0313

A constructivist approach to wayfinding map studies: Construction of spatial knowledge in people-map-space interactions

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I. Introduction

Wayfinding refers to the activities and processes of people navigating and finding their ways in an environment (Golledge, 1999, p. 24). A wayfinding map therefore is a map that assists people in solving wayfinding tasks. Disciplines such as cognitive science, geography, cartography, and graphic/information design are involved in the studies of designing effective wayfinding maps (see examples Allen, 1999; Casakin et al., 2000; Correa de Jesus, 1994; Darken & Peterson, 2001; Levine, 1982; Miller & Lewis, 2000; Passini, 1984, 1996; Talbot et al., 1993; Tversky, 2000; Zipf, n.d.). However, findings about the usability of maps is still inconclusive (M. Wood, 1993). This paper, derives from a PhD research undertaken in Curtin University of Technology, Western Australia, presents a constructivist approach to investigate the ways people learn about spatial knowledge from interacting with wayfinding maps and the actual built environment.

This paper first addresses the research problems in wayfinding map design and studies. This will be followed by the explanation of constructivism and its relevance to wayfinding and spatial learning behaviour. The paper will then describe the methods used in the field study that uncovered the construction of spatial knowledge in people-map-space interactions. Finally, conclusion will be made based on the findings from the field study.

II. Research problems in wayfinding map design and studies

The main issue in current wayfinding map design and studies is the lack of user-centred approaches. There have not been appropriate understandings about people-spatial and people-map interactions as applied to the design and research methods of maps.

Information designers, graphic designers, and communication designers are involved in current wayfinding map design. The application of knowledge and findings about map reading and wayfinding behaviour from other disciplines is not common and has not been documented adequately in map design activities. However,

the importance of cross- and interdisciplinary knowledge in map design is a topic for discussion within the discipline of design research. For example, Correa de Jesus (1994, pp. 33-51) emphasised that wayfinding system design requires much wider knowledge on the ways people understand the environment than focusing on just graphic treatments. Passini (1996, pp. 319-331; 2000, pp. 83-98), as an important writer and scholar in environmental psychology and architectural design, contributed knowledge about wayfinding and the understanding of people-spatial interactions to the profession of information design. Communication designer Paul Arthur emphasised the collaboration between designers and spatial planners, where he stated that the most effective way to approach wayfinding issues was to have architects and designers focused on the ways people responded to the actual environment (Large, 2001, p. 82). Despite these claims and concerns, current designers are not actively involved in integrating design with studies and knowledge from other related disciplines. This observation is reflected in the lack of publications about design of wayfinding maps by practicing designers.

Designers have conducted and published usability studies on completed wayfinding systems with the intention of improving these designs. These studies are limited and focus only on specific designs. The involvement of only evaluation and usability-testing methods in wayfinding maps is limited in providing adequate information on people's reaction towards the map. For example, graphic and information designers have mostly been testing of completed wayfinding maps for built environment such as hospital (Wright et al., 1990) and museum (Marino, 1997). Case studies have also being conducted on the effects of figure-ground contrast (Barker et al., 1986), the use of graphic conventions between rail and bus network diagrams in London (Burke & McLaren, 1981) and analysis of guidebooks used in London (Lasky & Kahn 1995). Although these study outcomes had suggested improvements to the specific completed designs, they did not focus on the understanding of the ways people interacted directly with the built environment.

The consideration of people-spatial interactions is necessary to wayfinding map design because such maps are representations of people's understanding of the actual environment. The lack of such consideration in current map design and studies calls for in-depth research on how people construct spatial knowledge from interacting with maps and the actual environment.

III. Constructivist approach to the studies of meanings and knowledge in wayfinding and map reading processes

Cartographers and urban designers use semiotic analyses to study the meanings in maps (MacEachren, 1995; D. Wood & Fels, 1992) and urban spaces (Eco, 1986; Gottdiener, 1995) while the process of a person using wayfinding maps to solve a wayfinding task involves more in-depth understanding on how s/he constructs meaning and spatial knowledge. Wayfinding map design requires designers to understand how people construct meaning and knowledge from maps and the actual environment. The application of constructivism in wayfinding map studies focuses on the construction of meaning and knowledge based on people's experience and interactions with the environment and other social artifacts.

Prior to the discussion of these theories in detail, there are three terms that require explanation:

1. Meaning;
2. Knowledge;
3. Reality.

First, 'meaning' refers to the sense that people make out of visuals, objects, and events. Meaning is viewed as being derived from people's former experience and learning process (Duffy & Jonassen, 1992, p. 4). Second, 'knowledge' is the set of meaning that is fundamental to a person's view of a 'real' world. From this, the third term 'reality', is defined as the phenomena that a person views as exist as prior to her/his control. These definitions are based on Berger and Luckmann's concept of 'reality' is 'a quality appertaining to phenomena that we recognize as having a being independent of our own volition' and 'knowledge' is 'the certainty that phenomena are real and that they possess specific characteristics' (Berger & Luckmann, 1971, p. 3). In addition to these definitions, 'knowledge' is also viewed as the fundamental drive to people's actions. In the context of this paper, people's actions refer specifically to map reading and wayfinding behaviour.

The understanding of 'meaning', 'knowledge' and 'reality' are core concepts for the process of a person using wayfinding maps to solve wayfinding tasks. People make meanings out of map signs and the built environment before they can construct their knowledge about the built space. People will further construct their knowledge of the built environment based on the sense of this knowledge. People's spatial knowledge about a built environment then forms the basis of their reality of the environment. The following will discuss the construction of meaning, knowledge, and reality in detail.

Constructivism: An overview

Constructivism refers to the studies of the ways people construct subjective reality (Larochelle et al., 1998, pp. 4-5). In the words of Duffy & Jonassen (1992, p. 3), constructivism

… Holds that there is a real world that we experience. However, the argument is that meaning is imposed on the world by us, rather than existing in the world independently of us. There are many ways to structure the world, and there are many meanings or perspectives for any event or concept. Thus there is not a correct meaning that we are striving for.

This notion has been developed and applied in many ways, such as radical constructivism, and constructivism in education. According to von Glasersfeld (1984, p. 24), radical constructivism 'is radical because it breaks with convention and develops a theory of knowledge in which knowledge does not reflect an "objective" ontological reality, but exclusively an ordering and organization of a world constituted by our experience'. He further explained this concept by stating that radical constructivism:

… Is an unconventional approach to the problems of knowledge and knowing. It starts from the assumption that knowledge, no mater how it be defined, is in the heads of persons, and that the thinking subject has no alternative but to construct what he or she knows on the basis of his or her own experience. What we make of

experience constitutes the only world we consciously live in. It can be sorted into many kinds, such as things, self, others, and so on (von Glasersfeld, 1995b, p. 1).

These definitions explain that knowledge did not exist without people actively constructing it themselves. In this sense, the construction of meaning and knowledge in peoples' minds is achieved through peoples' interaction with the society, but not constructed by the society.

Constructivism is applied in education. A constructivist approach in teaching and learning conceptualises that the students construct meaning and knowledge that is different from the information that teachers deliver. According to von Glasersfeld (1995a, p. 14):

From the constructivist perspective, learning is not a stimulus-response phenomenon. It requires self-regulation and the building of conceptual structures through reflection and abstraction. Problems are not solved by the retrieval of rote-learned "right" answers.

This definition, in relation to learning, proposes that people are able to construct meaning only when they are actively involved in the meaning making process within a given environment.

Constructivism in wayfinding behaviour and wayfinding map

This paper relates constructionism to the ways people learn about the actual environment. The application of constructivism to wayfinding and use of wayfinding maps suggests that people learn about the spatial structure of a built space by constructing individual understanding of the space, based on their interaction with maps and the environment. Wayfinding maps and spatial elements are entities that provide people with information about the spatial structure while the knowledge that people learn and understand from wayfinding maps and actual environment is constructed individually. This also suggests that spatial knowledge that individuals construct from wayfinding maps and the interaction with built space can be different from the spatial information that the map is depicting. In this sense, people understand about the actual environment even when they were interacting with the same environment and map. The idea of people constructing subjective understanding of the built environment is apparent when Gottdiener & Lagopoulos (1986, p. 10) stated:

There is sociologically speaking no individual image of the environment. Rather, the city is imaged differently by different people according to the group experience of social life … The conception of the environment is a social product which must be learned. For this reason the important variables in understanding the composition of commonly held urban images are those which grasp the nature of social experience.

In the context of individually constructed meanings in space, Tilley (1994, p. 11) explained,

Space has no substantial essence in itself, but only has a relational significance, created through relations between people and places. Space becomes detotali[s]ed by virtue of its relational construction and because, being differentially understood and produce by different individuals, collectivities and societies, it can have no

universal essence. What space is depends on who is experiencing it and how. Spatial experience is not innocent and neutral, but invested with power relating to age, gender, social position and relationships with others.

Tilley's statement suggests that a person's identity and activities construct her/his experiences about a space. The above discussions indicated that there are two aspects to the subjective construction of meanings in people-map-space interactions:

1. Personal experience;
2. External interaction (Symbolic interactionism).

The following sections will address these in detail.

Individual constructed reality based on experience

The notion of experience is important to the construction of individual's understanding about the actual environment. For user-centred approaches, peoples' experiences have a significant role in how they react to particular objects. According to Margolin (1997, p. 228),

The incorporation of experience into a discussion of how users relate to products is one way to fill out our understanding of who a user is. In our thinking about the product-user relation, we have moved from the idea of function to that of action. The discourse of functionality had to do primarily with the mechanical identity of the product while that of action refers to its use.

The above statement explains that peoples' experiences are important in learning about how they use products. Relating this to the ways people use wayfinding maps in a given built space, experience has the same level of importance in uncovering peoples' decisions and actions in wayfinding processes.

In the proposed unified theoretical framework, experience is referred to as knowledge that people construct through actively participating in meaning making processes. There are two kinds of experiences involved in people's wayfinding activities:

1. Experience about the environment prior to the wayfinding activity;
2. Experience involve in the process of people solving the wayfinding task

Both the experiences are important for the understanding of how people navigate within a built environment by using a wayfinding map. People learn about a built environment based their knowledge of the place constructed from former experience prior to the current encounter with the environment. Such experience is also derived from their experiences of interacting with the actual environment and wayfinding devices, such as map and signage. Boulding (1972, pp. 43-44) explained this in terms of a child's development:

The image is built up as a result of all past experience of the possessor of the image. Part of the image is the history of the image itself. At one stage the image, I suppose, consists of little else than an undifferentiated blur and movement. From the moment of birth if not before, there is a constant stream of messages entering the organism form the senses. At first, these may merely be undifferentiated lights and noises. As the child grows, however, they gradually become distinguished into people and objects. He begins to perceive himself as an

object in the midst of a world of objects. The conscious image has begun. In infancy the world is a house and, perhaps, a few streets or a park. As the child grows his image of the world expands. He sees himself in a town, a country, on a planet. He finds himself in an increasingly complex web of personal relationships. Every time a message reaches him his image is likely to be changed in some degree by it, and as his image is changed his behavio[u]r patterns will be changed likewise.

Applying Boulding's statement to the context of this research, a person's understanding of the actual environment derives from her/his learning process that involves her/his interactions with objects, people and events within the environment. For example, a person brings with her/him the previous experiences when s/he encounters a new situation or environment. S/he will learn new things in the unfamiliar setting, which will become part of her/his experience. The newly learnt experience is likely to change her/his ways of understanding and interacting with similar situations or environments in the future.

Symbolic interactionism: Individual's reality as derived from external interaction

According to studies in symbolic interactionism, people's understanding of the surrounding world is created by consistently interacting with things, events, and other people. Blumer (1969) stated:

1. The meaning of objects, events, and other people, is constructed based on the meanings that these entities have for a person (pp. 2-4).
2. Meaning of social entities (such as objects, places, events, and people) is derived from the interactions involved between people and the social entities (pp. 2-4).
3. People construct meanings of other objects, events, and people, through the process of interpretations (pp. 2-5).

Blumer's three premises of symbolic interactionism are relevant to the ways people read wayfinding maps and solve wayfinding tasks within built spaces. For example, in the context of wayfinding, a tourist who explores a city for the first time constructs her/his understanding of the city by interacting with people, and buildings within that built environment. The tourist would then learn about the city and how it functions by interacting with the entities within the city. In this sense, the construction of meaning for an individual self upon an environment derives from her/his interactions with the external entities.

The perspective of symbolic interactionism in wayfinding map studies requires understanding of how people interact with entities in the environment. Benelli et al. (2001 [Online]) conceptualised that people interact with primary and secondary artifacts in a given space. In this case, they view that maps are second level artifacts that mediate between people and primary artifacts (such as path, routes and road signs) in the environment. This notion derived from cognitive studies stating primary artifacts mediated between people and the physical world while secondary artifacts mediated between people and primary artifacts (Wartofsky cited in Benelli et al., 2001 [Online], pp. 22-23). In light of this, Benelli et al. concluded that people functioned in the existing spaces by making relationships between path-based learning on routes (primary artifacts), landmark-based learning of buildings (primary artifacts) and survey learning on maps (the use of map as secondary artifacts) (2001 [Online], p. 22).

IV. Research methods

This research involved a series of field study that were designed to uncover the ways people construct meaning and spatial knowledge through interacting with maps and the actual environment. The study is therefore a qualitative research focused on recording and analysing participants' responses towards maps and space.

Participants

This study involved 30 international undergraduate and postgraduate students living in Perth (Western Australia) metropolitan areas, for not more than five years. Not being local to Perth meant that they have not acquired the spatial knowledge of the city through consistent interaction with it. They needed to learn about and navigate in the built environment of Fremantle depending on the use of given wayfinding maps. Observations on the participants' reaction towards wayfinding maps and the actual space allowed me to uncover substantial information about the relationships in people-map-space interactions.

Places

The study required participants to find four places within the City of Fremantle. These places were namely the Western Australian Maritime Museum, the Round House, Fremantle Market, and Fremantle Prison. These places were selected because of their locations that covered the main corners of Fremantle. This situation offered significant input for investigating the relationships in people-map-space interactions because it required participants to explore most parts of the city. This allowed observations to be made on how participants relate map information to large scale actual environment.

Wayfinding maps

Three wayfinding maps were selected for this study based on iconic and symbolic representations. The first was an iconic map that presented the city in elevated illustration. It included the physical appearances of buildings as well as the visual presentation of the spatial structure of the city. Second map was a symbolic map that presented the City of Fremantle in simplified cartographic interpretation. Places in the city presented by only words. The third map was a map that presented both iconic and symbolic representations. It depicted important landmarks in illustrations while positioning them against a cartographic map. The three maps offered clear distinction in map representations. This allowed observations to be made on the different ways that people reacted to these representations

Observation points

The study was structured to uncover the relationships in people-map-space interactions. Observation points were constructed to investigate participants' interactions with the wayfinding maps, and the environment; and the ways they related the information from wayfinding maps to the actual space. Details of the observation included participants' emotion towards the maps and the actual environment, their behaviour in confronting the wayfinding tasks, and the spatial elements that they used on the maps and in the actual space.

The procedure

30 participants were asked to use three wayfinding maps in the study (10 participants for each map). Each trip in the study involved one to two participants (mostly one in each study). Every study required participant(s) to first draw a sketch map of the City of Fremantle, based on her/his previous experiences in the city. Observations were made on the way participants drew the first sketch maps. Participants who were on their first trip to Fremantle were not required to draw the first sketch map. Each participant was then given a wayfinding map, and told to use it to locate four recommended places in the city (Western Australian Maritime Museum, the Round House, Fremantle Prison, and Fremantle Market). Each participant was told that s/he was to take the trip as a relaxing journey. S/he could end the trip anytime, and could choose to not find any of the suggested places. Observations and conversations took place during the trip to document the reasons each participant conducted particular actions. After the trip, the participant was then sat down for light refreshment at any preferred restaurant or cafes in Fremantle. S/he would be asked to draw a second sketch map as a representation of the way s/he had understood the built environment of Fremantle after using the given wayfinding map to explore the city.

V. Results and discussion: Construction of spatial knowledge

Observations from the field study identified that there were two levels of knowledge that fostered participants' understanding of the actual environment:

1. The knowledge that participants constructed based on former experiences about the city;
2. The knowledge derived from the information provided by wayfinding maps, street signs and the actual environment.

Participants functioned in a particular built environment by utilising the combined knowledge from their previous experiences and their current interactions with wayfinding map and the actual space.

Experiential aspects

Findings from the field study indicated that human activities and events were factors that helped participants in understanding the city. Information documented from conversations with participants revealed that the different activities and situations that participants engaged in had influences on how they understand the city. Participants who had been to Fremantle for shopping produced sketch maps that depicted different impressions of the city than the sketch maps produced by participants who visited the city for leisure and dining purposes. The study indicated that participants viewed the City of Fremantle differently between night- and daytime because of different human activities that took place in the city. Clubbing and alcohol drinking were main activities that were commonly found the city at nights. Participants who had been to the city at nights stated that the spatial structure of the city (to them) at nights were different from what they understood the city as in the morning. This was because the human activities at nights were taken at different places from those in the morning. The differences of reality of a same place at different time influenced the ways people understand the space. This information indicated that the ways participants perceived the spatial structure of the city were based on the activities that they conducted within the city.

Memory was found to be an essential in the ways participants constructed the knowledge of the city. The study outcome indicated that participants' memory in people-spatial interactions were critical in building up their experiences of the actual environment. For example, one participant revealed that s/he remembered the 'look' of some of the places in the city that s/he had visited before but did not know the exact ways to get there. Another participant explained that s/he recognised the appearance of the Round House as from the memory of her/his former visit to the city. S/He only recalled about the appearance of the Round House when s/he physically arrived at the place. Two other participants explained that they recognised the physical appearance of the Western Australian Maritime Museum because they were told that it was the Maritime Museum. These examples suggested that participants' understandings of the places in Fremantle were based on their previous experiences with these places.

Apart from that, participants' experiences about places and city that they gained outside of Fremantle were found to be affecting the ways they understood the city. For example, one participant mistakenly took the Round House as Fremantle Prison because it looked like a prison (to note that the Round House used to be in fact a small jail). Another participant who was searching for the Fremantle Prison, realised that s/he was on the wrong track because s/he saw that the buildings around her/him did not resembles to those that s/he knew would look like prison. These examples indicated that participants' understandings of the places in Fremantle were constructed from their general knowledge on the appearances of these places.

External interactions

The field study revealed that participants constructed spatial knowledge about Fremantle through the interacting with external entities such as wayfinding maps, signage and talking to other people. In the process of solving wayfinding tasks with the use of maps, participants were found to interact with two categories of elements: primary and secondary artifacts in the environment, and people and human activities.

Primary and secondary artifacts

Primary and secondary artifacts were found to have important roles in shaping people's understanding of the actual environments. Participants responded to three main external entities: the physical world itself (buildings and urban spaces), primary artifacts (street signs), and secondary artifacts (maps). Participants were cross-referring to road signs, maps posted at roadsides, and street names in the actual environment for assistance in confirming their locations. This observation indicated that participants constructed the knowledge of the city by making relationships between primary and secondary artifacts.

The study also indicated that participants interacted with elements such as buildings, routes, signs, and maps posted in the actual environment when they were confused and could not locate particular destinations. This observation indicated that participants constructed different knowledge about the city from primary and secondary artifacts.

People-people interaction

One of the ways of communicating spatial information is through people-people interaction. Participants were found talking to other people to ask about directions and locations of places. Apart from that, participants were found to be able to construct knowledge of a place based on observing human activities. For example, a participant identified the location of the Round House because s/he saw a group of tourist taking photographs in front of the building. S/He related this human activity to the fact that the Round House being a tourist attraction, tourists who were visiting that place would most probably conduct activities such as taking photographs and walking around the building.

VI. Conclusion

This paper applied constructivist perspectives to the study of wayfinding map studies. It concluded that people construct spatial knowledge of the built space based on their experiences and the information provided by the actual environments and wayfinding maps. In other words, the construction of knowledge in people-map-space interactions involved knowledge constructed based on two levels:

- People's previous experiences;
- Current experience of the built space;

This outcome contributes to wayfinding map studies by providing knowledge on people's construction of spatial knowledge through interacting with maps and the actual environment.

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