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Role of Conceptualisation as a Catalyst in Capturing Urban Issues within the Studio Learning Environment

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Abstract

This study focuses on the role of conceptualisation in capturing the urban issues within the studio tutorial learning environment in Universiti Teknologi Malaysia. Essentially, it looks into how the conceptualisation process during design facilitates students' problem solving ability in dealing with tasks in hand. Evidences of this come from students' dynamic cognitive interactions with knowledge and experience as transpired through the studio environment. The study provides insight into the interactive role of experience as a key factor in facilitating design conceptualisation process and the course enables students to harness relevant problem-solving skills.

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Keywords: Sustainable urban regeneration project; creativity; conceptual design process; conceptualisation

1. Introduction

It is imperative for the design education system to play a vital role in educating, training and producing future architects and environmental designers who are mindful in addressing sustainable issues in the built environment, not least matters pertaining urban regeneration. The design studio environment, the mainstay of such a system, becomes an important formative platform for critical reflections on urban issues to be incorporated into design work (Batuman & Altay, 2014). Early awareness of urban issues and the ability to integrate them as fundamental constraints and parameters in the learning process is pertinent

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to the formation of erudite design professionals. The latter is those expected to possess basic skills in evidence-based inquiry and competency in applying those skills on complex, real-world problems.

To achieve such standard design studio curriculum needs to incorporate real world simulations to enable students to make an effective connection between overarching theories and concepts and relevant skills acquisition and real-life application. Our increasingly intertwined world demands that we regularly address contingent and reciprocal issues that affect people-behaviour, environment, and economy. As a consequence, increasing number of design schools worldwide are adapting their design studio curriculum to the prevalent context of urban regeneration projects in order to raise students' awareness and ability to deal with project complexity. Such a development in the academic world engenders good and more efficient design practices, all these for the betterment of society, nation, and environment. Recent studies on urban regeneration have already recorded actual transformation of large-scale, physical projects that brought about substantial benefit to community development, as well as increased policy awareness and development of areas of relative socio-economic affluence for the purpose of improving their quality of life and as a future investment (Alpopi & Manole, 2013; Lim et al., 2013; Raco, 2003). Such a hectic academic expansion to the urban regeneration discourse should prompt interest among educators and advocates of architectural design education, at least along the following general line of inquiry: how are issues on urban regeneration issues incorporated into architectural design studios?

2. Research Aim and Objective

The purpose of the study is to examine the role of the conceptualisation process of design within the studio learning environment. Conceptualisation could be described as a process that harnesses the student's problem solving skill through its iterating back-and-forth activities of multiple sources, generative and evaluative stages that gradually converge and filter the student's perspective on a preferred conceptual solution (The Design Society, 2011). Recent studies suggest that the notion of conceptualisation correlates design process with more comprehensive discussion on sketching activities, cognitive processes, as well as analogical and reasoning behavioural among designers and students (Kavakli et al., 1999; Purcell & Gero, 1998; Suwa et al., 1998, 1999). One of the key strategies of the current study is to analyse how students transform their ideas from abstract to physical form through the conceptualisation process within the studio learning environment. Two aspects were considered (1) the factors that influence and limit a student's actions in designing, and (2) the role of critique in stimulating the student's conceptual design towards final production stage. A key finding in the study will be a flow of the conceptualisation process that the student embarked upon during design.

3. Literature Review: Role of Conceptualisation in Knowledge Integration

The notion of conceptualisation in the design process could be traced back to Kolb's theory on experiential learning, and Schon's on reflective learning. Kolb had emphasised that direct experience could potentially transform abstract knowledge into reflective knowledge based on active involvement by the learner in the learning activity (Kolb, 1984). In parallel to this, Schon (1983) formulated his seminal view on the ‘reflective' nature of design as knowing in action. He also added that reflection is about concentration and careful consideration on practice, and the act of reflecting being an essential feature in the development of new knowledge, and a broader understanding of problems as stated by Kolb (Osterman, 1990; Schon, 1983).

Conceptualisation is strongly linked to experiences of significance that are stored in schematic forms (Schemata) in the human mind with the latter more readily recognisable through the designer's ‘repertoire of tricks' or gambits by experienced designers (Lawson, 2004). Four elements that make up the

conceptualisation process are prior knowledge, episodic memory that aids the recall of images previously perceived, case study precedence and recursive approaches, and strategies employed throughout the process (Lawson, 2004, 2006; Menezes & Lawson, 2006). The ability to 'recognise' from schemata distinguish expert from novice designers. It is also suggested that since design students have no extended access to knowledge compared to practising designers, they tend to fail to recognise inherent problems or reflect effectively on previous design practice or past projects (Ahmed et al., 2003; Cross, 2006).

Previously, Schon (1983) states the drawings and sketching become mediums of conversation to the designers and students. Schon & Wiggins (1992) added that these sketching activities have evoked the designers and students to the unexpected discoveries through the reinterpretation process. This reinterpretation process refers to the series of design sketches that illustrate the ability to transform and generate the new images in the mind while sketching (Kavakli & Gero, 2001; Menezes & Lawson, 2006). Goldschmidt (1991) acknowledges the process has triggered the new meanings, based on the same sketches, used by the designers and students as one of the reasoning methods in design. The previous studies reveal that the weakness in the ability of sketching has influenced the student's visual reasoning of the cognitive process, which contributes to the lower number of generated sketches and interpretations (Kavakli & Gero, 2001; Purcell & Gero, 1998). Their study reveals that a longer exposure to a single event, space or topic will conceive higher dependency of chunks on information. The dependence of information offers an extension for the students to connect their current segment into the past segments of experience, and opportunity to explore more functional considerations.

In summary, the role of conceptualisation especially in the studio learning environment cannot be ignored. The conceptualisation process has triggers the student's ability of solving the assigned design tasks, as well as promoted the specific abilities on the ways of thinking and behavioural actions in tackling the design problems. This design ability of knowing-how and knowing-what matches the needs in addressing the urban issues, of comprising on resolving ill-defined problems, adopting solution-focused cognitive strategies, applying design thinking and using non-verbal modelling media (Cross, 1990).

4. Methodology

The study highlights the outcome of an architectural studio design project undertaken by respondents in transforming a vacant land into a community service centre. The respondents were architectural students from the third year Design Project course SBEA3158 of semester 1, session 2013/2014 at the Faculty of Built Environment, Universiti Teknologi Malaysia.

4.1. Research approach

The study started on October 2013 using a questionnaire survey conducted on a limited sample of 10 students. The selection of students was based on purposive sampling method, which enabled students with two different backgrounds to be randomly selected from each third year studio work unit. The method was further augmented by a qualitative approach with which a case study method was employed together with questionnaire surveys that expounded the numerical relationships and patterns pertaining to students' design activities, especially those that dealt with the constraints, demands, and challenges of the project. Units of analysis derived for the purpose of this study have facilitated the description of critical phases of the design process as experienced by the selected group of architectural students. More crucially, such knowledge further infers to relatively rich and vivid conceptualisation activities and processes taking place among the students observed.

4.2 Data collection and analysis

The study also involved comparison between two different groups of students, each of which with contrasting backgrounds prior to attending the same and current Bachelor's undergraduate Degree programme. The ten students randomly selected for the study on conceptualisation process had comprised of four with the diploma of architecture qualifications while the remaining six students were formerly those who had undertaken general matriculation or mainstream study. More specifically, the diploma holders were defined as those with three year's studio experience in diploma studies, while the mainstream students had no studio experience while at their respective matriculation education centres. Data was collected through semi-structured interviews, observations and analysis on the student's sketches, and the final assessments. The data was assessed from two critical design stages; (1) idea development stage and (2) refinement stage. Findings from the comparison of activities between students in those stages help to circumscribe the nature of design conceptualisation process as observed through studio learning.

Part of the current study also involved applying content analysis of the selected students' sketches that facilitated the categorisation of such works into specific types of activities, forms, and patterns. Subsequent analyses of the student's design processes provided critical descriptions of the relationship between design activities, forms, and patterns. This enables us to establish to a certain measure students' abilities in designing, particularly with regards to conceptualisation. Hence, through identification and examination of student's activities, forms, and patterns, the current study has generated an in-depth understanding about conceptualisation and knowledge integration. This further helped to explain the role of conceptualisation in dealing with the urban issues found within the studio learning environment. The end results suggest that students who actively explored, iterated, and undertook critiques generate more productive design depictions.

5. Results and Findings

5.1. Trends of constraints that influence students' actions

From the interview and observation of the student's sketches, the students admitted facing difficulties at four phases of designing centred primarily within the idea development stage and during the refinement design stage. These four phases are conceptualising an initial conceptual plan, adapting the case studies into the plan, returning activities to the previous concept, and changing the concept. Compared to the previous studies by Purcell and Gero (1998) and Kavakli et al. (1999), they affirm that the design processes have generated several cognitive activities that varied in action. The current study has revealed that the students started to feel the stress pertaining to cognitive activities the moment conceptual design development stage begins in earnest. When asked about the possible factors contributing toward such a condition, the majority of observed students reflected upon four critical factors; (i) lack of knowledge and design experience, (ii) complexity of design stages, (iii) confusion on the design requirements, and (iv) conflict with the lecturers. The trend on constraints exists among the students in their design process is illustrated in Figure 1.

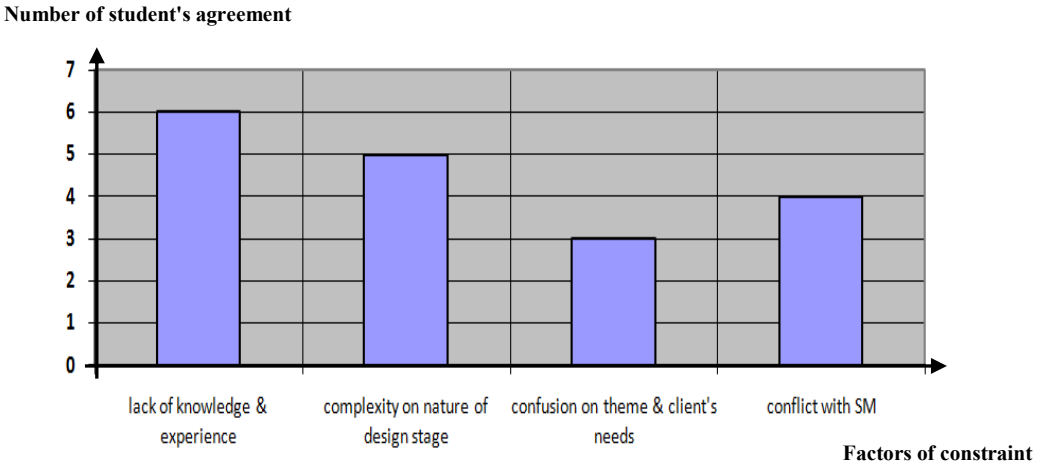

Fig. 1: Trend of constraint exists among architectural students

Five students claimed that the perceived complexity of design stages mostly occurred during iteration activities of design and when faced with the difficulties in terms of technical skills of modeling the 2D images into the 3D models. This led to the reappraisal of the initial conceptual idea, the construction and recostruction of design forms, reinterpretation of sketches and images, and reconfirmation of the augmented ideas and concepts ideas with the lecturers. In other reviews, even though the students have difficulties in the conceptual design development stage, it found that a majority of them managed to produce their initial conceptual idea. The availability of the conceptual idea was claimed due to the high motivation at the initial stage of designing, engaging with case studies through clear understanding, vitality of gathering information pertaining to site inventory and analysis stage.

During the refinement design stage, the students have problems dealing with; (i) the nature of design process, (ii) self-satisfaction in decision making, (iii) the instructor's teaching approach, and (iv) self-acceptance on the given feedbacks. Such problems point to the students' difficulty in undertaking design reasoning as part of the iterative and incremental nature of the design process, especially in the construction and reconstruction of design ideas and concepts. For example, a student named Joe expressed apprehension at designing with certain time frame or limitation in mind. He admitted at having to stop abruptly at certain stages of designing while ideas were still flowing into his mind and at the same time, realizing the pressing need to fulfill the design requirements within a given timeframe.

> *"Though I was reaching my final stage in designing, as I'm submitting my final submission and so on, the ideas suddenly popped up and new concepts might be coming in. But, we know that we have to stop and that is our limit, because we have limitation in time". - Joe*

Other students also argued that the teaching approaches of studio masters are sometimes lackluster and caused exhaustion in designing. For example, student named Syaza claimed that she had a hard time to understand the crux of what her lecturer was attempting to deliver in studio. Based on comments that made by the same student in an interview with the principal researcher, much of the problems compounding her in the studio design process appeared closely linked to the student's ability in comprehending the notions of knowledge paradigms, language of design, practicality in design as well as

certain pedagogical approaches conveyed by studio masters in the studio. Furthermore, they also revealed the failure to communicate and explicate design knowledge and experience by the expert (studio master).

> *"...he tried to help us. But, sometimes it's very hard to interpret his guideline. For me, his style is difficult for me to understand. The way he talked to me in term of design is too 'high'. It is like I cannot reach his 'level', maybe because he is also the practising architect outside, and that caused me having hard time to understand what he is trying to deliver". - Syaza*

The nature of difficulties and limitations pertaining to the design conceptualisation phase perceived by architectural students like Syaza as well as others are illustrated in Table 1.

Table 1. List of constraints and difficulties faces by the students

Stage	Worries and constraints face	Sub-constraints	Category of difficulties	Domain	Action taken to solve it
Idea development	Construction of the main/initial idea	• Availability of idea in initial stage • Idea acceptance	Knowledge transmission from site to design	Individual differences in abilities	• Refer site analyses, synthesis based • Use own exploration and metaphor • Used the case studies • Flip on design books, websites, magazines
	Adaptation of the case studies into design idea	• Confusion on adapting elements	Critical thinking and problem solving		• Trial and error on circulation, spatial arrangement, shape & façade treatment
Refinement design stage	Iteration and incremental process of idea	• Design have timeframe & limitation • Critique session & feedback	Nature of design process	Student's dilemma and confusion	• Await for critique & consultations with studio master • Generate own justification & proceed • Self-exploration, manipulate concept, reconstruct design & synthesis information • Compare elements and filter the mission option • Isolate and ignore the critique and consultation, proceed with it
		• Overwhelming & pops-up ideas • Uncertain of design needs • Avoid duplication on design • Dissatisfaction in design	Self-satisfaction and decision making		
		• Longer time to approve design concept • Ambiguous guideline in design	Instructor's teaching approach	Management of self-direct and acceptance	• Reconstruct based on feedback • Directly adopted the critique • Justify and make rationale on own design basis • Isolate, ignore and just proceed with own design

Degree of idea maintenance	• Major changes, need to redo • Minor changes on form circulation, orientation, shapes, alignments • If rejected, construct new idea	Self-acceptance

5.2. Conceptualisation process in student's sketches

To understand better the nature of the conceptualisation process as experienced by the architectural students when undertaking studio design tasks, the following illustrations provides a description of the design process with reference to sketches generated by Tan, another mainstream student in the 3rd year studio programme. The student was involved in the task of designing of an empowerment community centre for the autistic youth. During idea development stage, he had directly adopted the metaphorical element on the symbol of the autism awareness ribbon as the key design generator and further manipulated the geometrical curve of 'A' from of the word 'autism' (refer Figure 2 of A1-1). He then transposed the initial metaphorical images into a set of spatial arrangement for his autism centre by assigning three areas of public, semi-public and private spaces for each designated users (refer Figure 2 of A1-2). Later, he also expounded the overarching concept by integrating the areas for support services and treatment needs according based on the various types of autistic groups as well as landscape elements and parking spaces (refer Figure 2 of A1-3).

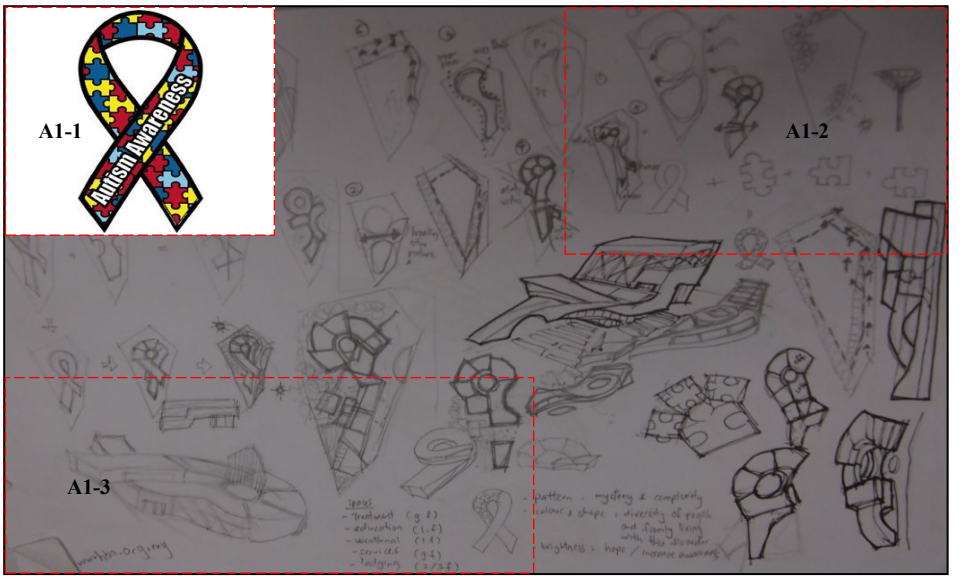

Fig. 2. Example of student's idea development in conceptual design process stage

Source: Student's sketches, Semester 1, Session (2013/2014)

During design refinement stage, the student Tan iterated his conceptual idea through a series of images reinterpretation on the main idea of autism, which is represented by the symbol of an intertwining ribbon,

and geometrical shape of the alphabet 'A'. He transformed the idea as shown in Figure 3 by improving the landscape area that is represented in a circle shape from B1-1 to B1-9. The student also rotated his geometrical shape from the vertical axis towards a horizontal direction. As shown in B1-10 to B1-13, the student later took out replaced the initial circular images representing the landscape areas with a series of pillars to denote the placement of shading devices along the entrance and drop-off area. He had also segregated the landscape spaces throughout the surrounding areas of the conceptual plan, and detailed the other areas such as the parking lots, drop-off area, and interior spaces within the conceptual design (refer Figure 3).

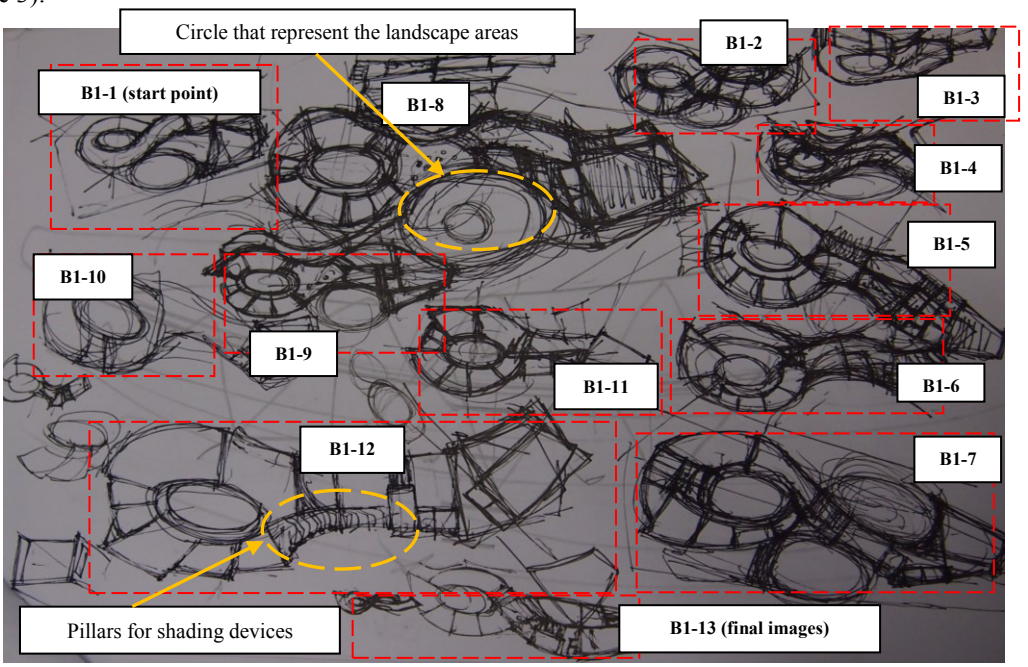

Fig. 3. Example of student's iteration process on the conceptual design

Source: Student's sketches, Semester 1, Session (2013/2014)

5.3. Role of studio critiques in assisting students in producing good conceptual design

For all his effort in generating design supported by sketches illustrated in Figures 2 and 3, Tan had achieved B+ grade in the final assessment of the related design project. Based on a subsequent interview, the student admitted to missing a number of critique and tutorial sessions with the studio master. The student also claimed that he loved to work alone and preferred to explore the feasibility and utility of spaces within the context of his conceptual design in a solitary manner. feeling of the spaces in his conceptual design by his own. This was testified by the studio master. This was testified by the studio master, who had revealed that while the student was very expressive in developing interesting design forms, the latter however appeared to have 'frozen' his conceptual design very early in the design phase and subsequently began to isolate himself from meeting the studio master by missing out on studio critique sessions. The student eventually managed to develop the proposed design from concept stage to final outcome in the process, had responded accordingly to the design requirements as stipulated in the given task. Nevertheless, studio panel assessors later deemed the student's final design work a 'half-

cooked' article while the studio master also observed the lack of overall improvement on the student's design.

6. Discussion

The result revealed that how through the design conceptualisation process, the students were able to transform urban issues and site information in relation to the development of a vacant land to visual ideas through interactive and evolving sketches. These sketches appear to serve as a vital cognitive tool in design. Rough sketches generated by the observed students contained many undefined entities at the start of the brainstorming phase of the idea development. As shown in Figure 2 (A1-1), the students had integrated elements derived from precedence knowledge and established case studies into their design. Due to information synthesis and integration as well as analyses of the site, the students generally explored and manipulated design forms through series of sketches as illustrated in the example of Figure 2(A1-2). At this stage, the students generally incorporated site information from site inventory analysis while adopting specific features of selected case studies like circulation configurations, spatial arrangements, and facade treatment into their main conceptual idea. Tutorial feedbacks from studio masters helped refine those sketches as well as concepts and ideas gradually into improvised and integrated design form. As revealed in Figure 3, studio critiques facilitated iterative processes that aided development of design forms. Iterative processes that comprises of backward analysis and forward synthesis of site information, case studies, and precedence ensured the critical and constructive improvement of the main conceptual idea. In addition, such processes further enhanced the parameters of design functionalities and requirements while providing greater degree of scrutiny and detailing to design forms.

Students' interviews in Section 5.1 suggested there were individual differences in the way student perceive design information, conceive design approaches and strategies as well as undertake ideation activities. These are internal factors that potentially influence the students' overall conceptualisation process in design. However, they also reveal certain students' limitations is due to knowledge proficiency, technical ability, understanding complex design stages, and formulating design requirements. Yet, the architectural studio inherently provides a very good environment for inculcating effective design process. It is where novice students can elicit greater understanding and assimilate the experiences of experts among studio masters through a unique learning mechanism called the studio 'critique'. These could significantly enhance the conceptualisation process in design.

Critique sessions (known also as 'crits') provide vivid and productive interactions between students and their studio masters on key issues pertaining to the related design project. For example, differentiated knowledge and understanding exchanges about the conditions of the site and user requirements between student and studio masters should trigger progressive expansion of the original design concept by the former. The examples of sketches illustrated in the study also reveal some evidence as to the vitality and rigour of the conceptualisation processes experienced by the students as transpired from studio critiques. Generally, students who actively explored, iterated, and participated regularly in studio critique sessions were observed to be more adept to transforming abstract ideas into physical design forms. Regular reviews by the studio master aided the students' effort in expanding their ideas and reforming the course of design. On the other hand, risk an outcome similar to a student cited earlier who had unwittingly ignored subsequent studio 'crits' with the studio master following premature termination of the conceptualisation process during designing. As in the case of the student's studio critique attendance, having a chequered outlook reflected rather unfavourably in the overall grading and evaluation by corresponding studio masters.

To produce good design, the students need to diligently undertake all activities within the conceptualisation phase of design. Those activities begin with 'brainstorming', an activity that frames initial concepts and ideas for a future scheme to be constructed upon based on abstract knowledge as well as the student's and studio master's previous experiences in dealing with site analyses (Stage 1). This knowledge is routinely verified with the related precedence and case studies (Stage 2), assimilated progressively into part and overall design based on elements and issues of personal preference (Stage 3), as well as validating design needs and requirements (Stage 4). Concepts and ideas become more refined as stages 1-4 iterates progressively during the period of development through activities like sketching, manipulating, and tracing of design forms (Stage 5). Sketching activities, in particular, supports the problem solving process through clarifying of reasons and functionalities, synthesising and reconstructing of new ideas, as well as the exploring forms and patterns (Goldschmidt, 1991). Conversely, knowledge transformed is refined further through studio critiques as well as the expansion of forms by synthesis feedbacks and self-exploration (Stage 6). This gradual activity of knowledge integration is known as the infiltration process (Figure 4).

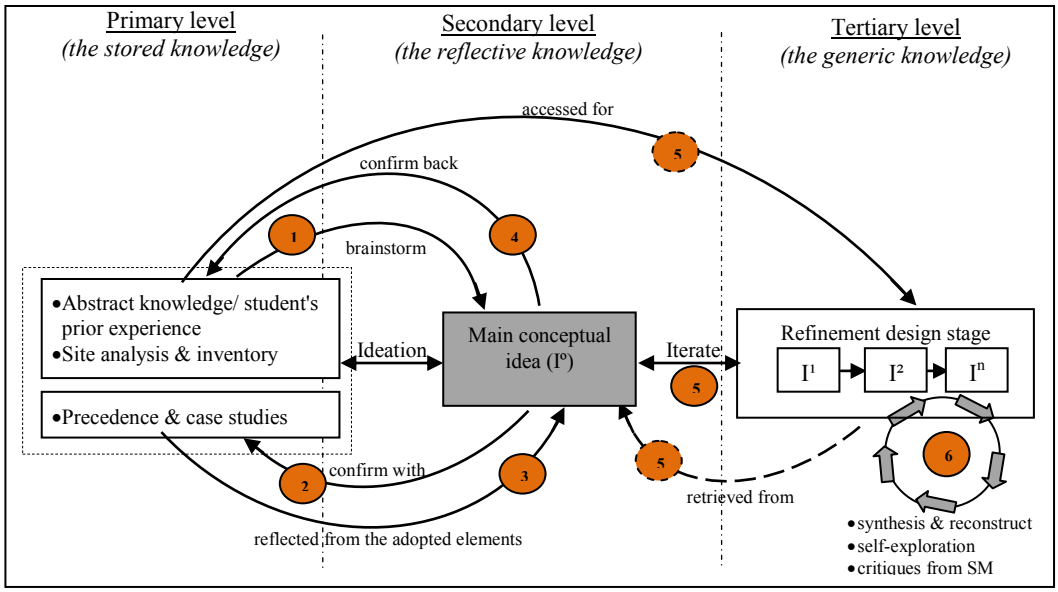

Fig. 4. Infiltration activities on knowledge in a conceptualisation design process in studio learning environment

7. Conclusion

It appears that the design conceptualisation process within the studio learning environment plays a major role in knowledge integration from the abstract into the physical form. This knowledge integration correlates with the domain of the stored knowledge in the student's mind, while reflective knowledge results in the transformation of the conceptual idea of Iº (initial conceptual plan) into a series of reinterpreted images (I1, I2, In). The next level described design refinement activities based on augmented feedbacks by experts like studio masters, thereby transforming reflective knowledge into a new form of generic knowledge. In the current study, students construct different pattern of conceptualisation process under the influenced of four factors. These factors are (i) student's prior knowledge, (ii) access to knowledge in the form of critique, synthesis knowledge, and self-exploration,

(iii) the ways students perceived difficulties and complexity of the design task, and (iv) the internal factors in the individual differences that vary in term of learning style and preference, design abilities, and the communication skill. Methods pertaining to the current conceptualisation study can thus be applied on other types of design studio as means for evaluating the significance of knowledge integration among students during design. This study generates clearer understanding on reflective knowledge and provides framework for design educators to assist and nurture the student's abilities in designing within the studio learning environment.

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References

Ahmed, S., Wallace, K. M., & Blessing, T. M. (2003). Understanding the Differences Between How Novice and Experienced Designers Approach Design Tasks. *Research Engineering Design*, *14*, 1–11. doi:10.1007/s00163-002-0023-z

Alpopi, C., & Manole, C. (2013). Integrated Urban Regeneration – Solution for Cities Revitalize. *Procedia Economics and Finance*, *6*(13), 178–185. doi:10.1016/S2212-5671(13)00130-5

Batuman, B., & Altay, B. D. (2014). Critique by design: Tackling urban renewal in the design studio. *Urban Design International*, (January), 1–21. doi:10.1057/udi.2013.40

Cross, N. (1982). *Designerly Ways of Knowing* (Limited Ed., p. 6). Springer-Verlag London.

Cross, N. (1990). The nature and nurture of design ability. *Design Studies*, *11*(3), 127–140. doi:10.1016/0142-694X(90)90002-T

Goldschmidt, G. (1991). The Dialectics of Sketching. *Creativity Research Journal*, *4*(2), 123–143.

Kavakli, M., & Gero, J. S. (2001). *Strategic Knowledge Differences Between an Expert and a Novice Designer* (pp. 1–10). Sydney.

Kavakli, M., Suwa, M., Gero, J., & Purcell, T. (1999). Sketching Interpretation in Novice and Expert Designers. In B. Gero, J.S. Tversky (Ed.), *Visual and Spatial Reasoning in Design* (pp. 209–220). Cambridge: Key Centre of Design Computing and Cognition, University of Sydney.

Kolb, D. . (1984). Experiential learning : experience as the source of learning and development. In E. Cliffs (Ed.), *Learning from Experience* (2006th ed., pp. 19–38). New Jersey: Prentice-Hall. Retrieved from http://www.learningfromexperience.com/images/uploads/process-of-experiential-learning.pdf

Lawson, B. (2004). Schemata, gambits and precedent: some factors in design expertise. *Design Studies*, *25*, 443–457. doi:10.1016/j.destud.2004.05.001

Lawson, B. (2006). *How Designers Think: The Design Process Demystified* (4th Editio.). United Kingdom: Architectural Press.

Lim, H., Kim, J., Potter, C., & Bae, W. (2013). Urban regeneration and gentrification: Land use impacts of the Cheonggye Stream Restoration Project on the Seoul's central business district. *Habitat International*, *39*, 192–200. doi:10.1016/j.habitatint.2012.12.004

Menezes, A., & Lawson, B. (2006). How Designers Perceive Sketches. *Design Studies*, *27*, 571–585. doi:10.1016/j.destud.2006.02.001

Osterman, K. F. (1990). Reflective Practice: A New Agenda for Education. *Education and Urban Society*, *22*(2), 133–152. doi:http://eus.sagepub.com

Purcell, T., & Gero, J. S. (1998). Drawings and the Design Process. *Design Studies*, *19*, 389–430.

Raco, M. (2003). Assessing the discourses and practices of urban regeneration in a growing region. *Geoforum*, *34*(1), 37–55. doi:10.1016/S0016-7185(02)00040-4

Schon, D. A. (1983). *The Reflective Practitioner. How Professionals Think in Action* (1995th ed.). New York: Basic Books.

Schon, D. A., & Wiggins, G. (1992). Kinds of Seeing and Their Functions in Designing. *Design Studies*, *13*(2), 135–156.

Suwa, M., Gero, J., & Purcell, T. (1998). Analysis of cognitive processes of a designer as the foundation for support tools. *Artificial Intelligence in Design '98* (pp. 229–247). Springer Netherlands. doi:10.1007/978-94-011-5121-4_12

Suwa, M., Gero, J., & Purcell, T. (1999). Unexpected discoveries: how designers discover hidden features in sketches. *Key Centre of Design Computing and Cognition* (pp. 145–162). New South Wales: Key Centre of Design Computing and Cognition; Department of Architectural and Design Science. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/versions?doi=10.1.1.25.7068

The Design Society. (2011). Concept Phase: Conceptual Design Curriculum. *The Design Society*. Retrieved March 20, 2013, from http://www.bath.ac.uk/idmrc/themes/projects/delores/co-design-website/teachers/curriculum/conc/curric.html