

A Phenomenological Understanding of Students' Lived Experience of Education Based on Design Thinking: Secondary School

Zahra Abulhassani^{1*} 

¹ Farhangiyan University, Tehran, Iran.

*Corresponding author: Zahra Abulhassani, z.abolhassani@ut.ac.ir

DOI: [10.22059/JDT.2022.347782.1081](https://doi.org/10.22059/JDT.2022.347782.1081)

Received: 27 August 2022, **Revised:** 3 November 2022, **Accepted:** 12 November 2022.

Abstract

This study was conducted to investigate the lived experience of female students of the first-secondary level of Baharestan city based on design thinking. This study was conducted qualitatively with a phenomenological approach. The data collection tool in this study was a semi-structured interview. The field of research was the female students of Baharestan city, 60 of whom were selected through available sampling and a group interview was conducted with them in the Shad application. Then, the text of the interviews was analyzed using the 7- Colaizzi's method. To verify the data, strategies such as the review of the interviewees' impressions and coding, the review of the collaborating researchers, and the agreement between the researcher and participants were used. In the research, the findings from the student's viewpoint include four themes: "high-order thinking; social skills; social awareness and interpersonal skills" with twelve sub-themes: "problem-solving thinking; creative thinking; critical thinking; cooperation; conflict management; "Increasing teamworking, empathy, needs assessment, responsible innovation, self-regulation, organizing and collecting facts, and paying attention to the surrounding environment." Finally, the results showed that the application of design thinking by using the problem-solving approach and its various styles can improve the social, academic, cognitive, and decision-making skills of students and help them achieve the goals of education, and to increase their cognitive and social abilities so that they can use design thinking in facing obstacles and problems of personal and social life in social environments, including school and family, and have control over their thoughts, emotions, and behavior.

Keywords

Design Thinking, Phenomenological, First-Secondary School.

Introduction

The rate of the training of specialized and committed human resources is the goal of every educational system. An efficient educational system promotes the economic, social, and political growth of society with effective education. One of the influential components of the educational system is teaching approaches, which is considered one of the most important factors in improving the quality of specialized education. Education by providing the necessary training suitably, also to transfer knowledge; creates the ground for acquiring the necessary skills for today's era. Quality teaching requires knowledge of paradigms; it is new approaches and theories that lead to deep learning. The results of the studies show that it is possible to change the way of thinking through theory and practice, which is a science in design, called design thinking (Johansson-Sköldberg et al., 2013).

Design thinking was conceptualized for the first time in the 1960s and over time has been described as a cognitive style and a general theory of design (Stock et al., 2018). Simon (1969) has defined design thinking as changing existing conditions to preferred conditions. Brown (2008) stated that designers not only rely on analytical processes but also have the ability to see and understand all important and fundamental and sometimes contradictory aspects of a problem and combine new solutions. In this sense, design thinking is a creative thinking process. Therefore, Brown's proposed definition is: *Design thinking is a discipline that uses the sensibility and methods of the designer to meet people's needs with what is technically possible and with an appropriate business strategy* be consistent with customer value and market opportunity (Brown, 2008).

The design thinking process has different advantages according to their special features. Vande Zande et al. (2014) describes design thinking as a means for solving creative problems. Design thinking can promote constructive thinking, creative problem-solving, and multifaceted collaboration (Cross, 2007; Kolodner, 2002). Also, Barseghian (2010) stated that design thinking is an *antidote* to the traditional teaching method. Design thinking, as a constructivist learning method or strategy, allows students to be motivated to explore solutions (Plattner et al., 2011; Bruton, 2010; Carroll, 2014; Scheer et al., 2012). Plattner et al. (2011) pointed out that design thinking is effective in enhancing the learning of 21st-Century skills through its application in complex interdisciplinary projects with a completely constructivist approach. Another advantage of design thinking is the interaction between the teacher and peers because this method emphasizes the design process and cooperation. The method of discussion with teachers encourages students to share (scientific) insight and create a deeper understanding of the subject (van Breukelen et al., 2017) and enriches the individual learning process (Roth, 2001). It is also a part of the interaction and cooperation related to providing and receiving feedback because constructive feedback is essential for self-regulation. Constructive feedback provides insight into working and thinking that reveals students' strengths and weaknesses (Kolodner, 2002). Constructive feedback is timely, relevant, targeted, behavior-oriented, collaborative, genuine, and respectful and focuses on knowledge, skills, practices, and attitudes (Wiggins, 2012).

In this context, results from Aranda et al. (2020) showed that students have different types of thinking. Cognitive memory, divergent thinking, and evaluation thinking are used in the design. In the continuation of Borge et al. (2020), stated that students act as active learners during the design process. Also, Stock et al. (2018), concluded that the repetition of stages in design thinking creates creative self-confidence, and the stages of competence development in areas such as empathy and emotional skills are created. Intending to investigate the impact of design thinking on the results of the questionable research, Guaman-Quintanilla et al. (2020) indicated an increase in teamwork, problem-solving, and creativity-considering design thinking. Van Breukelen et al. (2017) also concluded that design thinking is envisioned as the main strategy for promoting entrepreneurship skills in European schools. Also, Stephens and Boland (2015) stated that the direct involvement of physical senses in design thinking methods points to the importance of aesthetic knowledge for problem definition and solution generation.

Finally, [Thoring and Müller \(2020\)](#) argued that design thinking is beneficial for all disciplines and develops essential skills in the learner.

All the mentioned cases are stated while the secondary education as a place for developing human capital is considered an important and fundamental issue. This means that the selection and development and evaluation of new educational approaches, in turn, improve the level of education in the first-secondary school. One important and effective point in improving the level of education is the selection of an appropriate teaching method, teacher's attention to the satisfaction of the learners ([Amanat et al., 2010](#)). However, the results of research conducted in this field have emphasized the fact that design thinking is an effective and efficient approach to various aspects of student learning. But notably, the learner is a vital element in the teaching process, which is affected by the educational experience. In fact, the classroom is the last place and passage to apply all the educational experiences and a place where the expectations of the parties are fulfilled. Therefore, you must accept that the main and practical aspect of teaching is the students' perceived experiences. Therefore, it is necessary to examine the understanding and experience of students as the main elements and recipients of education. Also, the studies conducted in this regard show that there is no research documenting the lived experiences of students concerning thinking-based education. Therefore, this research is superior in terms of originality, and finally, the current research examines and explains the lived experience of first-secondary students from education with the design thinking method. In this regard, to understand how the role of education based on design thinking, students were asked to share their experiences with the researcher. This research was conducted by analyzing students' statements about their experiences from the new educational approach of design thinking. It can help teachers and education administrators in reaching a general understanding of the benefits of using the new educational approach of design thinking. Therefore, the main problem of the research is *what is the students' experience and evaluation of thinking-based education?*

Methods

This research was a qualitative and phenomenological study. The participants in this research were purposefully selected from female students in their first year of high school who were available and had been trained in 12 sessions of design thinking training with the Stanford School model. The Stanford School model is presented in [Figure 1](#). Also, [Table 1](#) shows the characteristics of the participants.

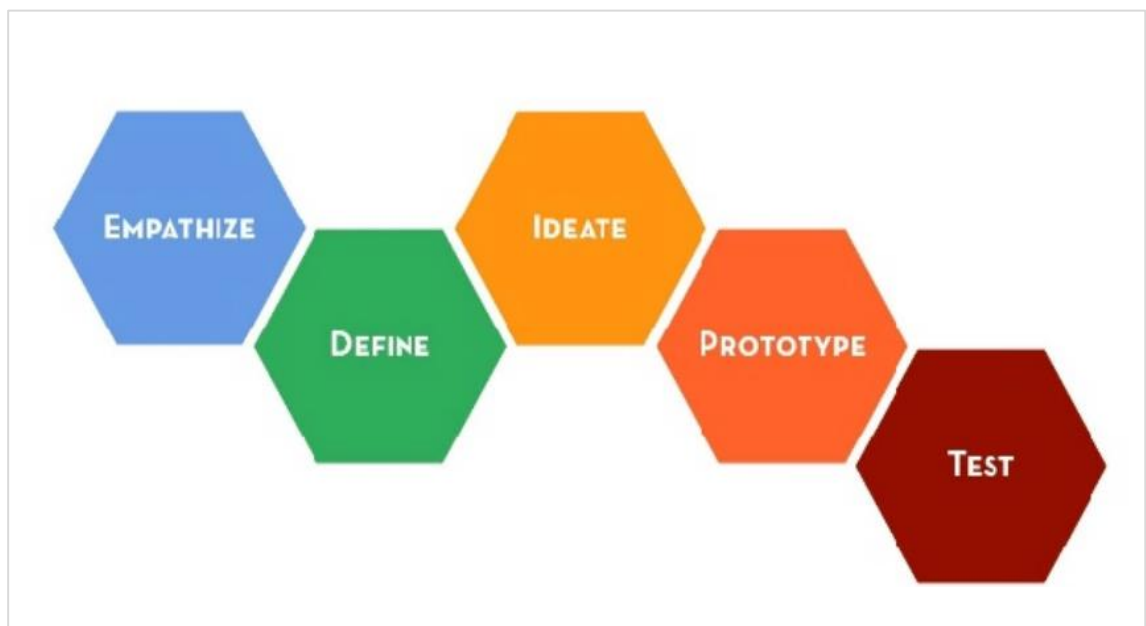


Figure 1: The design thinking model, Image by Stanford d-school.

Table 1: *The characteristics of the participants.*

Student profile	Grade	Frequency
Female students	Seventh Grade	20
	Eighth Grade	20
	Ninth Grade	20

In qualitative research, the researcher is usually the tool of information gathering, and this research was no exception to this rule. The basis of data collection semi-structured interviews. Note that due to the corona situation, the interviews were conducted online and in a group in a happy virtual environment. The interview guide was designed after reading the text. Then, it was modified based on the opinion of specialists and the central questions of the interview were determined. The central and basic question of the research (Please tell us about your experience of training in the design thinking method) was designed as an interview guide and was followed up with exploratory ladder questions wherever necessary. The answers of the interviewees guided the process of the interviews. The interviews were recorded with the permission of the participants and written on paper for data analysis. The data analysis was done using the 7-step Colaizzi method in the following order. First, the description of the participants in the study is read to gain an understanding of the whole. Then Important statements/phrases are then extracted. After that Meanings are formulated from important statements/phrases. The compiled meanings are organized into themes. A detailed description is written for each theme. Finally, the basic structure of the phenomenon is formulated. This process was done as a cycle for all interviewees. To measure the accuracy and validity of the results of data analysis, the results of the analysis and analysis, which included the initial manuscripts prepared from the interviews and labels obtained from the analysis, were made available to education experts to determine the blind spots of the research. To verify the data, strategies such as the review of the interviewees' impressions and codings, and the review of the collaborating researchers and the agreement between the researcher and participants in the research, as well as the immersion of the researcher in the data for a time can be used. The researcher's long and hard work with data collection can give proper credit to the research.

Findings

In response to the research question, *how is the student's experience and evaluation of education based on design thinking?*, in the current research, students lived experience of design thinking-based education was determined through the description of themes, their constituent elements, and the relationship between them, which are described in [Table 2](#).

The first main theme that was extracted from students' experiences of design thinking-based education was high-level thinking. Based on this, 3 related sub-themes were identified.

Sub-Theme 1

1. Problem Solving Thinking: Design thinking uses various problem-solving and problem-management tools. Design methods and tools are well suited to solving complex problems. The students stated that they could identify the problems around them after training and see the ability to solve the problems within themselves.

2. Creative Thinking: Design thinking is used as a strategy for teaching creativity and innovation in the field of education. A result of design thinking is creativity. In this context, the students believed that their creativity and the power of generating ideas and looking at issues from different aspects increased during the training period.

3. Critical Thinking: Critical thinking is considered a basic cognitive process that increases the ability of students in problem-solving, problem-solving, and decision-making skills in different situations.

According to Elder and Paul (1994), critical thinking is one of the important cognitive abilities and is the skill of thinking about people, which plays an essential role in challenging issues. In other words, critical thinking means thoughtful and logical thinking that affects decision-making, it is defined, and before it has the aspect of mere criticism, it is a kind of sharp-sighted look at issues. According to the participants, when reviewing the projects, they carefully examined the work from different aspects so that they could identify its weak points. Then, they shared the obtained information in the group or class.

Table 2: Themes perceived by students of education based on design thinking.

Axial Coding	Selective coding	Sample of interview
High-Level Thinking	Problem-Solving Thinking	I learned to think about every problem I have and find a solution to solve the problem. When we faced problems, I didn't know how to solve them, but now with empathy, we will solve the problem
	Creative Thinking	My circle of ideas has become bigger because in the group everyone looks at the subject from one side, and I look at it from their perspective. Each of us had a very different idea. Now see how many ideas are in the mind. We deal with many issues every day. Now we have learned, for example, how to plan for studying and what new ideas we have
	Critical Thinking	We were checking the work carefully to see where the mistake was so that the problem could be solved. Ma'am, we have learned to criticize and respect the opinions of others
Social Skill	Co-Operate	We cooperate and think with each other and we reach a good result. During this time, we realized the importance of working with people who have good opinions and we tried giving solutions to solve the problems of different groups of people by cooperating and consulting with others.
	Conflict Management	I try to listen to the opinions of others through discussion and dialog and not be selfish that only my own opinion is implemented. Another student said, <i>a better solution can be found by talking.</i>
	Increasing Teamwork	Each of us was responsible for one task and we could complete the work project by working together. Our tasks were determined by the group leader according to our abilities, and because we wanted to do the work Let's explain in class that we wanted to do everything right so that our work would be better
Social Awareness	Empathy	A thing I learned here was empathy. How to put myself in other people's shoes and empathize with people. We could find good ideas with empathy.
	Needs Assessment	First, we thoroughly examined the needs of the people and by planning, we were trying to find a solution to their problem that would solve their needs. I survey people and consider their comfort.
	Responsible Innovation	If I were in charge, I would first consider all problems and everyone's opinion, and then I would solve the problem.
Interpersonal Skills	Elf-Regulation	We learned how to divide the work so that we can do the best work on time. At first, I didn't know how to use the children's comments to improve my work, but I learned little by little. By planning, we try to meet people's needs and solve problems. The forms were excellent to have a clear goal for everything and we plan for it to reach that goal.
	Organizing and Collecting Facts	First, we consider the problem, then we investigate to see how this problem can be solved.
	Attention to the Surrounding Environment	Before you gave me the idea of the library, I didn't pay attention to it at all, and after reading the comments of the children, I didn't change the style of the library. Before this, I didn't care about it at all and I didn't see the problems. This course was excellent. We empathize with everything and pay attention to our surroundings and consider issues. I learned to pay more attention to my surroundings and not to ignore everything and every problem and use my thinking to solve it.

Main Theme 2: Social Skill

As humans, we are social beings, so we need to connect with others. Social skills are tools that enable people to communicate, learn, ask for help, meet needs in appropriate ways, get along with others, make friends, form healthy relationships, protect themselves, and generally be able to interact harmoniously with society. In this regard, 4 sub-themes were counted.

1. Cooperation: According to the interviewees, a working group creates an opportunity to receive positive and constructive opinions, and this cooperation leads to the successful advancement of projects.
2. Conflict Management: When doing projects, due to the division of tasks and the way each task is by the subgroup or when hearing criticism from other groups, there was a possibility of conflict. According to the interviewees, design thinking provides an opportunity for the students to discuss and resolve conflicts.
3. Increasing Teamwork: Another good feature of training with design thinking is doing things as a team. Teamwork does not mean that everyone does the same thing together or can do another's work. Teamwork is more a means of synergizing work, in such a way that the sum of small tasks by each team member becomes a big task.

Main Theme 3: Social Awareness

The students' meaning of social awareness was the ability to understand the feelings of others and use their feelings to achieve their goals, based on which three sub-themes were identified.

1. Empathy: The statements of the interviewees indicated that empathy is the first step to understanding the needs of those around you. Because empathy is the understanding of emotions; they assumed the priorities and goals of others.
2. Need Assessment: During the process of design thinking, students found it necessary to pay attention to the existing needs in solving the problem and paid attention to the fact that by considering the needs, they can solve the problems in a more useful way.
3. Responsible Innovation: in students' design thinking during problem-solving; They examined the problem from different sides and the perspective of all stakeholders, and considered themselves responsible for responsibly considering all the different needs and conditions in the solution they provide. Students understood responsible innovation in the sense of feeling the responsibility of all stakeholders of innovation for its social, ethical, and environmental effects.

Main theme 3: Intrapersonal Skill

Using this skill, students can know themselves and their feelings, understand their thoughts, understand what they like and what they don't like, and find their strengths and weaknesses. Based on these, four sub-themes were identified.

1. Self-regulation: Behavioral self-regulation refers to the optimal use of various resources such as (time, place, and how to get help from available resources, including teachers, parents, friends, and educational materials), which increases learning. The students stated that during the training, they gained the ability to control and regulate the use of resources to achieve the goal.
2. organizing and collecting facts: According to the statements of the interviewees, to be able to solve the needs and problems, there is a need for the skill of collecting information in different ways and finally organizing the information to summarize and find the best solution; and over time, this skill was strengthened in students.
3. Paying attention to the surrounding environment: issues in life are derived from the environment around people. During the training, the students realized how many issues there are around them that need to be solved, and this made them think about their surroundings and what they can do to improve the environment around them.

Based on the findings of this research, the main categories and sub-themes related to the research can be seen in [Figure 1](#).

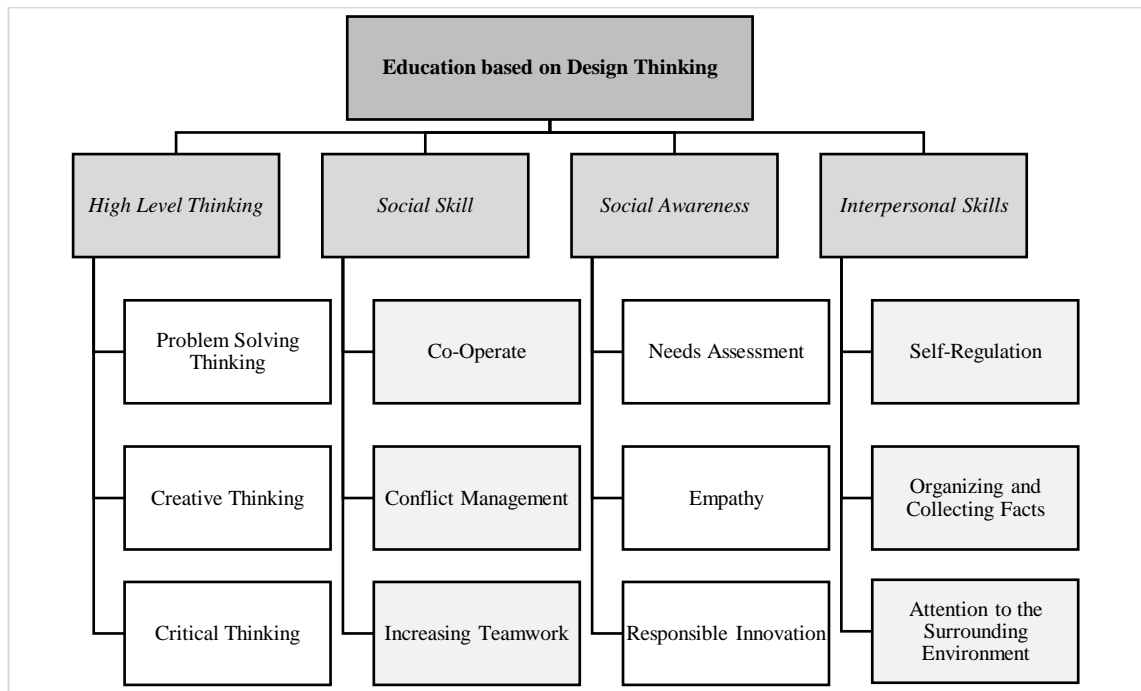


Figure 2: Themes perceived by students of education based on design thinking.

Discussion

This study was conducted to investigate the lived experience of the first secondary school students of design thinking-based education. By using the interviews conducted with the participants, the findings of this research regarding the current research question showed that education based on design thinking leads to the formation of different advantages in students. Of course, the results and interviews did not show a difference in obtaining these experiences among students in different grades. The findings obtained from the student's perspective include four themes: *high-order thinking, social skills, social awareness and interpersonal skills*. With twelve sub-themes, the theme was *problem-solving thinking, creative thinking, critical thinking, cooperation, conflict management, increasing self-esteem, empathy, needs assessment, responsible innovation, self-regulation, organizing and collecting facts, and paying attention to the surrounding environment*.

This is what emerges from the analysis of the content of higher-order thinking. The activities that are carried out in design thinking create an opportunity for students to reach high-level thinking. The use of higher-order thinking skills has always existed in design and technology (Rupnik & Avsec, 2019). The research findings showed; Education based on design thinking is the regular provision of cognitive and behavioral skills training that helps a person identify the most effective solution to a problem and effectively deal with future problems in the future.

In this regard, Hubbard and Datnow (2020), Guaman-Quintanilla et al. (2020), Ejsing-Duun and Skovbjerg (2019), Glen et al. (2015), and Renta (2016) state that education based on design thinking uses problem-solving thinking and increases problem-solving skills and decision-making power in students. It seems that people mastering design thinking can lead students to strengthen their problem-solving thinking. In teaching design thinking, students face a problem that they solve using a model of teaching design thinking, which in this research is the Stanford school model, which leads to the strengthening of problem-solving creatively and importantly.

It is one of the most important life skills, in addition, in this course, students learned how to comment on their group projects in a way that does not involve negative judgment. They learned how to critique their peers' projects, including both negative and positive points. They learned to first listen to everyone's explanation about the project and understand their perspective, then started giving opinions while respecting the class rules and maintaining respect. These steps help them avoid unnecessary and hasty judgments and to follow the opinions of their friends about each project.

Therefore, according to the evidence, the findings of the research indicate that students acquire critical thinking skills, including analysis, inquiry, broad-mindedness, and maturity in judgment. These findings conform to the statements of [Pakmehr et al. \(2012\)](#) who stated that critical thinking skills can be taught through the curriculum and included as a key factor in all academic curricula. Therefore, in explaining this part of the findings, it can be stated that critical thinking can be taught through design thinking along with the educational strategies of the curriculum. Also, research shows that various factors are effective in the development of critical thinking skills, including motivational, individual, sociological, cultural factors, teaching environment, teaching methods, etc. ([Pakmehr et al., 2012](#)). In this regard, according to the group work that was done in the class, the students were also motivated in terms of motivation, and they performed analyses and judgments with more enthusiasm. The development of critical thinking by using design thinking opens the door for criticism of projects and contributes to the growth and quality of the project. Additionally, when something was criticized, efforts were made to respond and rebuild that project. Secondly, when critical thinking prevails in a class, people do the next work and project more carefully. The findings of this research or the findings of [Deaner and McCreery-Kellert \(2018\)](#), [Val et al. \(2017\)](#), and [Shively et al. \(2018\)](#) who stated that design thinking improves critical thinking is consistent.

The results findings of the research showed that design thinking is effective in creative thinking and self-regulation. These findings are in agreement with the findings of [Murgaval et al. \(2019\)](#) who stated that education affects problem-solving and creative thinking. is equal because it showed that creative thinking and problem-solving can be increased by changing education. Another result of the research is the students' achievement of self-regulation. In this regard, creative thinking acts as a cognitive strategy related to self-regulation ([Gehlbach et al., 2016](#)), and a factor that affects creative thinking is self-regulation ([Walters et al., 2017](#)). In explaining this finding, it can be stated that another factor that plays a significant role in students' creative thinking is the quality of the teacher-student relationship ([Gehlbach et al., 2016](#)). Because in education with design thinking, teachers optimize the conditions in a way that creates a more favorable classroom environment, an environment identified through positive interpersonal relationships in which every person feels good. Also, the results of the findings of the research ([Jiang et al., 2018](#); [Aranda et al., 2020](#); [Jun et al., 2017](#)), concluded that design thinking is effective in creative thinking, innovation, and self-regulation.

Teaching students the way of design thinking is completely in groups and teams, and students learn the social skills necessary for teamwork while doing the project. They make many friends in the class and learn to respect others' opinions and take turns during group work. Also, according to the experiences of the students, teaching in the way of design thinking, how to create good relationships with other children, sharing their belongings, observing rules in the classroom cooperatively, sense of humor, reducing the fear of being judged by others, higher self-confidence, helping groups, being kinder to others, led to making more friends. Therefore, they could lead things well and talk better with others. Therefore, the results of design thinking increased social skills such as cooperation, conflict management, and teamwork. The results of the present findings conform to the research results of [Guaman-Quintanilla et al. \(2020\)](#) and [Lynch et al. \(2019\)](#).

In the theme of social awareness, students were able to learn about the needs, goals, and feelings of others through different methods such as empathy and needs assessment by using interviews with the stakeholders of the problem, research, and search. With the knowledge gained, students solve their problems with responsibility towards the needs of others and the stakeholders, including the surrounding environment. They defined the problem and started it.

For empathy, the students put themselves in the place of people in the problem and examined the problem from their point of view. In this regard, Owen (2006) stated that empathic people are sensitive to the events observed in their environment and can put themselves in the position of injured people. They are also sensitive to things that are not said or done or unusual habits and behaviors. Even further, they ask the stakeholders about the things that are done and the things that have not been done. This personality allows them to use all details of the observation and turn them into innovation (Brown, 2008). The results of the present findings are in-line with the research results of Renta (2016), Carroll et al. (2010) in the sub-theme of empathy, and with the research of Pavie and Carthy (2015) who introduced the design thinking method as a potentially suitable approach for solving problems as a responsible innovation.

We all have problems in our daily activities. We all need to find new ways to deal with these problems and find a solution that saves us time and resources. During the course, students learned that we are all designers of our own lives. Everyone can apply design principles to any aspect of their lives. One of the most important characteristics of design thinking is its organizational character. This means integrative use of facilities and situations (Chang et al., 2013). Also, embodied thinking includes information gathering, organization, description, and real-time skill and adaptation, which is used in design thinking (Kangas & Seitamaa-Hakkarainen, 2018). In this regard, the students stated that according to their need to identify and define the problem, they first started researching and searching and finally organized the obtained information and presented a coherent definition of the problem.

Conclusion

This study was conducted to investigate the lived experience of the first-secondary school students of design thinking-based education. According to the results of this article, it can be concluded that the application of design thinking by using the problem-solving approach and its various styles can improve the social, academic, cognitive, and decision-making skills of students and help them achieve the goals of education. Thinking about the contents of the textbook, getting involved in situations, and learning experiences will help improve self-learning abilities, strengthen thinking skills, and improve the level of learning. Also, to increase their cognitive and social ability so that they can use design thinking in facing the obstacles and problems of personal and social life in social environments, including school and family, and have control over their thoughts, emotions, and behavior. This method can increase the teacher's guiding and supervisory role in the teaching and learning process while reducing the volume of the teacher's lectures in the classrooms, and in this way, increases the opportunity for the teacher to interact with the students and turns the one-sided classes into classes full of activity and cooperation between the teacher and the student.

According to the results, it can be pointed out that the application of design thinking should be considered a part of the student's education program, which itself is placed in the framework of the curriculum development program, which in this way allows the possibility of equipping students with knowledge. Students acquire the skills needed to live in the present age, such as high-level thinking and develop social-emotional competencies, which subsequently increase the quality of education. Considering the importance of 21st-Century skills, it is suggested to the authorities to provide opportunities for teachers, curriculum planners, and related officials to become familiar with the standards of integration of design thinking and curriculum and to hold training courses in this regard. Also, the authorities should provide a platform for educational groups to review and evaluate the way of integrating design thinking and curriculum.

Also, teachers should be encouraged and motivated to apply design thinking in education. Given that this research was conducted in a girls' school in Baharestan, it is suggested to the researchers that this research be conducted in other schools, especially boys' schools, in a comparative manner.

References

- Amanat, D., Momeni Daraei, S., Amanat, N. (2010). *Evaluation of the students' attitude and satisfaction of educational situation in Shiraz dental school*. Journal of Dentistry Shiraz University of Medical Science. 10(4), p. 54-9. [in Persian]
- Aranda, M. L., Lie, R., & Guzey, S. S. (2020). *Productive thinking in middle school science students' design conversations in a design-based engineering challenge*. International Journal of Technology and Design Education. 30(1), p. 67-81.
- Barseghian, E. (2010). *Design thinking sparks learning in rural North Carolina*.
- Borge, M., Toprani, D., Yan, S., & Xia, Y. (2020). *Embedded design: Engaging students as active participants in the learning of human-centered design practices*. Computer Science Education. 30(1), p. 47-71.
- Brown, T. (2008). *Design Thinking*. Harvard Business Review. 86(6), p. 84.
- Bruton, A. (2010). *Teaching and learning for the 21st Century*. In International Council for Small Business: International Conference. Cincinnati, Ohio: ICSB.
- Carroll, M. (2014). *Learning from what doesn't work: The power of embracing a prototyping mindset*. Retrieved from http://web.stanford.edu/group/redlab/cgi-bin/publications_resources.php
- Carroll, M., Goldman, S., Britos, L., Koh, J., Royalty, A., & Hornstein, M. (2010). *Destination, imagination and the fires within: Design thinking in a middle school classroom*. The Journal of Academic Development and Education. 1.
- Chang, Y., Kim, J., & Joo, J. (2013). *An exploratory study on the evolution of design thinking: Comparison of Apple and Samsung*. Design Management Journal. 8(1), p. 22-34.
- Cross, N. (2007). *From a design science to a design discipline: Understanding designerly ways of knowing and thinking*. In Design Research Now. Birkhäuser Basel. p. 41-54.
- Deaner, K., & McCreery-Kellert, H. (2018). *Cultivating peace through design thinking: Problem solving with past foundation*. Childhood Education. 94(1), p. 26-31.
- Ejsing-Duun, S., & Skovbjerg, H. M. (2019). *Design as a mode of inquiry in design pedagogy and design thinking*. International Journal of Art & Design Education. 38(2), p. 445-460.
- Elder, L., & Paul, R. (1994). *Critical thinking: Why we must transform our teaching*. Journal of Developmental Education. 18(1), p. 34.
- Gehlbach, H., Brinkworth, M. E., King, A. M., Hsu, L. M., McIntyre, J., & Rogers, T. (2016). *Creating birds of similar feathers: Leveraging similarity to improve teacher-student relationships and academic achievement*. Journal of Educational Psychology. 108(3), p. 342.
- Glen, R., Suci, C., Baughn, C. C., & Anson, R. (2015). *Teaching design thinking in business schools*. The International Journal of Management Education. 13(2), p. 182-192
- Guaman-Quintanilla, S., Chiluiza, K., Everaert, P., & Valcke, M. (2020). *Mapping impact of design thinking in teamwork, problem-solving and creativity*. In Proceedings of the Design Society: DESIGN Conference. Cambridge University Press. 1, pp. 1715-1724.
- Hubbard, L., & Datnow, A. (2020). *Design thinking, leadership, and the grammar of schooling: Implications for educational change*. American Journal of Education. 126(4).

- Jiang, H., Tang, M., Peng, X., & Liu, X. (2018). *Learning design and technology through social networks for high school students in China*. *International Journal of Technology and Design Education*. 28(1), p. 189-206
- Johansson-Sköldberg, U., Woodilla, J., & Çetinkaya, M. (2013). *Design thinking: Past, present and possible futures*. *Creativity and Innovation Management*. 22(2), p. 121-146.
- Jun, S., Han, S., & Kim, S. (2017). *Effect of design-based learning on improving computational thinking*. *Behaviour & Information Technology*. 36(1), p. 43-53.
- Kangas, K., & Seitamaa-Hakkarainen, P. (2018). *Collaborative design work in technology education*. In *Handbook of Technology Education*. Springer. p. 597-610.
- Kolodner, J. L. (2002). *Facilitating the learning of design practices: Lessons learned from an inquiry into science education*. *Journal of Industrial Teacher Education*. 39(3), p. 9-40.
- Lynch, M., Kamovich, U., Longva, K. K., & Steinert, M. (2019). *Combining technology and entrepreneurial education through design thinking: Students' reflections on the learning process*. *Technological Forecasting and Social Change*. 119689.
- Owen, C. L. (2006). *Design thinking: Driving innovation*. The Business Process Management Institute. p. 1-5.
- Pakmehr, H., jafari, H., Saedi, M. & Karshaki, H. (2012). *Rule of the quality of teacher instruction and its components in the development of students critical thinking opportunities and challenges in higher education curriculum*. *Studdies Education Psychology*. 16, p. 15-1. [in Persian]
- Pavie, X., & Carthy, D. (2015). *Leveraging uncertainty: A practical approach to the integration of responsible innovation through design thinking*. *Procedia-Social and Behavioral Sciences*. 213, p. 1040-1049.
- Plattner, H., Meinel, C., & Leifer, L. (2011). *Design thinking: Understand-Improve-Apply*. Berlin: Springer-Verlag. <http://doi.org/10.1007/978-3-642-13757-0>
- Roth, W. M. (2001). *Learning science through technological design*. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching*. 38(7), p. 768-790.
- Rupnik, D., & Avsec, S. (2019). *The relationship between student attitudes towards technology and technological literacy*. *World Transactions on Engineering and Technology Education*. 17(1), p. 48-53.
- Scheer, A., Noweski, C., & Meinel, C. (2012). *Transforming constructivist learning into action: Design thinking in education*. *Design and Technology Education: An International Journal*. 17(3).
- Shively, K., Stith, K. M., & Rubenstein, L. D. (2018). *Measuring what matters: Assessing creativity, critical thinking, and the design process*. *Gifted Child Today*. 41(3), p. 149-158.
- Simon, H. A. (1969). *The sciences of the artificial*. (1st/3rd eds.). Cambridge, MA: MIT Press. Star, S. L., & Ruhleder, K. *Steps toward an ecology of infrastructure: Design and access for large information spaces*. *Information Systems Research*. 7(1), 111134.
- Stephens, J. P., & Boland, B. J. (2015). *The aesthetic knowledge problem of problem-solving with design thinking*. *Journal of Management Inquiry*. 24(3), p. 219-232.
- Stock, K. L., Bucar, B., & Vokoun, J. (2018). *Walking in another's shoes: nhaEncing experiential learning through design thinking*. *Management Teaching Review*. 3(3), p. 221-228.
- Thoring, K. & Müller, R. M. (2011). *Understanding the creative mechanisms of design thinking: An evolutionary approach*. In *DESIRE'11-Creativity and Innovation in Design*, Eindhoven: ACM Press.

Val, E., Gonzalez, I., Iriarte, I., Beitia, A., Lasa, G., & Elkoro, M. (2017). *A design thinking approach to introduce entrepreneurship education in European school curricula*. *The Design Journal*. 20(sup1), p. S754-S766.

van Breukelen, D. H., de Vries, M. J., & Schure, F. A. (2017). *Concept learning by direct current design challenges in secondary education*. *International Journal of Technology and Design Education*. 27(3), p. 407-430.

Vande Zande, R., Warnock, L., Nikoomanesh, B., & Van Dexter, K. (2014). *The design process in the art classroom: Building problem-solving skills for life and careers*. *Art Education*. 67(6), p. 20-27.

Wiggins, G. (2012). *Keys to effective feedback: Advice, evaluation, grades-none of these provide the descriptive information that students need to reach their goals. What is true feedback-and how can it improve learning*. *Educational Leadership*. 70(5), p. 11-16.



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