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Artistic Skills and Scientific Abilities in Architectural Education

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Abstract: The integration between art and science is required for the student in the department of architecture. This paper concentrates on the importance of integration between artistic skills and scientific abilities for the student to achieve high quality level of learning in the department of architecture in Iraq. It analyses the criteria of the architectural education and the educational method used. It demonstrates the integration relationship between art, science and architecture. It follows a descriptive analyses methodology to investigate the skills and abilities required for the student to cope with the criteria of architectural education. It conducted a case study on students in the department of architecture in Iraq to explore the impact of having these skills and abilities on the student's progression. It explains why a few students only graduate with high grades. The results obtained showed that the integration between artistic skills and scientific abilities is very important for the students. On the other hand, developing the artistic skills is harder than developing the scientific abilities in architectural education.

Keywords: Architectural education, artistic skills, scientific abilities, creativity, aesthetic sense.

1. Introduction

There are two types of requirements for the student in the department of architecture. One of them is related to science and the other is related to art. What is related to science includes the new technologies in building construction materials and systems and computer programs used in architectural presentation. These requirements are important and if they are not met by the student, they will be negative points that cannot be defended and they are similar at all projects and will be a justification for challenging the project. The artistic requirements are related to the distinction of a project from other projects and a student from another. The evaluation is based on the opinion of the public, whether local or global, and that the evaluation criteria are linked to prevailing and renewed values and what is proposed in these projects in terms of new ideas, forms and different methods of treatment for new problems such as sustainability. The variation in the artistic aspects differs from one student to another depending on the experience, specialization and culture in the field of architecture. The aesthetic requirements appear in the external form, the internal perspective and the presentation technologies. They could be seen in new principles proposed in specific time such as flowing space, mega structure and sustainability. The new product is often compared with well-known things to see the extent of its distinction and its compliance with artistic requirements.

Art was associated with architecture since its inception, as in the caves paintings inhabited by man, where the drawings on the walls documented the nature of the life he lived. On the other hand, the continuous scientific developments have a great impact on architecture especially in building materials and

technologies and in architectural presentation. Art, science and architecture developed and there was a relationship between them in each stage of this development. Classical architecture extended for a long time and when the art movements developed in Art Nouveau and the discovery of new building materials, modern architecture emerged. This resulted in moving away from details and historical elements. The new concepts in art and science had new and different influences on the new architectural movements such as post-modern architecture, international approaches in architecture, and high- tech approaches in architecture, deconstruction, and sustainable architecture.

2. Architectural education

Architectural education requires many artistic skills and scientific abilities. Artistic skills are drawing, presentation, projection and imagination. Scientific abilities are building codes and standardization, cope with new building materials and technologies, cope with computer programs used in architecture and Dealing with recent problems emerged. These requirements related with thinking, designing, presentation and building. The main course of this education is design where the students should learn two types of knowledge; conceptual design and materialization. Conceptual design deals with forms and compositions. Materialization is based on forms affected by building materials and systems. Architectural education depends on artistic ability, dealing with building materials and cope with new technology (Völker, H., et al, 1996, pp.90). The integration between artistic skills and scientific abilities is very important to achieve high level of learning for the students as it is shown in figure 1.

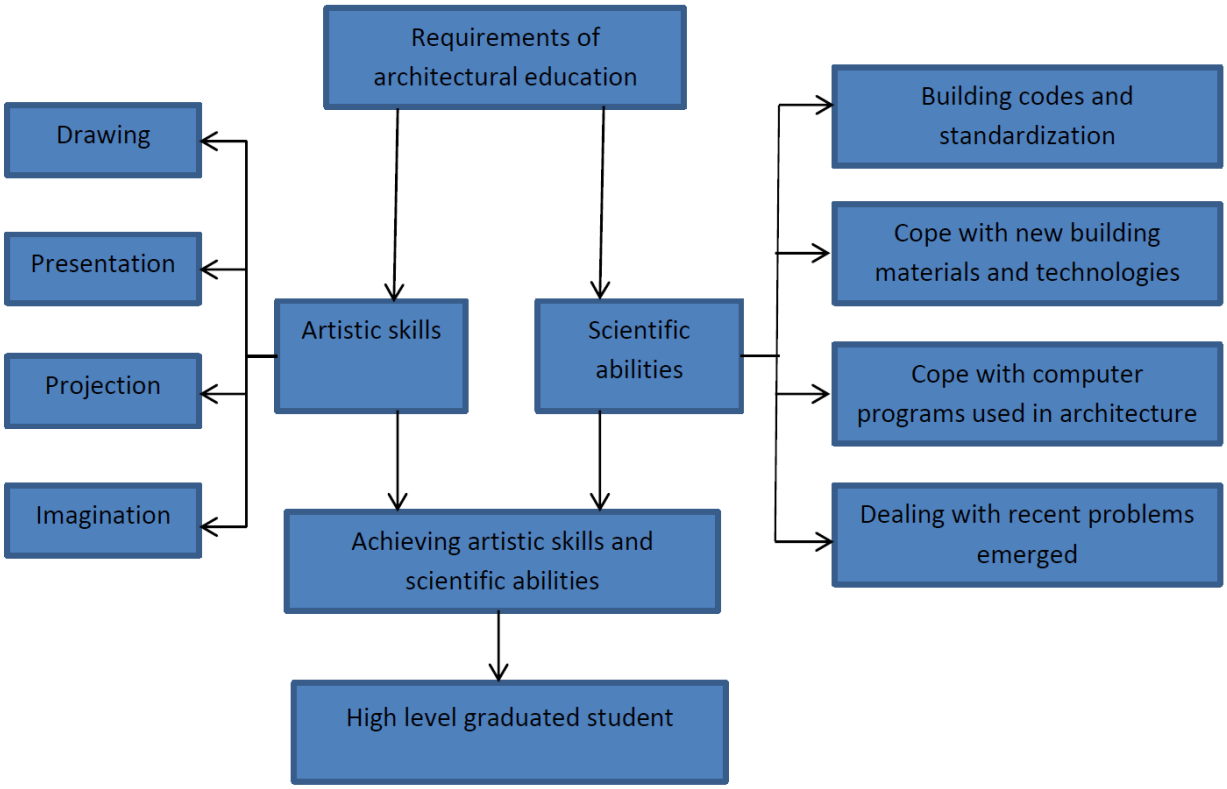

Figure 1 *The artistic skills and scientific abilities in architectural education*

The main objectives of the architectural education about design according to the UNESCO are the requirements of beauty and the building technologies as creative abilities for the students (Uzunoglu, S., 2012, pp. 93). Architectural education involves acquiring the ability to create architectural designs that meet both aesthetic and technical requirements. Adequate knowledge of architectural history and theories, related arts, technology and human science, knowledge of the fine arts as an influence on architectural design quality. The academic program prepares students who can further their knowledge of the art and architectural sciences (Farahat, B., 2011, pp.749).

The core criteria for architectural education varied widely across countries, the core requirement areas could be generally defined as design philosophy, technological frameworks, design documentation and professional practice (Bhattacharjee, S., and S., Bose, 2015, pp. 586).The educational programs were implemented in architectural education and included experimental studies to familiarize students with the basic principles of artistic movements that form the basis of the visual arts (Dizdar, S., 2014, pp, 277). In architectural education the studios are the locations where education in architectural design is encountered. They depend on the concept of skill building and exchanging ideas. The basic problem for the educational element and the student in the design studios is that there is no method which fits every student (Dizdar, S., 2014, pp. 278).

2.1. Educational methods

The integration between science and art should be applied in the educational methods. Educational methods are the way to organize the cognitive activity of the learner to ensure the acquisition of the student's knowledge and skills in the education process. Teaching methods used in an educational environment such as: lecture method, group discussions, individual presentations, assignments, seminars, workshops, conferences, brainstorming and role-playing. Brainstorming is a form of discussion for generating ideas that allows group members to participate equally and develop listening abilities. It is used to solve problems, to make decisions and to think creatively. Brainstorming also fosters team building.

Listening to music is also an effective method for awakening the senses. It is important for experiencing and exploring the aesthetic feelings. Reading/listening poems of famous poets, reading sections from classics are also valid for stimulating the senses, watching films is another way of understanding aesthetic experience (Uzunoglu, S., 2012, pp. 94).

The art of reading can be of great benefit to the brain. The architecture students should have the ability to learn as much as they can; in fact about all related things. Books exercise the brain and provide motivation and fill it with knowledge that makes it easy to create creative connections.

When considering all the details about the educational history of students in architectural design, it is clear that learning needs to be addressed from the perspective of creative thought. Given the characteristics of architectural design students who were short of imaginative training in their former school research and the real situation of our conventional frontal teaching model, the question of enhancing creative thinking in architectural education needs to be addressed (Irouke, V. and J., Ahianba, 2013, pp. 82).

2.2. The integration in practice

Learning architecture depends mainly on practice. The question of the relationship between the education provided and the skills required for successful practice is obviously of paramount importance in academic institution, which offers a professional degree in architecture. The design and general philosophy of the program are in line with the expertise provided in the school and the role of architects in society. In offering better conditions for contemporary communities, architecture as a

discipline would be justified. In recent years, the architectural profession has shifted, but the educational method, especially in architectural education in the Middle East, has changed.

The Gropius Bauhaus tradition influenced architectural education with on the one hand, the 'learning by doing' approach and on the other hand, the interest in analyzing spatial associations with the human body and objects encountered by individuals. In the Bauhaus curriculum, which evolved with the theory of Gestalt perception, the student proceeds through apprentice, traveler and master during the educational phase, which includes all the required applications for the level of creative work and the science fields (Dizdar, S., 2014, pp, 277).

The Gropius program at the Bauhaus honored craftsmen and apprentices: Gropius envisaged practical training of artisans as individual artists or architects (Rosenberg, F., 2012, pp. 102). It is believed that only a minority of the student body, since only a handful has an eye for architecture, would become professional architects. Thus, creative thought in architectural education was removed from the teaching of basic tools. Artistic training contained instructions on how to achieve successful design and beyond those parameters only the genius was tolerated. Art can be interpreted with romantic approaches some of which can be disregarded as rational. Architectural research was explored in two ways: establishing an aesthetic purpose and establishing scientific expertise for architectural practice (Rosenberg, F., 2012, pp. 108).

2.3. The integration between art and architecture

Many architects are masters of art before they have been architects such as Le Corbusier and Da Vinci. Being craftsmen helped them in dealing with formal details in architecture and was a direct reason for their success and distinction in architecture. They are artists in the first place and this provided the appropriate background for the practice of architecture, as it is highly related to artistic requirements. They practiced architecture as part of their artistic work and they used to mix art and architecture in their work. They use paintings in the walls and ceilings, as well as the sculptures that adorn the interior and exterior spaces of the buildings. In addition, they design the fountains, the gardens, and the statues within the architectural forms of the buildings.

In comparison between art and architecture, cubism is very similar to modern architecture in terms of the physical forms found in the paintings and what are resembled the facades and plans of buildings. The layouts and the colors are inspired architects to produce their architecture such as the works of Picasso and Mondrian. Also, the techniques used in forming shapes are similar, once there are straight lines and sharp geometric shapes similar to architectural products and flexible shapes such as Dalí's time plate resemble molded architecture as in the Aliyev Center for Zaha Hadid.

Architecture, described as the mother of all arts, is recognized as a valid form of creative art, because something is formed where nothing once existed. Any architectural training includes making, drawing, modeling or constructing, the belief that architectural education is inherently creative (Snell, K., 2014, pp. 38). Architecture is a collaborative method for the planning, design and construction of building structures. While the artist’s work from the reality to abstract, the architects have to work from abstract to fact. Although art may legitimize itself as an entity or as a case, architecture dissolves into a flourishing structure. Architecture, with all its constraints on engineering protection, efficiency, climate responsibility and economy, is a discipline to inspire us in the abstract with ideas on space and light quality (Bhattacharjee, S., and S., Bose, 2015, pp. 579).

In terms of aesthetics, such as variety, harmony, rhythm, contrast and hierarchy, there are common concepts between architecture and art. In architectural education, these concepts have a great influence on architecture. The use of

these concepts allows students in their projects to create successful forms, spaces and masses.

Insert visual materials are important in class to improve the students' sense of aesthetics. The literature related to art and architecture encourages the students to understand the main items of aesthetics in their presentations. It improves their abilities to interact with art from different points of view. It is also growing up the ability to discuss and understand architectural design with its relationship with art. The philosophy of aesthetics that support their projects will be easy to understand by the students (Uzunoglu, S., 2012 pp. 93). Architecture should be seen as an art in order to combine the philosophy of aesthetics with architecture (Uzunoglu, S., 2012 pp. 96).

In Iraq as a part of Middle East architecture schools, where students are encouraged to study picture books, the attitude of viewing architecture as an art can be found. What makes the situation worse is the influence of Western trends that have conquered architectural education in the Middle East and that even Western architecture has influenced the profession crisis (Farahat, B., 2011, pp.744)

A certain art world agent recognizes the historical or artistic significance of an object or type of thing. In this way cave paintings, religious objects, distinctive pieces of furniture, some embroidered quilts and some modern Italian cars were taken over by the art world and were given art status even though they were not art before this recognition (Davies, S., 1994, pp.10).

Although some buildings designed by architects are works of art, most buildings designed by architects are not of any type. Arguing that architecture is an art form is simply to argue that architects are artists who while performing their position, must produce works of art. Whereas if architecture is not an art some architects may achieve the status of artists. On the other hand, some buildings may have seen as art. Since architecture practice is subject to all kinds of regulations and restrictions, architecture can't be an art form. The construction of permanent, stable buildings shall abide by the gravity laws and the related properties of the material used.

The knowledge of fine art is also important to improve the design quality for the students. Artists give their ideas physical form, rendering abstract concepts, tangible by their creative action on the materials of their art. They integrate these immaterial concepts into their work, from their imagination (Snell, K., 2014, pp. 9). Art has the potential to inspire and transform the public by helping them to transcend their everyday worries and feelings.

2.4. The integration between science and architecture

The scientific development in construction techniques and the production of new building materials have greatly influenced architecture even since the early periods. The production of huge buildings such as pyramids and the techniques of stone lifting and the observation of the movement of the sun and its entry at specific times to certain places of the building.

On the other hand, the techniques used in hanging gardens and the mechanisms used to transport water to trees have had a great impact on the development of architecture. In modern architecture, the discovery of iron and concrete led to major change in the shape of architecture as its move away from arched shapes and domes to the horizontal shapes and openings. The possibilities provided by the new materials and glass, high-rise buildings, skyscrapers and towers of various forms have appeared. The development of forming iron and concrete, many architectural shapes have emerged. Base on the vision and ideas of the architectural designer, buildings were formed with organic and circular shapes.

With the industrial development, many new building materials such as plastics, polymers, as well as facade cladding materials, have appeared and have become popular in use recently. So, construction methods and materials are moving away from traditional approaches. Construction methods are

developed and it became possible to extend the space of the cantilever to longer distances and to produce suspended, inflated, shell and many free shapes. This development gave a great freedom to the designer in the forms that s/he thinks about or even that s/he imagine. It gave a strong impact on architectural forms and develops the designers' ideas.

As a result of energy saving and carbon mitigation, new types of architecture have been emerged such as sustainable architecture and green architecture. Buildings have been produced in forms that help to adopt these principles, such as the Gherkin tower, Madrid tower, and the Central Bank of Iraq.

At the same time as industrial revolution and advancement in various fields of science such as structural engineering , architecture departed from the modern structural applied technology and such a delay caused architecture to lose its control over the materials and construction of new buildings such as the grand hall of exhibits, shops and large roofed factories and other types of large-scale infrastructure buildings and even structural engineers sit back from work space.(Ranjazmayazary, M., et al, 2016, pp1).

Structure has undeniably been an integral part of architectural art throughout history, in reality. As historical architectural considerations tend to incorporate structure as an aesthetic feature, the structure and its association with architecture were expressed in the changes that took place in the 18th century, an era in which iron and glass were later known as large-scale construction materials. These industrial-era materials and architectural principles of manufacturing and higher steel strength were recognized and seen more in the factories, exhibition buildings and bridges. This can more or less be seen in the façade and structures of the Crystal Palace building, the Eiffel car gallery and the Sun bridge structure.

Two main characteristics were defined by the architectural type: the creation of a free plan and the creation of continuous glass surfaces on the house façade. Concrete, steel, glass and timber are the most common materials for use in the field of modern building. This attitude is obvious in Nervi's works. These innovations, later known as high-tech architecture, led to the introduction of new types of architecture. An aesthetic structure combined with technology to create architectural work is stressed by his architectural school supporters.

2.5. Creativity

The main task for the students is how to produce creative works. Creativity is an original form of cognitive skill and problem-solving that encourages individuals to use their knowledge in a way that is special and oriented toward a product (Irouke, V., and J., Ahianba, 2013, pp 78). It is artistic while traditional artistic practices (painting, sculpting, drawing, writing, dancing, performing or composing music to name a few) are widely accepted as creative activities. Art is not the only model on which a concept of creativity can be focused. The aim of the creativity form has been organized so that architectural education is included under the fine arts roof (Dizdar, S., 2014, pp, 277).

Creative thinking in architectural design education a series of actions to address a design problem need to be done. Studying at design studio, According to architectural education objectives, students should be prepared not only to acquire theoretical knowledge but also to turn this knowledge into practical practice through their imagination. Design is focused on know-how, practice and knowledge gained. It's understood as the product of cycles of thought. The architectural designer thinks about the entire spectrum about design parameters and specifications such as the proposal's esthetic and formal qualities (Irouke, V., and J., Ahianba, 2013, pp. 79).

In every discipline where one encounters new challenges which require a unique solution, creative problem solving is required. Having artists give ideas physical form, rendering abstract principles, tangible through their creative action on the materials of their craft. It is a non-scholarly platitude that creative people make creative objects, engaged in creative

processes (Snell, K., 2014, pp. 38). Architectural design process is situated on a linear scale between two opposites which are science and artistic processes, one of which considers this process to be fully opaque and the other to be completely transparent (Abowardah , E.,and M., Khalil, 2016, pp. 3).

Architecture schools should take action to promote student innovation. They should encourage students to participate in brainstorming. It helps them to come up with new ideas and help them to choose the creative ones. They should promote the habit of carrying small papers, pen and pencil. This is because certain ideas come as a spark, and once it happens, the student will find it quickly. Every design project requires a clear description of its design problem. Often the design role can appear very vague before specifics of the problem are identified. If a student is stuck to think when trying to solve a problem with design, he should possibly go for a stroll. At this time, a change of environment is good and some researchers have noted that gentle exercise helps to shake the brain cells

2.6. Aesthetic Sense

The curriculum should give considerable importance to the subjects in order to improve the students' aesthetic senses, helping them to solve aesthetic-related problems. For architectural projects, these issues inspire students to create new mental pictures. In all art disciplines, enhancing the sense of aesthetics could be seen as a foundation and it allows students to exercise art work with architectural design. Aesthetics broadened the students' architectural knowledge by making them gain significant values such as aesthetic philosophy and its importance in architectural design. The students who took the course aesthetics considered these values on their architectural design projects (Uzunoglu, S., 2012 pp. 97).

2.7. Presentation methods and technologies

The development of drawing and presentation methods also had a great impact on the development of architecture, especially after the use of computer programs such as AutoCAD, 3DMax, Revit, Lumion, and Photoshop. These programs assist the architect to produce complicated shapes and they provide the ability to see these shapes before implementation and modification. This is available to all architects, which led to develop their potentials. The wide use of computer programs by architects develops new architectural shapes and movements with new capabilities such as parametric and dynamic architecture. It also, led to find new techniques such as creating masses and openings that are changed according to heat at the elevation of the Arab culture institute in Paris.

Different strategies have been explored to develop the presentation technologies in architectural education. Some of them have turned tracking points into individual objects, varying their size and/or rotation based on movement speed to create expressive appearance. Others were lofting a surface along the tracking tracks. These technologies began developing a design identity for the students. They assist the students to face the challenge of turning the projects into physical sculptures. The students had to invent a construction logic which could be implemented using the laser cutter to build their models for example.

In turning motion capture paths into digital models the students followed different procedures. They focused on form generation through movement. Sculpting motion is taught at IAM and the Harvard GSD schools of architecture. Creating suspended sculptures of motion is usually helpful in their projects with limited amount of time. The task context involved reflection on motion in art and architecture, where it has long been a central theme. Theories about its importance and its expression were developed especially in the modern movement, inspired by contemporary discoveries in mathematics and physics (Spiridonidis , C., and M., Voyatzaki, 2007, pp. 30).

Interaction between humans and computers focuses not explicitly on the creation of objects, but on the possibilities for interaction between

Table1. The detailed evaluation of the students in the academic courses

Students under evaluation	**Courses**					
	Freehand drawing	Architectural graphics	Computer applications	Building construction materials	Advanced building technologies	Design
Student No. 1	2	3	3	1	3	2
Student No. 2	2	2	3	2	2	2
Student No. 3	1	2	2	2	2	1
Student No. 4	2	2	2	1	3	2
Student No. 5	1	2	3	1	2	1
Student No. 6	4	4	5	4	5	4
Student No. 7	1	1	2	1	2	1
Student No. 8	2	2	3	2	3	2
Student No. 9	2	2	4	1	3	2
Student No. 10	3	4	3	2	4	3
Student No. 11	1	1	2	1	2	1
Student No. 12	3	3	5	4	4	4
Student No. 13	2	3	3	2	3	2
Student No. 14	1	1	1	1	2	1
Student No. 15	3	2	2	1	2	2

them. The challenge is how to build resources that allow students to bring their imagination and new possibilities into the design process. By using computer software in a very unconventional way the students had to create, change and envision formations of different objects and the relationships between them as design proposals in reality.

The computer is becoming a tool for both the mind and the hand, increasingly. It is a construct tool which the students can build their projects virtually. The students utilize their computer using skills as part of their design process. The use of rapid prototyping systems such as 3D Printer, Laser Cutter, CNC milling machine was available and must be viewed as part of the overall context of the student's work. It is conceived that the process of design as being augmented by things- such as hybrid meta model of things and machines that help in thinking.

3. Case study

The case study is conducted on 86 undergraduate students in the department of architecture in Iraq. It depends on the student's grades in the departments courses. These courses at Al-Nahrain University have been classified into two classes. One of them is the courses that require artistic abilities such as architectural graphics, freehand drawings and computer programs used in architectural presentation. The other courses require scientific abilities such as building construction and materials, advance building technologies and computer applications. The grades of these two types of courses have been compared with the students' grades in the design course. The evaluation of the students was divided into five categories which are 1 from 50-59, 2 from 60-69, 3 from 70-79, 4 from 80- 89, 5 from 90-100 as they are shown in table one.

Table2. *The ratio of students with artistic skills and scientific abilities*

Ratio of students	Freehand drawing	Architectural graphics	Computer applications (Drawing programs)	Building construction materials	Advanced building technologies
	Artistic skills			Scientific abilities	
8%	●			●	
14%	●			○	
30%	○			●	
48%	○			○	

● High level, ○ Low level

Note: Computer applications (Drawing programs) involve artistic skills and scientific abilities

3.1 The results for the case study

The results obtained demonstrate that the students who have artistic skills and they cope with the new scientific developments in building construction and computer applications achieve high grades in the design course. The ability of imagination, thinking, drawing and presentation of those students is higher than those who have less artistic skills and scientific abilities. These skills and abilities are important for the student as tools to continue at the department of architecture with high grades.

The results show that 8% of the students represent high level of artistic skills and scientific abilities especially in computer applications and they got the highest scores in the design course. The students, who have high level in artistic skills and lower level in scientific abilities form 14% and they gain the second highest grades. About 30% of students present high level of scientific abilities and lower level of artistic skills and they got the medium grades in design. The students with lower artistic skills and scientific abilities got the lower grades and they form 48% of the students.

The curriculum of the school in case study presents a lack in practicing new building construction systems and materials and using advanced building technologies. On the other hand, it contains a high level of knowledge in computer applications using in drawing and presentation such as Revit, 3D Max and AutoCAD. The curriculum involves two year courses of architectural graphics and freehand drawings but they take less importance than computer programs

4. Conclusions

The paper explored the reason behind the low rates of most of the graduated students in the departments of architecture in Iraq. As there is a difficulty in developing the artistic skills for them and finding the integration with the scientific abilities in architecture. The

integration between the artistic skills and the scientific abilities is very important for the students. They form the main tools to continue with studying at the department of architecture. It is important for the department to support these skills and abilities through the curriculum especially in practice. Developing the artistic skills is harder than developing the scientific abilities in the department of architecture. The accepted students with higher level of artistic skills cope faster and easier than those who have less level. Artistic skills are more important than the scientific abilities for the students but the integration between them is the best. Creative thinking in producing form, function and construction is the main task the student should practice.

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