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Derivation of Learning Styles for Solving Technological Problems

Mika Lim[1] and Jinsoo Kim[2*]

[1]*Shindong Middle School, Korea*
[2*]*Corresponding author: Korea National University of Education, Korea*
[1]ssalzzyp@hanmail.net, [2*]jskim@knue.ac.kr

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Abstract

The purpose of this study was to derive the learning styles for solving technological problems using literature reviews, focused-group interviews, and grounded theory study. Results were obtained by examining the characteristics of the components from the extracted five categories namely Thinking-Intuition in recognition and judgement, Adaptation-Innovation in creativity, Reflection-Action in execution, Independence-Cooperation in interaction, and Avoidance-Participation in approach, all of which are aiming at different tendencies. The conclusions of the study were as follows. First, learning styles that reflects the characteristics of solving technological problems could be derived. Second, the learning styles of solving technological problems covers cognitive, affective and impressive area. Third, the learning styles were divided into five dimensions and two types for each dimension. From here, the following suggestions were made. First, empirical studies on how learners are classified to a specific learning type, which shows the characteristics on the actual learning process, should be conducted. Second, it need to be specifically investigated how learning styles were derived should be investigated as well as the various characteristics of the learner such as solving technological problems ability, operational ability and so on .Third, it was necessary to establish concrete method of lesson considering learning styles. Fourth, various studies should be conducted on the relation between learning styles and learning.

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1. INTRODUCTION

Psychologists have long assumed the existence of various types of psychology in humans and have tried to identify them. Swiss psychologist Jung (Jung, C. G.) said that although human behavior appears to be inextricable due to its diversity, it actually has a very ordered and consistent trend (Myers & McCaulley, 1985). Jung has been analyzing and categorizing human behavior for 20 years, and MBTI (Myers-Briggs Type Indicator) is a personality type test designed to use Jung's psychological type theory empirically and use it in real life. What about the students in our classroom? If a student in a classroom shows a solution that tends to be relatively consistent in the scene of the lesson, then there is some way to use the learning style consistently, at least in the context of the lesson. If the teacher does not understand the learner's disposition, the student's behavior may be considered inappropriate. Conversely, if the teacher has a good understanding of the learner's disposition, the teacher would accept the behavior as natural and could create the educational environment that the learner preferred. In this regard, it can be concluded that the learning styles, since 1970, have been actively conducted in Europe and the US (Kim Eun-jung, 1999), and as a result, various learner characteristics have emerged. Until recently, many studies in Korea and abroad have revealed that learning styles considering individual characteristics are important factors for improving learning outcomes (Kinshuk et al, 2009; Shaw, 2011; Bottalio, 2009; Erdem, 2009). However, learners prefer different learning styles depending on the subject (Kolb, 1984; Hee-soo Baek, 2009). For example, the learners' ability in math and art class is quite different. There will be differences in the appropriate learning styles to be considered for different subjects. Therefore, rather than applying

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the general theory of learning style, the characteristics of each subject should be reflected in the learning styles. As a result of analyzing the curriculum of the technology subject, it can be considered as a general subject for the purpose of cultivating technological literacy. It consisted of problem-solving activities for learning the adaptation and preparation of present and future life. Reflecting this, previous studies on technology education have been interested in developing technological problem-solving ability (McCade, 1990; Waetjen, 1989). But most studies did not consider individual problem solving tendencies (Hanjin Cho, 2013). Therefore, the purpose of this study is to identify the types of learners involved in technological problem solving and to derive the learning style of technological problem solving, in order to construct an appropriate teaching and learning environment according to the characteristics of students in technology subjects. This study has the following methods: first, the learner components related to learning styles of solving technological problems were extracted through literature review, focus group interview for teachers and grounded theory study for students. Second, based on the extracted components, a learning style for solving technological problem was derived.

2. THEORETICAL BACKGROUND

2.1. TECHNOLOGICAL PROBLEM SOLVING

The term ‘problem' in technology education refers to a problem that includes or reflects the unique characteristics of technology subjects based on the meaning of ‘problem’ in general education. The technological problem in technology education has been studied by scholars including Johnson (1987), Huchinson & Karsnitz (1994), McCade (1990), and Custer (1995). The technological problem refers to problems that aims to produce a tangible output or a related system through a problem-solving process involving operational activities, utilizing the learner's cognitive and affective characteristics and physical resources. On the other hand, technological problem solving is based on the concept of general problem solving made by reflecting the characteristics of the technological problem only. The concept of technological problem solving was defined in the work of several scholars which summarized the technological problem solving by analyzing objects and solving problems using human knowledge and physical resources in situations that create a type of output or system that relates to reality (Hutchinson(1987), Childress(1994), Barnes(1989), Dolye(1991), Winek and Borchers(1993), Borchers(1993), Huchinson & Karnitz(1994), MacPherson(1997), ITEA(2000), Burt(2005)).

2.2. LEARNING STYLE

Kolb (1976) defined learning styles as a preferred way of perceiving and processing information, determined by heredity, past experience, and personal disposition. Schmeck (1985) defined a universal tendency to show a consistent pattern in information processing activities as a learning style. Different perspectives on factors affecting learning styles developed four types of learning style research, depending on whether the focus was on learner cognitive, affective, and psychomotor characteristics. First, this study focuses on the types of cognitive information processing of learners in the studies of Biggs (1985), Entwistle (1988), and Schmeck (1985). Secondly, Grasha & Riechmann's (1974) study is one of the perspectives of learning styles focusing on affective characteristics such as learning attitude, sociality, and humanity. Third, it was developed by Kolb (1984) in terms of combining the cognitive and affective characteristics of learners. Fourth, Dunn's (1981) study corresponds to the view of learning style as considering learner characteristics including cognitive, affective, and psychomotor characteristics.

2.3. PROBLEM SOLVING STYLE

Problem solving styles are an individual's propensity to selectively pay attention to certain parts of information and to accumulate and process information in a unique way (Jung, 1931). The problem solving style is essential in deriving the technological problem solving learning style. The research on problem solving styles has not been more active than the study of problem solving learning, but there has been a steady stream of research from Koestler (1964) to Isaksen, Kaufmann & Bakken (2016). In particular, Treffinger & Isaksen (2002) stressed the necessity of research on problem solving styles, and researched problem solving styles in earnest, and

published a number of research results. This section explored the components of the problem solving style which is the basis of the technological problem solving learning style through the literature review of the problem solving style. As a result of reviewing the literature on problem solving styles, the theory of problem solving styles started from two perspectives - one based on creativity and the other on personality type. Creativity-based perspectives were developed by Koestler (1964), Basadur (1990), and Treffinger & Isaksen (2002), while the personality-type perspectives were embodied in the studies of Hellriegel & Slocum(1975). Problem solving styles are areas that have not been actively studied in comparison with studies on general problem solving. However, this study identifies the types learners' tendencies in the context of problem solving.

3. STUDY METHOD

The research method and contents to achieve the purpose of this study are shown in Figure 1.

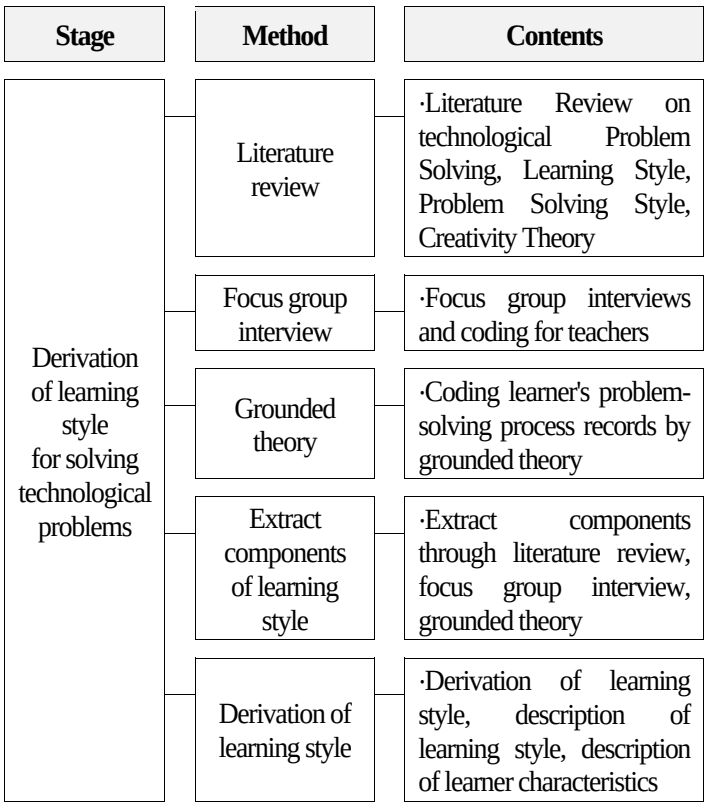

Fig. 1. Procedure

3.1. LITERATURE REVIEW

The literature and theories related to the learning style of technological problem solving were reviewed. Based on the understanding of technological problems, the details of each stage of technological problem solving and the related learner characteristics were identified. After that, the learner's character components in the technological problem-solving process was extracted by considering the learning style theory, problem solving style theory, and creativity theory.

3.2. FOCUS GROUP INTERVIEW

To identify components derived from literature review, a Focus Group Interview (FGI) was conducted on September 7 and 8, 2017. Four to ten members of FGI's group are appropriate, and interviews are written in detail according to open questions written in advance. After the discussion, important concepts and information that are to be obtained by transcription of the collected data are analyzed (Krueger & Casey, 2000). In this study, FGI was conducted for two groups of in-service teachers who have taught technical problem-solving learning activities for more than 10 years.

3.3. GROUNDED THEORY

Grounded theory helps explain what is happening in an event and allows for an understanding of changes and psychological processes within the group (Strauss & Corbin, 1990). Grounded theory analyzes data and approaches theories through coding. Coding consists of open coding, axis coding, and selective coding. In order to take advantage of the technological problems that are frequently used in the field of education, answers to the questions of ‘What are the technological problems that students present?’ and ‘What is the level of technological problems presented are analyzed?’. The field study through the grounded theory was conducted on 60 first grade students. In this study, case providers were selected, including all students from upper, middle, and lower groups. Students with a score of 80 or higher were assigned to the upper group, students with a score of 60 or higher and lower than 80 to the middle group, and students with a score below 60 to the lower group. The process of solving each of the three technical problems was recorded in the process record sheet. The gender composition of 60 case providers consisted of 28 female and 32 male students. The learners prepared a process record sheet for three technical problems, and as a result, a total of 159 process record sheets were

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used for analysis. If the meaning of the analysis process is ambiguous or detailed explanation is required, the concept is clarified and valid. The narratives related to the idea search phase in the contents of the process record and interview were analyzed according to the coding stage suggested by Strauss & Corbin (1990).

3.4. DERIVATION

Each component through literature research, FGI and grounded theory research was integrated and organized. In terms of meanings, components with similar concepts are integrated and those with different concepts were classified. Finally, the learning style of technological problem - solving learning was derived.

4. RESULTS

4.1. COMPONENT EXTRACTION THROUGH LITERATURE REVIEW

Based on the characteristics of the technological problem solving. and on the literature of learning style, problem - solving style and creativity theory, the components of learning style were extracted. The problem understanding phase is the stage of perceiving and clarifying the problem, which is closely related to the cognitive characteristics related to how to recognize the problem. The idea stage is the stage of generating and selecting ideas, which is closely related to the cognitive characteristics according to the idea generation method or the propensity of selection. The implementation phase is the planning and implementation stages, which is closely related to the psychological characteristics of the implementation method or preferred execution conditions. The evaluation phase is the process of evaluating the process and the results. It is closely related to the evaluation method and what is considered important. All the phases of technological problem - solving are affected by the learner's affective characteristics. In the result of the above-mentioned components extraction, components based on learning style theory, problem-solving style theory, and creativity theory could have similar or overlapping contents. So, the process of classifying and integrating the components is needed.

4.2. COMPONENT EXTRACTION THROUGH FGI

First, the learner types in the problem understanding stage could be categorized into students who are worried about the problem being difficult and worried about being failed when presented with the topic, students interested on the topics, and the students who are not responding. Second, the types of learners seen in the conception phase are those that actively explore ideas and generate creative ideas, those that actively explore but are difficult to generate ideas, actively explore and think carefully, and do not actively explore. Third, the types of learners seen in the realization phase can be categorized into types who are independent from the teacher or friend, those who are dependent on the teacher or friend, those who pretend to act rather than think, those who think and act carefully, and those who tend to be imitated. Fourth, learner types in the evaluation stage could be categorized into a type of competitive consciousness and a type of internal motivation.

4.3. COMPONENT EXTRACTION THROUGH GROUNDED THEORY

FGI had the advantage of combining various learners' behaviors from an objective point of view, but it was difficult to find out the students' internal processes. However, the study based on grounded theory allows learners to describe the process of technical problem - solving themselves. The cause of the learner's thinking process or behavior can be extracted from the subjective point of view. Each phase of the technological problem-solving process has distinctly different characteristics, so when the analysis is conducted by the grounded theory, generalized theories and procedures are derived for each step rather than the whole process. The results of collecting, describing, and categorizing the data described by the learner can be described as follows. First, in the problem understanding phase, ten attributes including the difficulty of the problem and 23 dimensions including the high difficulty of the problem were derived. Second, in the planning phase, nine attributes including problem - solving confidence and 18 dimensions including high problem - solving confidence were derived. Third, in the realization phase, 11 attributes including realization confidence and 23 dimensions including high realization confidence were derived. Fourth, in

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the evaluation phase, eleven attributes including realization outcomes and 22 dimensions including high achievement outcomes were derived. As a result of axis coding the categories and dimensions organized through open coding by each phase of technological problem - solving, a total of 41 attributes and 86 dimensions were extracted.

4.4. CLASSIFICATION AND INTEGRATION OF EXTRACTED COMPONENTS

Table 1 shows the final results by classifying and integrating the components of learning styles extracted from literature review, FGI and grounded theory.

Table I. Final Components Search through Classification and Integration

Literature Review	FGI	Grounded Theory		Final Component
Experience-Thinking Sense-Intuition	.	Experience-Thinking		Thinking - Intuition
Emotions-Thinking	Impulse- Pondering	Emotions-Thinking		
Overall-analysis	.	Thinking-Intuition		
Adaptation - Innovation	Adaptation - Innovation	Adaptation - Innovation		Adaptation-Innovation
Observe - Action	Observe-Action Reflection-Action	Observe-Action	⇨	Reflection - Action
Independence-Cooperation	Independence-Dependent	Interaction High-Interaction Low		Independence - Cooperation
.	Internal Motive-External Motive, Inward-Outward	Internal Motive-External Motive		
Task-Interpersonal	Competition-Cooperation	Task-Interpersonal		
Avoidance - participation	Avoidance - participation	Avoidance - participation		Avoidance - Participation

4.5. DERIVATION OF THE LEARNING STYLE OF TECHNOLOGICAL PROBLEM – SOLVING

As a result of examining the characteristics of the components in Table 1, thinking and intuition are recognition and judgement dimension, adaption and innovation are creativity dimension, reflection and action are execution dimension, independence and cooperation are interaction dimension, and avoidance and participation tend to be different trends in approach. Therefore, the learning style of technological problem - solving was derived from five dimensions of recognition and judgement, creativity, execution, interaction, and approach, with two types for each dimension. The learning style of technological problem - solving derived through this process is shown in Table 2.

Table II. Learning Style of Technological Problem Solving

Dimension	Type
Recognition and Judgement	Thinking - Intuition
Creativity	Adaptation - Innovation
Execution	Reflection - Action
Interaction	Independence - Cooperation
Approach	Avoidance - Participation

4.6. LEARNER CHARACTERISTICS BY TYPE

Based on the contents of the literature review, the characteristics of learners for each type are summarized as follows.

Recognition and Judgement dimension is divided into thinking type and intuition type. Thinking learners tend to follow established steps through analytical thinking. Intuitive learners often jump to steps and reach conclusions quickly through holistic thinking.

Creativity dimension is divided into adaptation type and innovation type. Adaptive learners value existing procedures, rules, conventions and norms to think and judge within established methods and procedures. Innovative learners value creation of new perspectives and ideas and have unpredictable characteristics.

Execution dimension is divided into reflection type and action type. Reflective learner observes and judges carefully and looks at things from various points of view in the process of observation. Active learners value the actual approach to realizing the idea rather than watching the problem.

Interaction dimension is divided into independence type and cooperation type. Independent learners prefer personal activities and are more concerned with solving the problem than

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with interacting with members. Cooperative learners prefer cooperative activities and value harmony and interpersonal relationships in decision making.

Approach dimension is divided into avoidance type and participation type. Avoidant learners feel burdened and are passive in solving problems when given a problem. Participant learners, given a problem, tend to focus their energy and try their best to solve the problem.

5. DISCUSSION AND CONCLUSION

In this study, the learning style was derived from literature review and empirical field studies of teachers and students. In the empirical field research, the teacher's opinion was able to look at the learner's behavior from an objective point of view, and the student's opinion was able to grasp the internal thinking process from the learner's subjective point of view. Compared with previous literature reviews of Lim & Kim (2018) and Grounded theory study of Lim & Kim(2019), this study provided a clearer understanding of the components. Therefore, the empirical field research process for both teachers and students has a significant meaning in the study of learning styles.

This study is to derive learning styles of technological problem - solving. The conclusions based on the results of the study are as follows.

First, research on learning styles has been steadily progressed in pedagogy, but research on learning styles of technological subjects or technological problem -solving is insufficient. In this study, based on the literature review focusing on the characteristics of technological problem solving, the field study for teachers and learners was added to derive the learning style only for technological problem - solving.

Second, there are five dimensions and two types of learning styles each for technological problem - solving. The contents were intuition and thinking at the dimension of recognition judgment, adaptation and innovation at the creative dimension, reflection and action at the execution dimension, independent and cooperative at the interactive dimension, and avoidance and participatory at the attitude dimension.

Based on the conclusions of this study, the following suggestions are made.

First, empirical research using methods such as interviewing or observing on the characteristics of learners classified into specific learning types in the actual learning process is necessary. Since the learning style in this study was mainly for the discovery and classification of types, the characteristics of learners were summarized and converged. Further empirical studies are required to identify learner behavioral characteristics in detail for each learning type.

Second, in-depth research on the relationship between learning style and learner's cognition, affection, and emotional characteristics is necessary. Detailed study on how the learning styles were derived from this study must be conducted in relation to various characteristics of learners such as technological problem - solving ability, interest, creativity, and operational ability.

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REFERENCES

[1] Banks, F. “Assessment of Performance Unit”. Learning through design and technology, Teaching Technology, London: Routledge, 1994.

[2] Barnes, J. L. “Learning to Solve Tomorrow’s Problems.” The Technology Teacher, 48.6 (1989): 25-29.

[3] Biggs, J. B. “Individual differences in study processes and quality of learning outcome.” Higher education, 8 (1979): 381-394.

[4] Childress, V. W. “The Effect of Technology Education, Science, and Mathematics Integration Upon Eighth Grader’s Technological Problem-Solving Ability.” Unpublished Doctoral Dissertation, Virginia Tech, Blacksburg, Virginia, 1994.

[5] Custer, R. L. “Examining the Dimensions of Technology.” International Journal of Technology and Design Education, 5.3 (1995): 219-244.

[6] Dunn, R. “Learning Style researchers define differences differently.” Educational Leadership, 38 (1981): 372-375.

[7] Feist, G. J. The function of personality in creativity: The nature and nurture of the creative personality, (Eds.). NY: Cambridge University Press, (2010).

[8] Getzels, J. W. Creativity and Intelligence:

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ISSN: 0193-4120 Page No. 5632-5638

Exploration with gifted student. NW; Wiley, 1969.
[9] Grasha, A. F., & Riechmann, S. W. "A Rational approach to developing and assessing the construct validity of a student learning style scales instrument." Journal of Psychology, 87 (1974): 213-223.
[10] Guilford, J. P. "The structure of intellect." Psychological Bulletin, 53 (1956): 267-293.
[11] Hutchinson, J., & Karsnitz, J. R. "Design and problem solving in technology." Peoria, IL:Delmar, (1994).
[12] Isaksen, S. G., Kaufmann, A. H., & Bakken, B. T. "An Examination of the Personality Constructs Underlying Dimensions of Creative Problem-Solving Style." Journal of creative behavior, 50.4 (2016): 268-281.
[13] Lim, M. & Kim, J. "Derivation of learning style for technological problem solving in practical arts education." Journal of Korean Practical Arts Education, 31.2 (2018): 63-84.
[14] Lim, M. & Kim, J. "Derivation of Learning Styles for Solving Technological Problems based on Grounded Theory." Teacher Education Research, 58.4 (2019): 427-438.
[15] Lim, M. & Kim, J. "The Learning styles of Middle School Students for Solving Technological Problems." Asia-Pacific Journal of Educational Management Research, 4.3 (2019): 21-28.
[16] Johnson, C. E. "Teaching Problem Solving." The Technology Teacher, 46.5, (1987): 15-17.
[17] Jung, C. G. "A Psychological Theory of types." In Collected Works, 6. Prinston: princeton University Press, 1931.
[18] Kolb, D. A. Experiential learning: Experience as the source of learning and development. NY: Prentice-Hall, 1984.
[19] Krueger, R. A., & Casey, M. A. Focus groups: A practical guide for applied research. Newbury Park, CA:Sage, 2000.
[20] McCade, J. "Problem Solving: Much More Than Just Design." Journal of Technology Education, 2.1 1990: 1-13.
[21] Schmeck, R. R. "Revised inventory learning processes". Material sent from the first investigator, 1985.
[22] Strauss, A., & Corbin, J. Basic of Qualitative Research: Grounded Theory Procedures and Techniques(1st). Newbury Park, CA:Sage, 1990.
[23] Torrance, E. P. "The Torrance Test of Creative Thinking". Norms-Technical Manual Research Edition-Verbal Teat, Forms A and B-Figural Test, Forms A and B. Princeton, NJ: Personnel Press, 1966.
[24] Treffinger, D. J., & Isaksen, S. G. VIEW: An assessment of problem solving style. Sarasota, FL:Center for Creative Learning, 2002.
[25] Waetjen, W. B. "Technological Problem Solving: A Proposal." International Technology Education Association (ERIC Document Reproduction Service No. ED 334.464), 1989.