A Study on Teaching and Learning Methods & Teaching Strategies in Mathematics for Late-Adult Learners: Focusing on the National Curriculum

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Purpose: This study aims to inform the field of mathematics education for late adult learners by considering the teaching and learning methods & teaching strategies of mathematics. It focuses on the adult literacy middle school curriculum developed for late adult learners.

Methods: This study applied a mixed-method approach. Through research of the literature, teaching and learning methods & teaching strategies were identified, and those featured in adult literacy textbooks were reviewed. The study was validated by receiving expert advice.

Results: To explore teaching and learning methods & teaching strategies according to the 2020 revised adult literacy textbook class procedure, at least three experts in each field were recruited for research validity. Employing the triangle verification method, nine experts from three different fields were consulted to verify the validity of the content.

Conclusion: As a result of exploring teaching and learning methods & teaching strategies in mathematics for late-adult learners, discussion methods, lecture methods, and cooperative learning were concluded to be appropriate teaching and learning methods. Situated learning, representation learning, and cognitive teaching strategies were identified as appropriate.

Keywords: Teaching and learning Methods; Teaching Strategies; Late-Adult Learners; the National Curriculum Introduction

INTRODUCTION

With the recently ageing society, improving the quality of life of the elderly has become a general social goal. The improvement of the quality of life in old age in a knowledge-based society requires ongoing education in old age. A study in late-age learning has already emphasized the need for further emphasis on education, starting with Paul Lengland's "Theories of Life Education" in 1965 (UNESCO, 1965). Education for older people has recently evolved to the point where there is a boom in reflecting individual characteristics such as health and hobbies, and active research is being conducted in academia (Ko, 2009). Recently, artificial intelligence and internet use are becoming a reality. In addition, the problem of information overload in a knowledge and information literate society makes us realize the importance of accessing helpful information. We face the need for mathematics education due to the increase in the use of mathematical knowledge by elderly learners. For late adults, repairing deficits in knowledge aims to improve the quality of life (Lee & Ko, 2018).

Korea is a country that has experienced the Korean War, and it is one of the few countries where there are still late adult learners who have suffered war or who have not been educated

during the social reconstruction period immediately after the war. At that time, late adult learners emerged as a social phenomenon, which was also the beginning of the current literacy education. The current late adult learners who were not educated at their school age were willing to be educated at the time, but instead were required to participate in economic activities due to their family situations. This neglected generation has finally been given the opportunity to continue their education in contemporary Korean society using a credentialled literacy program. Reflecting this phenomenon, the Korean government implemented a system to allow adult learners to use existing compulsory education programs, including elementary and middle school education, to complete a literacy education program under Article 40 of the Lifelong Education Act (National Institute for Lifelong Education in South Korea).

As part of the national curriculum in 2019, guidelines for all curricula for adult literacy middle schools were developed, followed by the development of a revised adult literacy textbook in 2020, which was published in February 2021. The change brought many concerns about the preparedness of the mathematics departments in the field. Concerns arose because of the potential that there could be many adult learners with mild cognitive impairments in the middle school mathematics course of late adult learners. There were also many concerns about the way math classes were taught by lifelong educators or volunteers in the field; the late adult learners for middle school math curriculum were elderly, and the lifelong educators or volunteers in the field are not math education experts. Their knowledge of math education for elderly learners was seen as insufficient as was the research on knowledge of math education in the field of elderly learners.

In response to the issues raised above, the National Institute for Lifelong Education (National Institute for Lifelong Education in South Korea) released textbooks and produced videos on learning methods in consideration of practicing teachers nationwide, but the need to develop teaching and learning methods for mathematics specifically is increasing. Therefore, this study aims to aid the math educators in the field who work with late adult learners by reviewing teaching and learning methods & teaching strategies of mathematics, focusing on the adult literacy middle school curriculum developed for late adult learners.

In this study, teaching and learning methods are defined as "the ways of teaching" or "effective and efficient pedagogical practice used to achieve educational goals", while teaching strategies are defined as the act of selecting and sequencing learning activities within each lesson (Paek et al., 2020).

Theoretical Background

The core value of education lies in "what and how to teach", and the method of education can be a collective term for all methodological and instrumental conditions required to realize the purpose of education (Hwang et al., 2003). This applies to all other areas except for the act of exploring, 'what is the valid purpose of education?' In a narrow sense, the educational method can be conceptualized as a method of teaching or an effective and efficient pedagogical practice used to achieve educational goals.

According to Kim et al. (1999), the educational method was defined as "a method used to effectively deliver content that meets the learning goals and supports learning activities". The educational method refers to the teaching technique used by instructors to achieve class goals within the curriculum, also referred to as teaching and learning methods, teaching forms, and teaching strategies (Ehwa Women's University Department of Education Engineering, 2001). However, the term 'teaching strategy', according to Na and Jung (2006), is a specific activity employed to establish teaching and learning methods, while the term 'educational method' is defined as an overall operational method or framework.

If discussion-based classes or lecture-style classes are teaching and learning methods, strategies such as memory activation, using repetition and memorization, or information integration methods, which connect new information with existing knowledge, are teaching strategies. The types of teaching and learning methods include lecture, discussion, and cooperative learning. Teaching strategies include setting the scaffolding of problem-based learning, self-directed learning, and situated learning. This study aims to review teaching and learning methods & teaching strategies for late adult learners through the following sections.

1. Teaching and learning methods

Teaching-learning methods refer to activities that teachers use to help students learn about selected and organized educational content (Paek et al., 2020). Upon the review of several studies related to teaching activities, Rosenshine and Furst (1973) cited 'clarity of class contents', 'diversity of class', 'passion', 'task-oriented attitude', 'criticism', 'providing learning opportunities', 'systemization of class contents', 'integrating students' input' and 'using questions' as examples of teaching behaviors related to the effectiveness of a class. In addition, Borich (2000) divided the teaching activities of teachers related to the effectiveness of classes into core activities and promotional teaching activities as follows (See Table 1): Teaching and learning methods are largely divided into lecture, discussion, cooperative learning, and discovery exploration

learning. The description of each method and its strengths and weaknesses shown in Table 2 are as follows.

2. Teaching Strategies for mathematics

(1) Representation Learning

Learners have difficulty representing the mathematical knowledge and strategic situation required for problem-solving. In general, in mathematical problem-solving situations, learners must find core information and be able to represent the information using representation methods, such as diagrams or symbols, to solve the problem. To achieve such successful mathematical prob-lem-solving skills, one can focus on a learning strategy that teaches how to represent the core problems; such a strategy is referred to as representation learning (Kim, 2003). This representation learning and teaching strategy is reported to have positive effects when learners are encouraged to speak about their thoughts or prob-lem-solve by creating diagrams for self-questions and suggestions (Hutchinson, 1993). Representation learning is also used in conjunction with cognitive strategies (Montague, 1993).

(2) Cognitive and Meta-Cognitive strategies

Meta-cognition is a method of thinking about 'thinking', and Meta-cognitive teaching strategies are those that introduce language skills into teaching principles and are based on behavioral models for learning (Kim, 2003). Meta-cognitive teaching strategies include self-monitoring and self-instruction, and meta-cognitive teaching procedures are widely used for learning. In addition, studies on interventions that emphasized cognitive strategies for mathematical problem solving produced positive results for school-age students, motivating learners to carry out real-life strategies and recognize links between strategies and learning content

Table 1. Core teaching activities and Promotional teaching activities

Core teaching activities	Promotional teaching activities
Clarity of instruction	Integrating students' opinions
The diversity of classes	Systematic summary
The degree of commitment to class	Asking questions
Active participation of students	Deepening and specifying statements
Increasing student success rate	Teacher's attitude

Table 2. Strengths and Weakness of teaching and learning methods

Teaching and learning methods	Content	Strengths	Weakness	Type	Related study
Lecture	A form of conveying and understanding learning information to learners under the leadership of instructors.	Effective in classes with more than 40-50 students. Cost-effective. Effective for transferring cognitive knowledge and learning.	Difficulty in reflecting personal characteristics. Difficulty in active participation of learners. Large influence of instructor characteristics: educational perspective, knowledge, attitude, etc.	Ausubel's meaningful learning	Kim (2014) Na, & Choi (2003)
Discussion	To achieve the learning goal, learners present their opinions and evaluate others' opinions. Through this process, one learns to solve problems.	This method can deepen, supplement, and expand learner's thoughts through listening to other people's opinions and acquiring information.	Easier to focus on presenters than on presentations. Learners may take a passive role. Minority opinions may be downplayed. Difficult for instructors to control and manage classes	A small group discussion, Round Table Discussion, Open discussion, Jury discussion, Single phase discussion, Buzz discussion.	Cho & Kim (2002) Kwon & Kim (2003) Oh, Park, & Lee (2014)
Cooperative learning	Learning methods that set common goals for members. Members work jointly to achieve goals, giving and receiving help.	Cultivation of a prosocial attitude. Development of decision-making skills. Positive social interaction. Provides an opportunity to move from concrete thinking to abstract thinking.	Since the members are heterogeneous, learners may have different levels of skills or knowledge base. This may lead to disputes. Some students may become "free-riders".	Team achievement, Distribution compensation techniques, Team tournament, Jigsaw, Group survey, Helper learning	Ahn (2018) Lee & Ko (2015)

(Wong, 1992). Thus, between the 1970s and 1980s, the paradigm shifted from lecture-based methods to cognitive strategies. Cognitive teaching strategies focus on teaching students 'how to learn.' They teach students strategies that can solve problems rather than specific skills; it is used in conjunction with representation learning (Montag, 1993).

(3) Situated Learning

The situated cognition required in situated learning starts from a socio-cultural perspective which emphasizes the social and cultural situations of mathematical activities (Park & Jeon, 1997). Cognition, in response to information, creates a symbolic representation of context and information in order to produce knowledge. Thus, the representation process is used to acquire and organize new information. In this way, cognition essentially gives abstract meaning through the symbol system and schema (Harley, 1991).

Situated cognition emphasizes perception rather than memory; when processing information, knowledge is no longer simply stored in the brain, but is processed in relation to context (Young, 1993). Indeed, situated cognition is about the interaction between context and information, and it emphasizes the importance of context in describing thought (Lave, 1988; Lave & Wenger, 1991). Young (1993) and Lave (1988) demonstrated this in their research. They created a situation of buying goods from the supermarket and demonstrated how people generally use mathematics to think and solve problems that have not been solved in classroom situations.

Given how learners think is closely related to the surrounding situation in which the thinking occurs (Lave, 1989; Suchman, 1987), the focus of situational instructional activities is to recognize situational intent. The learner's judgment of the situation has a profound influence on the desired behavior and learning.

Harley (1991) found that learners can develop a problem-solving strategy by reflecting on situational intentions in response to the environment. This implies that learners should be understood as contextual learners. For this, the teacher's role should be developing teaching and learning methods and curriculum that can emphasize collaborative activities to consider the complex interrelationships between what students already know and what they need to learn. Ultimately, it should be recognized that meaning is shaped by learners, not by teachers.

Through the above theoretical background, the current study intends to verify the validity of expert advice and identify teaching strategies suitable for late adult learners.

METHODS

This exploratory study aims to help late adult learners conduct math classes by examining math teaching methods and strategies, focusing on the use of an adult literacy middle school math textbook, and a national curriculum developed for late adult learners. To this end, teaching and learning methods & teaching strategies were explored through literature research, and their validity was determined by expert review. The research procedure is shown in Table 3. Teaching and learning methods & teaching strategies were explored in the middle course of the mathematics department of adult literacy textbooks published in 2021.

The middle school mathematics curriculum of adult literacy textbooks released in 2021 is organized in sequences of "Opening Thoughts – Get Ready – Learning – Mathematics in Life – Creative Experience Activities." In Table 4, the contents and examples are presented. In addition, in Table 4, teaching and learning methods & teaching strategies presented for validation were presented as hypotheses.

The final teaching and learning methods & teaching strategies were derived through expert content validity and usability evaluation based on literature and prior research review. Three experts in the field, three in educational engineering and three in mathematics education, validated the contents and evaluated the usability (Table 5). Experts conducted content validity with those with degrees in the related field, educational engineers, math education

Table 3. Procedure of study

Procedure	Contents
Literature study	Teaching and learning methods & teaching strategies mentioned in the study of mathematics.
↓	
Exploring teaching and learning methods & teaching strategies	Exploring teaching and learning methods & teaching strategies according to the teaching procedures of the middle school mathematics curriculum of adult literacy textbooks.
↓	
Expert validation	To verify the validity of this study, at least three experts in the field (triangle verification method) are secured through consultation with nine experts: three field experts, three experts in educational engineering, and three experts in mathematics.
↓	
Derive research results	Exploring teaching and learning methods & teaching strategies centered on the middle course of mathematics in adult literacy textbooks.

Table 4. Exploring teaching and learning methods & teaching strategies for the process of adult literacy textbooks

Process	Contents and examples	Characteristics	Teaching and learning methods	Teaching strategies
"Opening Thoughts"	Orient learners to the learning material by suggesting an appropriate situation.	Presents an appropriate situation and discussion at the beginning of the unit.	Discussion, Lecture	Situated learning strategy
"Get Ready"	Review of previous learning material.	Reviews the contents that match the unit.	Discussion, Lecture	Cognitive strategy
"Learning"	In this unit, concepts are learned, and example problems are solved together.	Adult literacy textbooks simply present concepts and solve examples and problems.	Lecture	Representation Learning Strategies, Cognitive strategy
"Mathematics in Life"	Organization of learning. Using the learned content to solve the problem.	Adult literacy textbooks are organized so that the contents learned in the learning organization stage can be applied directly in real life.	Discussion, Cooperative learning	Cognitive strategy, Situated learning strategy
"Creative Experience Activities"	At the end of the chapter, read or perform activities related to the chapter.	Motivates learning through interesting writings or activities.	Discussion, Cooperative learning	Cognitive strategy, Situated learning strategy

Table 5. Variables of expert background

Experts	Vocation	Experience (years)	Degree	Field	Expert validation	Evaluation
A	Headmaster	50	Ph. D	night school, lifelong education	√	√
B	Headmaster	14	Ph. D	lifelong education	√	√
C	Teacher	10	Ph. D	lifelong education	√	√
D	Professor	7	Ph. D	educational engineering	√	√
E	Professor	5	Ph. D	educational engineering	√	√
F	Researcher	5	M.D.	educational engineering	√	√
G	Teacher	10	Ph. D	math teacher	√	√
H	Teacher	12	Ph. D	math teacher	√	√
I	Teacher	20	M.D.	math teacher	√	√

experts, and field experts working with late adult learners.

In the survey conducted to evaluate the validity and usability of the class model, questions were organized to evaluate validity, appropriateness, explanatory power, and usefulness. The survey also presented opinions on strengths and weaknesses, improvements, suggestions (Table 6). The survey results were examined by quantifying experts' evaluations using the Content Validity Ratio (CVR). Content validity shows the validity of each item of the educational intervention plan (Rubio et al., 2003). Polit et al. (2007) suggested receiving a CVR of 0.78 or more from at least three experts to satisfy the criteria for validity.

RESULTS

Content Validity Verification by Experts

The results of content validity verification through expert con-

sultation are shown in Table 7. The validity of the teaching method and teaching strategy considering late adult learners are shown as follows: small group instruction, lecture method, cooperative learning (CVR = 0.99), and discussion method (CVR = 0.78) were found to be valid for the teaching method, and representation teaching strategy, cognitive teaching strategy, and situated learning were found to be valid teaching strategies (CVR = 0.99). The experts evaluated the validity of teaching and learning methods for cooperative learning (m = 5.00), small group classes and lectures (m = 4.56), discussion methods (m = 4.44). For teaching strategies, experts evaluated the validity of the situated learning teaching strategy (m = 4.78) and the representation learning teaching strategy (m = 4.67).

The appropriateness of the teaching method and teaching strategy of middle school mathematics for late adult learners, according to the progression of the curriculum, is shown in Table 9. Dis-

Table 6. Evaluation tool for class model

Type	Item Description
Validity	The results of this study are valid references for teaching and learning methods referring to strategies valid as teaching and learning methods & teaching strategies that can be referred to in implementing mathematics education with late adult learners.
Appropriateness	The results of this study are appropriate references for teaching and learning methods & teaching strategies at each stage of the curriculum for late adult learners.
	The results of this study appropriately present the steps for implementing math classes for late adult learners.
Explanatory skill	The result of this study easily explains teaching and learning methods & teaching strategies to be considered when implementing mathematics classes for late adult learners.
Usefulness	The results of this study can be utilized to implement math classes for late adult learners.
Universality	The results of this study are applicable when conducting classes for late adult learners.
	The results of this study are applicable when conducting math classes.

Table 7. Validity of teaching and learning methods & teaching strategies considering late-adult learners

Content	A	B	C	D	E	F	G	H	I	M(SD)	CVR
Validity of personalization classes	2	3	3	3	4	4	3	3	3	3.11	-0.56
Validity of small group classes	4	5	4	4	5	4	5	5	5	4.56	0.99
Validity of teaching and learning methods	5	4	4	4	5	5	5	4	5	4.56	0.99
Validity of the method of debate	5	5	5	4	4	5	4	5	5	4.44	0.78
Validity of cooperative learning	5	5	5	5	5	5	5	5	5	5.00	0.99
Validity of scaffolding setting	3	2	3	3	3	4	3	3	3	3.00	-0.78
Validity of self-directed learning	3	2	3	2	3	3	3	4	4	3.00	-0.56
Validity of problem-based learning	3	4	3	3	4	3	3	3	3	3.22	-0.56
Validity of representation learning	4	4	5	5	5	4	5	5	5	4.67	0.99
Validity of cognitive teaching strategies	5	5	5	4	4	5	5	5	5	4.78	0.99
Validity of situated learning	5	5	5	5	4	5	5	5	5	4.89	0.99

Table 9. A study on teaching and learning methods & teaching strategies for the middle school mathematics curriculum of adult literacy textbooks

Process	Teaching Method	Teaching Strategy
"Opening Thoughts"	Discussion	Situated learning strategy
"Get Ready"	Lecture	Cognitive strategy
"Learning"	Lecture	Representation learning strategy, Cognitive strategy
"Mathematics in Life"	Discussion, Cooperative learning	Cognitive strategy, Situated learning strategy
"Creative Experience Activities"	Discussion, Cooperative learning	Situated learning strategy

cussion methods and contextual learning strategies in 'Opening Thoughts,' lecture method cognitive strategies in 'Get Ready,' methods and representation learning strategies in 'Learning,' discussion methods and cooperative learning in

'Mathematics in Life,' situated learning and cognitive teaching strategies in 'Creative Experience Activities.' The results of content validity through expert advice are shown in Table 8.

Overall Validity

Table 10 provides evidence of validity by dividing teaching and learning methods and teaching strategies for late adult learners, teaching and learning methods & teaching strategies for mathematics departments according to the progress of the regular curriculum, and finally, teaching and teaching strategies in mathematics for late adult learners.

Since the teaching and learning methods & teaching strategies

Table 8. A study on teaching and learning methods & teaching strategies

Process	Teaching and learning methods & strategies	A	B	C	D	E	F	G	H	I	M(SD)	CVR
"Opening Thoughts"	Discussion	5	4	5	4	5	5	5	5	5	4.78	0.99
	Lecture	3	4	4	3	3	4	4	3	3	3.44	−0.11
	Situated learning strategy	5	5	5	5	5	5	5	5	5	5.00	0.99
"Get Ready"	Discussion	5	5	5	5	4	4	5	5	5	4.78	0.99
	Lecture	3	3	3	4	4	3	4	3	4	3.44	−0.11
	Cognitive strategy	5	5	4	5	5	5	5	5	5	4.89	0.99
"Learning"	Lecture	5	5	5	5	5	5	5	5	5	5.00	0.99
	Representation learning strategy	5	5	4	5	4	5	5	5	5	4.78	0.99
	Cognitive strategy	5	5	5	5	5	5	5	5	5	5.00	0.99
"Mathematics in Life"	Discussion	5	4	5	5	5	4	5	5	5	4.78	0.99
	Cooperative learning	5	5	5	5	5	5	5	5	5	5.00	0.99
	Situated learning strategy	5	5	5	5	5	5	5	5	5	5.00	0.99
	Cognitive strategy	4	4	5	4	4	5	4	4	4	4.22	0.99
"Creative Experience Activities"	Cooperative learning	5	5	5	5	5	5	5	5	5	5.00	0.99
	Discussion	5	5	5	5	5	5	5	5	5	5.00	0.99
	Cognitive strategy	4	4	5	4	4	3	3	3	3	3.67	0.11
	Situated learning strategy	5	5	5	5	5	5	5	5	5	5.00	0.99

Table 10. Validity of teaching and learning methods & teaching strategies for each area

Content	A	B	C	D	E	F	G	H	I	M(SD)	CVR
Teaching and learning methods & teaching strategies for late-adult learners	5	4	5	5	5	5	5	4	5	4.78	0.99
Teaching and learning methods & teaching strategies for mathematics according to the regular curriculum	5	4	5	5	5	5	5	5	5	4.89	0.99
Teaching and learning methods & teaching strategies in mathematics for late-adult learners	5	5	5	5	5	5	5	4	5	4.89	0.99

Table 11. Evaluation tool for teaching and learning methods & teaching strategies for overall validity

Type	A	B	C	D	E	F	G	H	I	M(SD)	CVR
Feasibility	5	4	5	5	5	5	5	4	5	4.78	0.99
Appropriateness	5	5	5	5	5	5	5	4	5	4.89	0.99
	5	4	5	5	5	5	5	4	5	4.78	0.99
Explanatory skill	5	4	5	4	5	5	5	4	5	4.67	0.99
Usefulness	5	5	5	5	5	5	5	4	5	4.89	0.99
Universality	5	4	5	5	5	5	5	5	5	4.89	0.99
	5	4	5	5	5	5	5	5	5	4.89	0.99

of late adult learners are different from those of school-aged students, experts were categorized by field in order to ensure the validity of teaching and learning methods and teaching strategies. Teaching and learning methods & teaching strategies were evaluated for feasibility, appropriateness, explanatory skill, usefulness, and universality. The overall appropriateness of teaching and learning methods & teaching strategies for mathematics for late-adult learners based on the review of the literature and prior stud-

ies conducted in this study was found to be very high. The feasibility, appropriateness, explanatory skill, usefulness, and universality of the overall validity were also determined (Table 11).

CONCLUSIONS

As a result of exploring teaching and learning methods & teaching strategies in mathematics for late-adult learners, discussion methods, lecture methods, and cooperative learning were found to be appropriate. The valid teaching strategies were situated learning, representation learning, and cognitive teaching strategies.

It was found that small group classes are more suitable as an appropriate teaching and learning method for late adults, and the appropriateness of cooperative learning also showed high validity. This has shown the same results as studies (Thompson & Savenye, 2007) that refer to the advantages of cooperative learning by enabling in-depth reflection and high-dimensional discourse through the exchange of information and knowledge.

In addition, it was found that representative learning, cognitive teaching strategy, and situated learning strategy showed very high validity as teaching methods and teaching strategies for late adults. There was an opinion that late adult learners find mathematical symbols difficult, but on the other hand, they are positive in using visualization rather than proceeding with mathematical situations as explanations.

Situated learning is a significant factor for late adult learners, and it is a process of deriving mathematical activities by recalling the real-life situation. According to Lee & Ko (2018), it was reported that late adult learners had a positive effect on understanding problem situations in real-life situations. Scholars who studied cognition, such as Choi, Hannafin (1995) and Young (1993), also discussed the significance of learning in the context of real-life based on experience. They explain that the learning outcomes that learners have acquired based on their experiences cannot be separated from their experiences. The research results of this study verify the results of the preceding studies above.

This study is meaningful in that it can provide implications for educators experiencing difficulties in teaching and learning methods & teaching strategies.

CONFLICT OF INTEREST

The author declared no conflict of interest.

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