HOW DO ARCHITECTS THINK?
LEARNING STYLES AND ARCHITECTURAL EDUCATION

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Abstract
Architecture is a complex process involving the divergent resolution of a multitude of factors—social, ecological, technical, economic, functional, ethical and aesthetic. Despite this diversity all architectural problem solving processes share one common factor—they must be resolved spatially. This paper sets out to explore how best to develop these spatial thinking skills in young architects through addressing their learning styles in education. The primary hypothesis tested is twofold. First—using the Solomon & Felder (2007) definition of learning styles and their Index of Learning Styles Questionnaire—the average profile of a study group from the freshmen and sophomore architectural student body at the Architectural Engineering Program of the American University in Cairo is mapped and compared to that of a control group from the general population of the university from a cross-section of majors. Secondly, using the Spatial Ability test by Newton & Bristoll (2009), the spatial ability of both the control and study groups are measured and compared. The analysis of these results tests the assumption that the majority of architectural students will be visual, rather than verbal; and active, rather than reflective, learners; as well as exhibiting higher spatial abilities, as compared to the control group.

The performance of students in these tests are then correlated against their learning styles profile using the following sets—low spatial ability against both reflective and verbal learning; moderate spatial ability against neutral learning styles; and high spatial ability against both active and visual learning. The results show a particular corroboration between high spatial ability and active learning in the entire group of students—both study, and control—as well as a strong corroboration between high spatial ability and visual learning—with a higher correlation in architecture students, reaching 100% in some classes. It is hoped that by understanding how our students think and learn, rather than operating on assumptions, we can provide more responsive and customized modes of learning and teaching in our studios.

Keywords
Architectural education, pedagogy, learning styles, spatial ability.

Introduction
Architectural education is based primarily around the design studio as a pivot and gathering point of all knowledge and skill accreted throughout the curriculum. Within this design studio the realm of 3-dimensional analysis, assessment, organization, manipulation and representation occupies a predominant role. A major and necessary part of every architect’s education becomes the ability to think, evaluate, problem...
solve and generate form three dimensionally and volumetrically, on the cognitive as well as communicative level. This objective is never more so the case than in an age when digital technology is permeating our every activity bringing with it the risk of replacing our student’s cognition with that of a micro-processor where computers are very tempting replacements for the basic skills of volumetric thinking and three dimensional problem solving.

Many pedagogical practices in design studios today have been based on a number of assumptions, particularly those revolving around such abilities. Each of us, as an educator of young architects, has an image and template in our minds of what makes a good architect, and consequently what makes a good architectural student. Such templates usually revolve around issues of critical thinking, artistic capability, geometric acuity and spatial problem solving and thinking. Although with the increasing complexity of architectural practice today, research tells us that we must address the multiple intelligences of our students, visual and spatial form generation skills remain at the forefront of the skill set we seek and cultivate in our students (D’Souza, N., 2007). We imagine students who learn through doing and experiment and explore creatively the three-dimensional world that it will become their responsibility to shape.

We assume that it is those with spatial ability and visual/active learning styles that will be drawn towards, and accepted into, our architectural programs (Goldschmidt, G., 2000). We also assume that our curricula are structured as such to nurture and empower these abilities, taking what initial skill and ability is present in each student and cultivating it to grow towards a level that is required of the professional world. Finally we assume that our assessment strategies and methods of evaluation reflect such spatial, visual and active abilities, and that students exhibiting such talents will perform better in the design studio, as attested to by the grade with which we award them.

But is this the case? The objective of this paper is to test these assumptions through a case study of the Architectural Engineering Program at the American University in Cairo.

Methodology

The methodology used to test the above outlined assumptions involves two stages, assessing spatial ability and learning style at each stage. The first stage takes a comparative look at a study group of students at the freshman and sophomore level of the architectural engineering program and compares them to a control group of students from the general population of the university, with a diverse cross-section of majors and intended majors, as represented by those enrolled in one of the core curriculum freshman courses. The total number of students participating in the test is 70, evenly distributed between the control and study groups.

The second stage takes a look at the correlation between spatial ability and learning style. Specific trends are looked at, as represented by the following correlation sets- low spatial ability with both reflective and verbal learning; moderate spatial ability with both neutral learning styles; and high spatial ability with both active and visual learning. Research has shown that students learning style profiles are not absolute,
and may shift according to the subject matter at hand (Smith, P., Dalton, J., 2005) nonetheless they provide a primary indicator of how an individual student assimilates knowledge into skill. Research has also shown that education can alter learning styles towards more favorable modes relevant to the material and knowledge being experienced and assimilated (Harvey, R., 2004).

Much research has been conducted analyzing the complex process of design thinking (Lawson 2006), and consequently tools have been developed to quantify how designers think and learn. Among these tools are psychometric testing and learning styles profiling, examples of which are used for both tools applied in this research.

Each of the above study stages uses two tools to assess the spatial ability and learning styles profile of students. The first tool is a Spatial Ability test adapted from the work of Newton & Bristoll (2009) - with permission from the publisher. Based on psychometrics this test uses a multiple choice format with 8 questions. Psychometric testing has been established through research as a viable tool to assess spatial visualization and problem solving skills, as well as a predictor of performance in architectural programs. Although not sufficient to independently ascertain architectural ability, it gives an indication of aptitude and is used by various architectural schools worldwide (Goldschmidt, G., 2000).

The test uses 8 visual puzzles and maps, with multiple choice answers. Each set of questions looks at one of the following spatial abilities- shape matching with spatial manipulation; spatial assembly; visual/spatial manipulation; mapping and navigation. Scores are measured out of 80, and stratified as follows: low spatial ability for those awarded between 0-30, moderate spatial ability for those awarded between 40-50, and high spatial for those awarded between ability 60-80.

The second tool is the Index of Learning Styles (Felder & Solomon, 2004). Research supports the importance of addressing learning styles as part of pedagogical development, particularly in areas related to design and engineering (Mills et al, 2005) & (Felder & Silverman 1988). This survey, consisting of 44 questions designed to ascertain the subject’s learning style profile, maps a subject’s preferred style according to a 4 sets of learning style pairs using a bipolar 11 point scale. These pairs represent opposite extremes of each learning style spectrum and are: active vs. reflective; sensing vs. intuitive; visual vs. verbal; and sequential vs. global. A student may be classified as one of the poles of learning - active or reflective; sensing or intuitive; visual or verbal; sequential or global- if they score from 5-11 along either pole. A student is considered neutral if they score between 0-3 along either pole. A particular attention is paid to the visual-verbal and active-reflective sets, as they are the most relevant to the assumptions of the research.

Patterns throughout the various student cohorts of the study group and control group are looked at and trends are outlined, particularly in correlation with the assumptions set forth in the research- namely a prevalence of visual and active learners amongst students of architecture as opposed to those of the general population- with a tendency to increase more towards these poles throughout the program. Research has shown that such trends are not
uncommon in architectural students, particularly in design studios, and that specifically designed studio exercises can actually shift these profiles (Mostafa, 2008).

The reliability of this tool has been verified (Litzinger et al., 2007) and although previous research has looked at the link between learning styles and design acuity, it has been primarily using the experiential learning model by Kolb (Kolb 1984). Such research has focused on the importance of the active pole of the active/reflective skill set and the assimilating experiential learner as opposed to the accommodating learner in their link to student performance in the design studio (Demirbas & Demirkan, 2003) and (Kvan & Yunyan, 2005). This paper sets out to verify these findings and expands them to include the visual/verbal skill set, in its correlation to performance in the design studio, as well as a distinguishing factor of architectural student, as compared to those from other disciplines.

These surveys were conducted over a 15 week semester and administered to a random sample of students currently enrolled in the core curriculum courses and architectural program respectively. Both surveys were posted on an online academic portal, accessible to all students enrolled in the test. All data was analyzed with the help of the university’s Center for Learning and Teaching to preserve anonymity of students. For academic integrity purposes, students were made aware that the results of the test would not influence their course assessment in any way and any publication of results would be summative and anonymous.

**Results and Discussion**

The first stage of the testing indicated the following trends in Spatial Ability amongst the study and control groups. The study group of architecture students was found to exhibit predominantly high spatial abilities, with 60% of the freshmen and sophomore students scoring between 60 and 80. This trend was also found in the control group, with 53% of the general population scoring between 60 and 80. (Figure 1).

The distinction between the study and control groups became more apparent in the learning styles profiling - with 100% of the architecture sophomores testing as visual learners. This is followed by 70% of architecture freshman and 61% of the general population of the control group (table 2). This distribution seems to confirm two the things: the first is that architecture students are predominantly better visual learners than general students, and their visual learning skills increase as they move through the program. Given that learning styles have been shown not to be absolute, or permanent, but rather subject to development and change.
(Harvey, R., 2004), this seems to indicate that the curriculum set forth in the program is successfully shifting students thinking towards the more visual. Additionally, given that learning styles may shift according to subject matter (Smith, P., Dalton, J., 2005), and the fact that these tests were conducted by design professors in the design studio, students may also be applying more visual learning to the design process.

The distinction, although apparent, is not as exaggerated in the comparative analysis of the active-reflective set amongst the study and control groups. Again architectural sophomores were seen to be the most active with 50% scoring between 5 and 11 on the active learning scale, confirming the active pole as the preferable architectural trait. This is followed by 39% of architecture freshmen and 25% of the general population scoring as high active learners. Interestingly 50% of architecture sophomores were also found to be reflective, with none scoring within the neutral range, illustrating an intriguing polarization of the group. Although not as indicative, these results also show the trend of architecture students to be more active learners, as compared to general students, confirming another of the assumptions of this research (Figure 3). They also show the role of the curriculum in shifting students learning, particularly in the design studio, towards the more active mode.

The second stage of the research illustrates the correlations assumed by the research in the following sets: low spatial ability against each of reflective and verbal learning; moderate spatial ability against neutral learning styles; and high spatial ability against each of active and visual learning. The highest correlation was found between high spatial ability and visual learning, in both study and control groups. Architecture students of the study group showed a 60% and 100% correlation of spatial ability with visual learning amongst the freshmen and sophomore groups respectively, as compared to 65% amongst the general population (Figures 4, 5, and 6). This confirms, firstly, the strong link between spatial ability and visual learning styles, and secondly its predominance as a phenomena amongst architecture students.

![Figure 2: Visual vs. Verbal Learning Styles- Study Group (architecture) vs. Control Group (general). (Source: Authors).](image)

![Figure 3: Active vs. Reflective Learning Styles- Study Group (architecture) vs. Control Group (general). (Source: Authors).](image)

Regarding Spatial Ability and the Reflective-Active learning style set, again a strong correlation was found amongst the study group of architecture students. One class of freshmen
exhibited a 100% correlation between spatial ability and active learning, with an average correlation of 50% across the entire study group. Sophomore architecture students generally showed a tendency toward a higher correlation between moderate spatial ability and neutral reflective-active learning, at 67%, although there was a 33% correlation between high spatial ability and active learning. Again this may indicate an influence of curriculum, where more design foundations courses involving hands-on, manual and active process are found at the freshman level, shifting to a more balanced approach as the student moves through the curriculum. It also indicates a weaker link between spatial ability as assumed to be required of a student of architecture, with active learning, but rather towards a more balanced neutral type of learning, a hybrid between physical or experiential learning (active) and cognitive or perceptive learning (reflective).

This correlation was not as strong amongst the control group, which generally exhibited a tendency towards a higher correlation of the moderate ability to neutral learning style set, with a 70% correlation between the two. There was only a 20% correlation between low spatial skills and reflective learning; as well as between high spatial skills and active learning in this group. This seems to confirm the natural distribution of this correlation amongst the general population of the control group.

### Conclusion and Recommendations

In conclusion this research seems to confirm a number of the assumptions set forth in this paper that architecture students exhibit higher spatial abilities and generally learn more visually and actively than the average student. Additionally
they show a higher correlation between strong spatial ability and visual learning, to a high degree, and strong spatial ability and active learning to a lesser degree. The results also indicate that the curriculum at the American University’s Architectural Engineering program is preparing its students favorably with spatial abilities, and shifting learning styles towards the more active, and particularly towards the increasingly visual.

Recent research encourages educators to formulate their curricula and modify their teaching methods to accommodate the learning styles of its students (Smith & Dalton 2005). The results of this research paper can therefore be used a departure point for the program at the American University to develop its curriculum to address such an accommodation, particularly of the visual and active learning styles of its students within the design studio. Teaching material, references, exercises, assessment techniques and general pedagogy will shift with this accommodation- hopefully to the more favorable. This process should be documented, and further research may track the progress of accommodating the curriculum to address the conclusive results of this research.

Further research could also look at the correlation between the sets of spatial ability, visual learning and active learning- with student performance. Again previous research indicates such a correlation which can be verified (Kvan & Yunyun, 2005). This will give an indication whether current assessment strategies and tools are appropriately awarding students’ spatial abilities and visual/active learning, and additionally whether the material is appropriately addressing and improving these skills.

Finally, it is proposed that with a better understanding of what our students know, and how they learn and acquire that knowledge, the better prepared we shall be to teach them, preparing them to be the comprehensive architectural thinkers required of this changing age.

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