The effect of spatial knowledge on sense of belonging
in university/academic environments

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ABSTRACT:

The simple task of navigating from one point to another involves multiple functions and is more complex than it appears to be. In order to travel from one point to another, a person employs different types of knowledge, defined as spatial knowledge, which facilitates the ability of wayfinding. The ability to acquire spatial knowledge can be enhanced by increasing the imageabiliy of the environment. This environmental characteristic could be linked to an important human behavior, the sense of belonging, the feeling of belonging to a group or a place. Previous literature has reported the significance of sense of belonging for psychological, social, and physical well being. A higher level of sense of belonging to a place can yield valuable results especially to an academic environment such as achieving better academic standing, closer relationships with peers, and elevated self confidence. Since sense of belonging deals greatly with the surrounding environment, it is necessary for educational facilities to have unique design characteristics to increase the different levels of spatial knowledge. This study focuses on the impact of spatial knowledge for a university campus on sense of belonging among college students. The study was conducted on 63 undergraduate students from the Department of Architectural Studies in University of Missouri. An eight-point likert scale questionnaire was devised to measure the college students' level of sense of belonging to University of Missouri and their Spatial knowledge on the university. Identifying the relationship between spatial knowledge and sense of belonging relates to understanding the connection between university students and their environments. This knowledge will prove invaluable in providing the ideal academic environment by creating settings for students which are more imageable as well as navigable. It was found that landmark and route knowledge were significantly predicting sense of belonging. Further findings were discussed in the paper.

CONFERENCE THEME: Social paradigm
KEYWORDS: Sense of Belonging, Spatial Knowledge, Imageability, Wayfinding, Academic Environments

INTRODUCTION

In order to travel from one point to another, a person employs different types of knowledge such as Landmark, Procedural (Route) and Survey, which as a whole is defined as spatial knowledge. Spatial knowledge facilitates the ability of wayfinding and the ability to acquire spatial knowledge can be enhanced by increasing the imageabiliy of the environment. This environmental characteristic could be linked to an important human behavior, the sense of belonging. Sense of belonging refers to the feeling of being part of a group or a place. The main hypothesis of the study is that the increase in the amount of spatial knowledge will trigger an increase in sense of belonging to that place. Our belief that higher level of spatial knowledge creates familiarity with the environment makes people feel attached to this environment and being part of it. Since sense of belonging leads to great benefit in the educational field, it is necessary for educational facilities to foster sense of belonging in students.. The aim of the study is to explore the impact of spatial knowledge on sense of belonging of university students to increase the students' academic performance through architecture.. Our main hypothesis in this study is that this fostered sense of belonging to that environment is a result of the spatial knowledge that the users can absorb through that environment.

LITERATURE REVIEW

SPATIAL KNOWLEDGE

Finding ones way through space has been given considerable attention through the years. The simple task of finding the path from one point to another involves multiple functions and is more complex

than it appears to be. The words wayfinding and navigation are often used to describe the process of moving through space which includes complex cognitive processes as well as physical muscular movements. Knowledge about the space (or spatial knowledge) which one occupies becomes a very important factor in this process. People acquire spatial knowledge by moving through an environment, by viewing maps and through simulated media (video, slides, and virtual environments). Spatial knowledge provides the essential information which is required to navigate through an environment, and it also provides the information needed to approximate ones bearings within that environment.

Spatial knowledge has been categorized into three types of knowledge's: landmark knowledge (knowledge about landmarks, a single point in space), route or procedural knowledge (knowledge about a sequence of points), and survey knowledge (knowledge about the spatial relation of at least two points) (Bruner, 1988; Piaget & Inhelder, 1967; Siegel & while, 1975; Thorndyke, 1981). Wiener et al. (2009) identifies these categories and organizes them as three levels of spatial knowledge; knowledge about the location of a specific goal, knowledge about a specific path toward a goal, and knowledge of the environment as a whole. The three main components, landmark, route and survey knowledge together which what is called spatial knowledge, provides the user the ability to navigate through an environment efficiently. Increasing these three components, especially landmark and route knowledge provides legibility and imageability to the environment (Lynch, 1960) and when an environment becomes more legible and navigable to the user it becomes easier for them to foster a sense of familiarity to that environment.

Thorndyke et al. (1981) operationalizes the spatial knowledge of users giving consideration to landmarks in the environment, using judgment of orientation, location, Euclidean distance between landmarks, and route distance along city streets between landmarks. In experiments using film as a medium for simulating movement through an environment, Craik (1968) measured subject's spatial knowledge using place recognition tests, and questionnaires of landmark, context and location. Cohen (1980) exposes subjects to a tour of a museum, and measures the subjects on their ability to recall sequential progression, recognition of elements, and a cued recall (association) task, in which subjects listed the features that they remembered in response to cue words. In an experiment to attempt a detail comparison of learning from direct and simulated spatial knowledge acquisition, Goldin et al. (1981a) attempts to measure the landmark knowledge, procedural knowledge, and survey knowledge. To accomplish this they use location recognition tests for landmark knowledge, and they also tested the location sequencing task using sequence of actions performed at various locations that constitute the route specifications, serial order of the perceptual features encountered along the route, distance between locations experienced as sensations of motion, speed and time, and local angle information represented as bearing changed along the route. The study also measured estimate of route distance and orientation. Survey knowledge was tested using Euclidean distance tests and landmark placement task (Golding et al., 1981a). Experiments have been conducted by Golding et al. (1981b) to measure different types of experiences resulting in different types of spatial knowledge's (landscape, route and survey) in these experiments measurements were made on tasks of orientation, route distance, map drawing, and euclidean distance. Taking into consideration studies conducted by Thorndyke (1981), Craik (1968), Cohen (1980), Goldin et al. (1981a, 1981b), within this study Spatial knowledge is measured through efficiency based methods such as association tasks, judgmental tasks, distance perception tasks, recognition/memory recall tasks, preferences and accuracy based methods such as task completion duration, and error calculation.

SENSE OF BELONGING

Sense of belonging has been identified as one of the basic human needs and an important component to individuals, family, and community (Hill, 2006; Krause & Wulff, 2005; Vanderhorst & McLaren, 2005; Winter-Collins & McDaniel, 2000). Previous literature has reported the significance of sense of belonging for psychological, social, and physical well being (Hagerty & Patusky, 1995; Hagerty, Williams, & Oe, 2002) and deficits in sense of belonging have been linked to problems in social and psychological functioning (Hagerty, et al., 2002; Hill, 2006). The concept of sense of belonging can be found in many disciplines including social sciences, education, and psychology. However, this study concentrates on research within the academic field to relate with the design typology

and objective of the study. Hagerty and colleagues advanced the concept of sense of belonging by defining it as "the experience of personal involvement in a system or environment so that the persons feel themselves to be an integral part of that system or environment" (Hagerty, et al., 2002, p. 796). The closest and most focused definition for sense of belonging in educational studies was defined by Pintrich and Maehr (2004) as "the sense of psychological membership in the school or classroom, that is, the extent to which students feel personally accepted, respected, included, and supported by others in the school environment" (pg. 28). Sense of belonging deals greatly with human behavior and the interaction with the surrounding environment, which is in this study an academic environment.

Sense of belonging can be measured through several variables. The study of Furrer & Skinner (2003) explored the effects of a sense of belonging on academic motivation and performance by connecting the affiliation and affinity of individuals to family members, classmates, and friends. Maestas et al. (2007) considered a related operationalization by comprising membership and partnership with the college community as the variables for sense of belonging. Reilly & Fitzpatrick (2009) had a similar operationalization for the concept by measuring community activity participation, and family supportThese variables could be grouped and addressed in fitting within the environment, valued involvement, respect and encouragement for participation, being part of a system, social support, social interactions, feeling the support, and affiliation and affinity between individuals.

Hagerty and Patusky (1995) developed a tool to measure sense of belonging that was adapted to a great extent. The concept was constructed on two dimensions, antecedent and psychological dimensions, measured by fitting within the environment and valued involvement. In a similar study in the educational field by Goodenew (1993), an instrument was created to measure the concept based on respect and encouragement for participation, involvement of the perceived responses of other members, and being part of the society. Hoffman et al. (2002) developed several measures of sense of belonging that includes students' perceptions of academic and social support, social interactions, isolation, and comfort variables. A similar approach was observed in the study of Newhouse et al. (2007) where the concept was measured based on feeling the membership, comfort, and support in college. In an attempt to measure the overall effect of sense of belonging, Johnson et al. (2007) developed a simplified instrument to measure sense of belonging as a whole to indicate the level of sense of belonging. Taking in to account the studies conducted by The study of Furrer & Skinner (2003), Maestas et al. (2007, Reilly & Fitzpatrick (2009) Hagerty and Patusky (1995), Goodenew (1993), Hoffman et al. (2002), Newhouse et al. (2007), Johnson et al. (2007) we see that the measurements used in the literature to measure the concept counted extensively on self report instruments to measure the variables on an ordinal level using likert-type scales. The generally adopted instrument, the Sense of Belonging Instrument developed by Hagerty and Patusky (1995), is a 33-items self-report questionnaire in a 4-point likert scale that measures an individual's sense of belonging. The scale consists of two important dimensions that are essential for an individual to experience the sense of belonging, antecedent and psychological dimensions. Their measurement was adopted by studies that follow based on its reliability and its flexibility to measure the concept in other domains.

METHOD

The aim of the study was to investigate the relationship between sense of belonging and spatial knowledge at an academic setting. In accordance with the primary hypothesis of the study that increased spatial knowledge of an environment provides heightened sense of belonging, the independent variable considered in the study was spatial knowledge and sense of belonging as the dependent variable. For the purpose of the paper, spatial knowledge was defined as the knowledge about the space which one occupies required to navigate through an environment while sense of belonging was defined as the experience of personal involvement in an environment so that the persons feel themselves to be an integral part of that environment, Spatial knowledge was constructed in three integral parts, landmarks knowledge, route knowledge, and survey, , and sense of belonging was constructed on the level of affinity a student feels toward the campus and peers To measure the college students' level of sense of belonging to the University of Missouri, a questionnaire was devised. It was grounded on the sense of belonging operationalizations previously described and

comprised items typical for measuring sense of belonging. The instrument for sense of belonging was developed using the Hagerty's 27 items questionnaire, Goodenow's 18 items questionnaire and Hofman's 18 items questionnaire. The sense of belonging questionnaire presented questions which were designed to measure the subject's sense of belongingness under four levels. The first level was peer relationships: how a subject feels connected to his or her friends, if they feel that they belong to a certain social group or not. The second level was relationships with mentors: how a subject thinks that his or her mentors see him or her, if there is a close mentor-student relationship or not. The third level was belonging to the department of study, and the fourth level was the belonging to the whole university. Some items of Sense of Belonging in the developed instrument were reversed and re-coded after collecting the data to have all scales in a positive direction.

The spatial knowledge a questionnaire was grounded on the operationalizations previously described and comprised items typical for measuring spatial knowledge. The questionnaire was based on the studies conducted by Thorndyke & golding (Golding et al. 1981; Thorndyke et al. 1981). The tool that was used in the study measured the three main aspects of spatial knowledge: landmark, route and survey knowledge.

The sense of belonging questionnaire contained 20 items measured on an eight-point likert scale, ranging from 1 (Strongly Disagree) to 8 (Strongly Agree). The spatial knowledge questionnaire contained 18 items, of which 13 items were measure on an eight-point likert scale, ranging from 1 (Strongly Disagree) to 8 (Strongly Agree) that measured the subject's general abilities of understanding spatial arrangements, and 5 items which were oriented towards the spatial understanding of the University of Missouri-Columbia.

The sample was selected on a voluntarily basis and consisted of 63 undergraduate students from the Department of Architectural Studies, University of Missouri-Columbia, 19 male and 44 female, within the age range of 18–32. One respondent with conflicting results was eliminated in the analysis to increase the reliability of the result. Extensive listings of the subjects' characteristic are displayed

Demographic Variables	Frequency	Percentage	Mean
Gender			
Male	19	30.64%	
Female	43	69.35%	
Race			
African American	7	11%	
Chinese	2	3.27%	
Korean	1	1.63%	
Vietnamese	1	1.63%	
White	49	80%	
Hispanic	1	1.63%	
Age			20.9193
Hometown			
Columbia, MO	5	8.06%	
Other cites, MO	53	85.48%	
Other states, US	3	4.83%	
Other countries	1	1.63%	
No. of years living in Missouri			3.27
Living location n			
In campus	13	20.96%	
Off campus	49	79.03%	
Academic level			
Freshman	9	14.51%	
Sophomore	21	33.87%	
Junior	16	25.80%	
Senior	16	25.80%	
Had a guide tour			
Yes	40	64.51%	
No	22	35.48%	
Academic performance			
Excellent	23	37.70%	
Good	34	55.73%	
Neutral	3	4.91%	
Bad	1	1.63%	

Table 1: Sample demographics of this study (N=62)

Variable	n	*M*	*SD*	*median*	*Range*
Spatial Knowledge	18				
Landmarks		0.8	0.22	0.75	1-0.25
Route		4.2	0.98	4.28	6.1-2.07
Survey		36.46	9.22	36.86	55.25-1315
Sense of Belonging	20	6.53	0.94	6.5	7.8-3.09

Table 2: Descriptive statistics

	Spatial Knowledge									
	Landmark		Route Time		Route Distance		Route Direction		Survey	
	R^2	β	R^2	β	R^2	β	R^2	β	R^2	β
Sense of Belonging	0.01	0.31*	0.07	-0.27*	0.06	0.25*	0.13	0.37**	0.002	0.04

* $p < .05$, ** $p < .005$

Note: This table showcase the probability of spatial knowledge variables to predict sense of belonging. A significant value of a spatial knowledge variable determines its involvement to achieving higher level of sense of belonging

Table 3: Prediction of spatial knowledge on sense of belonging

in Table 1. All subjects volunteered to participate in the study and signed an informed consent form. An appointment was set with the investigator at the place of recruitment (classroom in Department of Architectural Studies) and the study was explained to potential participants. Those who wished to participate signed the consent form and were then asked to fill out a survey.

ANALYSIS

Regression test was used to determine the effects of the independent variables on the dependent variables. All analyses were performed by using procedures in JMP Version 8.0. The average age of students was 20 year and the majority of the sample (%70) was females. Half of the participants were majoring in interior design (%50), less than half in Architecture (%40), and the rest in other majors (%10). Table 2 provides the descriptive statistics for the variables Sense of belonging, Landmarks, Route, and Survey.

It was found that landmark knowledge predicted sense of belonging (R2 = .09, F (1,59) = 6.40, p <.01), as did route. Route knowledge was tested with three factors, route time (p = .02), distance (p = .049), and direction (p = .003) estimation. Each of these three factors was highly significant, with R2 between .06 and .13, while having a negative effect with route time. Survey knowledge failed to predict sense of belonging. A list of the regression analysis results is displayed in table 3. A one-way ANOVA test was also used to determine the relationship between sense of belonging and academic performance. There was a significant main effect for sense of belonging, F (3,60) = 3.27, p < 0.05, which suggests that participants with higher level of sense of belonging achieved higher academic performance.

DISCUSSION

In our analysis it was shown that that landmark knowledge predicted sense of belonging and route knowledge tested through the three factors, route time, distance, and direction estimation also predicted sense of belonging. Survey knowledge failed to predict sense of belonging

Sense of belonging is essentially related with familiarity to an environment. In fact familiarity contributes to a sense of belonging of the particular environment (Annison, J., 2000; Goodenow, 1993), and familiarity is considered one of the key psychological processes that link people with an environment together (Inalhan & Finch, 2004). Familiarity can be defined as the process which people develop detailed cognitive knowledge of their environments (Fullilove, 1996). It has been shown that familiarity effects wayfinding tasks in an environment (Hölscher, et al. 2006) and this can considered the reason for the prediction. The more an environment is familiar to the user, the sense

Figure 1. Jesse hall and columns at the University of Missouri-Columbia

of belonging increases. Significant landmarks can symbolically represent that particular environment. For example in the case of the University of Missouri, Columbia, landmarks such as Jesse hall and the columns have become symbols of the university.

These reference points provide greater familiarity of an environment (Sorrows, M et al. 1999). The explanation for sense of belonging not predicting survey is less clear. The reason for this might have been due to the unequal distribution of female participation in the study. Gender differences in visual spatial skills (Geary, 2009) may affect the way female students perceive themselves, especially in the architecture department since architectural ability is dependent upon visual and spatial skills (Silverman, L.K., & Freed, J.N., 1991).

Since survey knowledge is specific to the individual and is mainly dependent upon his/her ability of conceiving cognitive maps of the environment, only route and landmark knowledge of the environment provides imageability. While the environment could be enhanced to provide more landmark and route knowledge which in turn will provide more familiarity and sense of belonging to the student, survey knowledge is more dependent upon the individual. In this study, significance was found in route time ($p = .02$), distance ($p = .049$), and direction ($p = .003$) estimation with sense of belonging. All the significance with the results suggests that our main hypothesis, that the increased spatial knowledge would lead to better sense of belonging towards that environment, was supported through the study.

There are several potential limitations to the study. The results of the study are only limited to the study's context specific to the location of the study at University of Missouri-Columbia. The sample is a main limitation to the study. Even though a significance between gender and sense of belonging was found, it is not a reliable one due to the unequal size if the sample that does not represent the population. Future research is needed to explore the effects of sense of belonging on additional components to spatial knowledge. The effects of sense of belonging on subjects other than students from the architectural department should be studied. Individual characteristics such as income, social status, and culture should be considered to have a better association on their perception. The questionnaire should be pretested and developed further to include more spatial components, such as adding extra landmarks recognition, to gather more solid data. Having a tour guide around the campus may affect the results of the study. Students who were guided and introduced to the campus

are supposedly more familiar with MU campus and its distinguished spatial characteristics. Therefore, treating this variable as a control variable is beneficial in future studies. Finally, the regression analysis revealed a negative relationship between landmark recognition and age. This may suggest that older students do not remember landmarks as much as younger students which in turns reflect in the accuracy of the data.

CONCLUSION

Increasing the imeageability of an environment will make that environment more legible and more navigable (Lynch, 1960) and will increase the ability of spatial knowledge acquisition which will reduce the time it takes for an environment to become more familiar. Since familiarity contributes to the sense of belonging to a place, our hypotheses states that the increase in spatial knowledge acquisition would lead to the increase in sense of belonging to that place. The analysis presents some significant evidence which would propose a connection between these two variables. Increasing the sense of belonging to a place can yield valuable results especially to a school/university environment (Pintrich et al. 2003). Not only does sense of belonging foster better academic standing in students it also is linked with other sociological factors such as relationships with peers and respecting norms and values of a society, more over their feeling about themselves and self confidence.(Osterman, K., 2000 ; Furrer, C et al. 2003; Hurtado, S., & Carter, D. 1997). Identifying the relationship between spatial knowledge and sense of belonging relates to understanding the connection between university students and their environments. This knowledge will prove invaluable in providing the ideal academic environment by creating settings for students which are more imageable as well as navigable.

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