated institution. This is in accordance with the ethical clearance received.

All participants signed an informed consent form. Each participant received a pseudonym to protect their identity. Various information behaviour studies have used pseudonyms, such as Goodall, Newman and Ward (2014), and Wilson (2016). Pseudonyms for this study do not reflect participant gender. Table 2 reflects the data collection of the full project.

SUMMARY OF DATA COLLECTION METHODS		
Method	**Profile questionnaire**	**Individual interviews** *(three different individual interview schedules for each of the sample groups)*
Administration mode	Online	- Online: 18 participants - Face-to-face: One participant - Skype video: None
Software	Google Forms	- Online individual interview: Google Form - Face-to-face session: Huawei P6 Smart Voice Recording software - Skype video session: Skype web application - Transcribing software: Dragon NaturallySpeaking 13 software
Number of questions	Seven semi-structured questions	1) Head of department interview schedule: eight questions 2) Lecturer of Module Anonymous interview schedule: nine questions 3) Third-year architecture students interview schedule: 12 questions
Time to complete	± 5-10 minutes	± 30 to 45 minutes
Time period	2016/10/17 to 2016/10/31	1) Acting head of department: 2016/10/27 2) Lecturer of Module Anonymous: 2016/10/06 3) Third-year architecture students: 2016/10/17 to 2016/10/31

Table 2: Summary of data collection methods and administration modes (Meyer, 2016)

Data analysis

Thematic analysis was chosen to analyse the data; a "thematic approach can produce an insightful analysis that answers particular research questions" (Braun and Clarke, 2006, p.97). Coding was done manually. It was guided by the research questions (top-down approach). Nine broad themes were identified (i.e. design project, prior learning and experience, design phases, collaboration, question-asking in design projects, resources of information, space and tool support, inspiration and creativity). These themes were collated into four main themes, namely: contextualisation of architecture design projects; questions asked throughout the design project; information activities throughout the design project; and, sources of information.

A smartphone audio recorder was used, with signed permission from the participants, to capture the interviews. Recordings were transcribed to text files using Dragon

NaturallySpeaking 13, a Windows-based speech-to-text software, and analysed through the application of thematic analysis as a theme-recognition technique.

Recruitment and actual participants

All participants were recruited via e-mail invitation. In total 60 third-year architecture students, registered for a third-year module in architectural design (called Module Anonymous), head of department and lecturer of Module Anonymous were invited to participate. The acting head of department participated on behalf of the head of department.

From the 60 students, only 25 participated (as indicated in Table 2). Two out of the 25 respondents entered the study and immediately exited, resulting in a response rate of 38% (23/60) for the online profile questionnaire. One question asked if participants were willing to participate in an individual interview. Only 19 students agreed to an individual interview, thus resulting in a response rate of 32% (19/60) for the individual interviews.

Background to findings on architecture students and procedure for data collection

Interviews with the acting head of department and lecturer of Module Anonymous provided valuable information to contextualise qualitative findings for the students.

- The interview schedule for the head of department (pseudonym Beth) covered three themes: architecture design projects, role of creativity during design projects, and spaces of support.
- The interview schedule for the lecturer of Module Anonymous (pseudonym Meredith) covered three themes: Module Anonymous curriculum, role of creativity during design projects, and spaces of support for creativity.

Nature of architecture design projects

Expectations of students emphasised artistic, technical, practical and theoretical knowledge and skills, importance of group work, and the use of information and information resources to complete architecture design projects. Students must incorporate a range of knowledge and skills (i.e. theoretical, practical, technical and artistic) accumulated throughout three years of study, into their final-(third) year design project. Group work is very important to cultivate active learning and co-construction of knowledge, ideas, opinions and solutions during creative tasks. The acting head of department and lecturer agreed that students need soft as well as hard information ("soft" and "hard" information were labels used by the lecturer). **Soft information** includes information from *reading sources* such as printed books and peer-reviewed journal articles, while, **hard information** includes information collected from the *city* (i.e. invisible information) through *LG diagrams, and physical* and *digital models*, and information collected from the *site analysis* through a wide spectrum of tools. This can include *physical and even anthropological interviews*[3] with people on the site, and spatial information from the hard factual environmental aspects.

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[3] Anthropological interviews are the "qualitative process of exploring in depth the why's and how's of human culture, behaviour, and expression" (Agency for Healthcare Research and Quality (AHRQ, 2013: 1).

Role of creativity

Creativity is seen as a core ingredient for architecture, especially for creative mapping, interpretation, information use and expression of information during various design phases. Information and information resources are very significant underpinnings as information gives integrity to design decisions. Architects' inspiration can also be triggered outside their profession, for example, by the movement of biomimicry, where one is inspired by nature or noting problems and finding solutions in nature.

Spaces of support

Various physical and virtual spaces were in place to support design projects, namely:

- **Physical spaces:** The *design studio* is used as a space for crowdsourcing and sharing of notions; *design pinup spaces* enable cross-pollination across all years of study; the *atrium space* for design critics (known by students as design crits) provides observers with interesting insights; the *reading room* provides access to a physical repository of information resources; the *archives* offer background information on historical meritorious architects. There is also a computer laboratory, and tools such as laser cutting, 3D printing and model-building facilities.

- **Virtual spaces:** The *computer laboratory* provides a range of software to move designs from physical to virtual spaces; the *electronic learning management system* is used as a communication and teaching tool; *Ted Talks* is used to foster discussion in the design studio; *virtual models* constructed on Revit software vs. physical model (mock-up model) provide a different lens for investigating a project. Other virtual supporting spaces to represent and communicate designs are e-reserves, electronic resources and the internet. Although the internet include eBooks, journal databases, and other online resources, it was clear from the interviews that participants distinguished internet resources, from eBooks and journal databases, as resources freely available and discoverable via a search engine (e.g. Google).

The design studio supports the notion of "*you learn more from your peers ultimately than you do from your lecturers*" (Meredith), and offers an important learning opportunity to foster creativity; robust setup of the building fosters conscious and subconscious engagements with work on the pinup spaces to stimulate creative ideas.

Information, information resources and information support should feature in physical and virtual spaces and should offer support throughout all design phases. The significance of students having a good understanding of what information sources and services are provided and what they should do with the information were highlighted.

Results from interviews with third-year architecture students

Data was collected from third-year architecture students through semi-structured interviews; twelve questions were asked. The following themes will be discussed, namely: contextualisation of architecture design projects; questions asked throughout the design project; information activities throughout the design project; and, sources of information.

Contextualization of architecture design projects

A diverse range of design projects were described by participants, namely: implementation of a bicycle transportation hub, riverside restaurant, protective and low-income housing, shelters, rehabilitation centre, library addressing media and information technology influences, urban orphanage, and a multi-religion meditation centre Generally, the projects concentrated on advance design challenges related to scale and complexity in an urban context.

> *"An architect that doesn't speculate, solve problems, find new ways of thinking and provide alternatives is not an architect. If someone just wants to copy and paste existing solutions then they were misguided in trying to become an architect and would be better suited as a draftsman"* (James).

Specific contemporary issues addressed formed motives for the projects selected, for example, *political issues* (protective housing, and shelters), *social and cultural issues* (rehabilitation centre, urban orphanage, multi-religion meditation centre), *economic issues* (low-income housing), and *educational issues* (library).

It also emerged that creativity was of great importance to set students' design projects apart of their peers and to solve complex design issues.

> *"I think to succeed in any design profession, creativity is the number one tool to have. To creatively think of a space, to creatively solve a design issue, to creatively suggest an alternative of the existing, to creatively communicate your vision"* (Frank).

In order to find solutions to complex design issues and to complete a project, various design phases must be followed. Additionally, collaboration was required at specific design phases. This revealed two sub-themes:

(1) Project phases

Students had to describe the phases they went through to complete their design projects for Module Anonymous. The majority gave a step-by-step list of project phases, while, a few described steps in more detail. James confirmed that:

> *"Design is a back and forth and certainly not a linear process"*.

Most responses included the key phases of site analysis, conceptualising, design and presentation. A few participants offered more detail; they mentioned precedent study, detail (sectional plans and evaluation, master plans), research, concept Marquette and digital (computer drawings/3D drawings).

> *"Site understanding... site manipulation and conceptualising according to results gathered on site. These phases work hand in hand with research...precedent studies and constant interaction to get other opinions...then designing...where experimenting with spatial principles occurs until the whole scheme is finished...then detailing...where one understands the construction of the project in detail. Then presentation. Where sleepless nights begin"* (Mike).

Less than a quarter of the participants used a re-design stage, idea generation stage, sketch/drawing stage, programme and site selection stage, experimentation stage, and construction stage. Only two participants elaborated on the use of design phases such as sketch-up model, planning, urban framework development, zoning, mapping, exploration, finalisation and feedback. Only a few mentioned briefing, macro and micro analysis, informal interviewing, extrapolation, integration, implementation, technical study, execution, evaluation, and critiquing.

Figure 1 portrays the general project phases that featured in most responses: (i) site analysis (research, precedent studies), (ii) concept design, (iii) design development, (iv) construction drawings (digital and detail drawing), (v) presentation and (vi) revise.
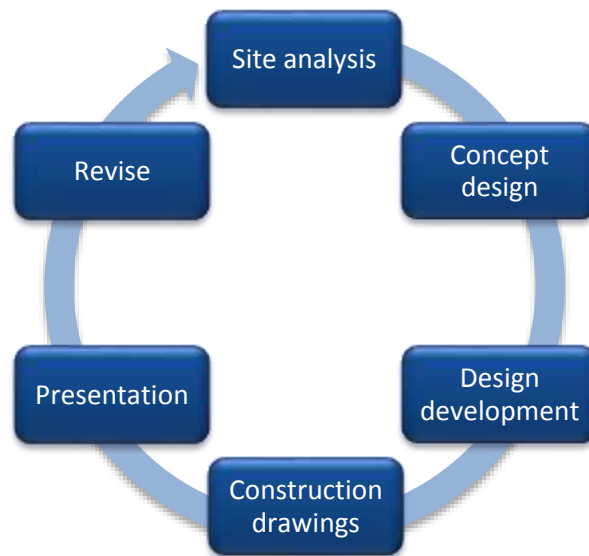

Figure 1: Key architectural design project phases

(2) Collaborative work and learning during design projects

Students were asked if they work alone during the project phases or with others in a formal or informal manner. A quarter distinctively preferred working alone and only needed advice and assistance from lecturers. More than a quarter, however, preferred working in groups. Depending on the design stage, a majority of the participants chose to work alone as well as with others.

"At the first 3 stages I worked in a group... then the rest I work alone... though there's compulsory consultations with lecturers which are helpful" (Mike).

"At the beginning of the project I was working in a group of 14 classmates to develop and design our urban framework. This is mostly done informally with discussions, brainstorming and so. After that I worked individually on my own project, and occasionally had informal discussions with peers and friends about my design. I also had formal sessions with lecturers where they would crit me" (Frank).

Overall, participants worked with others during site analysis, at the start of a project, when mapping, urban framework design and development, and idea generation. The main type of formal collaboration was with lecturers. Informal collaboration included informal discussions with lecturers, peers, friends, external parties, and group discussions and brainstorming sessions. Predominantly, the asking of advice, whether from their lecturers, peers or external parties, was of great importance during various phases.

> *"Working with others informally asking for advice on what design decisions were being made"* (Jessica).

Questions asked throughout the design project

Students had to discuss the questions they ask at the start, during the phases, and at the end of a project.

i.   At the **start** of a project questions are asked on: design problems, who will be affected, previous cases, design uniqueness, site and users' needs, design contribution, history of site, functionality, scale of context, socio-political (spatial) statements, obstacles, and failures and success.

ii. **During** the project phases, questions are asked on: materials, building efficiency, sustainability, design appeal, integration, better design, element arbitrary, contradictions, movement through the building, clarifying arguments, surrounding buildings, practicality, creativity and overall progress.

iii. At the **end** of a project questions are asked on: presentation, improvement, procrastination (why waited until the end), outcomes, goals, good architecture, success, lessons learnt and completion of the project.

There were also many smaller questions: *"Do I have enough pins? Is my work accessible? Will I not collapse due to lack of sleep?"* (Mike); *"Why did I leave all this work 'til the end?"* (Sue); *"Some small questions like how does scale work again? Am I contradicting myself?"* (James).

Questions pointed to a possible connection between thinking, sense-making and problem-solving processes, emotional wellbeing and a need of information resources. This is confirmed from the verbatim extract from Andrew:

> *"At the start it's important to understand what your concept and programme is, asking questions such as "What do I want to achieve at the end?", "Who will this programme benefit?", "Will it be sustainable in the long run?", "Does it excite me?". During the design, I often start to question my intention so I have to look back at what excited me from the beginning and realise why I choose to design this certain space. Questions become more that of: "How is my design going to be resilient?", "How can I achieve this through materiality and quality of light etc..?" Towards the end of the project, you have to look back and make sure you can justify why you placed certain elements where you did, why the access to the building is where it is, why you used certain materials etc. And when you can answer those questions you start to reveal your thought process and your building comes to life because it has a purpose".*

Information activities throughout the design project

During the completion of the design projects, various information activities emerged such as information seeking, information use, information encountering and information sharing.

Information seeking and use were the predominant information activities reported by the students. Specifically, active information seeking to find answers to design questions and problems. They sought information from various sources – from general internet surfing to scholarly journals.

"Specific answers are Googled, thus leading me to basic overviews. From there I either look at creditable sources it may lead me too (e.g. Archdaily) or Google Scholar" (Tom).

Participants also found information from precedent studies, lecturers, projects, theses, site-visits, books and people. A few mentioned the use of the library, reading room and practicing architects. Less popular sources included: personal experience, peers and class notes. The use of poetry, images, music and family members for information were only mentioned once. Significantly, the use of multimedia sources and social media platforms (e.g. Archnews, Pinterest, TEDTalks and YouTube) were key to provide inspiration and trigger creativity. This is confirmed by the following verbatim extracts:

I listen to a lot of music and I write poetry...that is where my inspiration for designs come from. But you cannot tell your lecturer that, thus I go read up on similar or contrasting sources and make it sound so "well informed" (Anne).

"PINTEREST: blogs such as this are extremely useful for inspiration. Pinterest allows me to visualise possibilities and adapt precedents" (Ruan).

Information encountering: A few participants highlighted the importance of browsing on the internet leading to inspiration. Participants did not label this as 'information encountering', but they noted the value of sensory experiences, aesthetic encounters and social exchanges (peer, lecturers, expertise, family and social media) for inspiration.

Information sharing: Participants noted the value of gaining and sharing informal information resources (i.e. images, videos, links and bookmarks) and social media sites and blogs specifically, Pinterest and Archdaily. Information sharing is motivated through collaborative work and idea generation.

"I worked with a classmate gathering information at times and at other times just sharing ideas and working together" (Andrew).

Sources of information to inspire creativity

Participants thought that inspiration for creativity could best be gained by using Pinterest, books and Archdaily, precedent studies, internet, lecturers and theses. Other resources were only mentioned once: poetry, music, peers, short stories, existing buildings, articles, marquette, material catalogues, Google images, Facebook, speaking to people, site analysis, writing, reading, research, old projects, archives, visual media and architecture forums.

All participants reported the use of information sources to inspire creativity, especially information acquired from people such as peers, lecturers, practitioners, family members, Architecture South Africa (national body that provides a code of ethics for architectural practices), technical information from people in the design industry, vendors, friends, groups, YouTubers, architects and artists.

Discussion

This section discusses findings as answers to the sub-questions.

Information behaviour of architecture students during design project

Information activities that featured most prominently were seeking information from the internet and scholarly journals and sharing information. Students use social media sites to collaborate and share images, videos, links and bookmarks. These findings are in line with findings by Campbell (2017) and Makri and Warwick (2010) noting the value of seeking, using and sharing informal information resources from search engines and networking sites from or to peers, specifically, blogs and Facebook for inspiration. A broad class of information activities are performed to draw inspiration, trigger creativity and solve complex design problems.

Information encountering is important for inspiration and triggering creativity. Sensory and aesthetic experiences encountered while designing spaces for users were of great importance. Specifically, not just the experiences of the architecture students, but also the experiences of the users of these spaces. One participant reported this sensory feeling as *"a sense of belonging"*. If information is interpreted as any type of memorable experience where useful or interesting information is unexpectedly discovered in everyday environments, this can relate to the work of Erdelez (1999) on information encountering.

Contextualizing factors influencing architecture students' information behaviour

Students were involved in a diverse range of design projects. They focused on advanced design challenges. They selected projects based on the information received in Module Anonymous (i.e. design themes, design briefs placing projects within a specific context and narrative and study guides), personal frame of reference (i.e. normative position) and practical experiences (Meyer, 2016). Creativity was essential in how key integrate theoretical and practical knowledge and skills to solve complex design challenges. In correspondence, Annemans, Van Audenhove, Vermolen and Heylighen (2014, p. 1630) explain that architects utilise a spectrum of information resources combined with personal and professional experience and knowledge, as "just collecting information will not be enough for architects to actually work with it. It will need to infiltrate their daily practice to a point that it forms part of both their tacit and explicit knowledge".

Students considered architectural design an iterative process. Harputlugil, Gültekin, Prins and Topcu (2016) also found that architectural design is an iterative process. Collaboration throughout some phases was confirmed (e.g. site analysis, concept design and design development). Specifically, sharing informal information resources from search engines and networking sites with peers (e.g. Pinterest and Archdaily (blogs)). A study by Makri and Warwick (2010, p. 1768) confirmed that collaboration among peers are done through sharing

images, videos, URLs and bookmarks on social networking sites. In essence, idea generation and sharing was the main motive for collaboration during design projects.

How information activities affect creativity during design projects

The students, acting head of department and lecturer stressed the importance of information resources to inspire creativity. An assortment of information resources ranging from drawing on personnel experiences and resources (e.g. personal book collections, design manifesto, industry experience (i.e. internships), family and friends (i.e. support systems)) to invisible aspects (e.g. normative position, politics, educational background, beliefs, etc.) and sources outside the profession (e.g. biomimicry - nature) served as sources to inspire creativity. Spaces of creativity and information support should position students to be aware of such information. There must be support for information encountering outside their discipline – for serendipity as argued by Erdelez, *et al*. (2016).

Although students highlighted a variety of information resources, it is not evident that they see the same potential for information resources outside their comfort zones, as noted by the academic staff. Their focus was on more conventional information resources and social media platforms to inspire creativity: peers, lecturers, practitioners, family members, Architecture South Africa, vendors, friends, user groups, YouTube, architects and artists. They should be guided towards a wider array of information resources.

Limitations of the study

The response rate to the study was lower than wished for and participants had to be invited several times to participate. However, this could be due to the fact that it was a very busy time of the academic year. The case study was conducted at only one institution with third-year architecture students; results might differ if the study was conducted at other institutions with a different year group.

Recommendations for future research

Further research can address the following theoretical and practical issues:

- Building on creativity models such as Webster's (2002) model of creative thinking or Velikovsky's (2012) creative practice theory model to provide a more comprehensive theoretical and conceptual model for studying creativity and information behaviour.
- Investigating the value of information encountering in creative tasks.
- Studying the nature of the questions asked by architecture students in connection to their thinking, sense-making and problem-solving processes and emotional wellbeing and how information resources feature in efforts to find answers.
- Exploring innovative methods of data collection more suitable to participants involved in creative tasks and activities such as brainstorming, visual narratives, infographics, analogy metaphors, autoethnographic research, biomimicry and mind mapping.
- Incorporation of context-sensitive support and guidance to support information activities in creative tasks.

- Combination of physical and virtual spaces to support creative tasks. In academic context physical makerspaces can be combined with virtual makerspaces. Both academic departments and libraries can play a role.

Conclusion

The study provided insight into the information seeking, use and sharing behaviour of architecture students during design projects. Browsing for formal information sources was not popular, but was used to inspire creativity. Although architecture students are enthusiastic users of the internet, they also use scholarly journals. Social media sites were used to collaborate and share images, videos, links and bookmarks. Overall, the architecture students strongly preferred the use of resources which are freely available and easily discoverable via the internet (e.g. Google). Collaboration in specific design phases, such as site analysis, the start of a project, mapping, urban framework design and development, sharing information, and idea generation, were of great importance. Collaboration was predominately seen as asking advice, whether from lecturers, peers or external parties, throughout the design project.

In conclusion, there is clearly a need for the construction of spaces where collaboration, question-asking and the provision of tools, facilities, expertise and information resources for creative endeavours are supported. Such a physical and/or virtual space can be developed by academic departments in collaboration with libraries to ensure that information needs are addressed and the information behaviour of architecture students supported.

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