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Original Research Article

Insight as Problem-Solving in Architectural Designs: A Case Study*

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Abstract

Problem statement: In the agreed-upon model of Wallas (1926), The Art of Thought, the third stage is illumination, which has remained a problem for design thinking. Without the ability to understand problem solving and illumination now, design thinking cannot be understood. Due to the instantaneity of this illumination and the nature of general illumination, it is impossible to provide a proper understanding of it.

Many different methods have been developed to negate the designer's direct confrontation with the problem and refer it to previous instructions. This means that a direct understanding of the design situation is not possible. However, there is evidence that suggests a direct understanding of the design problem. The questions of the present study are as follows: Is it possible to have a direct understanding of the design situation? If so, what is the mechanism? What does it have to do with productive thinking? What effect could it have on architectural education?

Research objective: The present study aims to examine the immediate and direct understanding of the design problem through practical observations of architectural design.

Research method: The present study is qualitative. To collect the data, the thinking aloud technique was used. This technique has long been used in the study of thinking. For this purpose, in-depth interviews were carried out with architectural design students. The data were analyzed using a modified version of Goldschmidt's (1991) method. In addition, library sources were used.

Conclusion: The present study introduces a three-stage model of insight. The designer first notices the inherent gaps in the design problem. These gaps have signs of structural connections within them, and understanding these connections leads to the restructuration of the design problem. These stages can be linked in a sequential cycle. The insight model shows that the designer can directly understand the above steps.

Keywords: *Insight, Productive thinking, Design thinking, Gestalt psychology, Restructuring.*

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Introduction and Problem Description

Design research has emerged since the sixties (Goudini, 2020, 29). In the early years of its establishment, it was still a theoretical science that tried to explain the designer's thinking with logical thinking patterns, and therefore attempted to remove us from the ambiguity that was identified in architectural thinking.

As time passed, understanding the fact that design research studies face major inconsistencies with the practical studies of design thinking was not hard; and one could realize the lack of a study on what happens in the design workshop, among the papers, and perhaps models in the designer's mind.

Finally, these studies led to an over-simplified understanding of the design process in which the existing and specific factors of the problem were combined in a logical process, making the conclusion possible. Christopher Alexander led the most important efforts in this regard. However, he later acquitted himself of the result (Alexander, 1984, 309). He tried to reduce the design problems to non-intuitive and predetermined components. These components were analyzed separately, and then new compounds were produced.

But the design problem cannot be completely pre-identified and prepared. When the designer does not even know the problem correctly, how can one be sure that s/he can identify all the components perfectly and recombine them in the secondary stages?

After the theoretical approaches of the first generation of studies, which were mainly rooted in logical thinking, field studies became the focus of research design work. The works that were written in this period, attempted to relate design thinking to pre-existing factors and, here, the designer's prior experiences. In other words, according to them, there should be a pattern or schema to understand what is currently being observed. Before this period, these facts were discussed by some researchers in the field of psychology of thought, such as Kintsch and Van Dijk (1978). Based on this type of view, Greeno (1977) introduced insight as an ability to apply a pre-existing schema to a novel situation.

By asking a question, the gaps in these theories become apparent to us: How can we understand whether a given schema or a particular prior experience is or can be used to understand the present situation? This question refers to a mechanism for direct understanding of the current situation. In other words, even assuming the use of such prior schemas is helpful; it is the understanding of the situation that is decisive in choosing the hypothetical schema. In this case, understanding the situation is more important than the concept of schema, and that is what such a research study should address.

Based on the studies of the author, it was deeply felt that there should be a mechanism that, instead of referring the design problem to predetermined patterns, even the designer's previous experiences, provide spontaneous clarification and immediate grasping of the designer from the design problem. Every problem should make a direct connection with the designer in a way that the designer can successfully understand the problem now, and feel a unique and inner relationship with it. This is what we recommend calling insight.

The present study seeks to clarify the following questions: Is it possible to understand the design problem or obtain an insight at the moment? If yes, what is its mechanism? And what is its relationship with creativity? Also, what effect can it have on architectural teaching methods?

Research Background

One of the studies that can be considered the beginning of the studies that are rooted in practical observations is the well-known research entitled "primary generator" by Jane Darke (1979). In the work of Darke, the most important aspect of the problem from the designer's point of view is called the primary generator, with which the designer finds the initial solution to the design problem. A relatively simple idea with which the designer can integrate the different dispersions of the problem

space. This relatively simple thought can even precede an accurate understanding of the problem. In other words, before the designer knows the problem correctly, the primary generator helps the designer. Darke added the primary generator to the model of Hillier, Musgrove & O'Sullivan (1972), which was based on conjecture-analysis (Darke, 1979, 38). According to her, the designer first achieves a relatively simple idea, and with that, s/he guesses a solution and then evaluates it.

Slightly similar to that, Schön (1984) says that at the beginning of the design, to understand the space of the problem better, the designer only enters some of the factors into the desired frame and puts the rest of the factors in a mode of suspension. According to Lawson (2005), just as a frame can be seen as a window on the problem space, a primary generator can be seen as a window on the solution space (Lawson, 2005, 371). Darke and Schön introduced important keywords into the design research literature. The part of the design research that works with the origins of architectural thought has nothing new to say, and it has this paradoxical point: Darke considers the primary generator to be influenced by personal judgments (Darke, 1979, 38), and Schön believes that the frame is affected by the preferences, values, norms, and meanings of the researcher (Schön, 1984, 132). In this case, the design research does not have the objectivity that it dreamed of. Because there is no objective criterion for understanding the personal judgments or personal values of the designer, and again everything goes back to personal judgments.

Regarding the methods of such studies, they are mainly based on interviews with designers. Some of these studies focused on theoretical inferences from observations more intensely, which revealed some shortcomings. For example, Schön (1987; 1983) tried to collect his observations as a reflective practice, under the title of experience. The result of his work was another attempt to link architecture to the body of the experimental sciences and, thus, to equate thinking in the scientific sense with design thinking; a connection that was not much constructive, and made experts such as Lawson (2005) eventually state that architectural thinking (or rather, design thinking) is fundamentally different from scientific thinking. They even stated some reasons for this difference and introduced a type of design knowledge that is different from experimental science. At the next level, Cross (1982; 2006; 2011) introduced the methods of design thinking as a unique type of thinking which is different from conventional scientific thinking. However, science was experiencing a newer meaning during these years, which researchers in the field of design research were unaware of (Farrel & Hooker, 2013, 38).

Today, some design researchers have approached information-processing theory to strengthen the scientific foundations of design research, which are still not solid. These efforts are also rooted in the study of artificial intelligence, which is typically observed in the work of Newell and Simon in 1972 and Simon in 1978. According to Wertheimer (1996), they "formalized what has become the prototype of the kinds of paradigms that have been taken for granted by cognitive psychologists, computer scientists, and cognitive scientists ever since" without proving its validity (Wertheimer, 1996, 11). Goldschmidt (1997), for example, interprets his observations one by one, based on the literature on information processing theory, such as the concept of problem space, initial space, operators, and the target space. Bjorklund (2013) recognizes the change in the representation of the problem space as an important part of learning to design, by quoting Visser (Visser, 2006, 225). Oxman's theory (1997) is also based on the representation of the problem space. The influence of Ohlsson's (1992) theory of representational change and the change in the initial representation of problem space in the work of Kaplan and Simon (1990), both of which are within the scope of information processing theory, is clear. Kolodner and Wills (1996) introduce the understanding of what is observed through strategic

controls (Kolodner & Wills, 1997, 388). Information processing theory specifically follows the principles of logic and believes understanding is possible through abstract concepts, schemas, and strategies.

Among Persian sources, there are many studies on design thinking. Some of them are reviewed here. In general, some research studies have identified strategies for increasing creativity in architectural design. For example, the studies of Mahmoodi (2005), Tabibzadeh, and Parva (2021) show divergent thinking in connection to the subject of creativity. The brainstorming method that is used to promote creative thinking (Sharif, 2014, 27).

Some other research studies have linked learning styles and personality differences to the subject of creative thinking. For instance, the results of the study of Hosseini, Falamaki, and Hojat (2019) show that individual differences affect creativity, and as a result, educational methods should pay attention to this point and, accordingly, provide guidelines for the growth of creativity. This research recommends a person-to-person education. The research of Bastani and Mahmoodi (2018) has concentrated on the relationship between various analogies and learning styles. In this study, individuals were divided according to the style of Felder and Soloman (2005) based on four criteria: reflective-active, sensory-intuitive, general-consecutive, and visual-verbal.

The study of Daneshjoo, Hosseini Alamdari, and Moeinipour (2019) focused on evaluating the success rate of architectural education environments on the creative thinking level of students. The research results confirm the effect of an architectural education environment on creativity, in such a way that educational environments in Iran have been useful for people with low general creativity because they do not tolerate the high level of creativity in people. In addition, the research results of Ashraf Ganjouei, Saghafi, and Iranmanesh (2019) showed the effect of visual stimuli in the environment on creativity.

Some studies have evaluated creativity using standardized tests such as the Torrance test. For example, Talebi, Moosavi, and Posheneh (2021) carried out research on the effectiveness of creative techniques in architectural design. They distinguish the two stages of finding idea and ideation in design. The results show that the brainstorming technique affects finding the idea in short term and the scamper technique influences ideation in the long term.

Sharif (2011, 2014) has categorized thinking into two types: creative thinking and critical thinking. The ideation stage is conducted by creative thinking, but critical thinking analyzes the idea.

Mahmoodi (2005) introduced the model of interactive thinking in which cognition is provided by the left hemisphere of the brain and is responsible for critical thinking, while ideation is done by the right hemisphere of the brain and is responsible for creative thinking, and finally presentation that uses the interaction of the two hemispheres of the brain and is connected to content thinking.

To summarize, the studies that were mentioned above can be classified into several categories. First, some examine strategies that increase the probability of obtaining creative thinking. Second, some investigate the influence of factors such as learning styles, environment, and external stimuli on creative thinking. Third, a few accredit a distinction between the very creative thinking and the type of thinking that atomizes and analyzes creativity.

The results of this research provide useful information to researchers. However, a few considerable studies on creative and productive thinking have delved into the very direct understanding, not essentially pertinent to prior experiences, strategies, schemas, and abstract concepts. This feature can be considered in connection with the keyword “illumination” in the field of cognitive psychology. Wallas (1926) mentions four stages for creative thinking: preparation, incubation, illumination, and verification (Tayyah, Mehdizadeh Seraj, Mahmoodi Zarandi, 2021, 96). Preparation is the step in which the designer starts searching. In the incubation stage, generally, there is no significant progress. In the illumination stage, an idea suddenly appears.

Verification is the evaluation of the third stage. Among these stages, illumination needs further investigation. This stage is usually expressed in terms such as the "flash of insight" (Hosseini et al., 2019, 129). But, what really happens when such an opening occurs in solving the design problem? The present study examines illumination from a new perspective. In this study, we refer to this instantaneous and direct understanding of the design problem as "insight." To understand this, our solution is to return to practical observation and see what happens.

Research Method

In this research, the definition of Fitzek's (2005) qualitative research method is used. Fitzek states that qualitative research is usually rooted in a structured understanding of reality. In qualitative research, from establishing the connection with the case of study, it is learned that the research process has resulted from the reality of experience and it proceeds by restructuring the initial understanding of the researcher, which inevitably has a structure since it is an understanding, thus its extension can and should be understood (Fitzek, 2005). In this definition, Fitzek uses the productive thinking of Wertheimer (1959; 1945) as the basis, and establishes a qualitative research mechanism by restructuring the researcher's understanding.

To collect the data, a technique which has long been used in cognitive psychology and design research, was used. In the technique of thinking aloud, an interviewee is given a topic and asked to think about it and express it aloud at the same time. This method was first proposed and used by Dunker (1945), a second-generation scientist of Gestalt psychology in the field of thinking and problem-solving.

Ericsson and Simon (1993) examined and confirmed this method. Leighton (2009) states that this technique can be used to observe, define, and measure the content of students' minds while they are thinking. Ericsson (2006) states in his research that "the think-aloud model of verbalization of thoughts has been accepted as a useful foundation for dealing with the problems of introspection." Gero and Tang (2001) state that "There is no associated interference with the ongoing design process when using concurrent protocols."Mackaullife recognizes these methods as one of the data collection techniques in research design (Mackaullife, 2013, 102). Reputable researchers in the field of research design, such as Goldschmidt (1991; 1992; 1999; 2000), Schaub, Goldschmidt, and Meiger (2010), have used this technique.

In this interview, a student was asked to design a house. The student first talked a little about the house that s/he was interested in, and then the interviewer demanded some design. The demands included a living room, a kitchen, a bedroom, a toilet, and a bathroom. There were also trees on the site that needed to be preserved (Fig. 1).

Interviews are semi-structured in such a way that, in addition to the design requirements, in the nature of the problem there are disturbances that are not discussed with the students, including 1- Entrance to the site can only be done from a small section on the north side. 2- The entrance is located in the

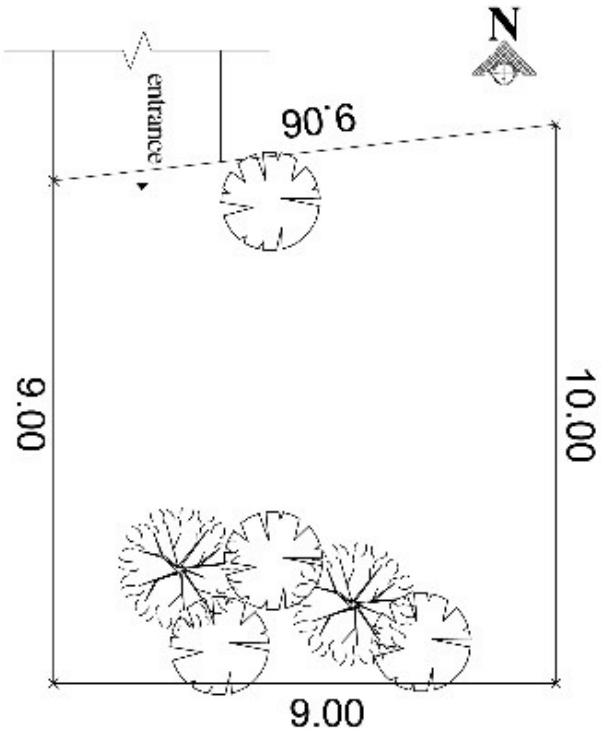

Fig. 1. The site. Source: Authors.

north direction and this can potentially affect the lighting of the building. 3- The land is small. 4- The trees are placed in a way that they occupy a relatively large area, and as a result, the effective area for the placement of the building has been reduced. 5- The space between a single northern tree and a group of southern trees is very important.

What is important in these studies is how the designer interacts with the design. Throughout the study of this subject, mostly, the examination of the inner relations in this interaction is important. Normally, even one case is worth such a focused review. For example, Schön (1984), in his very famous article, "Problems, frames, and perspectives on designing", used only one student to arrange the interview, and Goldschmidt (1994) interviewed a student in his article "On Visual Design Thinking: The Vis Kids of Architecture". To better understand the nature of the examined subject, the interviews should be continued until the issues are clarified. In another article, Goldschmidt (1991) dealt with seven cases. In this article, we present the results of three interviews. The first interview lasted about an hour, the second about an hour and fifty minutes, and the third about an hour.

In each interview, students began designing, and a video camera was employed to record the interview. After the interview, all the students' statements were written as transcripts and turned into the smallest units of argument and numbered. Student sketches were also recorded, and the sketches that were eliminated during the design due to being erased or being covered by another line were restructured according to the film using the Adobe Photoshop software. Subsequently, the modified version of Goldschmidt's method (1991) was used (Fig. 2).

Goldschmidt entered each statement as a square on the chart. In the present study, this diagram has been employed by applying some changes that are in line with the aim of the present study. The idea of changing Goldschmidt's method came from within the insight model that will be discussed in the next sections of this paper. In the insight model, understanding the gaps and places where the student's understanding is being restructured is crucial. We show the exact location of these developments on the graph. As a result, we can see where the student has been stressed and where s/he has managed to restructure his/her understanding. The relationship between these places provides important information.

Theoretical Frameworks

• Productive thinking

Productive thinking tries to explain the most unique characteristic of humans. Perhaps this ability can be called the creation of something that does not already exist. For this reason, the word 'production' seems appropriate for it. This simple word has become the subject of endless debate. This ability is not recognizable and reproducible in artificial intelligence.

Max Wertheimer (1945, 1959), the founder of Gestalt psychology, uses productive thinking to move from a perceptually ambiguous state to a more structured state. This is the metamorphosis of thought from the first perceptual state -structurally ambiguous- to the second perceptual state - with greater structural clarity - (Wertheimer, 1959, 238-242). The importance of Wertheimer's clarification lies in the point that instead of being rooted in the inarticulate and its commitment to arbitrary and impenetrable originates it in the existent situation. This is something that can be considered something unprecedented in the history of science.

Creation is rooted in the requirements of the current state. This means that the current state is not something static or just something in front of us. We are facing a dynamic situation that has its requirements. Wertheimer's work is about understanding a dynamic field, both in perception and thought.

What we see, probably can be seen more easily, and of course, it has laws that are the same as those in Gestalt psychology. Metzger (2006) introduces the Gestalt laws as the laws of seeing and states, "They assumed that thinking obeyed similar basic principles

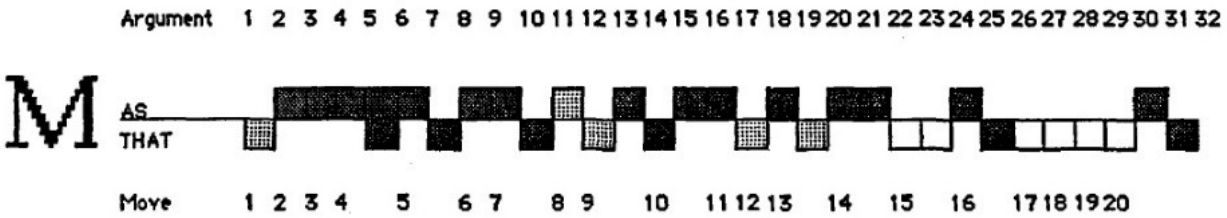

Fig. 2. Gabriela Goldschmidt's method. Source: Goldschmidt, 1991, 137.

(Gestalt laws) as perception." (Öllinger & Goel, 2010, 4).

- **Inner relations**

With a dynamic understanding, it is not necessary to be able to understand the problem in advance and with preparation. Sometimes we find ourselves in a situation that we cannot comprehend. In this dynamic field, identification of the problem is made possible by understanding inner relations. In the static model, such relations were ignored. The character of the problem is rooted in these inner relations. Wertheimer, for example, proposes the problem as follows: Obtaining the area of the shapes that can be observed in Fig. 3a.

Most people divide this shape into two parts, square and parallelogram (Fig. 3b), and try to solve it by using complex geometric methods. However, cannot the problem be understood more simply? The answer is that if we look deeper into the image, the square and the parallelogram suddenly disappear and two triangles appear instead (Fig. 3c). This is a structural transformation that ultimately makes it easier for us to reconstruct. A rectangle consisting of two right triangles whose size is also in question. The shape area can now be easily calculated (Fig. 3d).

Structural transformation reveals that the components are required for understanding the situation in a new way. Understanding inner relations allowed us to produce such a solution. This is the process towards the clarification that encourages us to follow it. Following this process, the above problem was completed with new construction. But in design problems, this process may be repeated over and over again.

- **Insight model**

Insight is a model that this research presents based on the observations of how students perform in solving design problems. This model covers many of the shortcomings of previous models. Insight typically has major applications in Gestalt theory. Insight means that instead of seeing the problem as an external object with an objective and observable order, the designer can see the inner components of the problem, and this is a process that requires patience and empathy with the design problem. Eventually, a kind of insight is obtained.

Inner relations always leave traces that are manifested in structural gaps. Structural disturbance and inherent gaps are observed in the problem and then disappear with the change in structure. This is how we achieve a creative understanding of the problem at each stage.

- **Three stages of design thinking**

Insight is looking into the structure of the problem. Observing students' ways of arguing indicates that they can directly see and immediately understand this structure. With the help of Wertheimer (1959), this understanding is known to include the following steps:

1. Seeing gaps, trouble-regions, and disturbances in the design problem and dealing with them structurally.

As long as the designer does not understand these gaps, any action is considered blind. Understanding these gaps requires some kind of coexistence with the problem. The success of the designer depends on the depth of this coexistence.

2. Inner structural relations of the design problem are sought among these disturbances and the given situation as a whole and among various parts.

The gaps internally point to the inner relations of the problem. The fact that to what extent the designer

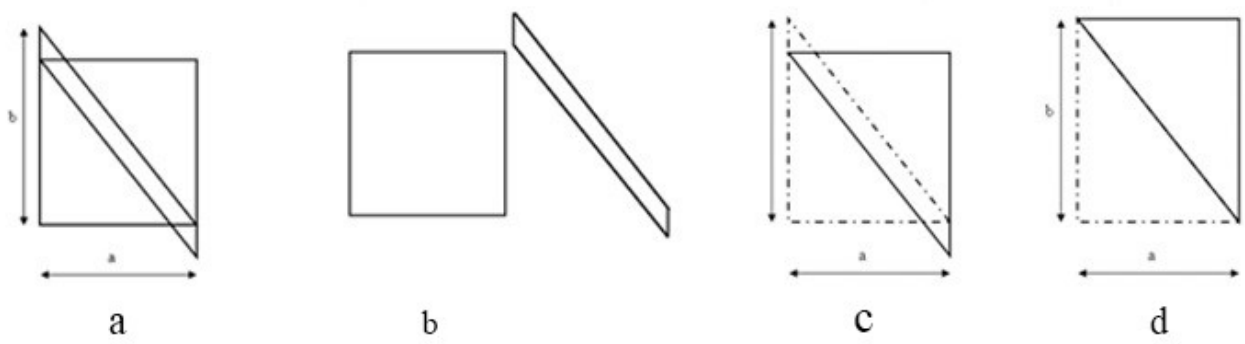

Fig. 3. Obtaining the area of shape (a). Source: Ollinger & Knoblich, 2009, 278.

can bring the gaps back into the connections requires multiple rounds and is a time-consuming and arduous task.

3. We have a kind of restructuring here: seeing inner relations leads to structural grouping and segregation as well as re-centralizing.

This is the third stage, and it is equally full of difficulties. The extent to which the designer can implement the inner relations of the problem in a new order.

These moments in designing are generally associated with the "aha experience", which is one of the most important keywords in the psychology of thinking. Most designers find new ideas that can completely change the fate of design in these moments.

The problem of creativity is solved in part: whenever the designer succeeds in obtaining an insight, creation occurs. The main feature of the insight model is the directness of the design problem. There is no distance between the designer and the design problem.

For an example of productive thinking, a type of thought, which does not limit itself to the previous instructions, we present Wertheimer's (1959) parallelogram problem, which can be useful in interpreting the results. Wertheimer gave the parallelogram problem to a child. However, before that, he taught the child how to obtain the area of a rectangle. The child first talked about the difficulty of obtaining the area of a parallelogram based on his previous instruction (how to obtain the area of a rectangular). Nevertheless, the next moment, the child looks at the left edge of the parallelogram and then at the right edge and says that these points are troublesome (Fig. 4). This is the moment when the child succeeds in looking inside the structure and as a result, sees the innate disorders in it. After a while, the child suddenly finds new structural connections among the disturbances of the situation. She shouts, "May I have a pair of scissors? What is bad there (on the left edge) is just what is needed here (on the right edge). It fits ". She took the scissors and "cut the figure vertically and placed the left end on the right (Wertheimer, 1959, 47-48). The new shape is rectangular. This brings a simpler construction to the situation.

Interviews

This three-stage model is based on productive thinking studies. It explains how the student copes with the problem. To understand the insight model better, interviews were conducted with architecture design students.

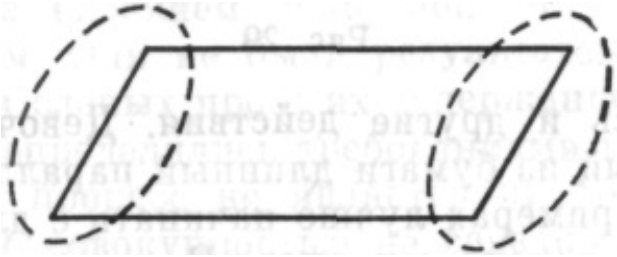

Fig. 4. "What is bad there (on the left edge) is just what is needed here (on the right edge)". Source: Wertheimer, 1959, 47-48.

- **First interview**

1. Seeing gaps, trouble-regions, and disturbances of the design problem and dealing with them structurally.

The student begins to argue and goes on to argument 25 (Figs. 5, 6a & 6b). During this period, the student follows a uniform path. The reason for this claim is that despite the presence of six disturbances that occur in this area, in just one argument, restructuring is observed (Fig. 5). At the end of argument 25, the demands of the design problem are answered. But the student does not feel satisfied with it (Fig. 6c).

In the first stage, the student does not notice the inherent disturbances and gaps in the problem. The student's mind is struggling to keep her previous teachings unchanged. This is one of the obstacles to productive thinking: trying to solve a problem solely based on previous instructions. Like lighting from the west, which the student does not consider appropriate based on her prior knowledge. But the shape of the land is not commensurate with this notion. This leads to confusion and redirection in understanding the gaps.

Argument 27: "I say this because the atmosphere is somehow that it cannot be touched much, for example, now, for example, if I bring my kitchen here (meaning the current living room), this will be the west. The living room on the west side is very bad. I do not know. Maybe it's good. Maybe if it comes here, we will see more space here, for example (meaning the trees on the southern front). For example, we will make a living room here, and a kitchen here." (Fig. 6d).

From the middle of this argument onwards, the student realizes that placing the living room on the west side of the land does not create an inherent gap in the present design situation. Rather, the inherent gaps in the situation are rooted in factors such as the trees on the site, which she explicitly refers to later.

2. Inner structural relations of the design problem are sought among these disturbances and the given situation as a whole and various parts.

Before this argument, the student did not notice the inherent gaps in the problem. But in argument 27, she notices them. It is at this point that the overall plan is restructured and new inner relations are found. "Maybe if it comes here, we will see more space here, for example (she means the trees on the southern front, which, as mentioned earlier, are among the things that can be inherently disruptive). For example, we will make a living room here, and a kitchen here." (Fig. 6d). "Look, I have this tree. Green space can be observed from this view. Maybe it is better than the living room to be here." Clearly, the student's imagination has undergone a general transformation, and her design thinking has expanded.

3. Seeing inner relations leads to structural grouping and segregation as well as re-centralizing.

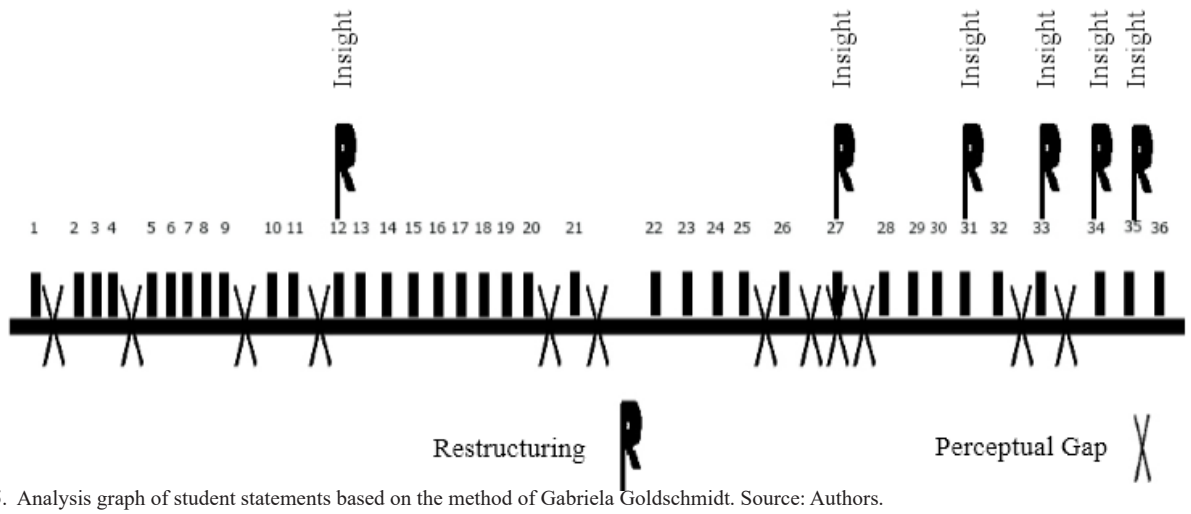

Fig. 5. Analysis graph of student statements based on the method of Gabriela Goldschmidt. Source: Authors.

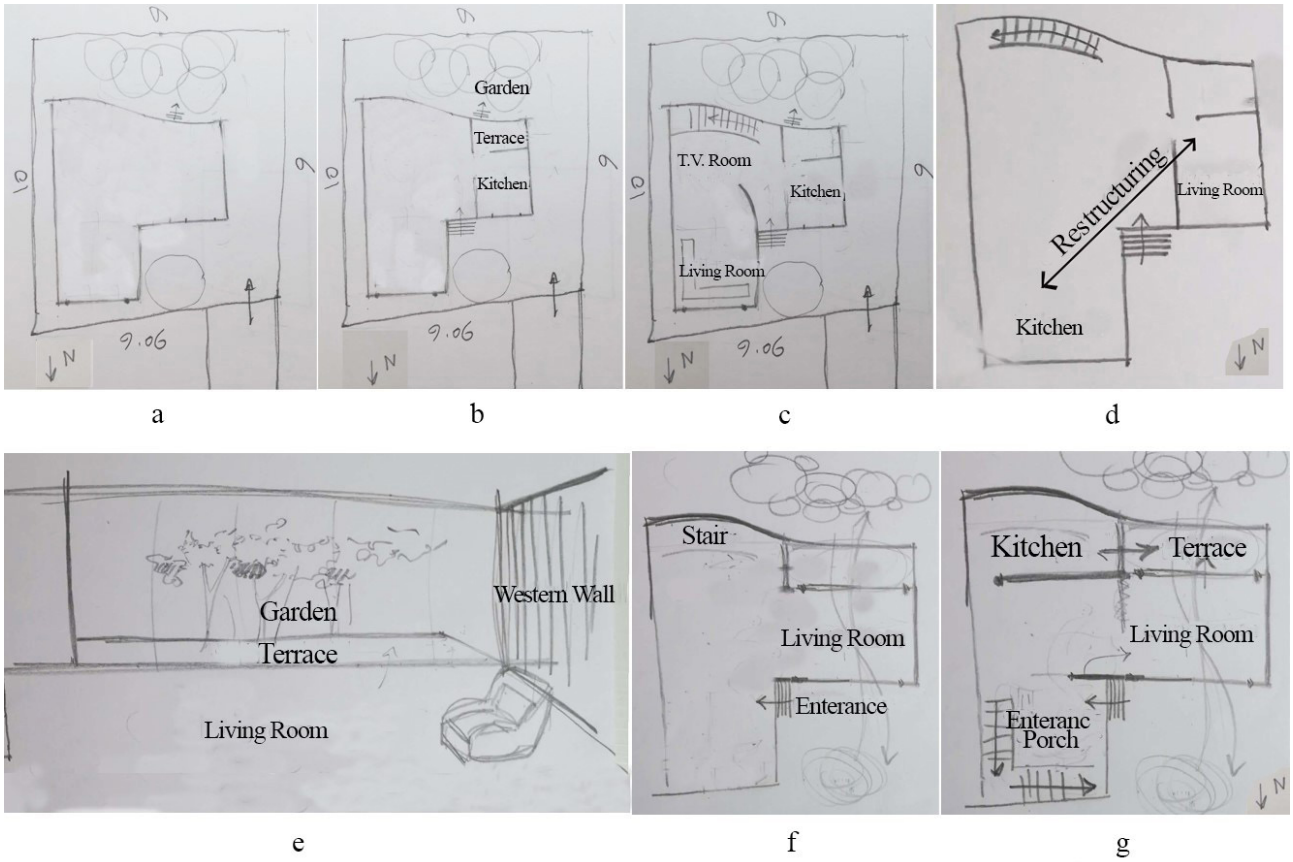

Fig. 6. Restructurings that occurred in the formation of the design. Source: Authors.

After this restructuring in argument 27, the student finds that four more new structures are being formed for the project. So that at the end of the design, she states: "But I think this (meaning, the plan that came after the restructuring in argument 27) is better than that the other one (meaning, the one before argument 27). This was my first thought and it doesn't matter anymore."

- **Second interview**

1. Seeing gaps, trouble-regions, and disturbances of the design problem and dealing with them structurally.

The second student quickly notices the trees at the first moment. "Now that these trees have come," she says (Figs. 7 & 8-a). Trees are a structural element in a design problem and seem to be a good starting point. This understanding addresses one of the structural points of the problem. Due to the compatibility of the student's understanding with the internal structure of the problem, the specific characteristics of the problem, and the student's lack of prior confrontation with the problem, a source such as an experience or any other external factor cannot be considered for this statement. According to the proposed model, with this statement, the student goes to the second stage.

2. Inner structural relations of the design problem are sought among these disturbances and the given situation as a whole and various parts.

The student tries to look for the inner relations of the design problem from the part that she naturally recognizes as the turning point. As soon as the student identifies the trees as the main problem of the situation, she also sees them as the main component of the structure. "I'd like everything to embody around these trees. It means that with the presence of these trees, I have to go back to some extent. Wherever they exist " (Fig. 8a).

As time passes and after argument 5 is stated, the student suddenly realizes the danger that threatens

these structural connections. After this, the first and second steps are repeated. The problem is that the student realizes that the components being added to this necessary component after Argument 1, have turned it into a theatrical element (Fig. 8b). In Gestalt theory, this addition of arbitrary components is one of the reasons for the loss of internal connections. As a result, the student removes those components and, once again, seeks structural relations through these disturbances. Therefore, it can be concluded that insight does not occur only once, and sometimes, despite the

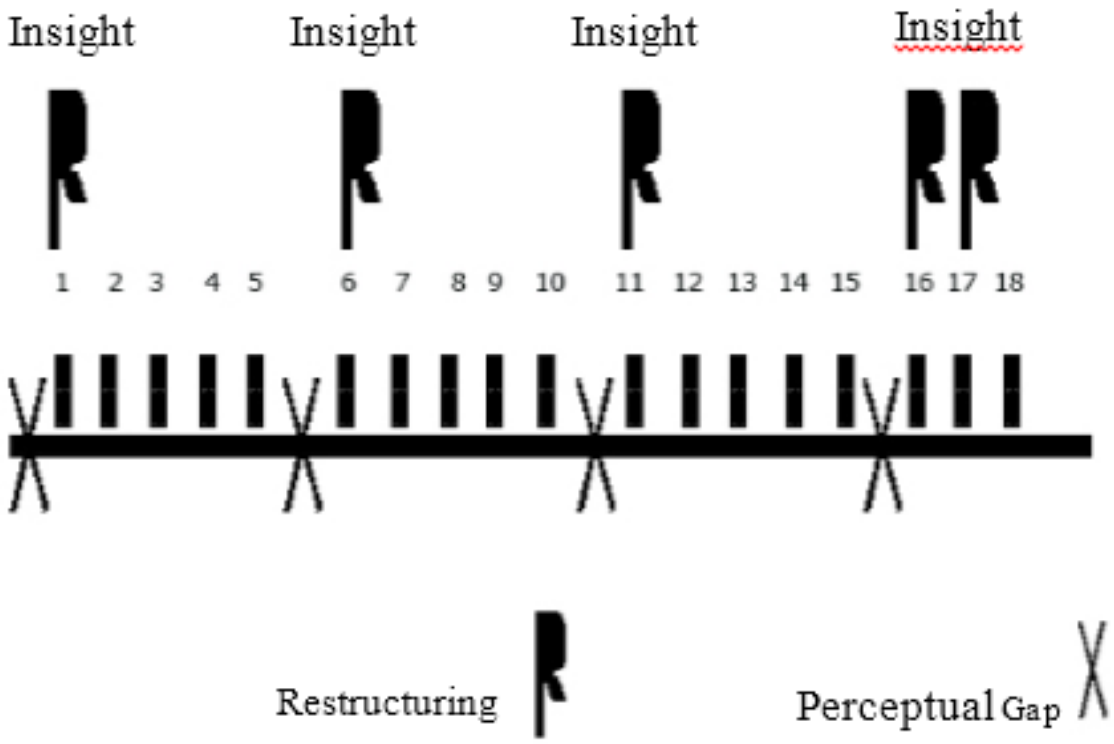

Fig. 7. Analysis graph of student statements based on the method of Gabriela Goldschmidt. Source: Authors.

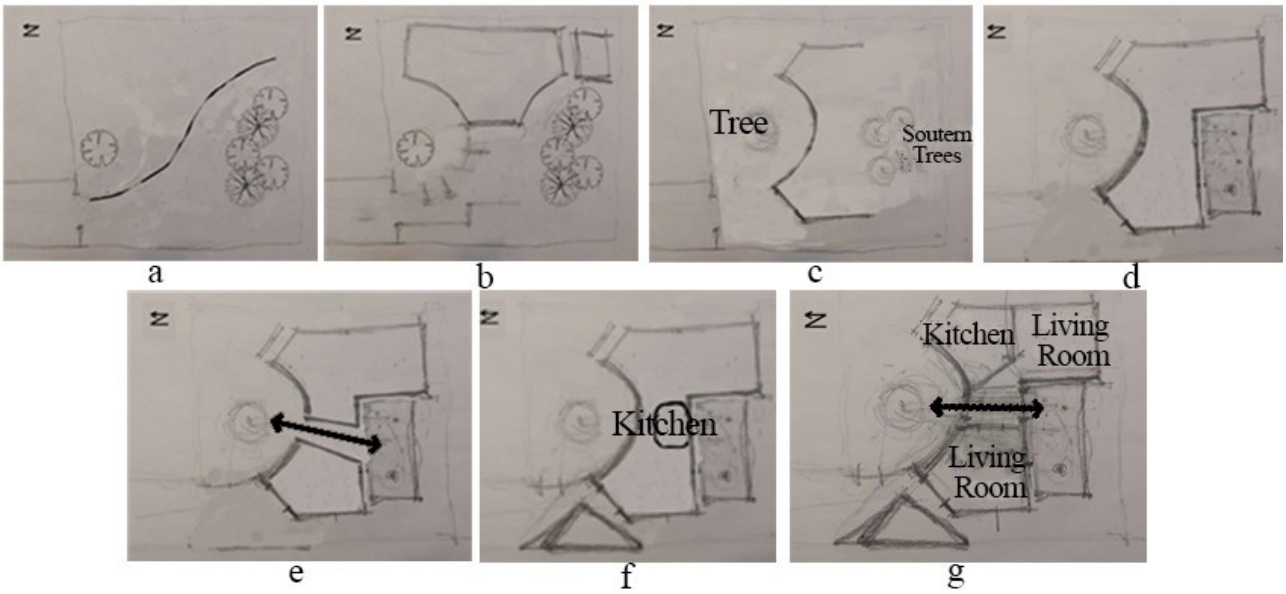

Fig. 8. The restructuring process of the student from the emerging project. Source: Authors.

initial proper understanding of the problem, in the later stages, disturbances are added by the designer herself.

Argument 6: "I want my house to be located in such a way that it can use one of these two (meaning the trees on the north and south fronts) in its spaces. It means that these should not be just for beauty or being in the yard. I would like my form to be changed in such a way that, from the same visual point of view, a person can understand that I set my form this way because of these trees. I had such a fraction in my form." (Fig. 8c). Behind this argument, the student seeks a more clear way to express her thinking process to the audience. This is the clarity that the student seeks in this insight model and reveals that: insight brings the need for expression with itself. We may call this need for expressing a desire to create. The student talks about a house that has not yet been built, but its inner requirements are directly and instantly understood by the student, and this understanding has these reflections: the house must be observed in such a way that it is clear that its form has this fraction because of the trees on the site (Fig. 8c). After this, the student adds components to it again (Fig. 8d).

3. Seeing inner relations leads to structural grouping and segregation as well as re-centralizing.

Our turning point has now presented a full understanding of the problem. Argument 11 suddenly connects the single northern tree and the group of trees behind the house by making a passage through the house (Fig. 8e). After that, the student puts the kitchen, as one of the requirements of the design problem, at the geometric center of the house (Fig. 8f). The placement of the kitchen at the geometric center of the house is one of the previous demands of the student. But this placement conflicts with the main structure of the house and destroys the passage of Argument 11. On the other hand, its proportions are questioned by the student. As a result, in Argument 16, the student suddenly removes the kitchen from the geometric center and moves it to where she calls the functional center of the house (Fig. 8g).

With this movement, the elements of the house are placed in a new group. In argument 17, the passage has been turned into an internal corridor of the house, which has windows on both sides to a single north tree and a group of trees behind the house (Fig. 8g).

- **Third interview**

1. Seeing gaps, trouble-regions, and disturbances in the design problem and dealing with them structurally.

At first, the third student states, "Well, I'm thinking about where to start first." The starting point of the design is very important for this student. "Well, I'm going to have a living room, a kitchen, a bathroom, a bedroom, yes?" she says. The student reviews the functions of the design problem. But her next argument indicates that planning is not the starting point for obtaining the features.

The student says, "Well, the best place I have for these trees..." (Fig. 10a). The starting point for her design is where the trees of the site lie. She sees the trees first. The place where can be potentially troubling. In the continuation of this sentence, the student talks about how the components of the problem are related, and in fact, the next stage of insight begins.

2. Inner structural relations of the design problem are sought among these disturbances and the given situation as a whole and various parts.

"Well, the best place I have for these trees is... They can be either a very good space for interaction or they can be a very good space for the yard ..." (Fig. 10b). As we see, the student seeks to structure the problem with a focus on a part of the situation, which could cause disturbance in the problem design.

After that, the student decides to place the center of the house in the place of the trees on the south front. She suddenly realizes that, in this case, the main yard of his house is located in the back of the house, and this creates a disturbance for the student. "Oh, my entrance is from this direction.

The entrance to my land is from this direction. If I want to place the bedroom here, maybe this cannot be my yard " (Fig. 10c). The student thinks for a moment, and a few moments later, for the second time, she experiences a type of insight and realizes that this disturbance is not related to the nature of the situation. Rather, it is a disturbance that she added to the problem: "Well, the thing is… I can consider both here (meaning behind the building) and maybe here (meaning in front of the building) as the yard." She strongly continues: "Well, I put my yard behind the house, which has no problem. I think if I put the yard here, it will be behind my house. This will be my yard, where my trees are preserved and I can even use them beautifully."

After this stage, the student locates the desired functions of the design problem around this yard. "I can have my bedroom here. I can even put it here,

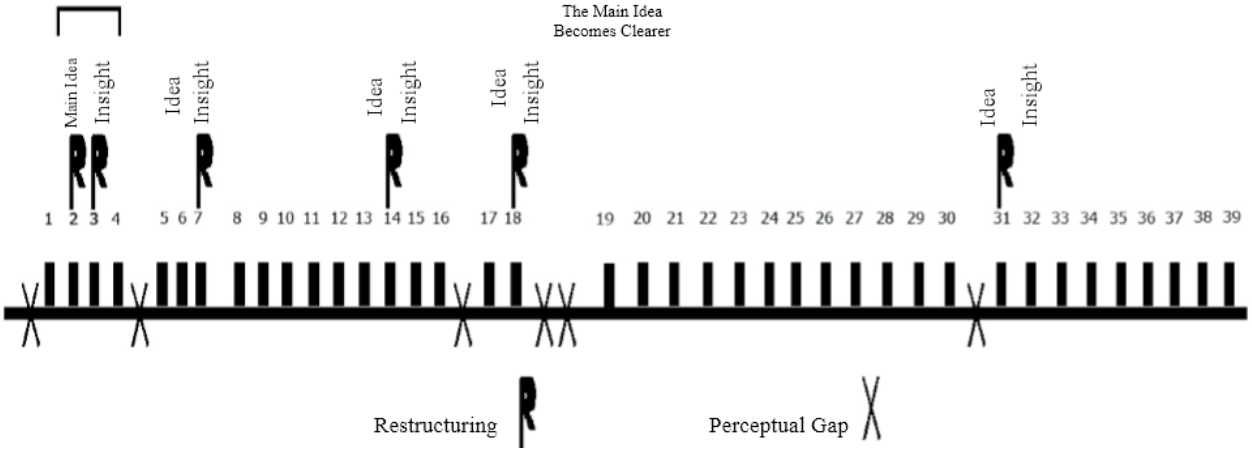

Fig. 9. Analysis graph of student statements based on the method of Gabriela Goldschmidt. Source: Authors.

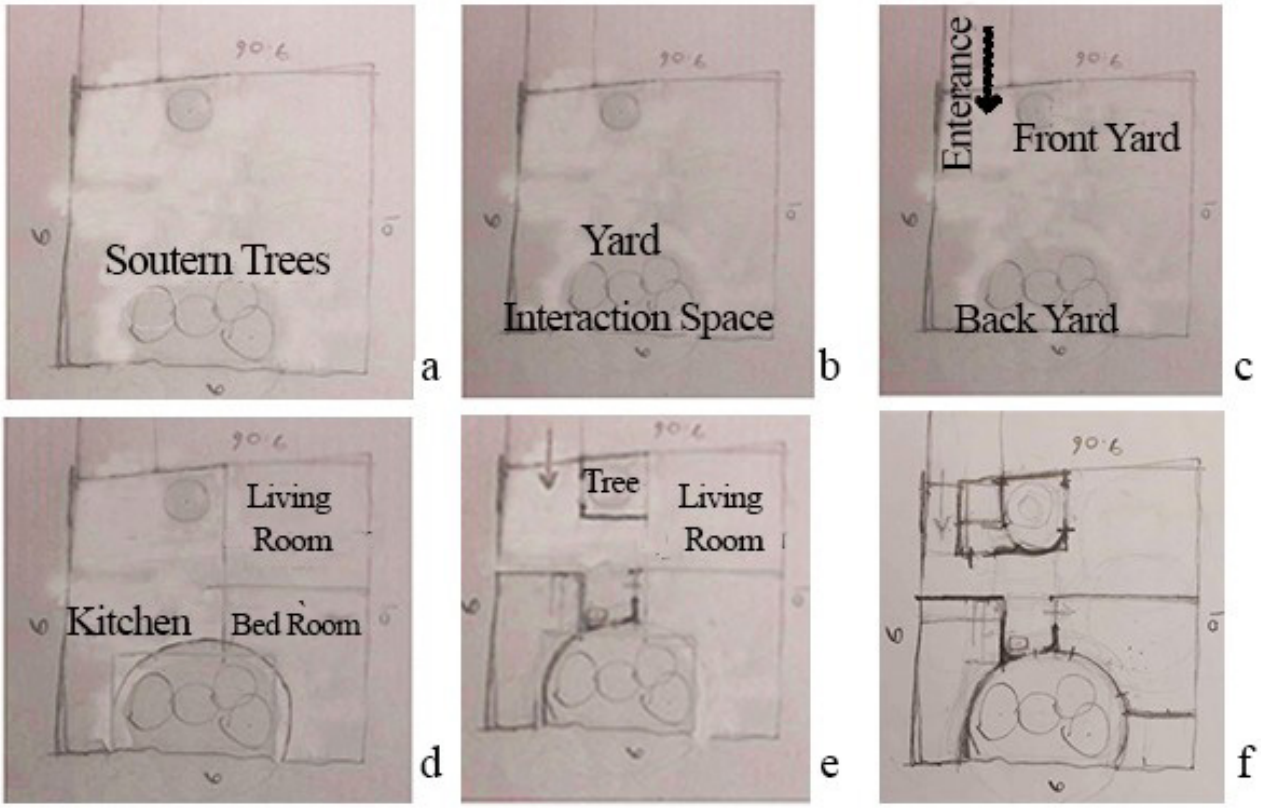

Fig. 10. The restructuring process of the student from the emerging project. Source: Authors.

and the bathroom can be here. It is better that I consider here for the living room. The bedroom can go here. When I go in to get to the kitchen, even in the kitchen, I can see these (the trees)." (Fig. 10d)

In the middle of the interview and argument 19, the student states a very important sentence. "If I want that, considering the thing that was on my mind (indicating the idea of the yard which was stated at the beginning of the interview), if I want to consider this without paying attention to the entrance from the north and south, when I see this site, for me in this place, I can see that feeling of centrality, that circle that wanted to connect these (the bedroom and kitchen)." Clearly, the student has succeeded in obtaining an insight again. One of the characteristics that this student expresses is the elimination of arbitrary components and reviewing the problem. At this point, she has reached the highest level of ability to see the inner relations of the problem. A state that makes the student able to see the problem in an instant as a unified whole or a good Gestalt (Fig. 9).

3. Seeing inner relations leads to structural grouping and segregation as well as re-centralizing. Although the student has reached an answer to the design problem by the end of argument 13, (Fig.10d), we see that she says: "Maybe, I would like to just draw some lines at first. Also, to know what I can put where...". Even at this stage, the student still tries to look at the inner requirements of the design problem. Immediately after this sentence, the student shows a new restructuring in Argument 14. "I think I would like this tree (meaning the tree on the northern front) to be in my house. I mean, I'd like to see the tree trunk inside my house. In the space of the house, except that it's out now." (Fig. 10e). This student finally managed to create six restructurings during the design period.

Discussion

In the insight model, understanding the inherent gaps in the problem is very important. This is a point that we have not yet fully understood. Up to this point, we have had a confrontation that we can call a blind encounter.

The evidence we get from the interviews tells us that the beginning of a design is a blind confrontation. The designer may approach the problem based on previous experiences (or schemas) by applying a solution that has previously worked. But usually, such an insistence is useless, and this situation continues until the designer realizes that she cannot proceed with this plan. This moment needs to be explained more.

This is the first moment that the inherent gaps and disturbances in the situation can be observed, and the designer realizes that there are critical points in the design problem. Then, the first sparks of inner relation within the problem can be found. This allows the designer to see the structure inside the design that is being formed.

In our first example, the student was not able to see the inherent gaps in the problem while she was trying to solve it by using her previous experiences, such as that the light from the west is not good and as a result, a western living room cannot be a good living room. Rather, she only failed to take advantage of her experiences and schemas. Something that made her dissatisfied with the design that was being formed.

This conflict causes the student to notice the non-uniformity and put her previous instructions aside for a moment. Then, the student confronts the gaps and disturbances that lie at the heart of the design that is being formed. She swaps the locations of the living room and the kitchen. At this point, the student can understand the inner structure of the situation. The living room is now located on the west side of the house. But she sees that not only has this living room acquired the desired quality, but also the overall structure of the design has improved. The most troubling element of the situation was the incorrect placement of the living room in its previous place. Through restructuring, newer structural connections were created, and it underwent several restructurings in the next stages. The second student points to one

of the elements from which the inherent gaps of the design are rooted in the very first moment. “Now that these trees have come...”. At the same time, her familiarity with the inner relations of the problem deepens.

I’d like everything to be centered around these trees. It means that, with the presence of these trees, I have to go back to some extent. Wherever they exist (Fig. 8a).

Trees as elements that can **cause** disturbances are hidden at the heart of the problem. The connection between the trees is observed in the problem. We see that the student is then able to obtain some new restructured version of the design that is being formed.

The third student also notices the group of trees at the end of the site from the beginning. She structures the situation in such a way that the trees become the main **focus** of the house. However, she later develops a mental disorder and doubts whether the yard should be placed in front of or at the back of the house. But she immediately realizes that this mental disorder is due to her imagination and not something related to the requirements of the problem. Well, I put my yard behind the house, which has no problem. I think if I put the yard here, it will be behind my house. This will be my yard, where my trees are preserved and I can even use them beautifully. “ The trees have been preserved and have become the center of the house, and they have been used beautifully.

What we want to get from the comparison of interviews is a recently conceived concept, which is called a “gap.” Since the gap does not notice a component, it inherently implies the existence of a whole and bears the semantic load of innate relations. The word itself may refer to a defect, but the driving force of productive thinking begins with this defect. The result of our research on productive thinking is summed up in the word “gap”.

We can consider the gap as a tendency to be completed. The gap is a prelude to restructuring. Naturally, we cannot stay in a state with gaps. As a result, with each encounter with the gap, all our efforts are to restructure the situation so that we can see it more coherently. This is rooted in seeing. Seeing does not accept the gap (Fig. 11).

The results of the discussion confirm the three steps that were previously mentioned. The following diagram summarizes the insight model (Fig. 12).

The present study confirms the result of Darke (1979). Among the three students in this study, the second and third students achieved the primary generator at the beginning. “Now that these trees have come… I would like everything to be centered around these trees. It means that, with the presence of these trees, I have to go back to some extent wherever they exist.” (Fig. 8a). “Well, the best place

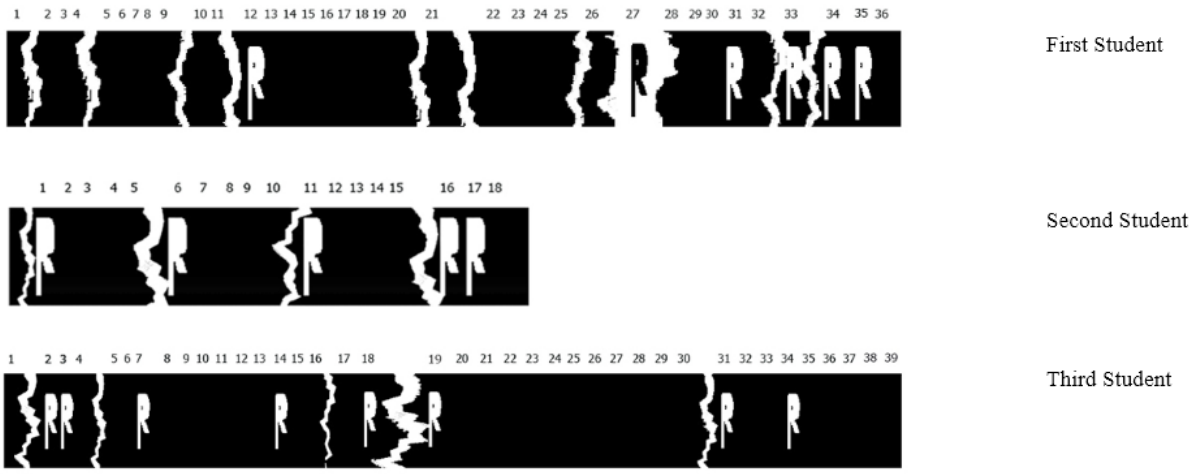

Fig. 11. A comparison of graphs. The location of gaps and restructurings. Source: Authors.

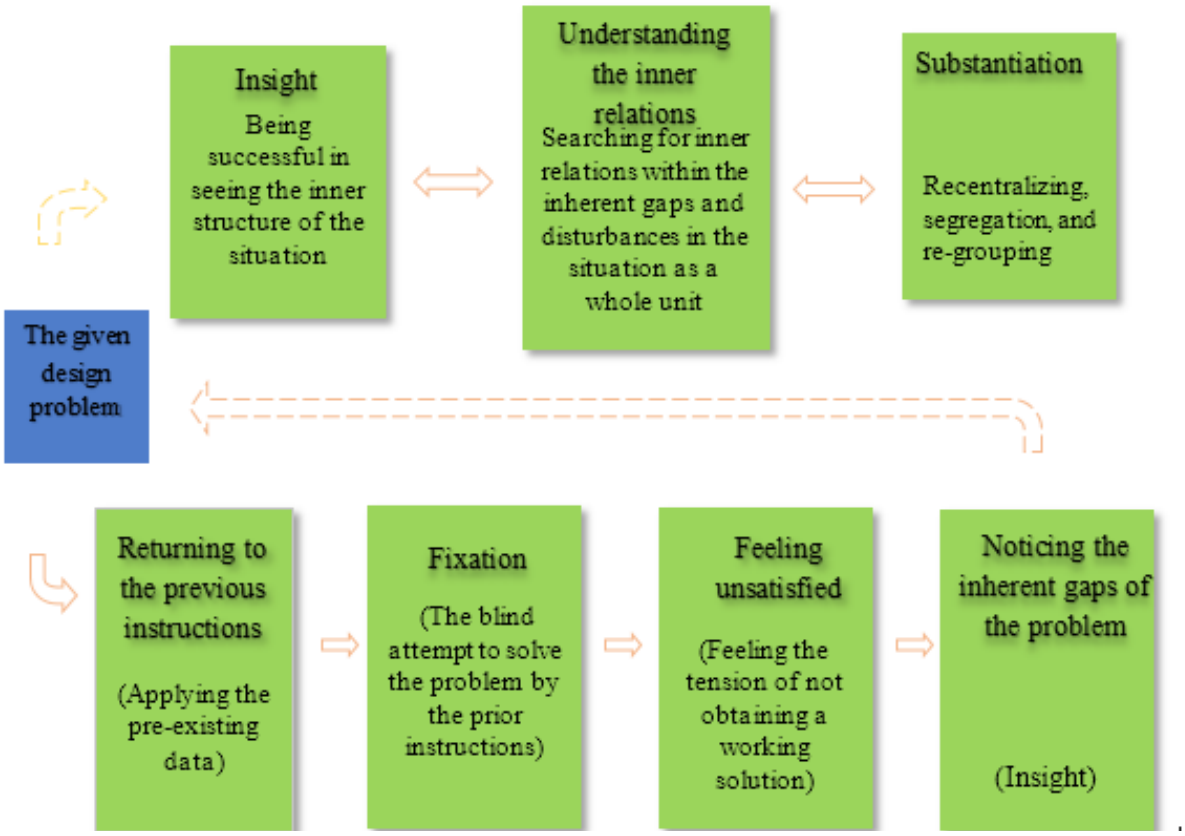

Fig. 12. The insight model. Source: Authors.

I have for these trees is... They can be either a very good space for interaction or a very good space for the yard...” (Fig. 10b). These relatively simple thoughts are the main ideas for structuring different design problems. But Darke’s opinion regarding “personal judgments” as the most important factor in the emergence of the primary generator remains somewhat ambiguous. The results of our research show that the primary generator is related to the requirements of the design problem. At the same time, the tree is both an element that, due to the lack of structural attention, can be troubling, and cause a perceptual gap, and it is also the main structuring element of the primary generator. It seems that it can be said that the primary generator is the result of the insight and causes the gap to disappear.

In the interviews, we also see that in different situations, the students were able to frame and restrict certain elements in one frame. For example, the third student states: “If I want that, considering the thing that was on my mind (indicating the idea of the yard which was stated at the beginning of the interview), if I want to consider this without paying attention to the entrance from the north and south, when I see this site, for me in this place, I can see that feeling of centrality, that circle that wanted to connect these (the bedroom and kitchen) together.” The student has succeeded in getting the factor of geographical directions and then the issues regarding the light of the building out of her mind for a moment and paying attention only to the factors that were in her mind. Factors such as the backyard where the trees grew on the site, as well as the bedroom and kitchen were included in the design problem. So in contrast to the opinion of Schön (1984) which considers framing to be influenced by the norms and values of the designer and its results cannot be judged, this student’s framing seems to be affected by the requirements of the design problem.

The present study also explains Schön’s (1983; 1987)

definition of design as a reflective practice, as well as the definition of design as 'seeing, moving and seeing again' (Schön, 1992, 135) in more detail. Insight tells us that at the beginning of the design, these are the inherent gaps of the situation that must be seen. This vision will naturally create new connections that we can compare to the concept of 'moving' in the study of Schön. Possible restructurings are also a review of the design situation.

Also, without direct understanding and insight, Oxman's theory of representational change (1997) and alternation in the representation of the problem space of Bjorklund (2013) remain suspended and ineffective. However, in these studies, representation in the problem space is presented as a strategy, but they do not answer the question of what direction the representation should take. Without answering this question, any representation would be based solely on probability and coincidence, which could not be commensurate with productive thinking. For instance, in the middle of the design, the first student succeeded in representing the design problem space. Before that moment, the student was acting based on her previous experiences. This created an inherent gap in the designed situation. But since this gap did not exist in the nature of the design situation, it led to confusion and redirection in understanding inherent disturbances and gaps. The student finally saw the inherent gap in the situation. Changing the place of the living room and kitchen was not by chance. The place of other spaces could have been changed, but we only see these two spaces were swapped. What leads to the representation of the problem space is the ability to see the inherent structure of the design problem. When we can see inside the problem structure, the problem space is represented. As a result, seeing this structure or insight occurs before the representation.

The research findings are incompatible with the design thinking methods that Cross (1982, 2006, 2011) and consequently Lawson (2005) propose as a particular way of thinking. According to their research, the designers should use some codes that translate the abstract requirements into real objects (Cross, 1982; 226). This means that understanding requires mediums called conceptual coding. Such literature is extensively observed in the field of information processing theory as well. But according to the findings of the present study, before the formation of any concept and just by paying attention to the problem, the designer feels the requirements of the design situation. These requirements are not abstract but are related to the concept of the gap, which can be directly understood in the design situation. This observation does not mean seeing emptiness in the situation. The gap is not an object for the subject to identify with her mind and fill. Rather, we realize that there is a feeling of imperfection in the whole situation. This understanding includes the inner relations of the situation and is directly present to us, and as soon as we understand it, different ideas begin to form for eliminating the gaps or solving the design problem.

With the understanding we now have of insight, the concept of illumination also seems to be clarified. Our explanation is insight, the ability to understand the problem directly. It is even a prerequisite for recognizing which prior experience can be applied in the present situation.

Sharif (2011; 2014) considers ideation as the result of creative thinking, while he believes critical thinking is responsible for evaluating ideas. Such a dual perception of thinking disappears on its own if we consider that the solution to the problem comes from an internal view of the problem. Creative thinking is not just a matter of finding a new solution inspired by the empty space in the designer's mind, which after inspiration requires a critical examination to meet the requirements of the problem. Creative thinking, or more precisely, what we prefer to call productive thinking, comes from understanding the circumstances of the problem.

- **Architectural education**

As we know, the design problem is an ill-structured issue. This means that either the problem itself is not clear or we do not know what the goal situation

is or we do not know how to get from the initial state of the problem to the final state. Sometimes it can be a combination of these factors. In such a situation, one cannot and should not expect to have predetermined methods to solve a design problem.

The insight model is not a method, but it raises awareness of the inside and the requirements of the design problem. This model encourages professors and students in the field of architecture education to provide support and empathy. A creative mind is a mind that is formed in coexistence with things and, instead of giving its desired form to problems, realizes the inner requirements of the problem. With this support, the student and the professor will have the opportunity to discover the inherent disturbances and gaps in the situation. There is no need to divide the problem into small components based on logical methods. The gap is a feature of the whole design problem that cannot be seen. By dividing the problem into its components, the gap is ignored and removed from the problem. A lack of understanding of these gaps closes the way to productive thinking.

Consider this example: In the middle of the interview, the first student was adding various components of the house to the design one by one. As if the house was the result of the algebraic summation of the house components. Even though to that point, the components that were required by the problem were put together, the student realizes that something is wrong. But we see that, in the end, she realizes the factor that caused the inherent gap in the situation. In fact, the role of the professor in the design process as an expert is to accompany the student until the inherent gaps of the problem are understood. Instead of asking the student to analyze various separate factors, the expert professor will know how to get the student to understand the gaps. This is the moment that is most likely to be associated with creativity. Understanding such gaps results in an understanding of structural relations, and leads to subsequent restructurings.

Conclusion

In contrast to the other models of thinking, in this paper, we introduced and developed an insight based on our observations. Insight explains how we can understand the inner relations and how we can understand the meaning of what we see without any medium. Considering that the proposed problem had an internal structure that students were struggling to understand during the design process, and in this way, referring to the previous instructions was solely an obstacle to the advancement of design thinking, insight gives us a good understanding of this progression.

The first step in the insight model is to see the inherent disturbances and gaps in the situation. Merely referring to the designer's ideas, schemas, and experiences can act as barriers to seeing these gaps. Whenever the designer can detect the inherent gaps in the situation, the designer has taken the first step to look inside the structure of the situation. Structural connections are sought through such gaps. From this point on, the perceptual laws of seeing, with new structural grouping and segregation, put together the elements that lead to the construction of the problem in different ways each time, resulting in different restructurings.

Insight is the main issue in design thinking and causes a change in our previous ideas and models. The researcher does not look at the design object here. The goal is not to focus only on the character of the designer. This is an intermediate and objective-subjective state. When someone is a designer and faces a design situation, a structure emerges from that situation whose existence depends on the existence of the designer. Insight is a direct encounter with this structure.

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