Journal of
Design Studio
v:3 n:2 December 2021

The Interpretation of Graphical Features Applied to Mapping SWOT by the Architecture Students in the Design Studio

Rahman Tafahomi
Department of Architecture, School of Architecture and Built Environment, College of Science and Technology, the University of Rwanda, Rwanda

Reihaneh Nadi
Independent Researcher, Rwanda

Received: November 4th 2021, Accepted: December 11th 2021.
Refer: Tafahomi, R., Nadi, R., (2021), The Interpretation of Graphical Features Applied to Mapping SWOT by the Architecture Students in the Design Studio, Journal of Design Studio, V.3, N.2, pp 205-221,
R. Tafahomi ORCID: 0000-0002-7172-1302, R. Nadi ORCID: 0000-0002-8005-7028
DOI: 10.46474/jds.1019310 https://doi.org/10.46474/jds.1019310

Abstract: The purpose of this study is to gain an understanding of how the architecture students deploy a range of graphical features to visualize SWOT, standing for Strengths, Weaknesses, Opportunities, and Threats. Architectural design studios provide students with a range of analytical techniques, and SWOT analysis is considered to be useful and effective, particularly at urban-scale design projects. However, it is a text-based framework and needs to be converted to thematic analysis maps across architecture and design fields. The main issue is that the determining factors affecting the way in which students choose graphical features to map the outputs of SWOT analysis is unclear at architectural design studios. The research employed qualitative methods, specifically observation, focus group, and graphical analysis, to examine SWOT maps produced by the architecture students. The findings demonstrated that the selection of graphical features in the process of producing SWOT analysis maps are dependent on scale of study (macro, meso, and micro), as well as location, spatial connection, and size of elements derived from SWOT matrix. For instance, lines and planes were most frequent features at macro level while the variety of symbols remarkably increased at micro level. In conclusion, the students personalized the process of mapping, meaning that they applied point, line, plane (shape), color, texture, and typography in several different ways. Therefore, SWOT analysis not only help architecture students to better understand the problems of their design projects, organize and consolidate information, and visualize opportunities and constraints, but could lead to the representation of realistic solutions in an innovative way.

Keywords: Architectural Design Studio, Graphical Features, Graphical Techniques, SWOT Map.

Introduction

Graphical techniques are applied to the process of analysis and presentation in built environment studies, particularly in academic settings such as studios and classes (Moughtin, Cuesta, Sarris, & Laurea, 1999). The fourth-year architectural design studio focuses on urban and pre-urban scale projects in the bachelors program, department of architecture at the University of Rwanda. Both students and instructors apply relevant methods and techniques with the architectural research and urban scales in the studio to meet the learning objective of the course (FAED, 2009). Architectural design

studios include a variety of methods and techniques such as architectural research methods and approaches (Faryling, 1993; Groat & Wang, 2002; Moughtin, Cuesta, Sarris, & Laurea,1999) behavioural sitting (Zeisel, 1984; Bonnes & Bonaiuto, 2002), sociology and interaction between groups (Altman & Chemers, 1984; Madanipour, 1996), economy aspects (Carmona, 2001), politic (Tschumi, 1997), public and private relations (Alexander & Chermayeff, 1965; Madanipour, 2003), and urban environment and sustainability (Thomas, 2002).

SWOT (Strengths, Weaknesses, Opportunities, and Threats) tends to be deployed in design studios, particularly in urban planning, urban design, and architecture for research, analysis, and policymaking. It has its origins in business and management fields, going back to 1950s (Sevkli, Oztekin, Uysal, & Torlak, 2012). However, this technique should be closely aligned with objectives, outputs, and processes of studios such as drawing, analysing, conceptualising, and designing.

Problem Statement

SWOT analysis is considered to be useful in a range of fields such as science, business, technology, urban and regional planning and design (Moughtin, Cuesta, Sarris, & Laurea, 1999; Ercoskun, 2012). Raw data can be collected through other methods and techniques such as content analysis (Krippendorff, 2012), structured observation and site analysis (White, 1983; Moughtin, Cuesta, Sarris, & Laurea, 1999; Groat & Wang, 2002). The studies highlighted that the outputs of SWOT are a little far from both graphical methods (Dandekar, 1988; Laseau, 2000; Lawson, 2005), and the research by design approaches (Faryling, 1993), meaning limitations on applications of SWOT in mapping processes (Ghazinoorya, Abdia, & Mehrb, 2011). As a result, SWOT analysis needs to be adapted to suit the graphic representation architectural design studios.

SWOT is normally a text-based technique (Pavelsky, et al., 2014) with a few details about locations as a reference point (Lee, Yuan, Jung, & Beighley, 2015), which could cause deficiencies (Ghazinoorya, Abdia, & Mehrb, 2011; Tafahomi & Lamit, 2011) in analysis stages such as site reconnaissance, site analysis, observation, and mapping. However, architectural design studios are mainly based on the graphical styles (Moughtin, Cuesta, Sarris, & Laurea, 1999) including sketching, drawing, mapping, and design (Laseau, 2000; Groat & Wang, 2002) to refer to a specific location. According to the importance of accuracy and level of precision data in the analysis phase, students have to produce maps based on the location using graphical techniques (Taketa, 1996) as a hybrid approach (Kurttila, Pesonen, Kangas, & Kajanus, 2000) to fit with architectural design studios. Seemingly, the text could create generality rather than specification with a reference point.

Although Moraes et al. (2014) introduced SWOT as a process of mapping and demonstrating documents, another study criticised the application of SWOT as an inappropriate tool to present data such as location, scale, size, and form by architecture students (Harwood & Rawlings, 2001). This specification of SWOT has affected the level of self-perception about the form of place (Relph, 1976), context of analysis (APA, 2006), and environment issues (Reed, 2012; Kim & Kim, 2015) by researchers.

Studies showed students their enhanced contextual knowledge through the personal mapping process (Okebukola, 1992), even with a simple drawing (Taketa, 1996; Tafahomi, 2020), or a freehand-based mapping to better perception about the context of the study (Metz, 1990; Reed, 2012) through the development of design thinking (Goldschmidt, 1992). The process of mapping helps students to better perceive the context (Umek, 2003; Pearsalla, et al., 2014; Kim & Kim, 2015) although Cho criticized the non-graphical outputs of students without graphical productions in terms of creativity and innovation (Cho, 2017) at design studios.

In fact, mapping is one of the significant aspects of the learning process, particularly in architectural design studios since it can reflect attributes of data such as location, size, and form in the whole process of the studio, including analysing, conceptualising, and designing. In this regard, SWOT as a text-based framework can support drawings, maps, and graphics. Therefore, there is necessity to convert those non-graphical data into graphical maps to enhance the level of learning in studios. In other words, architectural studies illustrate different aspects of data such as shape, form, and quality in the mapping process through graphical drawing and design (Ching, 2010). The mapping process requires graphical creativity such as symbols for an explanation of urban features (Shive & Francis, 2008) as representative of data (Gasselt & Nass, 2011) and colours (Brewera, MacEachrena, Pickleb, & Herrmann, 1997; Parker, 2006). Symbols are combined with figure (Trancik, 1986), figurative elements (Goldschmidt, 1991), diagrammatic and compositional (Tschumi, 2014), abstraction and schematic representation (Laseau, 2000). Point, line, polygon, and colours are the common graphical features to represent spatial objects on a map (Dua, Fengb, & Guoc, 2015; Tafahomi, 2021), which have been emphasised as the main element of graphical drawing by Ching (Ching, 2010). Therefore, the structure of SWOT could be harmonised with the mapping process and production through appropriate graphical techniques such as symbols and tones of the colours (Brewera, MacEachrena, Pickleb, & Herrmann, 1997).

The main question of this paper is how the students apply graphical features to mapping the non-graphical data at the architectural design studio? To discover determining factors, the process mapping SWOT by the students was carefully observed and interpreted.

Relevant Studies on SWOT and Mapping

SWOT has been used in industrial and marketing activities (Sevkli, Oztekin, Uysal, & Torlak, 2012) as internal and external assessment (Jessica, Kruse, & Miller, 2015), and it has since developed as a synthesis of research for higher analysis, or meta-analysis (Vermeersch & Vandenbroucke, 2014). SWOT can also serve systematic assessing, analysing, and formulating conditions and strategic decision-making (Dyson, 2004) and currently, it has been widely applied to diffident fields (Sevkli, Oztekin, Uysal, & Torlak, 2012).

There are varieties of studies about SWOT from different perspectives. For instance, a study highlighted SWOT as a meta-analysis level to summarise and re-categorise other research techniques (Vermeersch & Vandenbroucke, 2014) although Pavelsky and colleagues argued that SWOT has limitations in the experimental analysis (Pavelsky, et al., 2014). Moreover, other studies recommended that SWOT can be integrated with other techniques such as AHP (Analytic Hierarchy Process) (Kurttila, Pesonen, Kangas, & Kajanus, 2000; Etongo, Kanninen, Epule, & Fobissie, 2018), ANP (Analytic Network Process) (Sevkli, Oztekin, Uysal, & Torlak, 2012), and experimental inquiries (Pavelsky, et al., 2014), perception and feelings (Curtis, 2012), ecosystem and environment (Scolozzi, Schirpke, Morri, & D'Amato, 2014), and geography (Kalafsky & Sonnichsen, 2015) as a complementary technique. Another group of studies criticized that SWOT includes deficiencies that application of SWOT requires to be developed through other methods (Ghazinoorya, Abdia, & Mehrb, 2011), which was recommended a hybrid method for increasing the usability of SWOT (Kurttila, Pesonen, Kangas, & Kajanus, 2000).

Despite analytical ability, studies challenged SWOT in the mapping process. For example, Tafahomi attempted to represent the perception perception of inhabitants about the urban heritage elements through the graphical features although the level of the precision was not accurate (Tafahomi, 2021). Lee and colleagues (2015) mentioned that the

application of SWOT in mapping production challenges the mind of the researcher to discover new approaches to modify the key items in the matrix with spatial structure, which Fadel and colleagues highlighted the limitation of SWOT for covering data in specific areas (Fadel, Rachid, El-Samra, & Boutro, 2013). Non-graphical data have challenged researchers in the mapping process in terms of graphical representation. For example, Pearsalla and colleagues (2014) discovered that students have had a personal perception about the environment, so in converting the verbal information into spatial and mapping, they create their own idea in the mapping process. Particularly, freehand drawing has proved an increase in the level of learning in the mapping process (Umek, 2003) through location, shape, size in terms of important factors for students (Harwood & Rawlings, 2001). Choosing symbols and colours on the map has had a significant role in making visible data (Shive & Francis, 2008) and showing attributes of maps based on the readability of maps with colours such as purple/green (Brewera, MacEachrena, Pickleb, & Herrmann, 1997). Mapping SWOT needs appropriate symbols as a code (Gasselt & Nass, 2011) to graphically illustrate data (Otto, Gustavsson, & Geil, 2011) in terms of spatial objects (Dua, Fengb, & Guoc, 2015). In this case, studies also showed, there is a mutual process between decoding and coding environmental aspects in the process of mapping (Kim & Kim, 2015), which Reed highlighted the effective influences of the mapping process on the quality of learning among students (Reed, 2012).

Results of another study theorized that a conceptual map as a meta-learning tool could promote problem-solving skill individually and collectively between students (Okebukola, 1992) and this process of cooperative mapping was also mentioned in another study in terms of the open-street-mapping (Panek, 2015). Freehand sketching and mapping have provided a profound understanding of context of the study, also represented the meaning of the effectiveness (Metz, 1990). In this case, the quality of sketch-mappings has been less important than the estimation and measurement process of location, distances, and scales by students (Taketa, 1996). Designers applied freehand sketching to both figurative and nonfigurative forms (Goldschmidt G. , 1991) and diagrammatic and compositional drawing (Tschumi, 2014). Goldschmidt highlighted that although a sketch could not explain all aspects of the image and assumption of the designer for problem solving, this sketching process leads the designer to discover gradually an image about the entire project (Goldschmidt, 1992). Additionally, studies have shown that the results of expert opinions in the mapping process could provide validity and necessity in the mapping productions (Chu, Gao, Qiu, Li, & Shao, 2010) through graphical illustration based on design thinking and problem-solving process.

Methods and Materials

The methods and materials consist of methodology, research design, research process, research limitation, and the application of the methods as below:

Methodology

The methodology of the mapping process is connected with a range of studies. The first groups of the studies emphasized the graphical features, techniques, and ability to apply data in the mapping process (White, 1983; Laseau, 2000; Lawson, 2005; Ching, 2010; Tafahomi, 2021). The studies also advocated the geographical techniques to apply to the mapping and visualization data in analytical maps (Dua, Fengb, & Guoc, 2015; Jiang, 2015). Some studies referred to the qualitative methods in the application of data in the mapping and visualization process (Groat & Wang, 2002; APA, 2006; Neuman, 2009). In addition, the application of the techniques in the classroom was discussed to emphasize the process of the acquisition of knowledge by the students (Goldschmidt, 1991; Goldschmidt, 1992; Otto, Gustavsson, & Geil, 2011; Tafahomi, 2020; Tafahomi, 2021). Some research presented the integration of the graphical and nongraphical data with the mapping process (Brewera, MacEachrena,

Pickleb, & Herrmann, 1997; Curtis, 2012; Ercoskun, 2012; Fadel, Rachid, El-Samra, & Boutro, 2013; Kalafsky & Sonnichsen, 2015).

Research Design

The study employed qualitative methods (Neuman, 2009) including experimental approaches (Groat & Wang, Architectural research methods, 2002), focus group specifically the students (Neuman, 2009; Silverman, 2004), and emphasising interpretation of data (Groat & Wang, 2002). The research applied the systematic observation of the students' analysis activities using graphical techniques (Dandekar, 1988; Groat & Wang, 2002; Tafahomi, 2009; Neuman, 2009; Tafahomi & Nadi, 2020) to interpret (Mugerauer, 1995; Krippendorff K. H., 2012) SWOT as a technique having potential to be applied to the mapping process. The significant criteria were location, boundary, shape, and scale (Jiang, 2015; Tafahomi, 2021), which were presented through graphical features, such as point, line, polygon, colour, and symbol (Dua, Fengb, & Guoc, 2015). More importantly, there was an interpretative process of visualization of data, personalization of graphical features, and presentation of thematic and integrative maps. Figure 1 represents the relations between criteria, methods, and research outputs.

Research Process: the research involved active observation of students' activities to develop SWOT in the design studio during one semester in three stages of the assessment including Macro, Meso, and Micro mapping. To apply the method to a real project, the students were introduced to graphical techniques, illustration, symbol, and mapping process by the graphical features and techniques to demonstrate their analytical ideas based on the application of graphic in architecture and design literature (Moughtin, Cuesta, Sarris, & Laurea, 1999; Groat & Wang, 2002; Oxman, 2004; Lawson, 2005; Ching, 2010; Tafahomi & Nadi, 2016; Tafahomi & Nadi, 2020; Tafahomi, 2021).

To engage the students as the focus group in the research, 25 students were divided into 4 groups around six members. They participated in mapping SWOT analysis. They analysed a specific area using thematic layers such as spatial, functional, perceptual, visual, and other essential layers (Moughtin, Cuesta, Sarris, & Laurea, 1999; Groat & Wang, 2002; Tafahomi, 2014). For this reason, the students visited the site to collect data through structured observation (Tafahomi & Nadi, 2016; Tafahomi & Nadi, 2020), survey (Neuman, 2009), and site analysis (Groat & Wang,

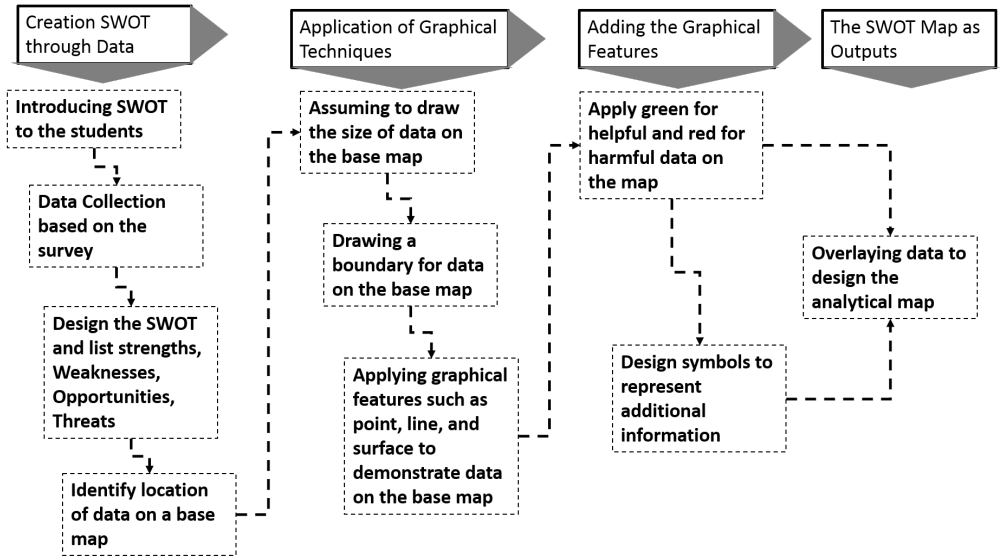


Figure 1: *Methodology of the Research*

2002). Secondly, all data were arranged (Reed, 2012; Kim & Kim, 2015) to develop SWOT matrix based on the students' perception and interpretation (Mugerauer, 1995; Krippendorff, 2012). Thirdly, the students identified the location of data on a map as placement of the data (Relph, 1976; Hedman & Jaszewski, 1984; Miller, Dingwall, & Morphy, 2004). Fourthly, the students transfigured data on a base map with some figurative elements importantly point, line, and polygon (Dua, Fengb, & Guoc, 2015; Tafahomi, 2021) regarding their own perception of location, size, and shape (Dandekar, 1988; Laseau, 2000; Tafahomi, 2009; Fadel, Rachid, El-Samra, & Boutro, 2013; Jiang, 2015). Fifthly, they designed iconic symbols to represent additional information on the base map (Otto, Gustavsson, & Geil, 2011; Kim & Kim, 2015). Sixthly, the students applied colours to distinguish the site-specific harmful and helpful elements on the map (Brewera, MacEachrena, Pickleb, & Herrmann, 1997; Shive & Francis, 2008; Gasselt & Nass, 2011), and finally the students overlaid data and thematic layers to produce SWOT map (Metz, 1990; Okebukola, 1992; Taketa, 1996). The aforementioned process was listed in the handout as the following items in Figure 2:

1. Create your own SWOT (Strengths, Opportunities, Weaknesses, and threats) based on the thematic layers of analysis
2. Map and specify the location, size, and boundary of data on the base map
3. Illustrate data on the map with visual features such as point, line, and polygon.
4. It is recommended to apply green colour for elements seen as helpful to the site and red colour for harmful ones with colors of spectrum showing intensity.
5. Overlay thematic layers and symbols to represent an analytical map.
6. Design and add symbols to express additional meaningful aspects on the map

Research Limitation: The research took the place in the fourth-year architectural design studio, where the students were introduced to urban scales such as Macro, Meso, and Micro based on freehand drawing, so, the possible effects of digitization on the process of the mapping were not evaluated. The students did analysis in seven weeks from the macro to micro-scale, and results could have been affected by extending time and duration of

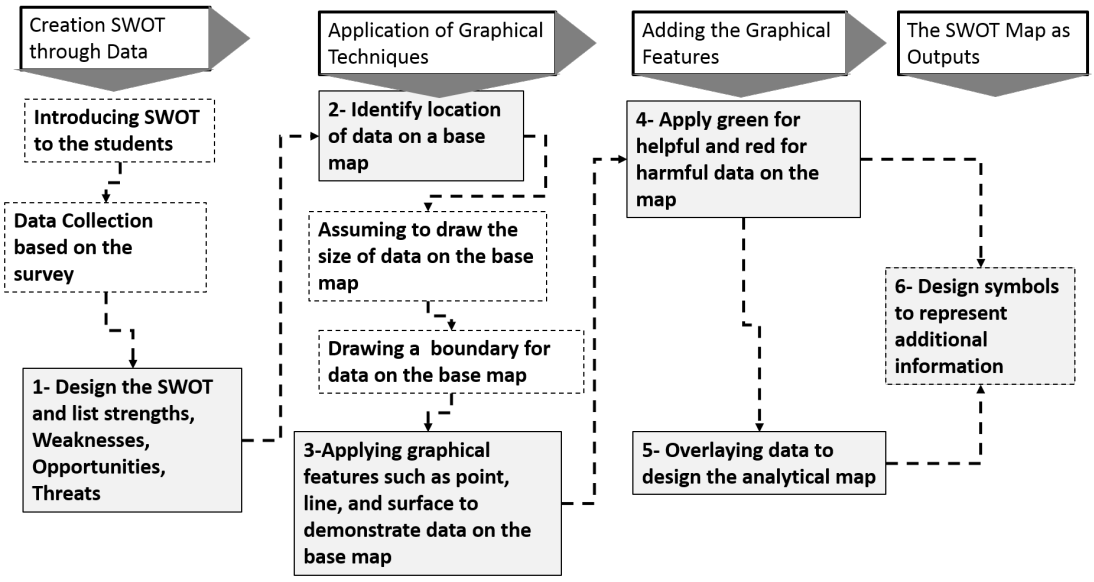


***Figure 2**: The Research Process in the Studio*

analysis on the application of graphical tools, techniques, and approaches.

Application of the methods: the students analysed wetlands at three levels including Macro, Meso, and Micro. For this activity, the students were arranged into four groups and each group collected data based on scales. At macro level, the students applied schematic mapping techniques to represent maps with a scale of 1/25000. They subsequently analyzed data with a scale of 1/10000 at meso level and from 1/5000 to 1/2000 at micro level. To collect accurate location-based data, they visited the site study and carried out survey. Consequently, the students received comments, critical points, and suggestions from instructors, other groups, and their own group members to revise, develop, and illustrate outputs in each stage of presentations.

The studio was held three times per week, and in each session; groups of the students presented the data, sketches, drawings, and maps for the desk critiques, suggestions, and discussion. Each group had time to revise the drawings and prepare the next presentation. The students explained the mapping process based on data, symbols, and logic in each presentation, the instructors and other groups criticized the presentation. Each scale of analysis such as macro, meso, and micro took two weeks of activities importantly five desk critiques and two presentations in the studio.

Analysis of the Results

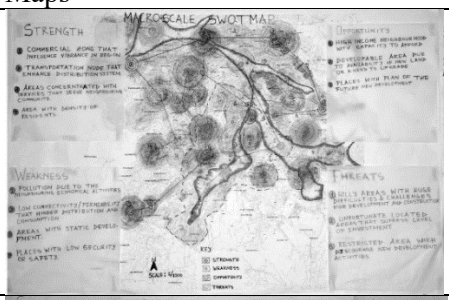
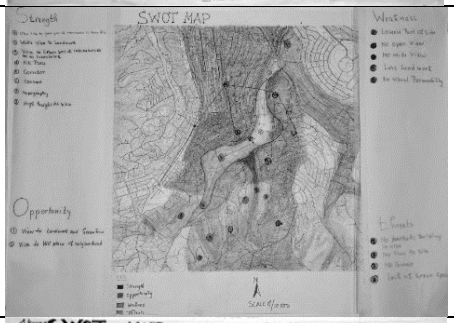
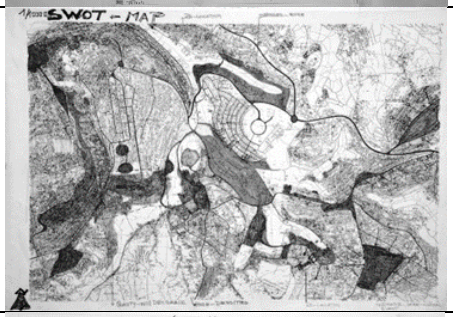
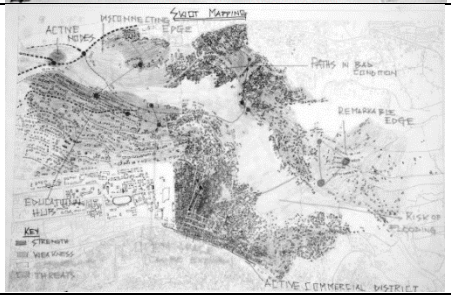
Tables 1, 2, and 3 demonstrate the graphical outputs of the students on three different scales, namely macro, meso, and micro, and table four and figure three compare the application of the graphical features on those scales.

Macro-scale specifications: the students applied polygon more than point and line on this scale. In other words, details of data were converted to the polygon (shapes) than other features. The application of tones of colours was more obvious than various colour on the scale, meaning a prodominent role of scale in comparison with diversity of data. In summary, three items applied frequently, namely polygon (planes), tones, and the overlaying technique as Table 1.

Meso-scale specification: the students applied graphical features in a modest way without any specific tendency. Indeed, the students mapped information and data in an average combination of the graphical features to discover visibility, and accuracy of graphical techniques. The maps reflected general information on marco scale and some parts with more detail referred to the micro scale. Table two represents the mapping presentation.

Micro-scale specifications: the students changed their approaches in the mapping data in micro-scale radically. The students highlighted some graphical features on this scale particularly lines, colours, and symbols in the mapping representations. The detailed data enabled the students to reflect the contrast, differentiation, and comparison of data in the mapping process, which was not possible in the other scales as Table 3 presents the productions.

***Table 1**: Application of Graphical Technique in the SWOTMAPPING Process, Macroscale*

No	Applied techniques by students	Maps
1	*Applying Visual Features:* Using points and lines as major forms of representation *Boundary:* using circles as boundary of the activities *Symbols:* no noticeable symbols in presentation *Illustration:* applying circles as the form of representation	
2	*Applying Visual Features:* Using points and polygons and some short lines to express analysis *Boundary:* using the roads as the boundary of those polygons. *Symbols:* no noticeable symbols in presentation *Illustration:* Using a wide range of surfaces based on the morphology	
3	*Applying Visual Features:* Using polygon as the context of analysis to express analysis *Boundary:* using the roads as the boundary of those polygons. *Symbols:* no noticeable symbols in presentation *Illustration:* Using different tons of red and green in the presentation of surfaces.	
4	*Applying Visual Features:* Using the large scale polygons to express analysis *Boundary:* using of the roads and topography as the boundary of those polygons *Symbols:* no symbols in presentation *Illustration:* Using different tons of red and green in the presentation of surfaces	

The scale was the important factor to apply different graphical features in the mapping process by the students. For example, the students applied points, buffer for the boundary, and overlaying technique more at macro-scale and meso-scale than micro-scale. However, line was more applicable to the micro-scale. The students applied both colour and tone with a limited variety on different scales. They were more adapted to define symbols on the detailed scales especially micro-scale than macro-scale in the mapping process. Therefore, these results identified the overlaying technique, buffer of boundary, and point features were more capable of the macro-scale although symbols and lines were more adopted to micro as Table 4.

Table 2: *Application of Graphical Technique in the SWOTMAPPING Process, Meso-scale*

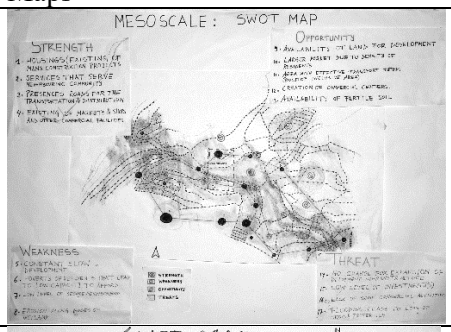
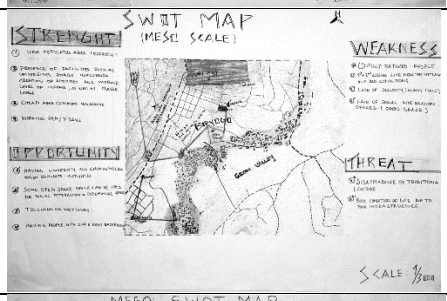
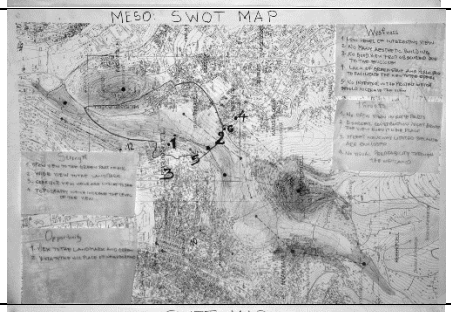
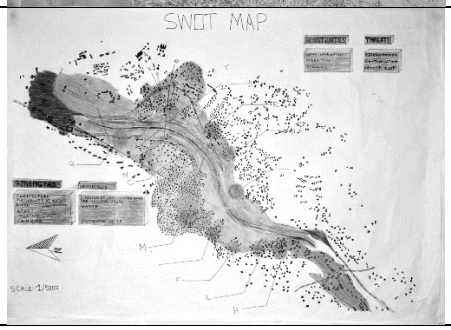
No	Specifications	Maps
1	*Applying Visual Features:* Using points and lines as major features in the representation *Boundary:* using the roads as the boundary *Symbols:* no symbols in presentation *Illustration:* figure and ground with the polygon and point used for the illustration	
2	*Applying Visual Features:* Using lines as major features in the representation *Boundary:* using the roads and wetlands as the boundary *Symbols:* no symbols in presentation *Illustration:* Applying polygons with different characteristics	
3	*Applying Visual Features:* polygons with the different tones *Boundary:* other polygons *Symbols:* no symbols in presentation *Illustration:* Applying polygons with different characteristics	
4	*Applying Visual Features:* Applying polygons and lines with different characteristics, Boundary: *Symbols:* Using the lines as major symbols in the representation *Illustration:* integration of tones of red and green to represent different meanings	

Table 3: *Application of Graphical Technique in the SWOTMAPPING Process, Micro-scale*

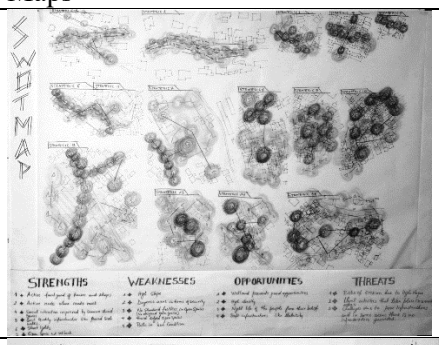
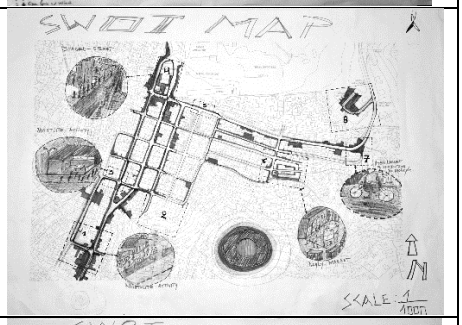
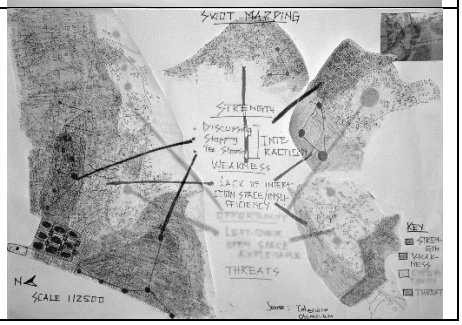
No	Specifications	Maps
1	*Applying Visual Features:* applying of the point in different compounds to achieve line and polygon illustration *Boundary:* unclear *Symbols:* applying tones of colours as the symbols *Illustration:* overlying points in varieties of size to form lines and polygons with diverse colours and tones Integration between texts and graphical symbols	
2	*Applying Visual Features:* applying lines as major features *Boundary:* unclear *Symbols:* sketches as symbols in presentation *Illustration:* some detailed sketches applied as the detailed symbols for the specific areas	
3	*Applying Visual Features:* using the lines and polygons as major graphical features in the presentation *Boundary:* applying the street as the line of boundary *Symbols:* using the combination of polygon and colour as symbols *Illustration:* integration of the polygon with overlaying	
4	*Applying Visual Features:* integration of all graphical features in the presentation *Boundary:* unclear *Symbols:* using the combination of line, polygon and colour as symbols *Illustration:* integration of the polygon with overlaying	

Table 4: *Comparison of Graphical Techniques in the Scale-Based Mapping Process*

No	Scale	Applied Elements in the Maps	Point	Line	Polygon	Colours	Tones	Symbols	Overlying	Texts links	Boundary
1	Macroscale	Group one	√	√	√	√	√		√	√	√
2		Group Two	√	√	√		√		√	√	√
3		Group Three	√	√	√	√	√		√		√
4		Group Four			√	√	√		√		
Ferequencies in Macroscale			3	3	4	3	4	0	4	2	3
1	Mesoscale	Group one	√	√			√		√	√	√
2		Group Two	√	√	√		√		√	√	√
3		Group Three			√	√	√	√	√		
4		Group Four	√	√	√	√	√	√			
Frequesncies in Mesoscale			3	3	3	2	4	2	3	2	2
1	Microscale	Group one	√	√	√	√	√	√	√	√	
2		Group Two		√		√		√			
3		Group Three		√	√	√	√	√		√	√
4		Group Four	√	√	√	√	√	√	√	√	
Frequesncies in Microscale			2	4	3	4	3	4	2	3	1

Figure three shows applying the graphical features and techniques for comparison with the three scales. Despite a variety of application of the graphical features in the scales, the figure illustrated a deep inconsistency in the application of the graphical techniques and graphical features due to scales.

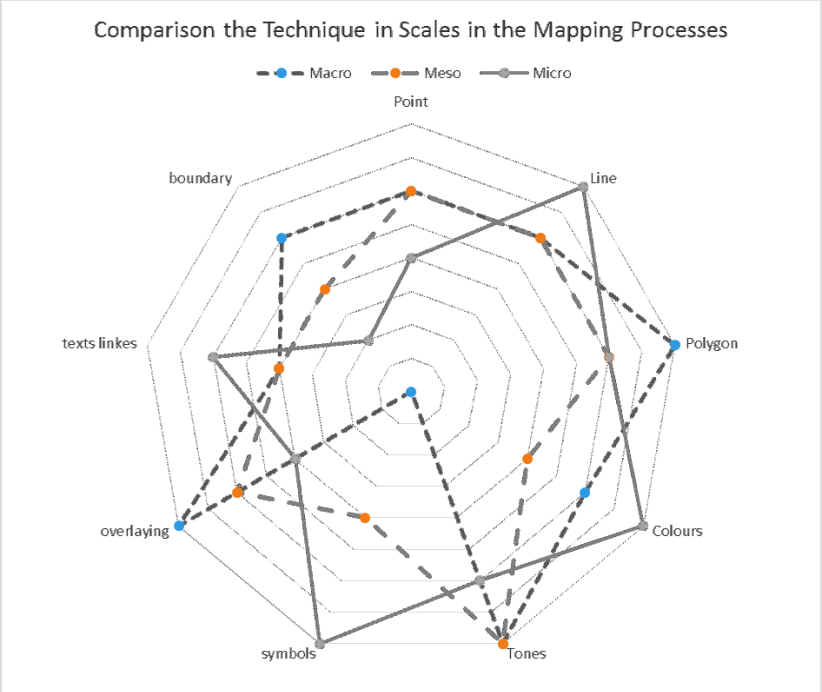


Figure 3: *Level of Application the Graphical Items in the Mapping Processes*

Discussion

Results of the study identified that the application of graphical techniques regenerated graphical outputs of SWOT to represent graphical maps in the architectural design studio. This output supported the ideas of Laseau (2000), Lawson (2005), and Ching (2010) as the application of graphical techniques in terms of a way of thinking through a graphical approach. The application of the graphical techniques in SWOT not only introduced the students to other approaches to represent graphical data but also helped the students to understand the value of the deep analysis of text-based data with effective results on the learning outcomes in the design studio. This result covered the arguments put forward by Fadel, Lee, Kim and colleagues about the absence of the use of location-based data and attributes at design studios (Fadel, Rachid, El-Samra, & Boutro, 2013; Lee, Yuan, Jung, & Beighley, 2015; Kim & Kim, 2015). The mapping process of SWOT regenerated the application of the graphical techniques based on the scales that supported the idea of Ghazinoorya (2011).

Mapping SWOT analysis confirmed both theories of graphical techniques and structure of Harwwod and Rawling (2001) and Laseau (2000) based on symbol, and overlying, and diagrammatic icons including location, size, and form, and graphical features grounded on the findings of Dua and Tafahomi (2015; 2021) such as point, line, and polygon. This process of mapping not only increased the level of perception, representation, and discussion among the students similar to the results of Pearsalla (2014) but also this process documented and demonstrated processes of skills development by the students to obtain a profound perception about analysis and design to proceed the idea of Oxman (2004) as the progress of thinking through mapping. Furthermore, this result covered the gap mentioned by Lee and colleagues (2015) as a limitation of SWOT in the mapping process and outputs.

Findings revealed that the students represented their own perception about context of the study, and they obtained a higher level of interpretation and illustration of data in scales progressively similar to the idea of Reed and Kim (2012; 2015) in terms of cognitive learning and learning through mapping. Also, this result concurred with the findings of Okebukola and Taketa (1992; 1996) as the positive effects of the mapping in the problem-solving process. Indeed, the students promoted the ability of their own team members with the design thinking in each stage of freehand mapping similar to the findings of Metz and Goldschmidt (1990; 1992) as the representation of the context in the mapping. The application of the graphical techniques enhanced the validity of data in the mapping process regarding expertise productions, which confirmed the idea of Chu (2010) concerning sufficient and efficient levels of perceptions about the context in the mapping process. The progress of the students in the mapping process was in the line with the findings of Umek (2003) and Pearsalla (2014) based on the progressive process by sketching-mapping.

The application of graphical features and techniques in the SWOT regenerated hybrid techniques such as sketching, drawing, and designing symbols. The students gained more opportunities to develop their ideas and understanding of the quality of the maps similar to the results of Laseau and Groat (2000; 2002) and Kurttila (2000) as graphical expressions. Illustration of data with the spatial specification in the mapping process such as location, size, and form improved those deficiencies introduced by Pavelsky (2014) and Lee (2015) in terms of experimental and location-based problems. The ability of localizing data and comprehending location-based relationships throughout the mapping process was aligned with survey methods and techniques like Moughtin and Groat studies (1999; 2002) in the site analysis technique.

Outputs of the analysis identified that the students illustrated symbols in several forms through graphical techniques in the mapping process. They applied symbols to attach information to the graphical features, such as point, line, and polygon, which were

highlighted by Dua (2015). The symbols were more iconic than symbolic and index signs. Despite the fact that the students used colors in a limited variety, colors were vividly connected with the type of data according to the findings of Brewera (1997).

Conclusion

Graphical techniques play a significant role in the analysis process in architectural design studios. Particularly, the application of graphical techniques, features, and symbols for non-graphical data could generate effective outputs in the design studio. Although the students of the architecture program are confident of tracing, sketching, and drawing for the analysis activities in design studios, adopting graphical techniques and features could develop their skills in production, presentation, and representation processes. These graphical techniques are suited to both location-based data through survey, observation, site analysis, and text-based data such as SWOT matrix. Therefore, mapping SWOT help students to enhance the level of understanding, consolidating, and visualizing data with different location, connection, size, and scale. Moreover, a graphic representation of SWOT analysis (SWOT map) as one of outputs of architectural design studio can facilitate both conceptualisation and design processes in the further stages of the design studio.

Application of the graphical techniques positively influences the students' products in the studios particularly on the process of the classification of data, presentation of analysis, and representation of the results. Therefore, the students not only personalise the process of the learning by personalising using graphical techniques but they also innovate their own styles as a subjective-learning process. This learning process develops through comments, critics, discussions in the group for innovation of the appropriate graphical techniques and features.

There is a clear process of personalisation of the graphical techniques in the mapping process in the architectural design studio. The students started from a rough, primitive, and simple style to apply the graphical techniques and they developed a more detailed and integrated style of mapping, from the macroscale to the microscale. The results of the research approve that both training the students to obtain new graphical skills and oriented critical sessions provide opportunities for the students to develop their abilities and skills. The application of the graphical techniques in the mapping process of the SWOT creates a paradigm-shifting from the non-specified texts to the location-based data as spatial analysis.

Nevertheless, the research also faced some deficiencies in the process of mapping that needs to be taken into account in future research. Firstly, presenting data requires more or integrated colours to facilitate representation particularly in the overlaying and overlapping. Specifically, the research took the place in an architecture design studio based on freehand drawing for mapping. This style faced a limitation to employ colour, tone, and contrast. Perhaps digitized design studios have more opportunities to apply a variety of colours in the mapping process. Secondly, although both colour and tone were sufficient for the presentation of the harmful and helpful data, the final maps require extra graphical features such as hatching, pattern, or coding to illustrate comprehensive graphical data. Finally, innovation of the symbols is a time-consuming activity in the mapping process in design studios, which introducing clusters of the symbols before the analytical phase facilitate the process of mapping. The symbols also require to be adjusted according to scale and relevant information. They can be derived from urban design, landscape, and geography-related mapping techniques to specify data based on themes, layers, and scales.

References

Alexander, C., & Chermayeff, S. (1965). *Community and privacy: Toward a new architecture of humanism* (1th ed.). New York: Mass Publisher.

Altman, I., & Chemers, M. M. (1984). *Culture and environment.* California: CUP Archive.

APA, A. (2006). *Planning and urban design standards.* New Jersey: John Wiley and Sons Inc.

Bonnes, M., & Bonaiuto, M. (2002). Environmental psychology: From spatial-physical environment to sustainable development. In R. B. Bechtel, & A. Churchman (Eds.), *Handbook of environmental psychology* (pp. 28-54). New York: John Wiley & Sons, Inc.

Brewera, C. A., MacEachrena, A. M., Pickleb, L. W., & Herrmann, D. (1997). Mapping mortality: Evaluating color schemes for choropleth maps. *Annual of the Association of American Geographers, 87*(3), 411-438.

Carmona, M. (2001). *Housing design quality: Through policy, guidance and review.* London: Spon Press, Taylor & Francis.

Ching, F. D. (2010). *Design drawing* (Second ed.). New Jersey: John Wiley & Sons, Inc.

Cho, J. (2017). An investigation of design studio performance in relation to creativity, spatial ability, and visual cognitive style. *Thinking Skills and Creativity, 23*, 67-78.

Chu, X. Z., Gao, L., Qiu, H.-B., Li, W.-D., & Shao, X.-Y. (2010). An expert system using rough sets theory and self-organizing maps to design space exploration of complex products. *Expert Systems with Applications, 37*(11), 7364-7372.

Curtis, J. W. (2012). Integrating sketch maps with GIS to explore fear of crime in the urban environment: A review of the past and prospects for the future. *Cartography and Geographical Information Science, 39*(4), 175-186.

Dandekar, H. C. (1988). *Qualitative method in urban planning* (Edit by Catanese, A. J and Snyder, J. C, Second ed.). New York: McGraw-Hill.

Dua, S., Fengb, C. C., & Guoc, L. (2015). Integrative representation and inference of qualitative locations about points, lines, and polygons. *International Journal of Geographical Information Science, 29*(6), 980–1006.

Dyson, R. G. (2004). Strategic development and SWOT analysis at the University of Warwick. *European Journal of Operational Research, 152*(3), 631-640.

Ercoskun, O. Y. (2012). *Green and ecological technologies for urban planning: Creating smart cities.* Hershey: Information Science Reference.

Etongo, D., Kanninen, M., Epule, T. E., & Fobissie, K. (2018, May). Assessing the effectiveness of joint forest management in Southern Burkina Faso: A SWOT-AHP analysis. *Forest Policy and Economics, 90*, 31-38.

Fadel, M. E., Rachid, G., El-Samra, R., & Boutro, G. (2013). Knowledge management mapping and gap analysis in renewable energy: Towards a sustainable framework in developing countries. *Renewable and Sustainable Energy Reviews, 20*, 576-584.

FAED, F. o. (2009). *Program specification of architecture.* Kigali: University of Rwanda.

Faryling, C. (1993). Research in art and design. *Royal College of Art Design Papers, 1*(1), 1-5.

Gasselt, S. V., & Nass, A. (2011). Planetary map data model for geologic mapping. *Cartography and Geographic Information Science, 38*(2), 201-212.

Ghazinoorya, S., Abdia, M., & Mehrb, M. A. (2011). SWOT methodology: A state of the art review for the past, a framework for the future. *Journal of Business Economics and Management, 12*(1), 24-48.

Goldschmidt, G. (1991). The dialectics of sketching. *Creativity Research Journal, 4*(2), 123-143.

Goldschmidt, G. (1992). Serial sketching: Visual problem solving in designing. *Cybernetics and Systems: An International Journal, 23*(2), 191-219.

Groat, L., & Wang, D. (2002). *Architectural research methods.* New York: John Willy and Sons Publisher.

Harwood, D., & Rawlings, K. (2001). Assessing young children's freehand sketch maps of the world. *International Research in Geographic and Environment Education, 10*(1), 20-45.

Hedman, R., & Jaszewski, A. (1984). *Fundamentals of urban design.* New Jersey: Planners Press, American Planning Association.

Jessica, R. G., Kruse, G. H., & Miller, S. A. (2015). Socioeconomic considerations of the commercial weathervane scallop fishery off Alaska using SWOT analysis. *Ocean & Coastal Management, 105*, 154-165.

Jiang, B. (2015). The fractal nature of maps and mapping. *International Journal of Geographical Information Science, 29*(1), 159–174.

Kalafsky, R. V., & Sonnichsen, T. (2015). Employing SWOT analysis in coursework on the geographies of regional economic development and trade. *Journal of Geography, 114*(5), 177-187.

Kim, E., & Kim, K. (2015). Cognitive styles in design problem solving: Insights from network-based cognitive maps. *Design Studies, 40*, 1-38.

Krippendorff, K. H. (2012). *Content analysis: An introduction to its methodology* (3 ed.). California: SAGE Publications, Inc.

Kurttila, M., Pesonen, M., Kangas, J., & Kajanus, M. (2000). Utilizing the analytic hierarchy process (AHP) in SWOT analysis- a hybrid method and its application to a forest-certification case. *Forest Policy and Economics, 1*(1), 41-52.

Laseau, P. (2000). *Graphic thinking for architects and designers* (3th ed.). New York: Wiley.

Lawson, B. (2005). *How designers think: The design process demystified,* (4th Edition ed.). Oxford, UK: Architectural Press,.

Lee, H., Yuan, T., Jung, H. C., & Beighley, E. (2015). Mapping wetland water depths over the central Congo Basin using PALSAR ScanSAR, Envisat altimetry, and MODIS VCF data. *Remote Sensing of Environment, 159*, 70-79.

Madanipour, A. (1996). *Design of urban space: an inquiry into a socio-spatial processes.* London: Willy.

Madanipour, A. (2003). *Public and private space of the city.* London: Routledge.

Metz, H. M. (1990). Sketch maps: Helping students get the big picture. *Journal of Geography, 89*(3), 114-118.

Miller, G., Dingwall, R., & Morphy, E. (2004). Using qualitative data and analysis. In D. Silverman, *Qualitative research: Theory, method and practice* (2th ed., pp. 325-341). London: Sage Publications.

Moughtin, C. J., Cuesta, R., Sarris, C., & Laurea, P. S. (1999). *Urban design: Method and techniques.* London: Architecture Press, Second Edition.

Mugerauer, R. (1995). *Interpreting environments: Tradition, deconstruction, hermeneutics.* Texas: University of Texas Press.

Neuman, L. W. (2009). *Social research methods: Qualitative and quantitative*

approaches (7th edition ed.). New York: Pearson.

Okebukola, P. A. (1992). Can good concept mappers be good problem solvers in science? *Education Psychology: an International Journal of Experimental Educational Psychology, 12*(2), 113-129.

Otto, J. C., Gustavsson, M., & Geil, M. (2011). Design, symbolisation and visualisation of geomorphological maps. *Developments in Earth Surface Processes, 15*, 253-295.

Oxman, R. (2004, January 1). Think-maps: teaching design thinking in design education. *Design Studies, 25*(1), 63-91.

Panek, J. (2015). How participatory mapping can drive community empowerment – a case study of Koffiekraal, South Africa. *South African Geographical Journal, 97*(1), 18-30.

Parker, B. (2006). Constructing community through maps? Power and praxis in community mapping. *The Professional Geographer, 58*(4), 470-484.

Pavelsky, T. M., Durand, M. T., Andreadis, K. M., Beighley, E. R., Paiva, R. C., Allen, G. H., & Miller, Z. F. (2014). Assessing the potential global extent of SWOT river discharge observations. *Journal of Hydrology, 519*, 1516-1525.

Pearsalla, H., Hawthorneb, T., Block, D., Louise , B., Walkerd , E., & Masucci, M. (2014). Exploring youth socio-spatial perceptions of higher education landscapes through sketch maps. *Journal of Geography in Higher Education , 39*(1), 111-130.

Reed, S. K. (2012). Learning by mapping across situations. *Journal of the Learning Science, 21*(3), 353-398.

Relph, E. (1976). *Place and placelessness.* London: Pion Ink.

Scolozzi, R., Schirpke, U., Morri, E., & D'Amato, D. (2014). Ecosystem services-based SWOT analysis of protected areas for conservation strategies. *Journal of Environmental Management, 146*, 543-551.

Sevkli, M., Oztekin, A., Uysal, O., & Torlak, G. (2012). Development of a fuzzy ANP based SWOT analysis for the airline industry in Turkey. *Expert Systems with Applications, 39*(1), 14-24.

Shive, J., & Francis, G. (2008). Applying models of visual search to map display design. *International Journal of Human-Computer Studies, 66*(2), 67-77.

Silverman, D. (2004). *Qualitative research: Theory, method and practice.* New York: SAGE Publications Ltd.

Tafahomi, R. (2009). Application the visual and graphical techniques of urban design in urban vision document. *Journal of Shar Negar (City Writer), 52*, 25-35.

Tafahomi, R. (2014). *Constituting of urban design framework through urban design deficiencies.* Hamburg: Lambert Academic Publisher.

Tafahomi, R. (2020). Educational outcome of students' group-table arrangement for collaboration in architectural thesis studio. *LWATI: A Journal of Contemporary Research, 17*(2), 22-46.

Tafahomi, R. (2021a). Application of physical and nonphysical elements in the conservation of historic core of city. *South African Journal of Geomatics, 10*(1), 75-86. doi:10.4314/sajg.v10i1.6

Tafahomi, R. (2021b). Insight into a personalized procedure of design in concept generation by the students in architecture thesis projects. *Journal of Design Studio, 3*(1), 5-18. doi:10.46474/jds.910234

Tafahomi, R., & Lamit, H. B. (2011). Environment as a pattern for design: Case of study Shandize valley in Mashhad, Iran.

International Journal of Architecture and Urban Development, 1(1), 11-16.

Tafahomi, R., & Nadi, R. (2016). Dehistoricisation the urban landscape through transition of the enclosure ratio in urban fabric of Gonabad city in Iran. *J Archit Eng Tech, Volume 5*(Issue 2). doi:10.4172/2168-9717.1000162

Tafahomi, R., & Nadi, R. (2020). Derivation of a design solution for the conservation of a historical Payab in the redevelopment of Doloeei, Gonabad. *International Journal of Built Environment and Sustainability, 7*(1), 1-9. doi:10.11113/ijbes.v7.n1.407

Taketa, R. (1996). Using field sketch mapping to teach basic mapping concepts in elementary school geography. *Journal of Geography, 95*(3), 126-130.

Thomas, D. (2002). *Architecture and urban environment: A vision for new age.* Oxford: Architectural Press.

Trancik, R. (1986). *Finding lost space: Theories of urban design.* New York: Van Nostrand Reinhold.

Tschumi, B. (1997). *Architecture and disjunction.* Cambridge: MIT Press.

Tschumi, B. (2014). *Notations: Diagrams and sequences.* New York: Artifice Books on Architecture.

Umek, M. (2003). A comparison of the effectiveness of drawing maps and reading maps in beginning map teaching. *International Research in Geographic and Environment Education, 12*(1), 18-31.

Vermeersch, L., & Vandenbroucke, A. (2014). Schools and cultural organisations: Natural partners in art and cultural education (ACE)? *Procedia - Social and Behavioral Sciences, 116*, 1032-1039.

White, E. T. (1983). *Site analysis: Diagramming information for architectural design.* Tallahassee, Florida: Architectural Media Ltd.

Zeisel, J. (1984). *Inquiry by design: Tools for environment-behavior research.* Cambridge: Cambridge University Press.