Print ISSN: 1738-3110 / Online ISSN 2093-7717
JDS website: http://kodisa.jams.or.kr/
http://dx.doi.org/10.15722/jds.18.8.202008.65

The Effect of Creative Potential on Innovation Behavior: focusing on Design Thinking

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Received: June 08, 2020. Revised: July 06, 2020. Accepted: August 05, 2020

Abstract

Purpose: The purpose of study is to examine the effects of design thinking-based programs on creative potential, creativity and innovation behavior, as well as the mediating effect of creative potential and creativity. **Research design, data and methodology:** The study was conducted through a four-step process. First, the previous studies were investigated. Second, a total of three experts were reviewed to improve and supplement the program. Third, a workshop-based design thinking program was conducted four times. Fourth, the effectiveness of the program was reviewed through data analysis. **Results:** The design thinking-based program was found to have a statistically positive effect on creative potential, creativity, and innovation behavior. As another hypothesis of this study, by applying the design thinking-based program, it was statistically confirmed that creative potential has a direct, indirect effect, and a mediating effect on innovation behavior. **Conclusions:** These results provide usability for design thinking in terms of direction for creativity-based creative problem solving and innovation. Finally, design thinking can be used to develop and utilize new services and discover new ideas, especially improve the competitiveness of the company. In addition, it means that the level of innovation action can vary depending on the level of the individual's creative potential.

Keywords : Design Thinking, Creative Potential, Creativity, Innovative Behavior.

JEL Classification Code: L26, M12, M53.

1. Introduction

The globalization of the world economy in the present era requires an innovative approach to individual, corporate, and national competition. With digital transformation at the forefront, the globalization of economic relations, the internationalization of production functions, and the convenience of transferring new technologies, the entire world is now playing a role in demonstrating the success of innovation (Vasiltsova, Dyatlov, Vasiltsov, Bezrukova, & Bezrukov, 2015). This means that we are living in a new kind of competitive era that is qualitatively different from the previously existing ones in the 21st century (Dyatlov, 2010).

In response, companies began to present 'creativity' and 'innovation' as core competencies as they searched for new strategies to compensate for the lack of existing statistical and logical management and attempted to secure global competitiveness amid a huge social trend that they had never experienced before. These trends also evaluate the economics of performance created through creativity-based programs or personal innovation in the direction of organizational innovation. However, it is not yet clear what is best for personal development (Anderson, Potočnik, & Zhou, 2014).

In the early 2000s, design consulting firm IDEO began to share design thinking as a major innovation performance process based on their experience (Brown, 2008) which was then shared by numerous businessmen and social innovators looking for ways to innovate. This led to design thinking becoming a new way for organizations to access uncertain and emerging organizational issues in a rapidly changing

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society, as well as an educational imperative to develop their 'creativity' and 'innovation' (Martin, 2009). Meanwhile, Klijn, and Tomic (2010) stated that creativity alone is not enough to create organizational innovation, so innovative behaviors should continue as an essential step to move from creativity to innovation. In particular, the individual creativity they talk about focuses on an individual's potential ability to generate creative and potentially useful ideas while innovation involves the process of actually applying new ideas. Based on such prior studies, this study aims to identify the effects of design thinking on each variable and determine how they relate to the variables, from the 'creative potential' inherent in the person from the perspective of own creativity to the 'creative potential' of the individual and the creation of new ideas and the 'innovative behavior' of the individual from the perspective of implementing the idea. In particular, we want to verify the mediating effect of creative potential on innovative behavior through creativity.

2. Experimental

2.1. Design Thinking

Design Thinking is a concept that expresses the designer's approach to design and process of thinking first discussed through Herbert Simon, the Nobel laureate in economics, in 1978 as a rational decision optimization model and a concept of limited rationality (Johansson-Sköldberg, Woodilla, & Çetinkaya, 2013). He noted the differences in the way designers and engineers think, distinguishing between activities that create new things, activities that deal with existing reality, and activities that do not fall under artistic creation and engineering(Kim, Park, & Suh, 2018). Since then, this concept of looking at design thinking has been understood and utilized in various ways through various researchers and institutions. Buchanan (1992) presented design thinking as a professional way of thinking about problems within social systems dealing with uncertainty and malicious problems that cannot be solved with fragmentary methods, which contributed greatly to gaining a deeper understanding of complex technology and cultural situations. Lawson (2005) understood design thinking as a process of creative activity based on practice-based activities and how to recognize objects(Park, 2019). Krippendorff (2005) called design thinking 'meaning creation' and said that visual expression in design thinking helped maintain execution as a medium of meaning transmission.

The concept of design thinking is rapidly increasing in importance as the core competencies required by companies change along with the knowledge-based economy. Accordingly, it is becoming more and more popular among companies around the world, and design thinking is being implemented in various forms in the curriculum of engineering and business schools (Muller & Thoring, 2012).

In particular, as the business environment changes based on ICT (Information & Communication Technology) and SW (Software) and the number of ambiguous and complex problems that have not been experienced before increase, design thinking is being utilized as a way to reconstruct problems based on users and draw out innovative solutions. Professor Roger Martin (2006) of the University of Toronto reconceptualized design thinking as part of management education approaching malicious or uncertain issues (Martin, 2009). This design thinking aims to create a concept for new products, services, or digital applications to promote innovation and develop solutions to so-called evil problems. Rather than focusing on quantifying solutions and starting the problem, it has a clear distinction in that it discovers as many diverse ideas as possible during the problem solving process and then rapidly prototypes and tests.

2.2. Creativity

Amid the rapidly changing social and economic trends based on technological innovation called the digital transformation, companies are evolving into new forms to secure their competitiveness for survival. As the core of this change, 'creativity' and 'innovation' are key capabilities of the 21st century organization (Amabile, 1988 ; Woodman, Sawyer, & Griffin, 1993). Thus, in terms of long-term success or value creation, individual creativity is presented as an essential component of organizational innovation (Kanter, 1983), which means 'creating something new or valuable' that is generally recognized. This is similar to the concept of creativity claimed by Guildford (1959), a master of creativity research, which states "the power to create new and novelty." In addition, Van de Ven (1986) said that creativity is the ability to develop and practice new ideas in given circumstances, while Torrance (1965) defined individual creativity as a characteristic of taking risks and tackling crises with courageous beliefs, curiosity, passion for work, independent judgment, and broad and positive thinking in every facet. Ambile (1983, 1966) refers to an individual as the ultimate subject of creativity, and refers to creativity as 'what is outwardly expressed, not internal creative potential'. Based on this concept, she defined personal creativity as 'the ability to gather ideas in a unique new way' or 'the ability to link ideas to related areas in an unusual way,' and DiLiello and Houghton (2008) said creativity is likely to occur when individuals have certain characteristics or innate skills or abilities.

This concept of creativity has often been used in recent years in combination with the word 'innovation' in order for companies or organizations to maintain their competitive edge(Lee & Park, 2019). Accordingly, Scott and Bruce (1994) classifies creativity as the output of different and

meaningful ideas, and innovation as a concept that includes the production of useful ideas followed by their adoption and execution. Meanwhile, in his study, Ambile (1988) said that the expression of creativity required an individual's intrinsic motivation, knowledge, and creative thinking skills, and that these factors also had a significant impact on innovative behavior.

2.3. Creative Potential

Creative potential refers to the state before creativity was expressed, and Tierney and Farmer (2002) calls creative potential a person's own creative capacity, skill, and ability. Runco (2004) supported an individual's creative potential by saying, 'Everyone is creative.' This includes the ability to develop new ideas, the confidence in the ability to solve problems creatively, the ability to develop other people's ideas, and the ability to find creative ways to solve problems, which are also linked to creative self-efficiencies (Tierney & Farmer, 2002). Meanwhile, Hinton (1968) argued that creative potential and creativity leading to practice were different, and a study by Neck, DiLiello, and Houghton (2006) confirmed that this concept represents the difference between the creative potential and practical creativity of an individual and that leading creativity to practice is different than having creative potential.

In addition, Pfeffer (2005), a master of human resources, said that the key to corporate success comes from creative potential, and argued for the importance of creative potential as a direction for creative management among human-centered management strategies. Kelley and Kelly (2013) shared the need for creative potential based on the case of Adobe Systems, an IT solution company. According to a survey of 5,000 leaders from three continents in the corresponding case study, 80 percent of respondents said "the expression of creative potential helps economic growth."

2.4. Innovative Behavior

In response to the rapidly changing social and environmental changes, innovation is considered one of the key factors in maintaining a firm's competitiveness. Innovation exists in all organizations and begins with the successful implementation of new ideas (Amabile, 1996), so innovative behavior can be said to be of paramount importance at the personal level of an organization's members in terms of being competitive, which is the result of innovation within the organization.

The concept of these innovative behaviors has been discussed in different ways, depending on the scholar. Damanpour and Evan (1984) understood innovative behavior as 'the level of which members of the organization accept change and the attitude to practice active behavior', while Kanter (1988) called innovative behavior the ability 'to create prototypes for innovation by building results to recognize new problems and gain support for ideas'. Innovative behavior as 'behavior to create, introduce, and implement new ideas' to enhance the performance of an individuals' duties and organizations. Park, Shin, and Choi (2012) called the entire process from "creating and proposing new ideas and recognizing and realizing the need for ideas to finally completing them" an innovative behavior.

On the other hand, Hammond, Neff, Farr, Schwall, and Zhao (2011) classified meta-characteristics and situational-characteristic variables for the antecedent factors affecting individual innovative behavior through meta-analysis studies. Among these, individual characteristics variables included personality, education level, intrinsic / external motivation, and self-efficacy. Situational characteristic variables included superior support, leadership, job autonomy, job complexity, creativity, job demand, positive organization, and atmosphere.

3. Research problem and Model

The study of individual creativity through design thinking has been measured in various ways, from individual characteristics to creative output. In particular, theories and studies of general creativity suggest that personal creativity is the basis of organizational creativity and innovation because it is a way to achieve useful results in a new way (Amabile, 1988; Abbey & Dickson, 1983).

Therefore, creative individuals are measured as a result of their creativity through creative behaviors based on their creative potential, which is also believed to have a positive impact on innovative behavior. However, while this is possible, further explanation is needed as no clear relationship has yet been identified, nor is it clear as to whether it has a direct impact or immediate effect on innovative behavior, even if it has good creative potential. In particular, innovative behavior has mainly been studied through the surrounding environment of individuals, but experimental studies related to the inherent factors of individuals have not been appreciable.

Nevertheless, innovative behavior is determined to have a clear impact on the factors that belong to the individual, and in particular, judged to contribute to the creative potential inherent in the person from the perspective of innovating and realizing it. Therefore, in this study, we first wanted to identify the effects of the application of the design thinking program on creative potential, creativity, and innovative behavior, and further identify the relationship between each variable, creative potential, creativity, and innovative behavior.

However, considering that creative potential may have a direct impact on innovative behavior, creativity was considered as a variable that could be mediated, but it may be necessary to have a time interval that goes through the process of execution rather than being immediately expressed. Creativity is a trailing variable of creative potential, a visible result through creative potential, and a leading cause variable before realization for innovative behavior. If creativity is excellent, it is believed to have a positive impact on innovative behavior. Therefore, creativity was determined to be an important variable that could fill the time gap between creative potential as an independent variable and innovative behavior as a dependent variable and inevitably mediate the relationship.

Therefore, the research problems set in this study in applying the design thinking program for the development of new services are as follows.

First, verify whether creative potential improved after the design thinking program was implemented.

Second, verify whether creative capabilities improved after the design thinking program was implemented.

Third, verify whether innovative behavior improved after the design thinking program was implemented.

Fourth, the direct and creative potential before and after the design thinking program is implemented is mediated with the direct and creative effects on innovative behaviors, and the total effects of combining the direct and indirect effects on innovative behaviors are compared.

For this purpose, 'Design-Based Research' was used as a way to create practical theories centered on the site, and the research model is as follows.

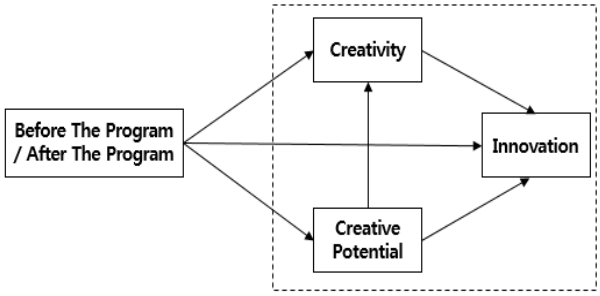

Figure 1 : Research Model

4. Methodology

4.1. Subjects

This study was conducted based on data obtained from the results of the design thinking program at A University in Gyeonggi-do in August 2018.

To this end, a self-entry survey was conducted on participants in the program and 62 people, excluding unfaithful respondents, were selected as subjects of the study. Frequency analysis was performed to identify the general characteristics of the subjects.

Table1 : General characteristics of the subject

Variable	Classification	Frequency	%
Gender	Male	43	69.4
	Female	19	30.6
Age	Under 25	27	43.5
	26-30	13	21.0
	31-35	8	12.9
	36-40	5	8.1
	41-50	5	8.1
	51-60	4	6.5
Education	High School Graduation	1	1.6
	Attend University	35	56.5
	The Master's Course	1	1.6
	Ph.D.	3	4.8
	University Graduation	18	29.0
	Master's Graduation	4	6.5
Major	Humanities	3	4.8
	Social science	2	3.2
	education	2	3.2
	Natural science	3	4.8
	Business Economics	12	19.4
	Engineering	29	46.8
	Arts and Physical	9	14.5
	Other	2	3.2
Job	Official	14	22.6
	Student or public	48	77.4
Total		62	100.0

Gender was 43 men (69.4 percent) and 19 women (30.6 percent), while age was 27 under 25, 13 from 26-30 (21.0 percent), eight from 31-35 (8.9 percent), five from 36 to 40 (8.1 percent), five from 41-50 and four from 51-60 (6.5 percent). This included one high school graduate (1.6 percent), 35 college students (56.5 percent), one master's course student (1.6 percent), three doctoral students (4.8 percent), 18 college graduates (29.0 percent), and four with master's degrees (6.5 percent). The majors were three humanities students (4.8 percent), two social sciences (3.2 percent), two education students (3.2 percent), management,

economics (12.4 percent), and 29.8 percent) art students (19.8 percent).

4.2. Method

4.2.1. Creative Potential

Creative potential refers to the creative capabilities, skills, abilities, etc. of an individual and includes creative self-efficiencies. To this end, the Design Thinking Creativity Test (DTCT), an individual creativity assessment tool presented by Hawthorne et al. (2016), was re-constructed into questions related to creative potential. It consists of a total of eight items, including "I can propose new ideas well", "I am confident in solving creative problems", "I try to have opportunities to utilize creative abilities", "You can find creative ways to solve problems", "It can make things easier", "It is comfortable to propose new ideas", "I try to have the opportunity to use our creative abilities", "I am taking full advantage of my creative abilities", and used a 5-point scale for recurrences. The inner inertia reliability of the creative potential item is Cronbach's α= of the dictionary data .908, Cronbach's α= of post data. The result was acceptable at 912. The confirmative factor analysis was conducted, the composite reliability of the creative potential item was .927 at the beginning of the Design Thinking workshop and .934 at the end of workshop.

4.2.2. Creativity

Creativity was adapted and reconstructed based on studies by Farmer, Tierney, and Kung-Mclntyre (2003), Tierney and Farmer (2002), including explaining various opportunities to practice individual knowledge and creativity. In this study, a total of 11 questions were measured on a five-point scale for recurrences, including "I can find creative inspirational problems", "I am not afraid to deal with a problem without a clear answer", "I can redefine a given problem", "Creatively change the external environment to solve problems", "Intermediate outputs can be shared with others in solving problems", "I think the idea to solve the problem is not the final or best solution", "After experiencing meaningful failures, we continue to solve problems", "Helping others to be more creative", "I know how to improve my creativity and practice it", "I can clearly define and explain the creative problem-solving process", and "Various creative alternatives are reviewed during the problem solving process". In terms of reliability, creativity was measured on a Cronbach's α= of pre-data.907, Cronbach's α= of post data. The result was acceptable at 896. The confirmative factor analysis was conducted, the composite reliability of the creativity item was .920 at the beginning of Design Thinking workshop and .914 at the end of workshop.

4.2.3 Innovative Behavior

Innovative behaviors recognize the need for change and lead the process to define the spread of ideas, the entire process, from idea creation to development, acceptance, and practice. Therefore, this study used the contents of Janssen (2000), Kleysen and Street (2001) as a measurement tool for innovative behavior as well as "I try to act innovatively in any situation", "In the process of doing things, they actively seek innovative ideas", "When a problem occurs, I try to present a new solution rather than the existing method", "I always emphasize an innovative approach", and "We recommend innovative projects even if they are more likely to fail". This was measured on a 5-point scale for the recursive data, Cronbach's α= of the pre-data.846, Cronbach's α= of post data. The result was acceptable at 830. The confirmative factor analysis was conducted, the composite reliability of the Innovative behavior item was .892 at the beginning of the Design Thinking workshop and .878 at the end of the workshop.

4.3. Process and Analysis

This study was conducted through a total of four stages. In order to design the design thinking program in the first stage, the relevant theory and prior research were investigated, and the structure of the entire program was derived by benchmarking the relevant program and implementation process. In order to verify the effectiveness of the program designed in the second stage, the improvement and supplementation process of the program was carried out through review by a total of three experts. A total of four workshop-type design thinking programs were conducted around participants to justify the effectiveness of the program developed in Step 3. Step 4 reviewed its effectiveness through data analysis of the overall program progress results.

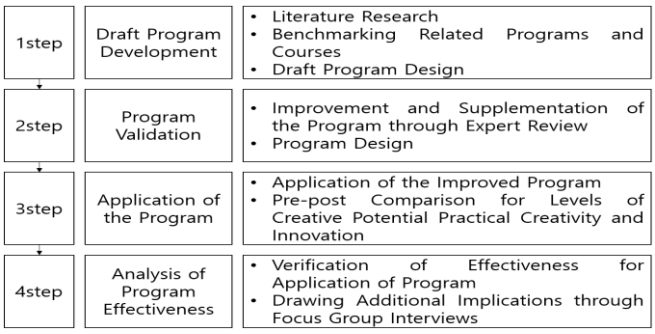

Figure 2 : Research procedure

4.3.1. (Stage 1) Draft program design

The literature related to design thinking, creativity, creative potential, innovative behavior, etc. were investigated for the draft design of the program, and the strategy and step-by-step activities for design-based program design were specified. The basic design of the entire program utilized the five-step process of design thinking presented by Stanford University's d.school, and detailed programs were organized in consideration of future strategy methods and commercialization strategies in the direction of proactively responding to rapid changes in the future and enhancing practicability in the field. This program has completed the first draft after a review, revision, and improvement process including four researchers in the fields of data science, management, and education.

4.3.2. (Step 2) Validation of the program

In order to ensure the validity of the program, the program was modified and supplemented through several consultation meetings and reviews by three experts with at least five years of experience in IT, education, and management, including researchers who participated in the program development for about two months from June to August 2018.

No.	Domain	Department	Position	Experience Years
1	Academia	Information Technology	Professor	5
2	Academia	Education	Professor	7
3	Industry / Academia	Management Consulting	C.E.O. University Time Lecturer	5

4.3.3. (Stage 3) Application of the program

The final derived program consists of 120 hours, including experience, in-depth workshops, and mentoring, and the detailed program is as shown in [Table 3]. Essentially, the author wished to shape the program based on the main principles of design thinking mentioned earlier, and focused on expressing creativity based on the context of solving new problems. For this purpose, different types of activities were sought for emotional support and activities, as well as cognitive support, and practical creative activities were deemed important due to the repetition of the process of convergence along with creative ideas.

4.3.4. (Stage 4) Results Analysis

A summary of the statistical analysis methods undertaken for this study is as follows. First, frequency analysis was conducted to identify the general characteristics of the research subjects. Second, Cronbach's α was calculated to determine the reliability of the measuring tool. Third, a response sample t-test was conducted to verify the statistical significance of changes in creative potential, creativity, and innovative behavior before and after the program was implemented. Fourth, Pearson's correlation was conducted to determine the correlation between creative potential, creativity, and innovative behavior. Fifth, hierarchical regression analysis was conducted to verify the relationship between creative potential, creativity, and innovative behavior. Sixth, the bootstrap verification proposed by Hayes was conducted to derive indirect, direct, and total effects of creative potential on innovative behavior by mediating creativity. IBM SPSS 25 was used for the above statistical analysis and statistical significance was determined based on a significant level of 5%.

Table 3 : Final designed design thinking program

Times	Program Category	Design Thinking Process	Subject	Action Plan
1	Orientation	Orientation	Understanding the program & Team composition	- Orientation - Understanding the program - Individual introduction - Team Composition
2	Design Thinking | Experiential Training	Empathize	Topic selection & Understanding user empathy	- The meaning and experience of the design thinking process through - Practice for empathy - Data research and analysis - What's New?
3		Define	What do users really need?	- Identifying stakeholders - Uncovering the hidden needs of users - Structuring the user's real problem - Expressing the subject clearly
4		Ideate	How to solve the problem?	- Giving ideas to solve problems from the user's perspective - Developing and designing a concept

5		Prototype & Test	How will you deliver the solution? What do users think about the solution?	- Developing prototypes for solutions - Collect internal evaluation and feedback - Collect user ratings and feedback
6	Design Thinking | Advanced Training	Empathize	Deepen empathy	- Deriving implications based on feedback - Review the problem definition and reconstruction status, concept - In-depth research and analysis such as service environment and future change direction
7		Redefine	What do users really need?	- Restructuring the user's real problem - Expressing the subject clearly
		Ideate	How to solve the problem?	- Explore solutions to address issues of redefinition - Deriving various ideas - Refining ideas for problem solving - Redesigning and modifying the concept
		Prototype	How will you deliver the solution?	- Redesigning and modifying prototypes - Review and feedback from users and experts
8		Test	What do users think about the solution?	- Modifying and supplementing solutions - Collect user ratings and feedback - Deriving implications based on feedback
9	Mentoring	Intensive mentoring	Upgrading the solution	- Mentoring experts by field of solution - External expert and user feedback - Iterating over modifying and supplementing solutions
10				
11	Wrap up	Sharing & Feedback	Sharing & Feedback	- Completing the final solution - Share the final solution

5. Results

5.1. Changes before and after application of the program

A response sample t-test was conducted to verify changes in the level of creative potential, creativity, and innovative behavior after the program was implemented.

The creative potential was shown in advance 3.56, post 3.71, and the corresponding t-test showed statistically significant differences (t=-2.591, p<.05). In other words, it can be determined that the creative potential increased significantly after implementation of the program.

Creativity was shown in advance 3.62, post 3.84, and the corresponding t-test showed statistically significant differences (t=-3.762, p<).001). That is to say, creativity can be determined to have increased significantly after implementation of the program.

Innovative behavior was shown at 3.43 in advance and 3.74 in post, and the corresponding t-test showed statistically significant differences (t=-4.239, p<).001). That is, after implementation of the program, innovative behavior can be determined to have increased significantly. As a result, creative potential, creativity, and innovative behavior were all improved after the design thinking program was implemented.

Table 4 : Difference between Creative Potential, Creativity, and Innovation Before and After the Program

Variable	Before The Program		After The Program		*t*	*p*
	Avg.	SD	Avg.	SD		
Creative potential	3.56	0.69	3.71	0.57	-2.591*	.012
Creativity	3.62	0.63	*3.84*	*0.53*	-3.762***	.000
Innovation	3.43	0.66	*3.74*	*0.63*	-4.239***	.000

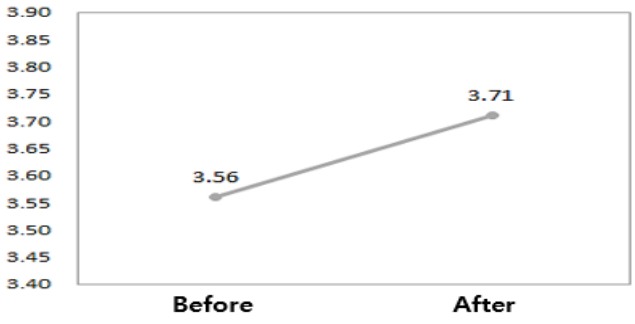

Figure 4 : Change in creative potential before and after the program

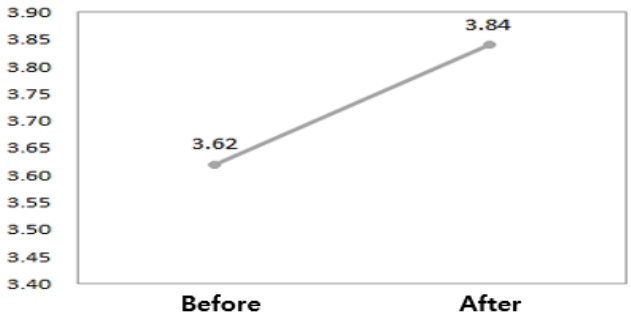

Figure 5 : Creativity change before and after the program

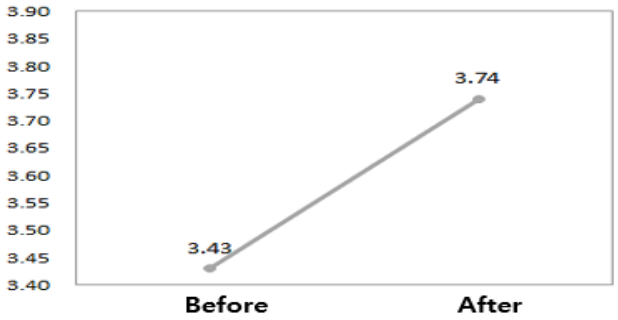

Figure 6 : Change in innovation before and after the program

5.2. Correlation of Creative Potential, Creativity, and Innovative Behavior

Pearson's correlation was performed to determine the correlation between creative potential, creativity, and innovative behavior.

As a result, [Table5] shows a significant positive relationship (r=.802, p<) between creative potential and creativity before the program.001), the correlation between creative potential and significant affection for innovative behavior (r=.586, p<).001), showed a significant positive (+) correlation between creativity and innovative behavior (r=.701, p<.001).

The relationship between creative potential and creativity after the program was implemented (r=.809, p<).001), the correlation between creative potential and the significant affection (+) of innovative behavior (r=.639, p<).001), creativity, and innovative behavior showed a significant positive correlation (r=.672, p<).001).

It has also been verified that there is a significant positive correlation between creative potential, creativity, innovative behavior, creative potential, creativity, innovative behavior before and after the program.

5.3. Influence relationships between creative potential, creativity, and innovative behavior

Hierarchical regression was conducted to verify the relationship between creative potential and innovative behavior, and to verify the mediating effect of creativity between creative potential and innovative behavior.

First of all, the verification of the impact relationship between variables before the program was conducted showed that creative potential had a significant positive effect on creativity (B=.737, p<).001). Creative potential was also shown to have a significant positive effect on innovative behavior (B=.566, p<).001), and, in controlling the impact of creativity, did not significantly affect innovative behavior. Creativity was shown to have a significant positive effect on innovative behavior (B=.681, p00.001) as well. In other words, creative potential before the program was implemented and creativity between innovative behavior can be seen as a complete medium.

Next, the verification of the effect relationship between variables after the program was conducted showed that creative potential had a significant positive effect on creativity (B=.760, p<).001) and a significant positive effect on innovative behavior (B=.705, p<).001). The creative potential of controlling the effects of creativity did not significantly affect innovative behavior, and creativity was shown to have a significant positive effect on innovative behavior (B=.530, p<).01). That is, creativity can be seen as a complete medium between creative potential after the program is implemented and innovative behavior.

Table 6 : Correlation between Creative Potential, Creativity, and Innovation

Variable	1	2	3	4	5	6
1. (Before) Creative Potential	1					
2. (Before) Creativity	.802***	1				
3. (Before) Innovation	.586***	.701***	1			
4. (After) Creative Potential	.748***	.643***	.484***	1		
5. (After) Creativity	.691***	.707***	.495***	.809***	1	
6. (After) Innovation	.458***	.527***	.596***	.639***	.672***	1

* Significant at 95% confidence level

6. Conclusion

6.1. Results Summary and Implications

This study sought to identify the effects of design thinking-based programs on creative potential, creativity, and innovative behavior and to examine the mediating effects of creative potential and creativity on the relationship with innovative behavior. The following findings and implications related to these research objectives are presented.

First, application of design-thinking-based programs has been shown to have statistically positive effects on creative potential, creativity, and innovative behavior. To verify this, this study designed and applied a design thinking-based program on the basis of expert review. Further, detailed factors were selected for each variable, including eight items for creative potential, 11 items for creativity, and five items for innovative behavior, and their feasibility was secured through frequency analysis and reliability analysis. The response sample t-test confirmed that the study hypothesis was statistically significant. These results provide usefulness for design thinking from the perspective of creative problem solving and innovation based on creativity, and are believed to be applicable to various real-world sites such as remodeling new businesses, development and utilization of new services, finding new ideas, and service proposals. They are especially applicable to education related to creative potential, creativity, and innovation, which are required to improve the competitiveness of companies in a post-intelligence information era.

Second, as one of the hypotheses of this study, it was statistically confirmed that the application of a design-thinking-based program has creative potential as well as direct, indirect, and overall mediated effects on innovative actions in addition to the enhancement of creativity. In this study, the correlation and influence relationship between variables was identified through Pearson correlation and hierarchical regression analysis, and the statistical interfactor mediating effect was confirmed through bootstrap verification. This means that the level of innovative behavior may vary depending on the level of individual creative potential, and it can be interpreted that it is helpful to increase not only individual creativity but also creative potential in order to increase innovative behavior.

While existing studies mainly focus on verification of reliability and validity through measurement, the results of this study contribute to clarifying the relevance of the creative potential, creativity, and innovative behavior of the participants, along with the validity of the design thinking program. Therefore, it suggests the need to improve design thinking and creative potential in the direction of solving problems based on creativity and achieving innovative results in the future, and it is believed that it can help derive approaches for developing design thinking-based programs in various fields and achieving better results.

6.2. Limitations

On the other hand, despite these results, the limitations of this study are as follows. In this study, no separate comparable group was set up to verify effectiveness through participation in the Design Thinking Program. Therefore, there may be limits to generalization, and this study can be seen only in terms of the perception of individuals through self-populated surveys. Therefore, in the future, in-depth research on its effectiveness will be needed based on other problem-solving processes and results other than design thinking. Another limitation of this study is the failure to take into account demographic variables of participants such as the type of work, age, number of years of service, etc. In the future, we hope that studies will be conducted to develop and utilize design thinking programs applicable by stage and level by securing more diverse samples depending on the target and context and deriving various improvement directions by type through hierarchical regression or cluster analysis. It is also a limitation that the sample size of this study was 62. Larger sample size is required to obtain meaningful regression statistics. Also the samples used in this study were recruited through one class. For diversity of research, sample should be collected through various groups. In the next study, the sample size needs to be further expanded.

Design Thinking has a variety of sub-concepts and requires their total utilization. This may require measurement items from different perspectives by sector and organization. Although this study was limited to creative potential, creativity, and innovative behavior as variables that represent effectiveness through design thinking, it is hoped that design thinking will be used to derive more diverse innovation outcomes through studies that extract, examine, apply, and analyze various factors.

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