DEVELOPMENT STUDY ON SUPPORTING STRATEGIES FOR LEANERS' TASK SELECTION IN SELF-DIRECTED E-LEARNING ENVIRONMENT

By

GYUMIN LEE

Doctoral Dissertation

Submitted to the Faculty of the Graduate School of

Seoul National University

In partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

Major: Educational Technology

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Abstract

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The purpose of this study is to develop learners' task selection-supporting strategies in self-directed e-learning environment and examine their effects and optimality. To achieve the purpose, this study established the following two research questions: (1) developing learners' task selection-supporting strategies and (2) verifying the effects and optimality of learners' task selection-supporting strategies for self-directed learning. Further, the second research question comprised three subordinate research objectives: (1) investigating the effects of self-directed learning on learners' task-selection accuracy, self-directed learning abilities, and learning achievements; (2) verifying the effect of learners' task selection-supporting strategies on learners' task selection decision making; and (3) investigating the optimality of learners' task selection-supporting strategies in self-directed learning.

In Research 1, this study drew relevant strategies based on literature review to develop strategies to support learners' task selection in self-directed learning and then validate the strategies through experts' primary and secondary reviews. Then, this study developed an e-learning program with the final strategies reflected and subsequently validated the program through prototype evaluation on the storyboards and through usability evaluation.

In Research 2.1, this study selected 236 sixth-grade elementary school students and applied the e-learning program with the final strategies reflected to investigate the effects of learners' task selection-supporting strategies on learners' task selection accuracy, self-directed learning abilities, and learning achievements for self-directed e-learning. Path analysis revealed that task selection-supporting strategies had a significant effect on learners' task selection accuracy in self-directed e-learning, while learners' task selection accuracy had a significant effect on their learning achievements.

In Research 2.2, this study collected data from 27 sixth-grade elementary school students to examine the effect of learners' task selection-supporting strategies on learners' task selection decision making in self-directed e-learning. One-way ANOVA revealed that task selection-supporting strategies did not have a significant effect on learners' task selection decision making in self-directed e-learning.

In Research 2.3, this study collected qualitative data from 27 sixth-grade elementary school students and confirmed the optimality of task selection-supporting strategies in self-directed e-learning, Overall, this study has great significance in that it developed strategies to support learners' task selection in self-directed learning and confirmed their positive effects on learners' task selection accuracy and learning achievements and even confirmatively analyzed the future direction of learners' task selection strategies by comprehending the optimality of the strategies.

Keywords: Self-Directed Learning, Task-Selection, Task-Selection Accuracy, Self-directed Learning Abilities, Learning Achievement, Task-Selection Decision Making

Student Number: 2004-30476

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CHAPTER I. INTRODUCTION

1. Background of the Study

Self-directed learning (SDL) refers to an active, constructive process in which learners plan, monitor, and control their learning process (Knowles, 1975). This type of learning can occur at different levels—from learners diagnosing their current status and controlling which tasks they want to perform, to learners conducting overall assessments of their learning process (Danis, 1992; Gibbons, 2002; Knowles, 1975; van Merriënboer & Sluijsmans, 2009; Tough, 1967). This study explores self-directed learning in which learners control which tasks they wish to perform.

Providing learners with control over task selection is a key factor in self-directed learning (Brockett & Hiemstra, 1991; van Merriënboer & Sluijsmans, 2009; Williams, 1996). It has been regarded that learners' choice of task is closely associated with self-directed learning (Loyens, Magda, & Rikers, 2008). Kicken, Brand-Gruwel, and van Merriënboer (2008) emphasized that "there is a chicken-and-egg relation between the two. To enable students to develop their [SDL] skills, they should be given control over task selection; but at the same time, these skills should already be developed to some minimum level, to protect students from the negative effects of being for the first time in control of their own learning." Such learners' ability to control their own learning—such as control over task selection—is regarded to be a precondition for self-directed learning.

Especially, the reason of high importance of task-selection is that an appropriate task-selection brings out high self-directed learning abilities (Kicken et al., 2008) and learning achievement (Corbalan, Kester, & van Merriënboer, 2008; Kostons, van Gog, & Paas, 2012). It is expected that knowing what they need would enhance learning achievement and self-directed learning abilities in a long term. This appropriate task-selection is interpreted as task-selection accuracy (Camp, 2001; Corbalan, Kester, & van Merriënboer, 2008; Kostons, van Gog, & Paas, 2012; Salden, Paas, Broers, & van Merriënboer, 2004). An appropriate task selection means they are making an accurate task selection in consideration of competence and cognitive load, and it would ultimately bring about improved learning achievement (Corbalan, Kester, & van Merriënboer, 2008).

However there has been some controversy over the advantages and disadvantages of giving learners choices in task selection. Empirical results concerning the benefits of choice are rather ambiguous and confusing. For instance, some studies suggest that giving learners a choice is associated with major positive results in learning. These studies have repeatedly demonstrated that such learners increased intrinsic motivation, perceived control, and life-satisfaction (Deci, 1975, 1981; Deci & Ryan, 1985; Glass & Singer, 1972a, 1972b; Langer & Rodin, 1976; Rotter, 1966; Schulz & Hanusa, 1978; Taylor, 1989; Taylor & Brown, 1988). In fact, numerous important theories in social psychology—including the attribution theory (e.g., Kelley, 1967, 1973), dissonance theory (e.g., Collins & Hoyt, 1972; Cooper & Fazio, 1984; Linder, Cooper, & Jones, 1967), and reactance theory (e.g., Brehm, 1966)—assume that giving learners a choice positively affects their learning (Iyengar & Lepper, 2000).

Others, however, indicate that it has no impact (D'Ailly, 2004; Parker & Lepper, 1992; Reeve, Nix, & Hamm, 2003), or even has negative effects (Flowerday, Schraw, & Stevens, 2004; Iyengar & Lepper, 1999, 2000).

Negative effects of offering choices to learners have been reported from various research, and they could be divided as cognitive, meta-cognitive, and motivation problems. One of the cognitive problems is cognitive load and learners could experience cognitive load when they are not pretrained on task-selection or have an extensive number of task-selection options. Research (Dhar, 1997; Shafir, Simonson, & Tversky, 1993; Shafir & Tversky, 1992) have shown that when there are attractive alternatives, individuals experience conflict and delay decision, explore new alternatives, or simply opt not to choose. Furthermore, Hauser and Wernerfelt (1990) suggests that both the number of options made people tend to consider fewer choices. Accordingly it is concluded that the selections are undoubtedly affected by the number of options (Payne, 1982; Payne, Bettman, & Johnson, 1988, 1993; Timmermans, 1993; Wright, 1975).

One of the meta-cognitive problems is poor recollection of their learning process. In other words, learners do not know what they do not know. To be an effective self-directed learner, learners have to monitor their performance over the course of performing a task, and utilize their monitoring results as a material for self-assessment and select a new learning task on the basis of that assessment. However, learners may experience difficulties in each of those phases. “It has been shown that monitoring while engaging in a complex learning task is very difficult for learners often they have a poor recollection of their performance after completing a task. These difficulties with monitoring affect self-assessment as well: if learners do not have a good recollection of the task, there is not much upon which they can base their assessment (Kostons, van Gog, & Paas, 2010, p.932)”. Eventually these problems affect task-selection, and learners are not able to choose an appropriate task because they do not know what they do not know.

Motivational problems show that learners have a tendency to make a random selection or use less complex strategies when they have a complex decision making. Bereby-Meyer et al. (2004) and Davidson (1991a, b) have investigated children’s decision-making. When complex options are provided, children, similar to adults, tend to make a random selection without consideration of the options. Iyengar, Huberman and Jiang (2004) term this situation choice overload. “When choosers feel they cannot handle the choice overload, or believe that the consequences of the wrong choice will be negative, they instead decide not to choose, or may ask someone with more expertise to choose for them (Katz & Assor, 2007, p.434)”.

Resolution of the above mentioned negative effects requires cognitive, meta-cognitive, and motivational support to enable learners to select appropriate tasks. One of the reasons that options generate such negative outcomes is that learners are not yet prepared to assume control over task selection. A great number of existing learning environments do not always consider the learners’ undeveloped self-directed learning skills (e.g., lack of ability to plan, monitor, and assess their performance). By contrast, well-developed self-directed learning skills are a precondition for effectively performing functions in an self-directed learning program (Biemans, Nieuwenhuis, Poell, Mulder, & Wesselink, 2004; Brockett & Hiemstra, 1991). Therefore, cognitive, meta-cognitive, and motivational strategies are necessary to support learners to have proper control over task selection in self-directed learning .

As the strategies to reduce cognitive load on learners’ task-selection, strategies such as ‘the number of tasks learners can choose should be provided differently’ and ‘make learners possess fundamental prior knowledge before learning’ could be examples (Mayer, Mautone, & Prothero, 2002; Pollock, Chandler, & Sweller, 2002). Through these cognitive strategies, learners are expected to feel less cognitive burden. As the metacognitive strategies, ‘reflection prompt on task-selection’, ‘self-assessment’, ‘feedback’, ‘plan’ could be one of them (Kicken et al., 2008; van Merriënboer & Sluijsmans, 2009; Sadler 1983). These metacognitive strategies will allow students learn to think for themselves, make plans, and take action. They think about their thoughts in order to make good decisions and about their decisions to ensure successful action. Motivation strategies that best allow for a conceptualization of choice is the self-determination theory (SDT) (Deci & Ryan, 1985; Katz & Assor, 2007; Shin, Jin,

& Kim, 2010). “SDT is a macro theory of human motivation concerned with the development and functioning of personality within social contexts. According to this theory, there are three basic psychological needs that when satisfied enhance intrinsic motivation and lead to autonomous internalization of behaviors of initial extrinsic origin (Ryan & Deci, 2000). The three psychological needs posited by SDT are the need for autonomy, the need for relatedness and the need for competence (Katz & Assor, 2007, pp.430-431).” Ryan and Deci (2000) posit that intrinsic motivation can emerge only if people feel that all three needs suggested by SDT are being satisfied. Therefore motivation strategies are needed to satisfy all three basic needs: autonomy, competency, relatedness.

Also, self-directed learning is getting emphasized even more due to the introduction of electronic textbooks in elementary, middle and high schools, and developments of strategies that support task selections of elementary, middle and high school learners are even more necessary. Self-directed learninghas its origins in adult learning (Tough, 1971). In a knowledge-based society, self-directed learning is important as one pursues lifelong learning when engaging in non-routine analytic tasks and complex problem solving. In recent years, self-direction has been recommended as an important life-skill to be fostered through K-12 education (see K-12 educational reports e.g., Partnership for 21st century skills, 2006). Several programmes aimed at building the self-direction skills of students have also been launched (e.g., Bartel, 2001; Glaubman, Glaubman, & Ofir, 1997). In particular, the need for studies on such self-directed learning ability is increasing due to the introduction of digital textbooks.

In Korea, The Ministry of Education and Science Technology and Council on National ICT Strategies jointly announced the “Smart Education Pursuing Strategy” on June of 2011 and it was decided to develop all textbooks in a ‘digital textbook’ format by 2015 and use them together with paper textbooks. Therefore, the government plans to complete the development of digital textbooks by March of 2015 and distribute them to elementary, middle and high schools and use them together with existing paper textbooks. They also established plans to implement online class and evaluation systems in all cities and provinces by 2015 and greatly increase schools with online classes such as cyber home learning. Digital textbooks becoming the main learning tool for students speaks volumes. Self-directed learning is emphasized the most in digital texts. Digital textbooks include contents of existing paper textbooks as well as vast learning data such as reference books, workbooks and learner's dictionaries, and are defined as primary texts that make classes and individualized learning customized for students' own aptitude and level possible (The Ministry of Education, Science and Technology, 2008). According to such definition, the ultimate goal of digital textbooks should be about learners conducting self-directed learning themselves, in addition to being used as texts in classes (Heo & Choi, 2009). In such ways, due to the dawning of the web 2.0 age that includes digital textbooks, developments of strategies that support the learner's task selection in self-directed learning are even more necessary.

2. Statement of Problems

Thus far, little research has investigated and validated whether cognitive, meta-cognitive, and motivation strategies facilitate learners' task selection in self-directed learning. Although several different strategies have been proposed to support learners in selecting tasks, it is still difficult to find an integrated strategy that takes three aspects of learners in task selection. Previous studies have proposed strategies that correspond to a few aspects (e.g., Corbalan, Kester, & Merrienböer, 2009; Kostons, van Gog, & Paas, 2010). For appropriate task selection, it is not enough for learners to merely solve one or two aspects of problems. Even thoough Kicken et al.(2009) suggested integrated strategies, it were not specific strategies applicable to this learning program and guideline actually; it is necessary to come up with strategies that solve such problems systematically.

At the same time, it is difficult to come across research that investigates either the direct effects of learners' task selection supporting (LTSS) strategies on task-selection accuracy, or the indirect effects on self-directed learning abilities and achievements. There exists a very close association self-directed learning and the selection of tasks by learners; in fact, some researchers (e.g., Brockett & Hiemstra, 1991; Williams, 1996) even believe that learners' control over task selection has positive effects on their self-directed learning abilities. This proves, in a sense, that when learners constantly select tasks and perform them, this act will improve their learning achievements (Corbalan, Kester, & van Merriënboer, 2008). Therefore, it is necessary to investigate the effects of LTSS strategies on learners' task-selection accuracy; it is also necessary to explore the possible indirect effects on their learning achievements or self-directed learning abilities. Also of importance are learners' opinions on the effectiveness of and improvements in self-directed learning between groups with and without LTSS strategies.

3. Research Questions

The purpose of this study is to develop LTSS strategies and investigate their effects and optimality. To investigate the type of strategies that can support learners' task selection in self-directed learning, we used theories on cognitive, meta-cognitive, and motivational perspectives as the framework for determining the strategies supporting learners' task selection. Therefore, in this study, we attempt to develop LTSS strategies based on cognitive, meta-cognitive, and motivation perspectives and explore the effects and optimality of these strategies. The research questions for this study are listed below:

1. What are the LTSS strategies in self-directed e learning?
2. What are the effects of LTSS strategies on learners' task-selection accuracy, self-directed learning abilities, learning achievements, and task-selection decision making?
    - 2.1. What are the effects of task selection supporting strategies in self-directed learning on task-selection accuracy, self-directed learning abilities, and learning achievement?
    - 2.2. What are the effects of task selection supporting strategies in self-directed learning on task-selection decision making?
    - 2.3. What is the optimality of LTSS strategies in self-directed learning ?

4. Definition of Terminology

4.1. Self-Directed Learning and Self-Directed e-Learning

Self-directed learning is viewed as both the process of learning and the outcome of that learning (Candy, 1991). In terms of self-directed learning as an outcome of education, self-directed learning refers to the consciousness of what a learner expects as an outcome of a learning process (Brookfield, 1985). In terms of a learning process, self-directed learning represents an activity whereby learners take the initiative to diagnose, choose, implement, and assess the task (Danis, 1992; Knowles, 1975; Tough, 1979). This study focuses on the (learning) process of self-directed learning aimed at enhancing learner's self-direction (outcome). Self-directed e-learning is a form of Web-based instruction that reflects the process of self-directed learning and enhances its outcomes; self-directed e-learning utilizes the Web to deliver instruction and learning resources (Kim, 2005).

4.2. Task-Selection Accuracy

Task-selection accuracy refers to the manner in which a task is chosen efficiently; accuracy was derived from the absolute difference between the desirable step size and the step size chosen by the participant (Kostons, van Gog, & Paas, 2012). Desirable step size indicates the number of jump sizes recommended to either go back to a previous task or progress to next one. The desirable step size was determined by interim scores and the mental effort scores after each task was completed in the course of the program (Salden et al., 2004).

4.3. Self-Directed Learning Abilities

The ability of an individual to take control determines that individual's potential. This means that learners have a choice about which direction they want to pursue. Along with this control comes the responsibility for accepting the consequences of one's thoughts and actions as a learner (Brockett & Hiemstra, 1991).

CHAPTER II. THEORETICAL BACKGROUND

1. Process and Outcome of Self-Directed Learning in Formal Education

The meaning of self-directed learning differs depending on whether it is viewed as an outcome of education (Brookfield, 1985), a process of learning (Danis, 1992; Knowles, 1975; Guglielmino, Guglielmino, & Long, 1987; van Merriënboer & Sluijsmans, 2009; Tough, 1979), or both the outcome of education and the process of learning (Candy, 1991).

In terms of an outcome of education, self-directed learning can be described as "a specific method of learning by a learner who is in the process of pursuing self-realization and a change in self-directed learning ability or consciousness of a learner expected as an outcome of a learning process" (Brookfield, 1985). As a learning process, self-directed learning represents an activity whereby learners take the initiative to diagnose their learning needs, formulate goals, choose and implement strategies, and then utilize the outcome (Danis, 1992; Knowles, 1975; Tough, 1979). The third description—that self-directed learning is both the outcome of education and a process of learning (Candy, 1991)—is the one adopted in this study.

In other words, this study focuses on the (learning) process of self-directed learning aimed at enhancing self-directed learning ability, that is, a learner's self-direction (outcome).

1.1. Self-Directed Learning in Formal Education

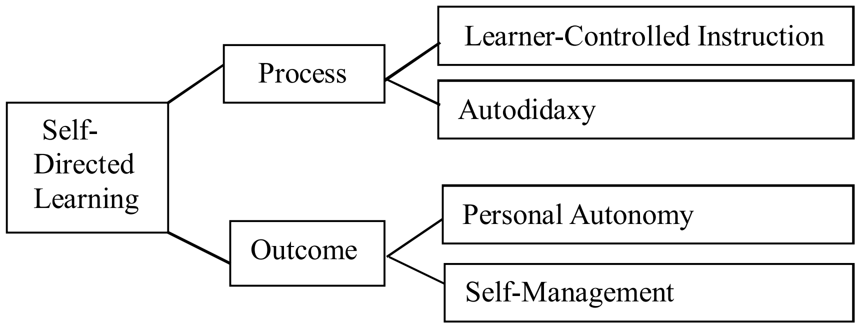


Figure II-1. SDL framework (Candy, 1991)

In "Self-Direction for Lifelong Learning," Candy (1991) argues that SDL is both a process of learning and an outcome of education. Candy's book, which is regarded as a seminal work on self-directed learning (Wilcox, 1996), provides a framework for his (Candy's) definition of self-directed learning; Candy subdivides the process of self-directed learning into learner-control (self-direction of learning in formal educational settings) and autodidaxy (autonomous learning in which learners participate outside of formal institutions of learning). Candy also divides the outcome of self-directed learning into personal autonomy, which is a personal attribute or disposition, and self-management, which refers to the willingness and capacity to educate oneself.

In terms of the process of self-directed learning, this study focuses on "learners' self-direction of their learning in formal educational settings," as stated by Candy(1991). In other words, this study focuses on self-directed learning whereby learners engage in learning at their own discretion in an institutional framework; the study does not deal with learning that takes place naturally, outside the scope of formal education. Therefore, while learners can control the process of self-directed learning for themselves, all their activities fall within the framework of the educational curriculum.

With respect to the outcomes of self-directed learning, this study focuses on both personal autonomy and self-management, as suggested by Candy(1991). In this study, the outcome of self-directed learning refers to a learner's self-direction encompassing personal autonomy and self-management, which will be discussed in detail in Chapter III.

1.2. Self-Directed Learning as an Outcome

In this research, outcomes of self-directed learning are indicative of learners' self-direction. Brockett and Hiemstra (1991) synthesized many self-direction theories and conceptualized the Personal Responsibility Orientation (PRO) model. According to this model, self-direction is recognized to be one of the personality characteristics of learners. In other words, self-direction is a kind of personal responsibility, referring to individuals' ownership of their thoughts and actions.

What determines learners' self-direction is "the ability or willingness of individuals to take control that determines any potential for self-direction. This means that learners have choices about the directions they pursue. Along with this goes the responsibility for accepting any consequences of one's thoughts and actions as a learner" (Hiemstra, 1999, p.13).

In other words, self-concept, readiness for self-direction, experience, and learning styles are factors determining learner self-direction; all these factors account for the learners' self-direction, which is the main aim of personal learning. This emphasis on a learner's personal characteristics or internal factors refers to learner self-direction. Therefore, in essence, learners' self-direction implies those individual characteristics that make learners take primary responsibility for their personal learning.

1.3. Self-Directed Learning as a Process

Self-directed learning is a theoretical approach that explains the manner in which people recognize the need for learning and adopt steps to satisfy that need. Major researchers who regard self-directed learning as a process include Danis (1992), Knowles (1975), Guglielmino, Guglielmino, and Long (1987), van Merriënboer and Sluijsmans (2009), and Tough (1979).

Tough (1967) developed one of the primary linear models of self-directed learning. After interviewing 40 adult learners of an self-directed learning project, he encapsulated a common self-directed learning process. The adult learners who participated in self-teaching tasks reported that they conducted the following twelve activities: (1) choosing a goal, (2) deciding upon the activities appropriate for achieving that goal, (3) obtaining printed materials and other resources, (4) estimating the learners' current levels of knowledge and skill, (5) dealing with learners' difficulty in grasping certain parts, (6) deciding the time at which learning should occur, (7) deciding the location at which learning should take place, (8) deciding how much money to spend, (9) dealing with learners' lack of desire to achieve the goal, (10) dealing with learners' dislike of the activities necessary for learning, (11) dealing with learners' doubts about success, and (12) deciding whether or not to continue.

Knowles (1975, p.18) provided the most widely known definition of self-directed learning: "a process in which individuals take the initiative, with or without help from others, in diagnosing their learning needs, formulating goals, identifying human and material resources, choosing and implementing appropriate learning strategies, and evaluating learning outcomes."

Further, in his book titled "Self-directed Learning: A Guide for Learners and Teachers", he suggests that if a facilitator provides the following assistance to a learner, the learner's self-directed learning will be successful: (i) establishing a suitable environment for self-directed learning; (ii) preparing the learner to select appropriate learning resources; (iii) diagnosing the learner's learning needs and ascertaining whether the learner is ready for such learning; (iv) converting the learner's learning needs into a realizable learning goal; (v) outlining a learning plan, including a learning strategy; (vi) providing feedback to the learner and participating in learning together; and (vii) evaluating learning outcomes on the basis of feedback among the learner, peers, and the facilitator.

There are three primary stages in the process of self-directed learning, as proposed by van Merriënboer and Sluijsmans (2009): performance, assessment, and selection. In the performance stage, learners perform a task in order to acquire domain-specific skills. In the second stage, learners assess their own performance, after which, in stage three, they select future learning tasks that might help improve their performance. Learners assess their learning needs through a critical reflection on previous task performance in relation to agreed standards for acceptable performance (What did I do? What went right or wrong?) The main aim of the selection process is to identify appropriate future learning tasks through a critical "preflection" on future task performance in relation to the fulfillment of identified learning needs. (What should I do next? How will that help me improve my performance?) Therefore, learners eventually take responsibility for the entire learning cycle, including their performance of the learning tasks, assessment of the quality of own task performance, and the selection of future tasks that could optimally contribute to further learning. van Merriënboer and Sluijsmans (2009) also emphasized that the results obtained by learners on earlier tasks affect their selection of later tasks. Learners find it possible to plan their learning tasks more dynamically because the main aim of the assessment process is not to provide corrective feedback and arrive at pass/fail decisions, but to compare the quality of performance over time (i.e., ipsative assessment) and formulate learning needs. This enables the planning of an individual learning trajectory or the iterative selection of new learning tasks.

Gibbons (2002) suggests six stages in the process of self-directed learning: (1) setting goals; (2) choosing what to study; (3) learning the skills and processes involved in setting goals, making plans, and initiating action; (4) negotiating learners' proposals with teachers for learning and acting; (5) undergoing self-directed challenge activities; and (6) reviewing the assessment of their own work. Danis (1992) also listed six stages in the process of self-directed learning: (1) reacting to a triggering event, (2) seeking and selecting specific knowledge and resources to be acquired, (3) organizing and structuring the knowledge to be acquired and the strategies to be used, (4) acquiring and integrating newly obtained knowledge, (5) assessing the quality of the learning outcome and learning strategies, and (6) applying the new knowledge.

The processes of self-directed learning, as suggested by Gibbons (2002), Danis (1992), Knowles (1975), Tough (1967), and van Merriënboer and Sluijsmans (2009) are listed in Table II-1. In essence, the processes suggested by these researchers involve "diagnosing the status," "selecting the task," "performing the task," and "assessing the task." In the first stage—diagnosing the status—the level of learners' existing knowledge is ascertained, that is, their needs are diagnosed, and their learning goals are established. In the second stage—selecting the task—it is determined which task will be learned using what strategy. In the stage of performing the task, new knowledge is accumulated by utilizing a variety of strategies. Finally, in the last stage of assessing the task, the quality of learning is evaluated and a future learning plan is mapped out based on the identification of deficiencies. These four stages are not completed in a single cycle and, rather, are repeated continuously as long as learners desire, as illustrated in Figure II-2, below.

Table II-1. SDL processes

Researchers	Processes
Gibbons (2002)	(1) Setting goals; (2) choosing what to study; (3) learning the skills and processes involved in setting goals, making plans, and initiating action; (4) negotiating learners' proposal with teachers for learning and acting; (5) undergoing self-directed challenge activities; and (6) reviewing the assessment of their own work
Danis (1992)	(1) Reacting to a triggering event, (2) seeking and selecting specific knowledge and resources to be acquired, (3) organizing and structuring the knowledge to be acquired and the strategies to be used, (4) acquiring and integrating newly obtained knowledge, (5) assessing the quality of the learning outcome and learning strategies, and (6) applying the new knowledge
Knowles (1975)	(1) Diagnosing learning needs, (2) formulating learning goals, (3) identifying human and material resources for learning, (4) choosing and implementing appropriate learning strategies, and (5) evaluating learning outcomes
Tough (1967)	(1) Choosing a goal, (2) deciding upon the activities appropriate for achieving that goal, (3) obtaining printed materials and other resources, (4) estimating the learners' current levels of knowledge and skill, (5) dealing with learners' difficulty in grasping certain concepts, (6) deciding the time at which learning should occur, (7) deciding the location at which learning should take place, (8) deciding how much money to spend, (9) dealing with learners' lack of desire for achieving the goal, (10) dealing with learners' dislike of the activities necessary for learning, (11) dealing with learners' doubts about success, and (12) deciding whether or not to continue
van Merriënboer and Sluijsmans (2009)	(1) Performing the task, (2) assessing the task, and (3) selecting the task

Table II-2. Process of newly integrated SDL

SDL Process	Description
Diagnose the status	-Learning the skills and processes involved in setting goals, making plans, and initiating action; setting their own goals (Gibbons, 2002) -Diagnosing their learning needs; formulating learning goals (Knowles, 1975) -Choosing the goal; estimating the learner's current level of knowledge and skill (Tough, 1967)
Select ***&*** ***perform*** the task	-Choosing what to study (Gibbons, 2002) -Choosing and implementing appropriate learning strategies (Knowles, 1975) -Deciding on the activities appropriate for achieving the goal (Tough, 1967) -Deciding the time and location for learning (Tough, 1967) -Deciding how much money to spend (Tough, 1967)
	-Performing the task (van Merriënboer, 2009) -Undergoing self-directed challenge activities (Gibbons, 2002) -Organizing and structuring the knowledge to be acquired and the strategies to be used; acquiring and integrating the newly acquired knowledge (Danis, 1992) -Dealing with learners' difficulty in grasping certain concepts (Tough, 1967)
Assess task perform	-Reviewing the assessment of their own work (Gibbons, 2002) -Assessing the quality of the learning outcome and the learning strategies used (Danis, 1992) -Evaluating learning outcomes (Knowles, 1975) -Dealing with learners' dislike of the activities necessary for learning; deciding whether or not to continue (Tough, 1967)

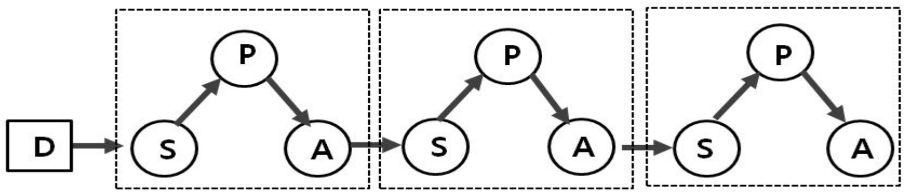


Figure II-2. SDL process: diagnosis (*D*); performance (*P*); assessment (*A*); and selection (*S*)

1.4. Formal Education and SDL

Although discussions on self-directed learning once focused on adult education alone, the importance of this learning is now emphasized for primary and secondary education as well. self-directed learning ability is inherent to all learners. Humans are born with an instinct to be positive and active learners. This desire to learn for oneself is even common to infants, though it does not always manifest when people reach adulthood (Ryan & Deci, 2000). self-directed learning is commonly believed to be a characteristic of adulthood; however, the tendency to learn for oneself is actually a universal characteristic shared among all humans regardless of age (Knowles, 1990). In other words, self-directed learning ability does not only appear when people become adults, but it is steadily built even during childhood.

Self-directed learning ability in the school setting is one that can be improved by learners for themselves, with the help of teachers. In other words, self-directed learning is a synergistic process in which a teacher helps learners to use various strategies and perceptual skills to learn on their own, become more responsible for their learning, and take charge of their lives. self-directed learning not only enables learners to acquire knowledge of subject matter but also allows them to understand themselves and their work habits, perceptions, aspirations, value systems, and potential. Self-directed learning helps students rely on their own learning power instead of depending solely on the teacher; it also teaches them how to cooperate when working in groups (Areglado, Bradley, & Lane, 1996).

Self-directed learning in formal education can be classified into four stages, as listed in Table II-3. Grow (1991) interprets self-directed learning as the degree of choice that learners have within an instructional situation. The teacher's purpose is to match the learner's stage of self-direction and prepare the learner to advance to a higher stage.

Table II-3. The staged SDL model (Grow, 1991)

Stage	Student	Teacher	Examples
Stage 1	Dependent	Authority coach	Coaching with immediate feedback; drill; informational lectures; overcoming deficiencies and resistance
Stage 2	Interested	Motivator guide	Inspiring lectures and guided discussions; goal-setting and learning strategies
Stage 3	Involved	Facilitator	Discussion facilitated by teachers who participate as equals; seminars; group projects
Stage 4	Self-directed	Consultant, delegator	Internships, dissertations, individual work or self-directed study groups

Stage 1. In this stage, learners are dependent, and there are two ways in which they can be taught—through coaching and through insight. Grow (1991, p.130) explains that "in this stage, the teacher is an expert whose mastery must be real. Dependent learners respond best to a clearly organized, rigorous approach to a subject. Prescribe clear-cut objectives and straightforward techniques for achieving them. This stage also requires learners to be involved in the design and content of the learning."

Stage 2. In stage 2 of self-directed learning, teaching is similar to the good teaching found in many schools and colleges. Grow (1991, p.132) explains that "examples of stage 2 teaching include a lecturer as inspiring performer, industry training programs, teacher-led discussions, demonstrations by an expert followed by guided practice, structured projects with predictable outcomes, close supervision, highly interactive computerized drills, structured projects of commercial art. These examples involve the combination of two elements: strong personal interaction and a strong focus on subject matter."

Stage 3. In this stage, teachers teach through facilitation. Grow (1991, p.133) explains that “the teacher comes closest at this stage to being a participant in the learning experience. Teacher and students share in decision making, with students taking an interesting role. The instructor concentrates on facilitation and communication and supports students in using the skills they have.”

Stage 4. In the earlier stages, the focus was subject-matter; this stage, though, has a learner focus. Grow (1991, p.135) explains that “the stage 4 teacher’s role is not to teach subject matter but to cultivate the student’s ability to learn. The ultimate subject of stage 4 is the learner’s own personal empowerment. The teacher may consult with learners to develop written criteria, evaluation checklists, timetables, and management charts for each project they develop.”

From among the above four stages, the strategy used in this study corresponds to stage 2: teachers should support learners to learn what they want within the structured instruction.

2. Importance of Task Selection in the Self-Directed Learning Process

Learner control over task selection is believed to have a positive impact on SDL ability (e.g., Brockett & Hiemstra, 1991; Williams, 1996; Zimmerman, 1994; Kicken et al., 2008). Learners’ ability to control their own learning, for example, control over task selection, is a precondition of self-directed learning. Similarly, Kicken et al. (2008, p.226) emphasized that “there is a chicken-and-egg relation between the two. To enable students to develop their self-directed learning skills, they should be given control over task selection; but at the same time, these skills should already be developed to some minimum level, to protect students from the negative effects of being for the first time in control of their own learning.”

SDL and self-regulated learning (SRL) have a great deal in common, as demonstrated by the fact that numerous researchers regard them to be the same concept (Loyens, Magda, & Rikers, 2008; Zimmerman & Lebeau, 2000). In fact, Evensen et al. (2001) even used these two terms synonymously. Both SDL and SRL encompass the process of setting goals, analyzing tasks, implementing plans, and conducting self-assessments of the learning process based on learners' active engagement and goal-directed behavior. In addition, both SRL and SDL emphasize proactive meta-cognitive skills. Meta-cognition is involved in all stages preceding the actual learning activities (i.e., establishing a goal and setting up a plan for its accomplishment) and in the follow-up evaluation of those acts. Through such meta-cognitive processes, students can continuously determine what they know and what they do not know (Hmelo-Silver, 2004). As explained above, SDL and SRL have many similarities: in both, learners themselves control their learning process. However, there is a difference between SDL and SRL in terms of the level of control over learning tasks, which varies; this level of control forms the starting point of the learning process. In SDL, learning tasks are always defined by learners. Self-directed learners can determine what learning is required and choose the details of learning for themselves (Candy, 1991; Loyens, Magda, & Rikers, 2008).

> In SDL, the learning task is always defined by the learner. A self-directed learner should be able to define what needs to be learned (Candy, 1991). The learner is the initiator of the learning task. In SRL, the learning task can be generated by the teacher…. In this sense, SDL can encompass SRL, but the opposite does not hold. SRL seems more concerned with the subsequent steps in the learning process, such as learning goals and strategies, while SDL clearly provides a crucial role for the learner at the outset of the learning task. (Loyens, Magda, & Rikers, 2008, p.418)

As seen from the above quote, learning tasks in SRL are generated by teachers. With regard to these tasks, students freely choose their learning strategies and engage in SRL activities. In this respect, SDL may include SRL, but not vice versa.

Granting learners the right to select a task is one of the most important characteristics of SDL, differentiating it from SRL.

3. Advantages and Disadvantages of Task Selection

One of the most distinctive characteristics of SDL is allowing learners to select their own learning tasks. It is widely known that choice promotes learning motivation (Flowerday & Schraw, 2000). Yet, there remain mixed views on the effectiveness of offering choices to learners in the classroom setting.

While some studies demonstrate that providing a choice has positive outcomes (Assor, Kaplan, & Roth, 2002; Cordova & Lepper, 1996; Reynolds & Symons, 2001), others indicate that it has no impact, or even has negative effects on learners (D'Ailly, 2004; Flowerday & Schraw, 2003; Reeve, Nix, & Hamm, 2003; Schraw, Flowerday, & Reinsetter, 1998).

Offering choices to learners is said to have many benefits in terms of learning motivation. First, when learners are given the choice to select their own tasks, their motivation is enhanced because learning motivation emerges naturally when learners are interested in the learning process (Deci & Ryan, 1985; Ryan & Deci, 2000). In addition, learners experience autonomy when given the freedom to choose. This freedom enables them to reach their learning goals, making learning more meaningful.

Giving learners the freedom to select their own tasks is particularly effective in promoting self-determined motivation. Learners can make their own decisions, enhancing their self-determined motivation (Lillard, 2005). Several psychological theories and research suggest that providing learners with the choice of task selection has positive impacts on intrinsic motivation, perceived control, task-performance, and life satisfaction (Deci, 1975, 1981; Deci & Ryan, 1985; Glass & Singer, 1972a, b; Langer & Rodin, 1976; Rotter, 1966; Taylor & Brown, 1988). Researchers conducted two experiments and compared their results. The students of one group were each allowed to choose one of six activities; the students of the other group were instructed by a teacher on which activity to undertake. The result revealed that students' intrinsic motivation was enhanced when they were allowed to make their own choices. In addition, fields such as the social psychology, which include the attribution theory (e.g., Kelley, 1967, 1973), dissonance theory (e.g., Collins & Hoyt, 1972; Cooper & Fazio, 1984), and reactance theory (e.g., Brehm, 1966) have reported that offering a choice shows remarkable effectiveness in promoting learners' motivation.

Various researches have also reported the negative effects of offering choices to learners; these negative effects can be divided into cognitive, meta-cognitive, and motivation problems. One type of cognitive problem is cognitive load. Learners experience a cognitive load when they have an extensive number of task selection options. Research (Dhar, 1997; Shafir, Simonson, & Tversky, 1993; Shafir & Tversky, 1992) has shown that when many options are similarly attractive, learners tend to defer decisions, or even decide to not make a choice (Dhar, 1997; Shafir & Tversky, 1992). Furthermore, as the number of options and the information about these options increase, learners tend to process a smaller fraction of the overall information available (Hauser & Wernerfelt, 1990). Similarly, when the complexity of making choices increases, learners tend to simplify their decision-making processes by relying on simple heuristics (Payne, Bettman, & Johnson, 1988, 1993; Wright, 1975). In other words, the higher the number of options given, the more often do learners use the strategy of elimination. Therefore, too many options might lead to cognitive overload, causing learners to make in efficient decisions.

One problem associated with meta-cognition is the poor recollection of the learning process, indicating that learners have difficulties in selecting appropriate tasks for themselves. To become effective self-directed learners, they need to continue monitoring their own learning process even while a performing task; further, they have to assess their performance results after completion of the task. Based on such monitoring and assessment, learners can proceed to select the optimal task for themselves. However, it is not easy to self-monitor progress without any help. Poor monitoring of one task will have negative effects on subsequent self-assessment, eventually hampering learners from selecting appropriate task. These problems affect task selection, and learners are unable to choose the appropriate task because they are unaware of what they do not know.

Problems associated with motivation are that learners tend to make random selections and use less complex strategies. Bereby-Meyer et al. (2004) and Davidson (1991a, b) investigated these problems in the context of children's decision-making process. When the options provided are complicated, children, similar to adults, tend to make random choices without properly considering available options. When options become complex, learners tend to choose randomly or make non-optimal choices. Such a tendency ultimately undermines one's sense of competence. Iyengar et al. (2004) term this situation as a "choice overload." Learners may experience a choice overload when they have trouble making a choice. If they are not confident that the consequences of their choice will be positive, they tend to choose the default option, or simply opt to not make a choice (Shafir, Simonson, & Tversky, 1993).

4. Cognitive, Meta-Cognitive, and Motivational Support for Learners' Task Selection

To eliminate the negative effects associated with offering choices to learners, it is necessary to provide learners with cognitive, meta-cognitive, and motivation support to facilitate appropriate task selection. One of the reasons for these negative effects is that learners are not ready to have control over task selection. Many existing learning environments do not always take into account learners' underdeveloped SDL skills (i.e., their inability to plan, monitor, and evaluate their own performance); at the same time, well-developed SDL skills are a prerequisite for effective SDL (Biemans et al., 2004; Brockett & Hiemstra, 1991). Therefore cognitive, meta-cognitive, and motivation strategies are needed to support learners' control over task selection in SDL.

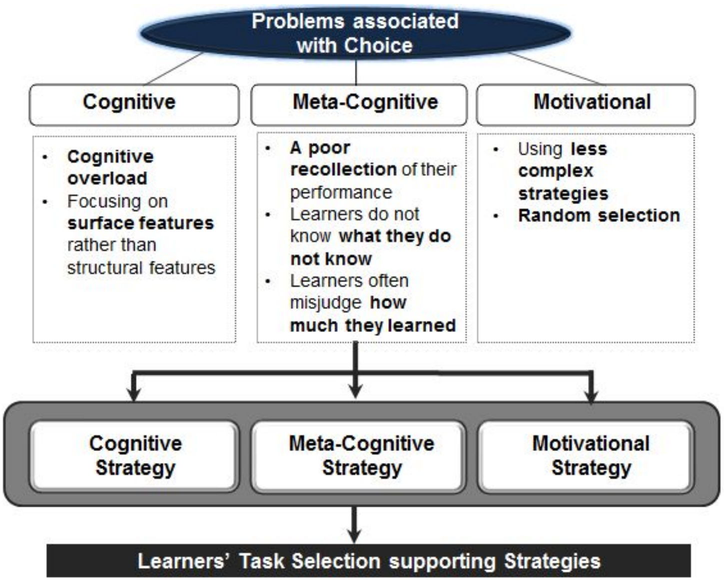


Figure II-3. Framework of support strategies for learners' task selection

4.1. Cognitive Strategies for Supporting Learners' Task Selection

Cognitive strategies aimed at supporting learners' task selection can be deduced from the cognitive load theory (CLT); these help to reduce the mental load placed on learners during task selection. The CLT assumes that learners store automated schemas in their long-term memory through learning so that the working memory can be reduced during problem solving (Sweller, 1994). Moreno and Park (2010) explain the following about memory and information processing:

> This assumption is based on the distinction between automatic and controlled processing proposed by Shiffrin and Schneider (1977) more than a quarter-century ago. Considerable research had identified two qualitatively distinct ways to process information. Automatic processing is fast, effortless, not limited by working memory capacity, and developed with extensive practice; in contrast, controlled processing is relatively slow, mentally demanding, and highly dependent on working memory capacity. (Fisk & Schneider, 1983; Logan, 1979, 1980; Posner & Snyder, 1975) (p.13)

As seen from the excerpt above, schema development reduces the constraints of a limited capacity working memory in two ways. First, well-developed schemata, even highly complex schemata, are processed as one element rather than as multiple interacting elements. Second, well-developed schemata enable learners to process tasks automatically, even with minimum cognitive resources. Consequently, the CLT assumes that it has to assist instructional designers to structure information appropriately so that irrelevant cognitive load is reduced, and novice learners are able to spend their limited cognitive resources on schema development.

Intrinsic load refers to the load that is imposed by the basic characteristics of information. More specifically, if some materials are difficult to learn or some problems are difficult to solve, it is because these materials and problems require th e processing of several elements that interact with each other simultaneously. According to the CLT, intrinsic cognitive load depends on two factors: (1) the number of elements that must be processed simultaneously in the working memory for any learning task and (2) the prior knowledge of the learner. The load resulting from element interactivity varies among and within different subject areas. Moreover, novice learners with low prior knowledge have a large number of interacting elements, while experts with high prior knowledge integrate a number of interacting elements, reducing their cognitive load. Unlike other loads, such as extraneous and germane loads, the intrinsic load is directly related to learning because it is associated with schema acquisition and knowledge acquisition through automation.

Extraneous cognitive load refers to the cognitive load that can be improved by instructional strategies such as learning method and the manner of material presentation, rather than the level of difficulty of the learning tasks themselves (Sweller, 1994). However, extraneous cognitive load is influenced by the intrinsic cognitive load. In other words, even if an inappropriate instructional design causes extraneous cognitive load, learners will have no difficulties in solving the problems if the learning tasks have a low intrinsic cognitive load; this is because extraneous cognitive load does not exceed working memory capacity.

Germane cognitive load refers to mental effort that is directly associated with learning within the boundaries of the working memory capacity (Sweller, 1994). When learners are provided with extremely low- or high-level learning materials, there is no cognitive load. When they are offered appropriate level materials, however, learners invest mental effort in solving problems. This type of cognitive load is called “germane cognitive load.”

Table II-4. Effects of cognitive load (Sweller, 2010, p.30)

Cognitive Load Effect	Description	Cognitive Load Source
Worked-out examples	Studying worked-out examples results in better performance on subsequent problem-solving tests, compared to solving equivalent problems (Renkl, 2005).	Extraneous
Completion	Making learners complete partially solved problems can be just as effective as making them study worked-out examples (Paas & van Merriënboer, 1994).	Extraneous
Expertise reversal	With increasing expertise, instructional procedures that are effective with novices can lose their effectiveness, whereas ineffective techniques can become effective (Kalyuga, 2005).	Extraneous
Guiding fading	With increasing expertise, learners should be presented with worked-out examples followed by completion problems and finally full problems, rather than worked-out examples alone (Renkl, 2005).	Extraneous
Element interactivity	Cognitive load effects occur only when using high rather than low element interactivity material (Sweller, 1994).	Intrinsic
Variable examples	Examples with variable surface features enhance learning, compared to examples with similar features (Paas & van Merriënboer, 1994).	Germane

Worked-out example effect: The effectiveness of a worked-out example is one of the most well-known instructional effects associated with the CLT. Sweller and Cooper (1985) performed several seminal studies to demonstrate this effect. Using a series of experiments, they showed that various worked-out examples have very positive impacts on learning, particularly leading to better subsequent problem-solving performance on structurally identical problems (near transfer: same solution procedure).

The traditional CLT explanation of the worked-out example effect is relatively straightforward. In early research on skill acquisition, learners attempted to solve problems by using general search strategies, for example, means-ends analyses. As a result, they focused not on schema-relevant principles, but on specific features of the problem in order to reduce the difference between current and goal problem states. Moreover, the task of reducing the difference between problem states required learners to manage sub-goals and consider different solution options, resulting in cognitive overload.

As research on cognitive skill acquisition progresses, the worked-out example effect starts to disappear. For example, if learners have high prior skill levels, problem solving can foster more effective learning compared to merely studying worked-out examples. This is referred to as the reversal of the worked-out example effect and an instance of the general expertise reversal effect, as described by Kalyuga et al (2003). This implies that the instructional effects introduced by the CLT eventually disappear and reverse themselves over the course of cognitive skill acquisition. In other words, studying worked-out examples undermines the results of later researches in this field. As learners establish a sufficient knowledge base, they become better equipped by acquiring the ability to solve problems independently.

Pre-trained effect: One approach to maintaining intrinsic cognitive load is to help learners acquire prerequisite knowledge. For example, when students are made to watch a narrated animation explaining the breaking system of a car, they then have to build component models of each part and a causal model of the entire system. If a learner is unfamiliar with cars, the task of identifying each part would become so demanding that there would be little capacity remaining to build the casual model. In this case, the solution is to provide learners with pre-training in the main components of the system to be learned, including the names, locations, and functions of the components of a car.

Expertise reversal effect: According to the expertise reversal effect, the mo st effective learning method can be different, depending on the level of the learner's expertise. According to the CLT, the volume of mental load depends on t he learner's previously acquired schemata. Therefore, learners' schemata determine what constitutes a learning factor and which factors interact. If learners have well-developed schemata, they have a high level of prior knowledge; if learners have less-developed schemata, they have lower prior knowledge. Simply put, changing learning methods is effective when the learners' level of knowledge is different. The expertise reversal effect occurs when an instructional procedure that is relatively effective for novices becomes ineffective for more knowledgeable learners; therefore, different instructional designs should be adopted depending on the learners' background knowledge (Kalyuga, 2005, 2007; Kalyuga, Ayres, Chandler, & Sweller, 2003).

4.2. Meta-Cognitive Strategies for Supporting Learners' Task-Selection

Meta-cognition is defined as cognition about cognition. It involves thinking about knowing, doing, and thinking. Meta-cognition is an integral part of SDL that helps students learn how to think, plan, and act autonomously. Learners think about what they think in order to make good decisions; they think about their decisions to adopt successful measures; they also think about procedures to follow, solutions for potential problems, and ways to improve performance.

In essence, SDL is founded on meta-cognition abilities. If learners know what they are aware of and what they are unaware of, they will be able to undertake accurate task selection. However, most learners—particularly those with insufficient research knowledge—lack the ability to assess their strengths and weaknesses, thereby encountering difficulties in accurate task selection. Therefore, it is necessary to examine meta-cognitive strategies such as self-assessment, feedback, and immediate incorporation into planning.

Self-assessment—the ability to identify elements of one's strengths and weaknesses for the improvement of one's performance—plays a critical role in SDL. It is a process whereby learners can continuously reflect upon and assess their learning status. Sedikides (1993) asserted that self-assessment encourages people to not only search for information in order to identify uncertain self-concepts, rather than certain self-concepts, but also use self-assessment to improve the certainty of their self-knowledge.

Feedback is a process of communication whereby a sender sends a message, and the recipient sends back his/her response based on its influence and impression. Feedback is defined as various pieces of information and procedures related to the accuracy of the response of a learner in a teaching and learning process. In other words, feedback is a process by which to communicate information or opinions on the accuracy and appropriateness of a learner's response in a teaching and learning process. Schimmel (1983) divided feedback into three types:(1) identification, (2) accurate response, and (3) explanation re-adjustment; Schimmel stressed that various data need to be provided in order to study feedback, because there is always a difference in how easy it is for learners to memorize information in different subjects or even in the same subject. Rha (1988) classified feedback into three levels in terms of amount of information:(1) no feedback (NF), (2) knowledge of result (KR), and (3) knowledge of correct response information (KCRI). Additionally, ipsative feedback can provide learners with feedback on their progress, thus motivating learners and helping them compare their quality of performance over time (Harlen & James, 1997).

Effective planning can help learners discover their weaknesses, thereby he lping them choose the next task more appropriately. In general, planning refers to the process of examining the time and resources relevant to the effort to attain intended objectives. Planning allows learners to not only identify what resources and learning tasks are required for them to attain their learning objectives but also decide the methods of doing so. If learners do not invest enough effort in the planning process, time and costs may be wasted, having a negative impact on subsequent task selection.

4.3. Motivational Strategies for Supporting Learners' Task Selection

The self-determination theory (SDT; Deci & Ryan, 1985; Katz & Assor, 2007) provides the clearest theoretical explanation of learners' right to select. According to the SDT, there are three main psychological needs that improve intrinsic motivation and form the basis of self-motivation (Ryan & Deci, 2000): the need for autonomy, relevance, and competency. Ryan and Deci (2000) postulated that people can be self-motivated when all these three needs are satisfied.

According to SDT, people feel a sense of autonomy when they find themselves relevant to the value of the task in which they are involved, and can thus identify with the task. The sense of autonomy becomes stronger, particularly when they perceive the task to be closely associated with their values, interests, and goals (Assor, Cohen-Melayev, Kaplan, & Friedman, 2005).

Some recent studies, which are consistent with these views, suggest that what students greatly value is probably not the simple act of selection but the ego of the participant and the value of that selection for personal goals. For instance, a correlational study carried out by Assor, Kaplan, and Roth (2002) found that a student's tendency to participate becomes stronger in proportion to the level of relevance of the teacher's behaviors toward that student's goals. Another study carried out by Katz and Assor (2003) revealed that even if students did not select the task, the sense of autonomy and intrinsic motivation improved dramatically if the learning task was consistent with their interests. In addition, Ullmann-Margalit and Morgenbesser (1997) distinguished “picking” from “selecting”: picking does n ot reflect one’s needs, while selecting reflects one’s needs and preferences. A comparison between two groups—one engaged in picking and the other in selecting—indicated that when the former chose something, it did not have any impact on their sense of autonomy; when the latter selected something, their sense of autonomy improved. Therefore, it is assumed that since picking—which does not reflect one’s preferences—does not influence one’s interests, free will, goals, and values, it generates less motivation compared to selecting.

According to an SDT-based study (Alfi et al., 2004; Deci et al., 1996; Ryan & Deci, 2000; Skinner & Belmont, 1993), teachers can support the competency of learners by carrying out initial assessments of learners’ knowledge and then assigning optimal tasks. Teachers can help learners formulate action plans for their tasks and provide guidance on the components of tasks already completed by them as well as on other components to be completed through further practice. Since learners are motivated when selection is not too difficult or complicated, it is necessary that teachers consider the ages and cognitive abilities of their learners when setting the complexity and levels of difficulty of tasks.

The provision of proper feedback to learners can also improve their competency (Alfi et al., 2004; Flowerday & Schraw, 2000). It is well known that the correction of errors found in the process of judgment and provision of information to help set better directions for learning is more advantageous than the feedback type that compares the ability of one student with those of others (Brophy, 1981). Through this feedback process, students can focus on the tasks that they have selected without anxiety about their performance levels and the possibility of negative assessment; this improves motivation as it enhances their competency in the long run.

One way in which teachers can strengthen learners' sense of relevance to tasks is by encouraging peer acceptance and empathy in class and minimizing social comparisons and competition; this sets a solid foundation for learning and research (Alfi et al., 2004; Battistisch, Solomon, Watson, & Schaps, 1997).

In particular, studies on multiculturalism suggest the necessity of satisfying the needs of learners for relevance when providing selections (Katz & Assor, 2003). In particular, since Asian learners, unlike Westerner learners, share a strong collectivism-oriented culture, they tend to not select options that could threaten their sense of belonging to their groups. Therefore, in this context, it is important to provide selections that are not in conflict with the values of the group in order to satisfy individuals' needs for autonomy (Katz & Assor, 2003). If those who make selections are concerned that their selections could result in social rejection, belittlement, or harassment, their motivation could be negatively influenced. There fore, it is necessary for teachers to create an accepting, friendly, and sympathetic environment if their students are to make advantageous selections. Various ways in which this can be done have been suggested by Battistisch et al. (1997): the arbitration method, which is designed to promote prosocial development. The arbitration method (Child Development Project or CDP) provides numerous opportunities for students to cooperate, give meaningful mutual help, and receive help when necessary; to discuss and think over the experiences of others in order to understand and accept their needs, feelings and views; to relate fundamental prosocial values to their interests, respect others, and discuss and think over their behaviors and others' behaviors; to develop and practice critical social capabilities and be autonomous; to participate in the decision-making process for class rules and activities; and to bear responsibility for the appropriate hidden side of class life.

CHAPTER III. RESEARCH MODEL and HYPOTHESES

This study predicted that there will be differences in task-selection accuracy, learning achievement, and self-directed learning abilities between the experimental group, in which learners were provided LTSS strategies and guidelines, and the control group, in which they were not. First, the experimental group is expected to have a higher task-selection accuracy compared to the control group (A lower score indicates higher task-selection accuracy). That is, participants in the experimental group should be better able to choose tasks that are appropriate for their learning based on the cognitive, meta-cognitive, and motivation strategies given to them. It is expected that their higher task-selection accuracy will ultimately have significant impacts on their learning achievement and self-directed learning. In order to examine such differences between the experiment and control groups, five hypotheses were formulated, and a research model was established based on the hypotheses. Finally, the statistical significance of each hypothesis and the research model were verified.

1. Research Model

The primary purpose of this study is to examine the impact of LTSS strategies and guidelines on task-selection accuracy, learning achievement, and self-directed learning abilities. Based on the theoretical rationale discussed earlier, we developed a research model that posits processes by which LTSS strategies and guidelines exert their effect. This model is presented in Figure II-4.

The first path occurs when LTSS strategies, according to our hypothesis, increase task-selection accuracy. In turn, task-selection accuracy leads to improved self-directed learning abilities and learning achievement. This means that the provision of LTSS strategies has a direct effect on task-selection accuracy and an indirect effect on self-directed learning abilities and learning achievement.

According this model, learners who are provided with LTSS strategies will make a more accurate task selection than those who are not given such strategies, and learners with high task-selection accuracy will also have high self-directed learning abilities and learning achievement.

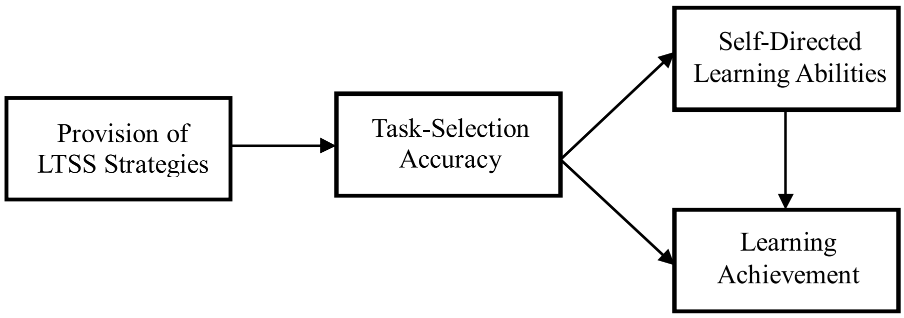


Figure II-4. Research model

2. The Significant Direct Effect of LTSS Strategies on Learners' Task-Selection Accuracy.

Strategy 1.1. Ensure that learners possess fundamental prior knowledge before learning. [Cognitive strategy]

When learners have fundamental prior knowledge relevant to the task, they can utilize this knowledge to easily select an appropriate task. Novices usually lack sufficient prior knowledge, and for this reason, they tend to choose tasks that they prefer, rather than ones that they need. This eventually has a negative impact on their learning (Kostons, van Gog, & Paas, 2009; Kicken, Brand-Gruwel, & van Merriënboer, 2008). Corbalan, Kester, and van Merriënboer (2009) described the potential negative effect as follows:

> "If learners select what they like rather than what they need, learner control may even have negative effects on learning. For example, learners may reduce instructional time by skipping or omitting considerable amounts of instructional materials essential for good performance (Merrill, 2002; Ross & Morrison, 1989; Snow, 1980; for a review, see Williams, 1996). Hence, learners with inadequate knowledge should not be allowed to make instructional choices unless they are taught or supported to make the right selections first."(p. 291)

Similarly, according to the pre-training principle of the Cognitive Load Theory, learners experience cognitive load when learning with insufficient prior knowledge. In order to reduce their cognitive load, they should acquire essential prior knowledge by attending pre-training. Thus, more effective learning outcomes are achieved when core elements are pre-trained prior to learning (Mayer, Mautone, & Prothero, 2002; Pollack et al., 2002).

For example, Mayer, Mathias, and Wetzell (2002) presented learners with a narrated animation explaining how a car's brake system works. Before the narrated animation, some learners could click on any part of the braking system shown on their computer screen to see its name. Learners who received this pre-training outperformed their counterparts who had not received the pre-training on a transfer test. Likewise, when learners acquire fundamental terms and concepts prior to selecting a task, they feel less cognitive load in the task selection.

In these ways, diagnostic tests are expected to help learners acquire prior knowledge for task selections and reduce their cognitive load during the task selection, thereby enabling them to make appropriate decisions.

Strategy 1.2. Have learners set their own learning goals (Moos & Azevedo, 2008) [Motivation strategy]

Learners can make self-determined choices after they have formulated their own goals. Once a goal is formulated, it is easier for the learners to judge which tasks are related to it. When learners believe tasks are related with their personal goals, they have a greater sense of autonomy in their studying. This view is consistent with Self Determination Theory (SDT; Ryan & Deci 2000; Ryan, 1993), which assumes that people experience a sense of autonomy when they realize their personal goals. They also suppose that learning may be internalized under these goal-connected situations, even though most school activities are extrinsically motivated. Note that most school activities cannot be intrinsically motivated; however, under an autonomy-supportive condition, such activities can be internalized despite their extrinsic origin (Assor, Kaplan, & Roth, 2002).

For example, Assor, Kaplan, and Roth (2002) studied the effects of teacher behavior toward students on engagement. As a result, it was confirmed that clarification of a task's relevance to students' goals had a more positive effect on school achievement than behaviors such as 'choice provision' and 'criticism control.' Katz and Assor (2003) also confirmed that autonomy and intrinsic motivation was improved when the tasks consistent with personal interest of each learner were provided.

Furthermore, students often cannot set learning goals successfully; that is, they do not formulate goals in terms of target behavior, conditions (Mager, 1962), or Specific, Measurable, Attainable, Realistic, Timely (SMART) goals. "The poor specification of goals inhibits students from systematically selecting their tasks and working deliberately on improving their performance" (Kicken et al., 2008, pp. 226–227). In particular, it is difficult for beginners to set learning objectives themselves; thus, an effective method of helping them make selections is to provide learning objective examples and worked examples. A worked example is "a step-by-step demonstration of how to perform a task or how to solve a problem" (Clark, Nguyen, & Sweller, 2006, p. 190). Studying worked examples is regarded as an effective instructional strategy for novices because example-based instruction provides the steps of a solution (van Merriënboer, 1997).

As the participants in this study are beginners in self-directed learning, it makes sense to show them examples and allow them to select, instead of having them write down objectives from the start. Therefore, learners will be able to make self-determined choices when they are given learning objective examples, encouraged to establish their own learning objectives, and allowed to select the next task.

Strategy 1.3. Have learners share learning objectives (Katz & Assor, 2003, 2007). [Motivation strategy]

It is expected that sharing learning objectives with one's peers will increase relatedness among learners and, therefore, enhance the effect of choice. The connection between satisfying the need for relatedness and the effects of choice appears unintuitive. To understand this issue, we draw on psychosocial theories that suggest there are cultural differences in the preference for independence or interdependence (Katz & Assor, 2007). According to Markus and Kitayama (1991), Westerners strive to recognize themselves as having unique attributes that make them distinct from others around them. They aim to become independent from others and to discover their unique attributes in order to achieve autonomy. In contrast, Asians individuals recognize themselves as being interconnected and interrelated with others. They emphasize their relationship with others. Further, Iyengar and Lepper (1999) showed that the European-American participants were highly motivated when choices were given to each of them. On the other hand, the Asian-American participants were highly motivated when the task chosen by a member of their in-group (e.g., a parent or classmate) coincided with that they chose.

In other words, for Asians, self-determination motivation does not increase by simply giving individuals the right of choice. Even if one makes his or her own choices, one's motivation increases only when one's decision does not deviate from the group's common objective (Iyengar & Lepper, 1999; Katz & Assor, 2003). If an individual learner's choice deviates from the common objective, not granting him or her the right of choice and providing the learner with given tasks are more effective for improving motivation (Cordova & Lepper, 1996). Therefore, comparing a learner's objectives with those of his or her peers in the process of setting learning objectives and selecting tasks according to these objectives can increase the learner's relatedness and, thus, enhance his or her self-determination motivation.

Strategy 2.1. Provide metadata to learners prior to their task selections (Bell & Kozlowski, 2002; Kicken et al., 2008). [Cognitive strategy]

To select tasks that fulfill their learning needs, students must be informed on the metadata of tasks. Learners can more easily make appropriate task selections when they know the task content, level of difficulty, and learning methods.

If it is difficult to determine the task content when making task selections, learners may feel cognitive load (Bell & Kozlowski, 2002; Kicken, Brand-Gruwel, & van Merriënboer, 2008). In order to prevent this cognitive load or burden of choice, "students should be provided with detailed and structured information on the characteristics of the learning tasks they can choose from" (Schwartz, 2004). Detailed information on tasks can help to reduce the burden of choice. Such information helps learners select tasks that fit their own objectives and interests while avoiding tasks that do not meet their objectives.

Flowerday et al. (2004) provided learners with empty choice (choosing a packet without knowing its content). Such a choice did not consider any of interests, values or goals. Thus, it did not have any effect on participants' learning or motivation. In other words, not choosing but simple picking did not bring positive effects. It is possible that the subjective belief that one can determine the chances of success in a given task makes the task personally meaningful, even if this belief is objectively false. It is also possible that "these metadata could include the task's level of difficulty and support, the applicable performance standards, and prerequisite skills, knowledge, and screen capture of the task" (Kicken, Brand-Gruwel, & van Merriënboer, 2008, p. 232). Among them, a screen capture of the task visually presents the task information and helps learners mentally envision the task content, compared to other information.

Strategy 2.2. The number of tasks learners can choose should be provided differently (Schwartz, 2004). [Cognitive strategy]

The number of tasks a learner can select should vary according to the learner's ability. According to the expertise reversal effect, learners' organization knowledge structures (schemas) differ by the level of prior knowledge; therefore, cognitive load experienced during the learning process also varies. According to Plass, Kalyuga, and Leutner (2010, p. 67), "a learning element is a function of the level of learner expertise. What constitutes a learning element and which elements interact with each other depends on a learner's schemas: a set of many interacting elements for one person may be a single element for another, more expert learner." In other words, the volume of long-term memory differs by the learner's level of prior knowledge, and learners can experience a decreased working memory load. This is expected to be applicable to the task selection as well. Learners with high prior knowledge do not experience difficulty even with many task selection options, but learners with low prior knowledge may.

However, even with a high level of prior knowledge, too many options can hinder the learner's selection. Recent findings have revealed that more selection options actually hinder selection and decrease the learner's level of satisfaction (Haynes, 2009; Iyengar & Lepper, 2000; Shah & Wolford, 2007; Tversky & Shafir, 1992). Schwartz (2004) demonstrated that if consumers have too many choices, they feel overwhelmed, and even when they make a selection, their level of satisfaction drops. He pointed out that consumers tend not to purchase products when there are too many choices available. Certainly, if a person knows exactly what he or she wants, then more choices are likely to be better, as he or she must simply locate the product that is most similar to the desired product. However, most consumers do not know exactly what they want.

Moreover, an abundance of choice is likely to produce worse decisions because people attempt to simplify the choice to the point where the simplification impedes their ability to choose well (Schwartz, 2004). Iyengar and Lepper's (2000) showed that a large display of deluxe jams (24) attracted more attention than a small display (6). However, surprisingly, extremely low percentage of people purchased one of the jams in the 24-array condition (3%).

Carroll, White, and Pahl (2011) found that groups presented with a relatively large choice set (30 options) were more likely to defer making decisions than those shown a small choice set (10 options).

Thus, given that excessive selection options can actually hinder selection, it is recommended to provide learners with an appropriate number of options in task selection. In this study, 8 task selection options, which is less than 10, and 4 task options were provided to help learners make selections according to their learning level.

Strategy 2.3. Provide learners with reflection prompt after they select a task (van Merriënboer & Sluijsmans, 2009). [Meta-cognitive strategy]

Reflection prompts should accompany learners' practicing the selection of learning tasks. After selecting a task, learners are asked to reflect on their decision (van Merriënboer & Sluijsmans, 2009). The reflection prompt encourages them to evaluate their selection. It is assumed that in e-learning environments, reflection prompts can be used to elicit learners' reflection (Butler & Winne, 1995; Seale & Cann, 2000; Winne & Stockley, 1998). Responding to questions about why they chose a specific task can help learners acquire the sequential skill in the self-direction stage and facilitate the induction.

However, if learners are not accustomed to reflecting on their task selection, they may find it difficult to do so without assistance. In this case, learners' cognitive load can be reduced by providing various examples of the reasons behind a selection. Reasons for task selection can be largely classified into the three categories of goal, prior task, and current task. For example, a learner might cite the reason for his or her decision as "This task will help me achieve my learning objective" (goal) or "I feel that my learning at this stage is insufficient, after performing the previous task" (prior task). Reasons related to "current task" include "The level of difficulty is appropriate," "Self-learning and the explanation methods look fun," and "The topic is interesting."

Selecting an appropriate task is one of the difficult self-directed learning processes. Through frequent reflection on their previous task selections, learners can learn to choose more appropriate tasks.

Strategy 3.1. Have learners self-assess their learning process after completing the task (Kicken, 2008; Sadler 1983). [Meta-cognitive strategy]

Students are better able to select a task if they assess their own strengths and weaknesses (Kicken et al., 2008; Sadler 1983). Through self-assessment, they can reflect on their progress, thereby facilitating appropriate task selection. Azevedo and Bernard (1995) conducted a meta-analysis of feedback in computer-based instruction. As a result, the feedback should stimulate learners' cognitive process in order to bring out learners' deep understanding. For instance, the activity that learners revaluate themselves before submitting answers is more effective than frame-by-frame immediate feedback. They will become more responsible learners who can control their performance through such self-assess activities including reflection and self-evaluation will make learners. Yet, although self-assessment plays an important role in self-directed learning, inexperienced self-directed learners often lack self-assessment skills, meaning that they do not know what they do not know. This situation can lead learners to make a decision based on a distorted perception of their learning and, finally, to select an inappropriate task or quit too early because they incorrectly believe they have achieved the learning goals (Tousignant & DesMarchais, 2002).

However, learners can evaluate their own learning if the program provides them with a self-assessment tool. The program can guide students through the self-assessment process using the method of self-questioning. For example, Lopez and Kossack (2007) examined the effect of self-assessment across several times throughout the course on perception or performance of learners. As a result, the continuous self-assessment group showed better results than pre- and post-course self-assessment group or non self-assessment group.

In another study, Mok et al. (2006) contended self-assessment led to changes in students' metacognition and processes of knowledge construction.

Therefore, it is necessary to help learners self-assess their performance to identify strengths, weaknesses, and areas for improvement, and to enable the learners to make appropriate task selections.

Strategy 3.2. Provide ipsative feedback on the score of the interim test (Harlen & James, 1997). [Meta-cognitive strategy]

By viewing the accumulated "interim check" results, learners can identify gaps in their learning. Knowing one's strengths and weaknesses is helpful in task selection. This ipsative feedback on learners' progress motivates them to continue learning and allows them to monitor and compare the quality of their performance over time (Harlen & James, 1997). Further, ipsative feedback helps learners overcome negative past experiences, move forward in their studies, and focus on learning rather than grades. van Merriënboer and Sluijsmans (2009, p. 59) stressed that "the dynamic planning of learning tasks becomes possible because the main aim of the assessment process is no longer to provide corrective feedback and to make pass/fail decisions, but to compare the quality of performance over time (i.e., ipsative assessment) and to formulate learning needs. This enables the planning of an individual learning trajectory, or, the iterative selection of new learning tasks that are dependent on individual assessment results."

Ipsative feedback encourages learners to evaluate how their learning has progressed over time. Even if a learner's score is low compared with that of other students, the learner can be motivated by focusing on his or her individual learning development process and making objective evaluations of his or her status. This will help the learner accurately judge which learning tasks are appropriate when selecting the next task.

Strategy 3.3. Have learners set up plans for the next task him/herself (Loyens, Magda, & Rikers, 2008). [Meta-cognitive strategy]

In order to select an appropriate task, learners must plan for the task selection beforehand. By understanding the gaps in their learning and formulating a plan to acquire the missing knowledge, they can choose an appropriate task to perform next. Candy (1991, p. 55) suggested "self-management, which is one's willingness as well as ability to manage his or her own learning, is another important aspect of SDL. A self-directed learner takes initiative to plan and manage his workload and time without the supervision of teachers or other adults." He also highlighted that "during the implementation of the plan, a self-directed learner will explore alternatives for better decision-making. He actively analyses and evaluates his options to make a sound decision that is not based on intuition but based on logical reasoning." Establishing plans in this way is an important part of self-directed learning that ultimately enables learners to make better decisions (Loyens, Magda, & Rikers, 2008).

Overall, we posit that LTSS strategies will lead to learners' appropriate task selection and significantly influence their task accuracy.

> **Hypothesis 1.** LTSS strategies and guidelines will have a significant effect on learners' task-selection accuracy.

3. The Significant Direct Effect of Learners' Task-Selection Accuracy on Learning Achievement.

When learners select appropriate tasks, their learning achievement increases. An appropriate task selection is defined as a selection that is accurate in terms of learner competence and cognitive load and enhances learning achievement (Corbalan, Kester, & van Merriënboer, 2008).

Many studies have demonstrated the effectiveness of task selection based on the consideration of competency and cognitive load (e.g., Camp, 2001; Corbalan, Kester, & van Merriënboer, 2008, Kostons, van Gog, & Paas, 2012; Salden et al., 2004). For example, Salden et al. (2004) showed that dynamic task selection, through the combination of mental effort and performance, is significantly more efficient than non-dynamic task selection. Kostons, van Gog, and Paas (2012) found that a group of learners who studied competence and cognitive load as task selection skills exhibited greater performance enhancement than the control group. Kostons, van Gog, and Paas(2012) suggested the following rule for task selection: "When selecting a task, do not only regard your performance, but also the amount of effort you invested, and if your performance was high and your invested mental effort was low, you can select a more complex task" (p. 129). They stressed the effectiveness of this rule in learning.

As such, if tasks are selected based on the consideration of individual competence and cognitive load, the learner's performance will be enhanced. An appropriate selection of tasks guided by the learner's competence and cognitive load levels can have a positive influence on achievement.

> **Hypothesis 2.** Learners' task-selection accuracy will have a significant direct effect on learners' achievement.

4. The Significant Direct Effect of Learners' Task-Selection Accuracy on Self-Directed Learning Abilities.

Task selection is closely related to self-directed learning. Researchers includ ing Brockett and Hiemstra (1991), Williams (1996), and Zimmerman (1994) believed that a learner's control over task selection positively affect s the development of his or her self-directed learning ability. Specifically, control over task selection and other aspects of learning is a precondition of self-directed learning (Kicken et al., 2008).

Kostons, van Gog, and Paas (2012, p. 126) pointed out that task-selection skills are "considered to play a pivotal role in the effectiveness of self-directed learning." Kicken et al. (2008, p. 226) also stressed that "there is a chicken-and-egg relation between the two. To enable students to develop their self-directed learning skills, they should be given control over task selection; but at the same time, these skills should already be developed to some minimum level, to protect students from the negative effects of being for the first time in control of their own learning."

As discussed above, by consistently practicing how to select appropriate tasks, learners can enhance their self-directed learning ability. Accurate task selections indicate what each learner does or does not know. Accurately knowing what one needs is the starting point of self-directed learning, and accurate task selection is an important factor in the development of self-directed learning ability.

Hypothesis 3. Learners' task-selection accuracy will have a significant direct effect on their self-directed learning abilities.

5. The Significant Direct Effect of Self-Directed Learning Abilities on Learning Achievement.

Self-directed learning abilities have a significant positive effect on learner achievement. Various studies (Redding, Eisenman, &Rugulo, 1999; Long & Morris, 1996) have shown that there is a direct relation between the self-directed learning readiness and school achievement. For instance, Wall, Hoban, and Sersland (1996) confirmed that junior high school students' achievement in mathematics became higher in proportion to the self-directed learning readiness. Long and Morris (1996, pp. 146–147) has shown that the self-directed learning readiness is "a useful single-predictor variable of academic success next after intelligence" (GMAT scores).

Thus, several studies have shown that it is easier for learners to become more independent and responsible to their own learning in accordance with the level of self-directed learning readiness (Knowles, 1990). In addition, Reio (2004, p.19) stressed that "individuals who demonstrate higher levels of self-directed learning readiness are more likely to be independent and responsible for their own learning (Knowles, 1990), tolerant of risk and ambiguity, reflective, self-starting, creative, and ultimately successful in various learning contexts (Candy, 1991; Reio & Leitsch, 2003)." Even when learners face difficult and ambiguous tasks in various learning environments, the self-directed learning ability is driving force that helps learners to overcome them and to achieve better results. Therefore, we can hypothesize that self-directed learning abilities have a significant effect on learners' achievement.

Hypothesis 4. Self-directed learning abilities will have a significant direct effect on learners' achievement.

6. The Significant Indirect Effect of Provision of LTSS Strategies on Learners' Achievement and Self-Directed Learning Abilities.

When learners are provided with LTSS strategies, their learning achievements and self-directed learning abilities are predicted to be enhanced. According to Hypothesis 1, when learners are given LTSS strategies, their task-selection accuracy improves. Then, according to Hypotheses 2 and 3, as learners' task-selection accuracy increases, their self-directed learning abilities are enhanced as well. Therefore, when LTSS strategies are provided to learners, their self-directed learning abilities and learning achievements are indirectly improved through their task-selection accuracy.

LTSS strategies are composed of different supporting strategies to solve cognitive, meta-cognitive, and motivation problems that occur when learners select tasks. Such integrated LTSS strategies will help learners to select appropriate tasks, and as their task-selection accuracy increases, their learning achievements and self-directed learning abilities are enhanced as well.

In other words, learners' selection of proper tasks indicates that they can perform an accurate task selection in consideration of their competence and cognitive load, which will ultimately increase their learning achievement (Corbalan, Kester, & van Merriënboer, 2008; Salden, 2004). The higher task-selection accuracy learners have, the greater their self-directed learning abilities will be. As a result, when learners are given LTSS strategies, their self-directed learning abilities and learning achievements will be indirectly enhanced through their task-selection accuracy.

Hypothesis 5. The provision of LTSS strategies will have a significant indirect effect on learners' achievement and self-directed learning abilities.

CHAPTER IV. METHODS

The purpose of this study is to develop learners' task selection supporting (LTSS) strategies and guidelines in self-directed learning, as well as to investigate the effects and optimality of LTSS strategies and guidelines. For this purpose, the methods of this study included two researchs; the methods used for a separate research are also presented herein. Additionally, a project checklist was used to show the procedures followed; the completed checklist is presented in Appendix A.

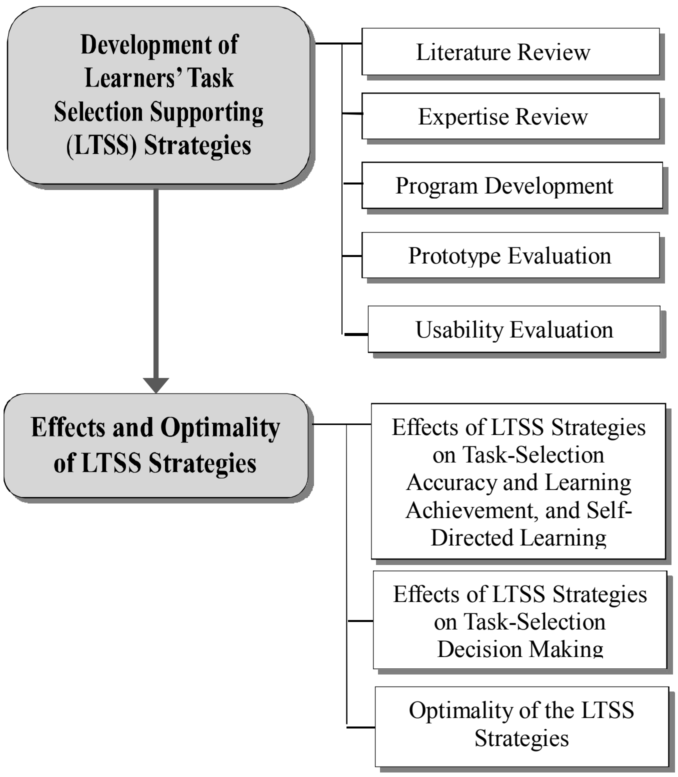


Figure IV-1. Research process

This research was conducted in two steps: "strategy development" and "strategy validation." The former was based on a procedure developed by

Reigeluth and Stein (1983) for developing instructional theory. The latter was based on the validation methods of Richey and Klein (2007); these methods were sub-divided into internal validation and external validation. Richey and Klein (2007) suggested three methods of internal validation (i.e., expert review, usability documentation, and component investigation) and two methods of external validation (i.e., field evaluation and controlled testing). Among these methods, this research mainly included two kinds of internal validation (i.e., expert review and usability documentation) and two kinds of external validation (control test and learners' evaluation), as shown in Figure IV-1 and IV-2.

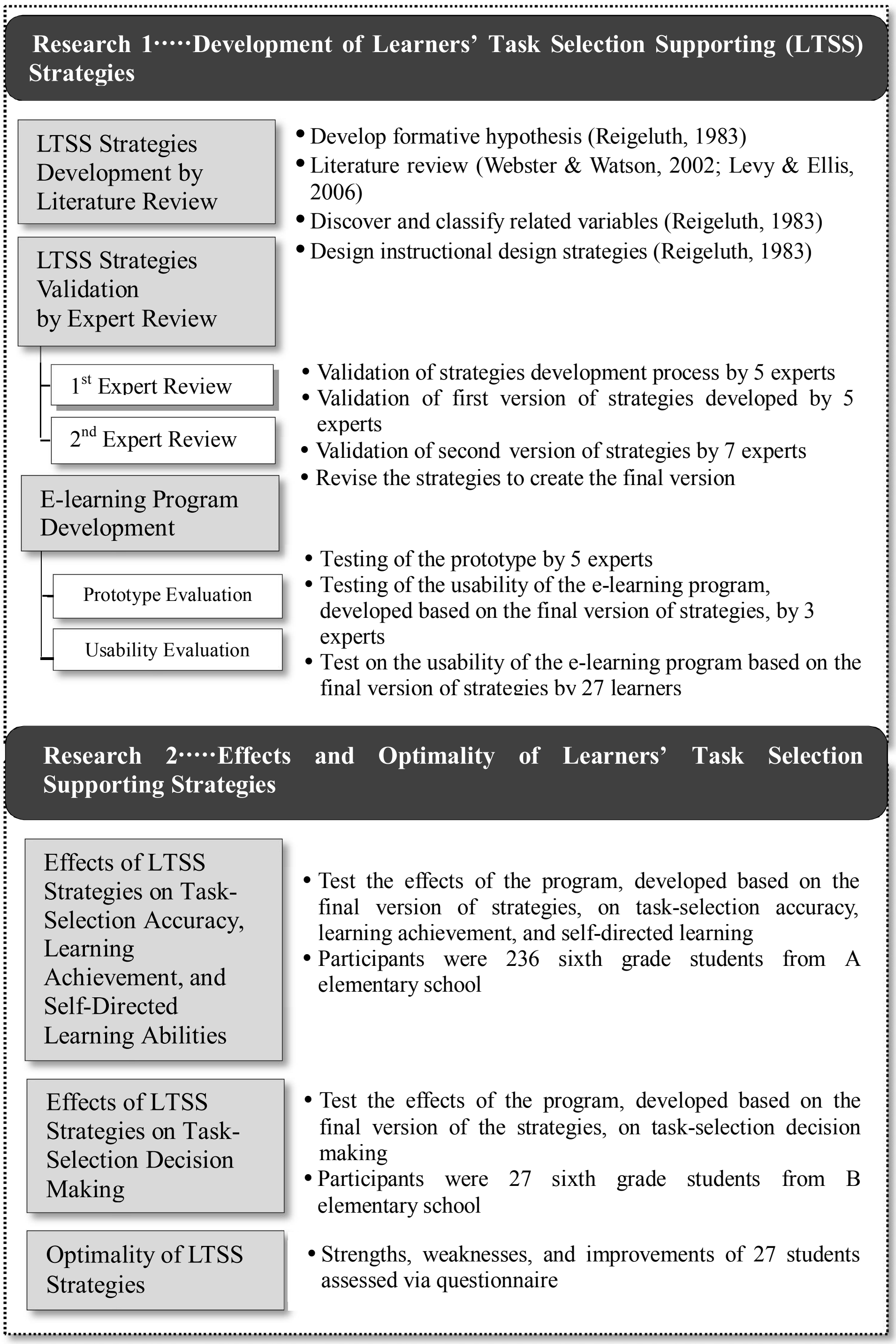


Figure IV-2. Research procedure

Research 1. Development of Learners' Task Selection Supporting Strategies

1. Development of LTSS Strategies through Literature Review

1.1. Purpose

The purpose of research 1 was to identify and describe the LTSS strategies and guidelines. The information from the literature review on the topics of instructional design, motivation, metacognition, and cognitive load formed the basis of the development of the LTSS strategies.

1.2. Procedure

This study followed steps based on the procedure for developing instructional theory put forth by Reigeluth and Stein (1983) and the method for conducting review of the literature put forth by Levy and Ellis (2006). Reigeluth and Stein (1983) suggest a four-step process for developing instructional theory: 1) development of a formative hypotheses; 2) development of a taxonomic classification of variables, including outcomes, conditions, and methods; 3) development of strategies of instructional design (i.e., cause-and-effect relationships between variables that can be empirically tested); and 4) development of comprehensive theories and models of instructional design. This study followed the first through third steps with the intent of focusing on developing strategies of instructional design; however, it was outside the scope of this study to create comprehensive instructional theory, as described in the fourth step.

Levy and Ellis (2006) suggested the method used to conduct a systemic literature review. They divided this method into three steps: keyword search, backward search, and forward search. Related to this systemic literature review, Webster and Watson (2002) stressed that "a systemic search should ensure that you accumulate a relatively complete census of relevant literature" (p. 16).

Based on the processes developed by Reigeluth and Stein (1983) and Levy and Ellis (2006), the procedures for developing instructional strategies in this study were created (Figure IV-3).

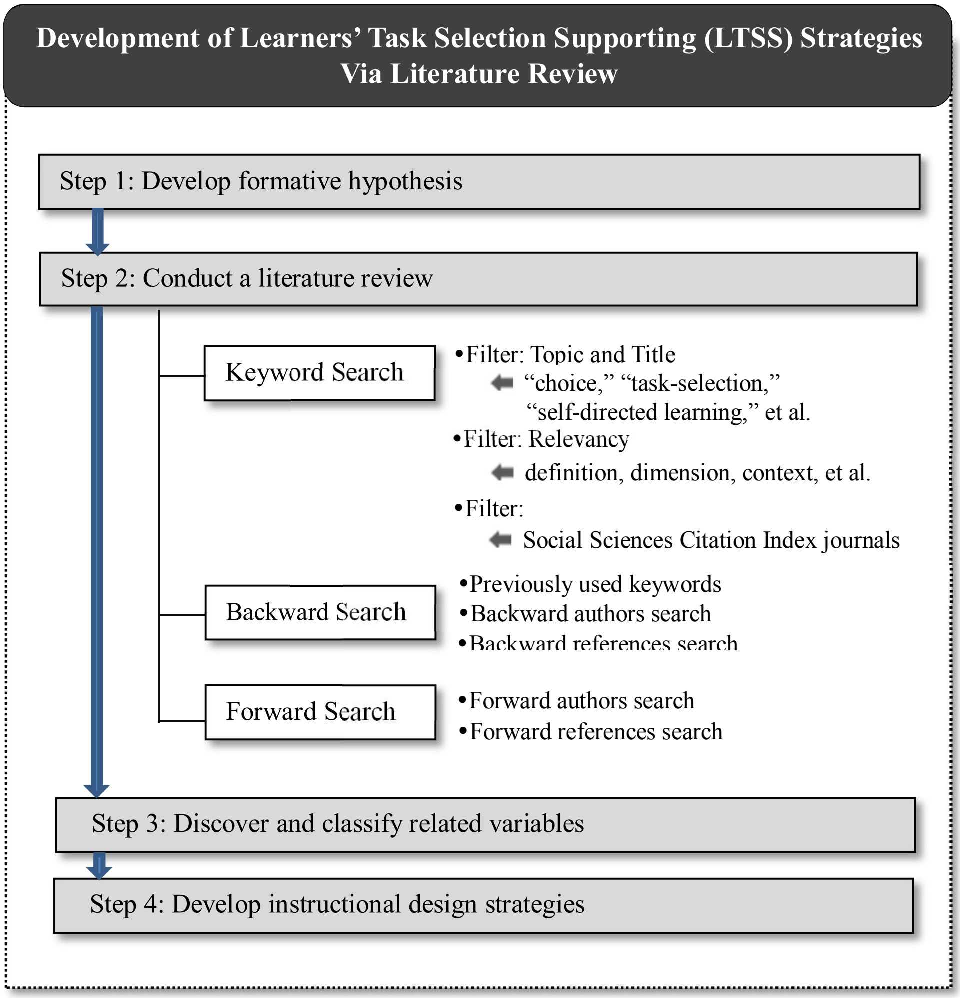


Figure IV-3. Research procedure in research 1

Step 1: Development of a formative hypothesis

This study hypothesized that it is important to give learners chances to select their tasks in self-directed learning. Therefore, it is necessary to inquire about LTSS strategies.

Step 2: Literature review

A review of the literature is a crucial endeavor for any academic research study (Levy & Ellis, 2006; Webster & Watson, 2002). The need to learn what is already known in the literature before initiating a research study should not be underestimated (Hart, 1998). Moreover, Creswell (2009) notes that all research efforts should be initiated by a literature review to determine whether the topic is worth studying and to present the previous research related to the topic.

For the systemic literature review in this study, the methods put forth by Levy and Ellis (2006) were used. Those authors suggest three specific techniques for an effective literature review, namely, keyword search, backward search, and forward search.

Keyword search refers to a search of the databases by keyword. In the research for this study, databases were searched for the keywords "choice," "task selection," "self-directed learning," "self-determination theory," "meta-cognition," and "cognitive load." The data set was filtered to exclude articles not related to this research. Articles were read carefully to distinguish the relevant from the less relevant articles. Moreover, the data set was filtered to include only Social Sciences Citation Index (SSCI) journal articles (*Educational Technology Research and Development*, *Journal of* Educational Psychology, Computers and Education, Educational Psychology Review, Applied Cognitive Psychology, et al.). Although the keyword search is a necessary step, it should be the initial rather than the main step for a literature search. If only naïve keywords are used for the literature search, the depth of the literature background could be limited (Levy & Ellis, 2006, p. 190). It is, therefore, necessary to include the backward-search and forward-search approaches.

The backward search can be divided into three sub-steps: backward references search, backward authors search, and previously used keywords. *Backwards references search* involves "reviewing the references of the articles yielded from the keyword search" (Levy & Ellis, 2006, p. 191). For example, when searching the keyword phrase "Task Selection," backward search involves reviewing all the relevant references on task selection, such as Kostons et al. (2010). From this backward references search, the researcher can learn more about the origins of the theory and model as they relate to the study.

Backward authors search refers to "reviewing what the authors have published prior to the article" (Levy & Ellis, 2006, p. 191). For example, if an article by Salden, Paas, and van Merriënboer (2006) was found in the search, previous articles from these authors were further studied. *Previously used keyword search* refers to "reviewing the keywords noted in the articles yielded from the keyword search" (Levy & Ellis, 2006, 191 p.). For example, articles related to "task selection" (Kostons, van Gog, & Paas, 2010) note the term "choice" as a keyword related to their study.

Forward search can be divided into two sub-steps: forward references search and forward authors search. *Forward references search* refers to "reviewing additional articles that have cited the article" (Levy & Ellis, 2006, p. 191). For example, because an article by van Gog and Paas (2009) was found, the research for this study involved using an electronic library database to search for articles that including van Gog and Paas (2009) in their citations.

Forward authors search refers to "reviewing what the authors have published following the article" (Levy & Ellis, 2006, p. 191). For example, a forward authors search based on an article by Sweller, van Merriënboer, and Paas (1998) can be conducted by conducting an electronic library database search for articles including "Sweller," "van Merriënboer," or "Paas" in their citations.

Step 3: Discover and classify related variables

Variables were discovered and classified into cognitive, meta-cognitive, and motivational types. The variables were classified with descriptions. After the variables are discovered, relationships among the variables are formulated.

Step 4: Create instructional design strategies

The instructional design strategies for supporting learners' task-selection in self-directed learning were developed based on the results of the previous steps. Cognitive, meta-cognitive, and motivation strategies were developed from the literature review. Detailed descriptions of the variables and implication were used to develop guidelines.

2. LTSS Strategies Validation by Expert Review

2.1. First Expert Review

2.1.1. Purposes

The purpose of first expert review was to validate the strategies developed in this research and the process of developing strategies. Further, this research was intended to use expert review to analyze and to create a second revision of the strategies developed in this research.

2.1.2. Participants

The population for second expert review consisted of the five experts who represented the discipline of educational technology; four of them had a wide range of experiences related to the development of strategies and guidelines, as well as e-learning programs based on them.

Table IV-1. Profile of experts who performed the first validation

Expert	Degree and Position/ Affiliation Fields	Experience (Years)	Validation Date
A	Ph.D./ Professor./ S. University/ E.T., Cooperative Learning. E-learning,	8	11/28/2011
B	Ph.D./ Professor/ S. University E.T., Strategy Development, E-learning	9	11/24/2011
C	Ph.D./ Professor/ University of S. E.P. and E.T., Strategy Development, Self-Directed Learning	5	11/26/2011
D	Ph.D./ Professor/ University of S. E.T., Strategy & Model Development, Self-Directed Learning	5	11/21/2011
E	Ph.D./ Professor/ K.University E.T., Strategy Development. E-learning	8	11/24/2011

E.P. indicates educational psychology; E.T., education technology.

They had all researched the development of models, strategies, or guidelines as the topic of their doctoral dissertation. Moreover, experts C and D had adequate professional knowledge about self-directed learning and experiences to teach courses on those topics. Information about the profiled experts is shown in Table IV-1.

2.1.3. Procedures

To review the validity of the LTSS strategies, face-to-face interviews were conducted with 5 experts, each of whom was interviewed for two to three hours using a semi-structured questionnaire. Experts were thanked before the interview; also, the interview process and validity tools were explained to them. The validity questionnaire attempted to assess the validity of the strategic process of deduction and that for strategies and guidelines (Appendix B). The strategy deduction process and strategy and guidelines were evaluated using a five-point scale.

First, the experts evaluated whether the model deduction process was valid, using the tool that had been used in studies by Jin (2009) and Lee (2012). Afterward, experts evaluated the validity of the strategies and guidelines for this study. The tool used by Rha and Chung (2001) and Lee (2012) was adopted as a validity evaluation tool for the strategies and guidelines for this study. The interview was recorded and its data were analyzed quantitatively and qualitatively. The results of the first expert review were reflected in the second version of the strategies and guidelines. The tools used to validate the strategy deduction process, strategies, and guidelines are shown in Table IV-2 and Table IV-3.

Table IV-2. Instrument for validating the process of strategy validation theorization

Item	Description
Comprehensive Literature Review	Relevant literature was comprehensively reviewed to deduct strategies and guidelines.
Appropriate Terminology	Appropriate terminology was used to describe the strategies and guidelines.
Appropriate Interpretation and Summary of Reviewed Literature	Reviewed literature was appropriately interpreted and summarized to develop the strategies and guidelines.
Logical Organization	The strategies and guidelines were organized in a logic fashion.
Appropriate Reflection of Literature Review	The information gained from the literature review was been properly reflected in formulation of the strategies and guidelines.

Table IV-3. Instrument for validation of the strategy and the overall process

Item	Description
Validity	The strategies contain necessary activities, processes, and prescriptions.
Explicability	The strategies helped the instructor to figure out how to support task selection in self-directed learning among learners.
Usability	The strategies will be useful guides for instructional designers.
Generality	The strategies enable the instructor to design environments that support task-selection in self-directed learning among learners.
Comprehensibility	The strategies are easy to comprehend.

Data generated by the results of validation by the experts were analyzed using the content validity index (CVI) and inter-rater agreement (IRA). The CVI was measured based on the representativeness of the measure. Several methods can be used to calculate the CVI. To determine whether a method was recommended, the number of experts who rated the items was counted and divided by the total number of experts, to show the proportion of experts who regarded the item as valid in terms of its content (Davis, 1992; Grant & Davis, 1997). Davis (1992) recommends that if the CVI is higher than .80, the method has content validity. IRA was measured to calculate the extent of reliability in ratings performed by experts. Agreement among the experts was calculated to measure the IRA for each item; the number of items considered to be 100 percent reliable was divided by the total number of items. IRA is also said to be reliable if it exceeds .80.

CVI is initially evaluated by a 4-point scale; questions with 3- and 4-point evaluations are converted to 1 point; their scores are then added up and divided by the total number of questions. Since this study used a 5-point scale, it was converted to a 4-point scale. The Likert-scale point system—1 (strongly disagree), 2 (disagree), 3 (neither agree nor disagree), 4 (agree), and 5 (strongly agree)—was converted to the CVI scale—1 (strongly disagree), 2 (disagree), 3 (agree), and 4 (strongly agree). The Likert scale answer of 3 (neither agree nor disagree) was converted to the CVI scale answer of 2 (disagree); this considers the tendency of the Likert scale to yield an answer of 3 points. Still, modifications are required to a certain extent.

2.2. Second Expert Review

2.2.1. Purposes

The purpose of the second expert review was to validate the second version of the LTSS strategies. The results of the expert reviews were used to create the final version of these strategies.

2.2.2. Participants

The second expert review was conducted by seven experts that represented the disciplines of educational psychology and educational technology, as shown in Table IV-4.

Table IV-4. Second validation: Profile of experts

Expert	Degree/ Position/ Affiliation Fields	Experience (Years)	Validation Date
A	Ph.D./ Researcher/ S. University E.P./Self-Directed Learning/Motivation, Meta-Cognition	9	1/17//2012
B	Ph.D./ Professor/ C. University E.T., Design and Development of e-learning,	9	1/27/2012
C	M.D./ Teacher/ D. Elementary School Elementary Education, Self-Directed Learning	5	1/10/2012
D	Ph.D./ Researcher/ S. University H.R., e-learning	9	1/30/2012
E	Ph.D. Candidate/ Specialist in Instructional Design/ S. University Instructional Design, e-Learning, Flow	6	1/25/2012
F	Ph.D./ Researcher/ S. University E.T., Strategy & Model Development, Self-Directed Learning	5	12/26/2011
G	Ph.D./ Professor/ K. University E.T./Principle Development /e-learning	8	12/20/2011

E.P. indicates educational psychology; E.T., education technology; H.R., human resources.

All individuals recruited as experts had a wide range of experiences related to development. Experts A, C, and F were recruited because they had professional knowledge about self-directed learning, conducting continuing research on self-directed learning or having adequate experience to teach courses on the subject. Expert C was recruited because of her 20-year expertise in teaching science to elementary-school learners and her experience developing science curricula to enhance self-directed learning abilities.

2.2.3. Procedures

To review the validity of the strategy, face-to-face interviews were conducted with seven experts, each of whom was interviewed for two to three hours using a semi-structured questionnaire. Experts were thanked before the interview; the interview process and prepared validation tools were explained. The validity questionnaire measured validity for strategies and guidelines.

Experts evaluated the validity of strategies and guidelines. The tool used in the first expert review was used as a validity evaluation tool for the strategies and guidelines in the second review. The entire interview was recorded; data generated by the interview were analyzed quantitatively and qualitatively. CVI and IRA were used to analyze the results of validation by the experts.

3. E-Learning Program Development and Evaluation

3.1. Purposes

e-learning program was developed that reflects LTSS strategies derived from research. Detailed procedures for developing an e-learning program that reflects each strategy are shown in the following subsection.

3.2. Procedure

This study's e-learning program development process is based on the development process put forth by Tracy and Richey (2007). Those authors built an instructional system design (ISD) model incorporating multiple types of intelligence by synthesizing related procedural ISD models and multiple-intelligence (MI) models, which reduced logical jumps by deriving a new procedure from many other existing procedures. This study developed an e-learning program development process by synthesizing seven chosen models: four instructional systems design models and three models incorporating self-directed learning (Table IV-5). Each model was chosen due to its current contribution to the field, its applicability in a variety of environments, and its representation in the range of years of model development.

The review of the seven models in this study included identification of the four major activities in design, as defined by Gustafson and Branch (1997), and ten sub-activities defined by the researcher. The activities defined by Gustafson and Branch are as follows: 1) Analysis (including "Analyze Instructional Goals," "Analyze Learner," "Analyze Task," and "Analyze Environment"); 2) Design (including "Develop Assessment Instrument," "Diagnose the Status," "Select the Task," "Perform the Task," and "Assess Task Development"); and 4) Development and Evaluation ("Prototype Evaluation on Storyboards," "Develop the Program," and “First Usability Evaluation of the Program”). This development process is detailed in Figure IV-4.

Table IV-5. Summary of process models

Major Activity	**Analysis**				**Design**					**Development and Evaluation**		
Sub-activity	**Analyze Instructional Goals**	**Analyze Learners**	**Analyze Tasks**	**Analyze Environment**	**Develop Assessment Instrument**	**Design “Diagnose the States”**	**Design “Select the Task”**	**Design “Perform the Task”**	**Design “Assess the Task”**	**Evaluate the Storyboard Prototype**	**Develop the Program**	**Perform First Usability Evaluation of the Program**
ISD Model												
Seels and Glasgow (1998)	•	•	•		•					•	•	•
Smith and Ragan (1999)	•	•	•	•						•	•	•
Morrison, Ross, and Kemp (2001)	•	•	•		•					•	•	•
Dick, Carey and Carey (2002)	•	•	•	•	•					•	•	•
SDL Model												
Gibbons (2002)		•				•	•	•	•	•		•
Piskurich (1993)	•				•	•	•	•	•			•
Knowles (1975)		•	•			•	•	•	•			

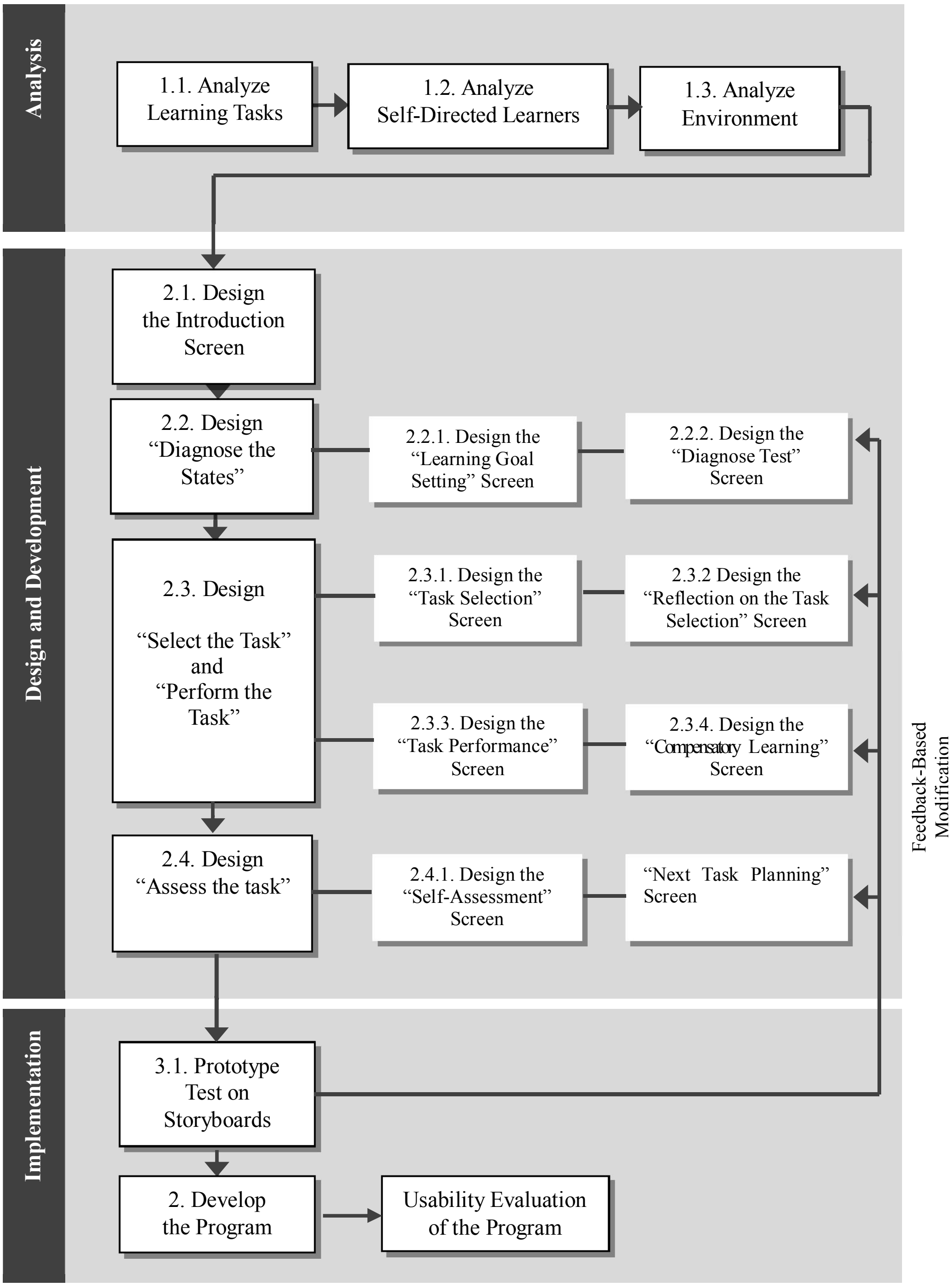


Figure IV-4. The process of development of the e-learning program

Stage 1. Analysis

Analysis is a stage for examining factors related to learning. This stage consists of analysis of learning tasks, learners, and learning environments.

1.1. Learning-Task Analysis

In learning-task analysis, in-depth analysis of learning tasks and related data collection was conducted. First, the learning goals for this lesson were "understanding and explaining changes in season." According to this goal, learning tasks were divided into a total of eight tasks according to four levels of difficulty and two types of learning method (i.e., low interactive and high interactive); details are shown in Table IV-6. Results of learning task analysis were validated by two elementary-school teachers.

Table IV-6. Results of learning task analysis

Level of Difficulty	Low Interactive	High Interactive
Level 1 Changes in season	Spring Summer Fall Winter	Spring Summer Fall Winter
Level 2 Changes in season and meridian transit altitude	Altitude Meridian transit altitude	Altitude Meridian transit altitude
Level 3 Meridian transit altitude and temperature	When meridian transit altitude is high When meridian transit altitude is low	When meridian transit altitude is high When meridian transit altitude is low
Level 4 Cause of changes in season	When the axis of rotation is vertical When the axis of rotation is tilted	When the axis of rotation is vertical When the axis of rotation is tilted

1.2. Learner analysis

Learner analysis involves inquiring about general characteristics of the learner, such as achievement, ability, experience, and attitude. The “achievement and ability” aspect identified the age and grade of the learner, “experience” identified prior knowledge about the topic, and “attitude” identified self-directed learning ability. The self-directed learning ability of 31 learners who would use this program was measured by self-directed learning readiness questionnaires, as used by Guglielmino (1977). The findings are as follows (Table IV-7).

Table IV-7. Result of learners analysis

Classification	Learner Analysis Rsult
Achievement and ability	Age: 13 Grade: Elementary School, 6th Grade
Experience	Level of prior knowledge: Has not been taught the “changes in season” unit in the 6th-grade elementary-school science curriculum
Attitude	Self-directed learning ability: Results of the self-directed learning ability test are shown in chapter IV

1.3. Learning Environment Analysis

Learning environment analysis involves investigating the learning environments of learners who will be using the e-Learning program developed in this study. Even if a program is developed using the latest computer features and cutting-edge technologies, its educational effects cannot be fully realized if its features are not appropriate for the learning environments of learners who will be using the program. Learners used the developed e-Learning program in an elementary school’s computer lab; the learning environments of the applicable computer laboratory are shown in Table IV-8.

Table IV-8. Results of learning-environment analysis

Variable	**Learning Environment**
Operating System	Window XP
CPU	Pentium Dual Core, Windows XP
Internet Speed	50-100 Mbps
Other	Java program needs to be installed. There are computers without Hangul[a] and Microsoft Word programs.

CPU indicates central processing unit.
[a]Korean alphabet.

Stage 2. Design

The learner's self-directed learning process is divided into four stages, which are "Diagnose the status," "Select and perform the task," "Assess task performance," Applicable screen designs were performed according to the process detailed in section 2.2: "Diagnose the status," "Select the task," "Perform the task," and "Assess task performance." Details are shown in Figure IV-5

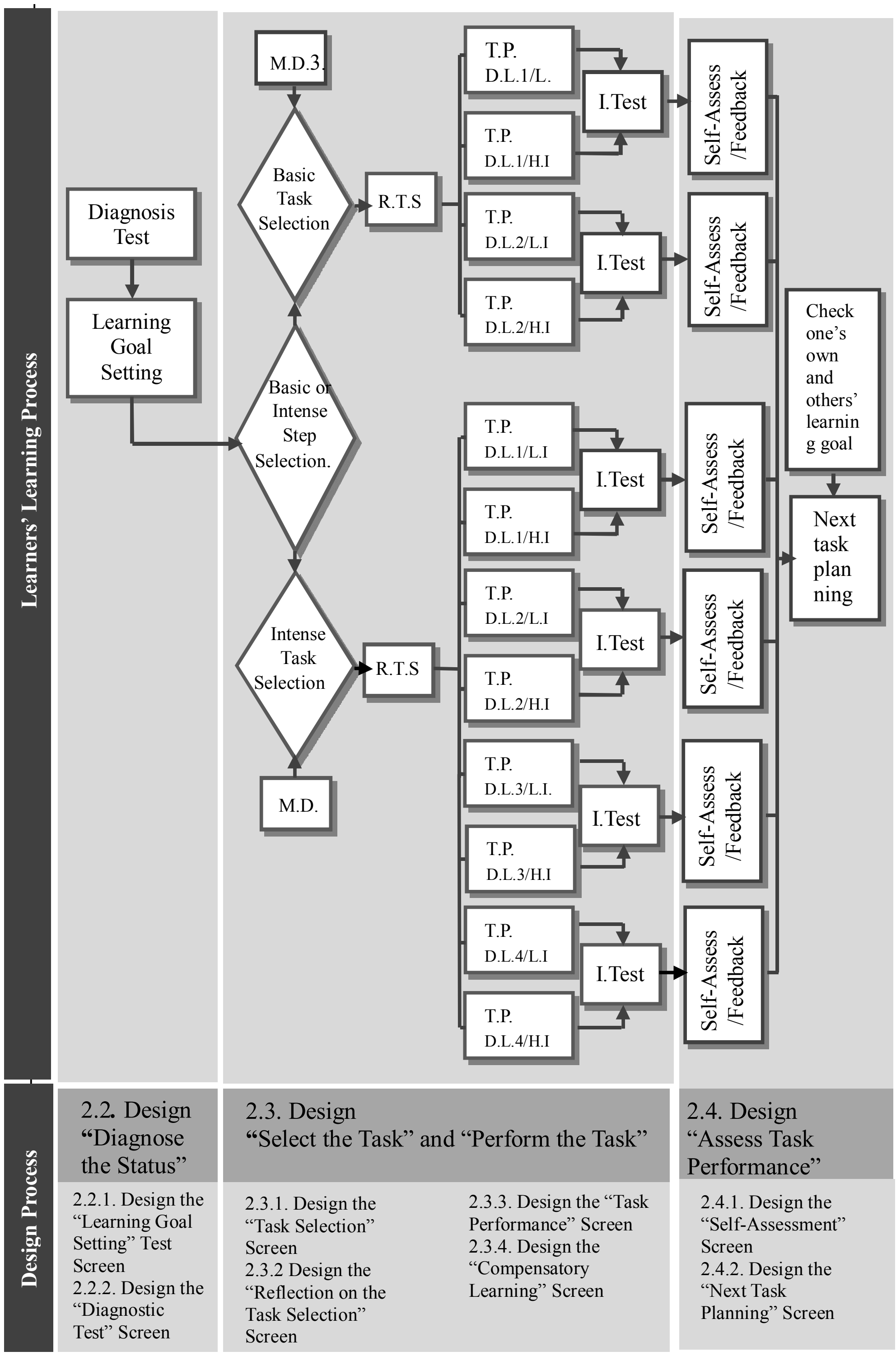


Figure IV-5. Correspondence of the design process of e-learning program to the learning process

D.L. indicates degree of level; H.I., high interactive; L.I., low interactive; I.Test., interim test; D. L., degree of level; M.D., metadata; R.T.S., reflection prompt on task selection; T.P., task performance

2.1. "Introduction" Screen Design

The "Introduction" portion states that the self-directed learning ability development program for the science curriculum is about to begin. The learners enter their school, grade, class, student number, and name, then click on the SAVE button. Once the SAVE button is pressed, the NEXT button flickers.

2.2. Design "Diagnose the status"

"Learning goal setting" screen and the "diagnostic test" screen are designed in "Design 'Select the task'". *"Learning goal" screen design:* Basic and Intense learning goals are suggested, but it is the learner himself/herself who chooses the goal. The selected learning goals are saved, and an individual's learning goal can be viewed anytime by clicking on the "MY LEARNING GOALS" button at the bottom of the screen. Also, friends' learning goals are shared and can be accessed by clicking on the "FRIENDS' LEARNING GOALS" button at the bottom of the screen.

"Diagnostic test" screen design: Before the instruction starts, the learner's level is determined through a diagnostic test. There are four levels of difficulty, each containing three questions (12 questions in all), which are classified into two categories: BASIC (questions 1-6) and INTENSE (questions 7-12). A five-point scale method is used, and answers can be checked by clicking on the "CONFIRM" button. The diagnostic test results are displayed once all 12 questions have been completed, showing the number of correct answers in each category. The learner himself/herself chooses the category, based on the diagnostic test results.

2.3. Design “Select the task”

The task selection screen and reflection on the task selection screen are designed in “Design ‘Select the task.’” *“Task selection” screen design:* The task selection screen is divided into the “basic stage task selection screen” and “intense stage task selection screen.” In both stages, the tasks were divided by learning methods, depending on the level of difficulty and interaction. The basic stage has two levels of difficulty, and the intense stage, four. The tasks for each level in both stages are divided into “listen to explanation” (low level of interaction) and “learn by yourself” (high level of interaction). In order to provide metadata for the learners, the program was set up in such a way that they could see the contents by moving the mouse over the task button in both the basic and intense stages. A “click” mark was put on the task button so that the learners could easily identify the button.

“Reflection on the task selection” screen design: This is the stage where learners can think about why they selected the task. The “task selection cognitive load” is first measured to examine how much effort was put in when selecting the task.

2.4. Design “Perform the task”

The compensatory learning and task performance screens are designed in “Design ‘Perform the task’.” *“Compensatory learning” screen design:* Should they desire it, the learners are able to look at the learning contents before studying about “change of seasons.” *“Task-performance” screen design:* The learning screen consists of eight types, in accordance with the four levels of difficulty and two levels of interaction. An interim test follows each learning task. The cognitive load for the task performance is measured first, then five assessment questions with two point scales are provided.

2.5. Design "Assess the task"

"Design 'Assess the task'" designs the self-assessment and planning screens. *"Self-Assessment" screen design:* In the self-assessment stage, questions are provided that allow the learner to reflect on the task performance process. There are four types of self-assessment questions, depending on the four stages of difficulty.

"Ipsative Feedback and Planning" screen design: The screen where learners can plan their next learning task is designed. In the Ipsative feedback and planning screen, the scores of the interim tests that were given after each task are displayed. Using these results, learners can confirm in which stages and learning methods they were weak, and get to choose the next task. If a learner wishes to terminate the process, he/she presses the "terminate learning" button. When the "learning termination condition" button is pressed, information on learning termination conditions is given. The first learning termination condition is "if 'my learning goals' have been met"; the second, "if the 'intense stage task' has been learned"; and the third, "if the learner got at least four of the five interim test questions. If all three conditions are met, a statement appears informing the learner that he/she can terminate the learning process. Once the "terminate learning" button is pressed, self-assessment questions appear, asking if the three learning termination conditions have been met (Figure IV-22). If the learner answers YES to the three questions, the screen goes to the learning termination page. If the learner answers NO to any of the questions, he/she is brought back to the planning screen.

Stage 3. Implementation and Evaluation

Storyboards and an e-learning program are developed based on the final version the learners' task selection supporting (LTSS) strategies. As a 2^{nd} internal validation, a "prototype evaluation on the storyboard" and "usability evaluation on the program" were performed.

3.1. Prototype Evaluation on the Storyboards

3.1.1. Purposes

The prototype evaluation was run to test the usability of the storyboards. Instructional design experts checked whether the strategies were properly reflected on the storyboards, and if there were any errors in the storyboard contents.

3.1.2. Participants

Four experts participated in the 2^{nd} prototype evaluation on the storyboards. Their qualifications included 5-8 years of instructional design experience, research and lecture activities, and fundamental knowledge in self-directed learning, motivation, and meta-cognition. Their profiles (A, B, C, and E) are shown in Table IV-5.

3.1.3. Procedures

The experts reviewed the completed storyboards. They found usability problems and determined which features could be made more workable. They were asked to assess whether individual strategies were appropriately reflected in the storyboards and used a 5-point Likert scale in scoring each strategy.

3.2. Usability Evaluation of the E-Learning Program by Experts and Learners

3.2.1. Purpose

The purpose of the evaluation was to test the usability of the e-learning program. It was conducted by instructional design experts and learners.

3.2.2. Participants

Three experts participated in the usability evaluation of the e-learning program. They were selected for their instructional design or usability evaluation experience. One expert is a researcher at S. National University and has professional experience in developing e-learning programs. Other experts' profile (C, E experts) are shown in Table IV-5. Learners were 27 sixth grade elementary school students in Seoul, South Korea, of whom 16 were male and 11, female.

3.2.3. Procedures

Experts were asked to check the e-learning program for usability problems and determine which features could be made more workable. The "User Interface Dimensions" was employed as a tool for usability evaluation. User Interface Dimensions, developed by Reeves and Harmon (1994), is used to indicate areas that need improvement. The dimensions help evaluate the usability of the system. This research used 10 dimensions: 1) Ease of Use, 2) Navigation, 3) Cognitive Load, 4) Mapping, 5) Screen Design, 6) Knowledge Space Compatibility, 7) Information Presentation, 8) Media Integration, 9) Aesthetic Appreciation, and 10) Overall Functionality. A low score in any dimension can pinpoint where the program may need specific improvement. Scores above 5 on the scale indicate high usability.

Learners carried out the evaluation in two researches after completing the program. First, they answered a questionnaire based on the nine elements enhancing the design of user interfaces for digital textbooks in the classroom, which was developed by Lim, Song, and Lee (2012).

Research 2. Effects and Optimality of the LTSS Strategies

1. Effects of the Learners' Task Selection Supporting Strategies on Task Selection Accuracy, Self-Directed Learning Ability, and Learning Achievement

1.1. Participants and Experimental Design

The participants were 236 sixth grade students (comprising nine classes) from A elementary school in Seoul, South Korea (Table IV-9); 112 were male and 124, female. The students were randomly assigned to two groups, one with LTSS strategies and the other, without. The group with LTSS strategies had 113 members and the other group, 123. There were no significant differences between the two groups in prior knowledge scores ($F(1, .109)=.19$, $p=.66$) and self-directed learning readiness scores ($F(1, 82.67)= .17$, $p = .68$). Originally, 252 students participated in this experiment, but the data of 16 participants could not be computed due to missing values.

All participants had been given weekly lessons in operating computers and were thus used to working with them. Students had not yet received any formal education on "change of seasons"—the subject used in the experiment. The study was conducted as a regular class.

Table IV-9. Number and percentage of participants in two groups—one with LTSS strategies and the other, without LTSS strategies

	A group with LTSS strategies		A group without LTSS strategies		Total	
	n	%	n	%	n	%
Male	**55**	48	**57**	46	**112**	47
Female	**58**	52	**66**	54	**124**	53
Total	**113**	100	**123**	100	**236**	100

1.2. Procedure

Experiments were conducted for about 90 minutes in computer classrooms at the participants' school, where they could all use individual computer terminals. Each computer had a headset so the participant could listen to the verbal explanations. After having been given a welcome, the participants were informed that the purpose of the program was to enhance learners' self-directed learning abilities. They were also told that all the collected information would be kept confidential. The participants were given detailed directions on how to use the program and were asked to take written prior knowledge and self-directed learning readiness tests before starting. During the program, participants in experimental group and conditional group could choose from eight tasks; it was they who decided when to finish the program. After each task, they were asked to take a five-item interim test and score their perceived cognitive load. After completing the e-learning program, the participants took self-directed learning readiness and achievement tests on the concept of "change of seasons." Finally, they were debriefed and thanked for their participation.

1.3. Materials

The control groups consisted of “task-selection” and “task-performance” Like the screen of “task-selection” as shown in Figure V-9, learners with the control group chose 4 different levels of difficulty in low-interactive and a high-interactive, 8 in total, within two interactivity tasks. The learners moved on to “task-performance” when they completed one of these tasks. In the “task-performance” stage, the learner listened to task instructions for low-interactive tasks, but the learner did not receive any instructions for high-interactive tasks and learned the task by self-operating the program. The e-learning program with 9 different LTSS strategies was used in the experimental group. The strategies used by the experimental group are noted in Figure V-2 to Figure V-15. The e-learning program used in the study was developed on the basis of the computer-based science learning program installed by the “Korea Science Foundation” and “LG Science Land.”

1.4. Measures

1.4.1. Cognitive Load

Mental effort was used as an index of cognitive load; it refers to the amount of working memory capacity allocated to problem solving. Mental effort was measured during the program and the post-test with a 9-point rating scale (Kester, Kirschner, & van Merriënboer, 2006; Paas, 1992; Paas, van Merriënboer, & Adam, 1994). The mental effort measures developed by Pass (1992) ranged from extremely low (1 point) to extremely high (9 points). The participants were asked: “How much mental effort did it require to learn the task?” The mental effort was scored and administered electronically after the participants completed each task during the program. The mental effort ratings during the program were used to determine the task selection accuracy, in line with the method used by Kostons et al. (2012); Salden et al. (2004); and Salden, Paas, and van Merriënboer (2006). Paas (1992) found an internal consistency coefficient (Cronbach's α) of .90. Paas and van Merriënboer (1994) also evaluated the scale as a highly reliable and sensitive instrument for the assessment of cognitive load (α = .82). Although more cognitive load measures are currently being developed, this subjective rating scale technique is still the most commonly used in the field (Paas, Tuovinen, Tabbers, & Van Gerven, 2003. The reliability coefficients of the cognitive load test were Cronbach's α = .91.

1.4.2. Self-Directed Learning Readiness

Among the instruments that measure self-directed learning, the Self-Directed Learning Readiness Scale (SDLRS) developed by Guglielmino (1977) is the most frequently quoted. SDRLS consists of 58 questions and 5-point scale, and measures 8 factors such as openness to learning opportunities, self-concept as an effective learner, initiative and independence in learning, informed acceptance of responsibility for one's own learning, love of learning, creativity, positive orientation to the future, and the ability to use basic study and problem-solving skills. This high total score means that the readiness for self-directed learning is high. Several studies have shown that this measurement instrument has high reliability and validity (Guglielmino, 1989; Guglielmino & Guglielmino, 2003).

Guglielmino's SDRLS is considered to have too many items. West and Bentley (1990) solved the problem by reducing the number to 33 in six factors. This study used West and Bentley's items in its SDRLS. Confirmatory factor analysis was conducted to verify the validity of the items, all of which were found appropriate in reliability (Table IV-10, Table IV-11).

Table IV-10. Standardized factor loadings for the six factor in West and Bentley (1989) SDRLS

	Six Factor						Item Variance Explained
	F1	F2	F3	F4	F5	F6	
Q1	.540	0	0	0	0	0	.291
Q2	0	0	.490	0	0	0	.240
Q3	.618	0	0	0	0	0	.381
Q4	0	0	-.049	0	0	0	.002
Q5	0	.520	0	0	0	0	.270
Q6	0	.383	0	0	0	0	.146
Q7	0	0	0	0	0	.773	.598
Q8	0	0	0	0	.627	0	.393
Q9	.606	0	0	0	0	0	.367
Q10	0	.437	0	0	0	0	.191
Q11	0	0	.485	0	0	0	.235
Q12	0	0	0	0	.635	0	.403
Q13	.460	0	0	0	0	0	.212
Q14	0	.587	0	0	0	0	.344
Q15	.602	0	0	0	0	0	.363
Q16	0	0	.272	0	0	0	.074
Q17	0	0	0	.679	0	0	.461
Q18	0	.484	0	0	0	0	.234
Q19	0	0	0	.653	0	0	.426
Q20	0	0	0	.517	0	0	.267
Q21	0	0	0	.525	0	0	.276
Q22	0	.528	0	0	0	0	.278
Q23	0	.550	0	0	0	0	.302
Q24	0	0	.621	0	0	0	.385
Q25	0	0	.683	0	0	0	.407
Q26	.763	0	0	0	0	0	.582
Q27	.760	0	0	0	0	0	.578
Q28	.747	0	0	0	0	0	.558
Q29	0	0	.376	0	0	0	.142
Q30	0	0	0	0	0	.715	.511
Q31	0	0	.514	0	0	0	.264
Q32	0	.731	0	0	0	0	.535
Q33	0	.503	0	0	0	0	.253

Table IV-11. Results of reliability in the West and Bentley (1989) SDRLS

Factor	Number of items	Cronbach's α
Love of learning	1, 3, 9, 13, 15, 26, 27, 28	.87
Self-confidence as a learner	5, 10, 14, 18, 22, 23, 32, 33	.70
Openness to a challenge	2, 4, 11, 16, 24, 25, 29, 31	.65
Inquisitive nature	17, 19, 20, 21	.64
Self-understanding	8, 12	.75
Acceptance of responsibility for learning	7, 30	.71

1.4.3. Prior Knowledge Test

The multiple-choice prior knowledge test (Cronbach's α = .82) consisted of 12 paper-and-pencil questions designed to assess students' basic knowledge of the change of seasons. For example, "When meridian transit altitude is high, the length of the shadow is [___] and sun is in the [___] sky. (a) short, eastern; (b) long, western; (c) short, southern; (d) long, northern; and (e) short, northern." Each correct answer was assigned one point; the maximum score was 12 points. The 12 questions were subdivided into four levels of difficulty: 1) change of seasons, 2) change of seasons and culmination altitude of the sun, 3) culmination altitude of the sun and temperature, and 4) the cause of the change of seasons. (For a sample of the test questions, see Appendix G.) This test was developed by the researcher based on Shinsago (2012), in cooperation with two science teachers in the elementary school.

1.4.4. Interim test

The quiz (Cronbach's α = .76), given after a task of the program is finished, consists of five two-choice questions. The quizzes of the four complexity levels were different, while the quizzes at low- and high-interactive tasks of the same complexity level were not. Each correct answer was assigned one point; the maximum score was five points. The tests after each task were used in tandem with the mental effort ratings for determining the task selection accuracy, in line with the method used by Kostons et al. (2012), Salden et al. (2004), and Salden, Paas, and van Merriënboer (2006). This test was developed by the researcher based on Shinsago (2012), in cooperation with two science teachers in the elementary school.

1.4.5. Learning achievement test

The multiple-choice achievement test regarding the change of seasons (Cronbach's $\alpha = .85$) consisted of 12 paper-and-pencil questions designed to assess the students' basic knowledge of the topic. Each correct answer was assigned one point; the maximum score was 12 points. The achievement test contained questions that were equivalent, but not identical, to the prior knowledge tests; they had similar structural features, but the surface features (cover stories) differed. This test was also developed by the researcher based on Shinsago (2012), in cooperation with two science teachers in the elementary school. (For a sample of the test questions, see Appendix H)

1.5. Data Analysis

1.5.1. Task-Selection Accuracy

Task-selection accuracy was the absolute difference between the desirable step size and the step size chosen by the participant (Kostons, van Gog, & Paas, 2012). The desirable step-size indicates the number of jump sizes recommended for going back or progressing to next task; it was determined by the interim and mental effort scores after each task was finished (Salden et al., 2004).

To calculate the desirable jump size, the relationship between performance and mental effort scores was depicted in a table (Table IV-12). This table could be used to draw the rules specifying a desirable "step size" for task selection. Kostons, van Gog, and Paas (2012) explain the desirable step size as follows:

> A positive step size means a recommendation to select a more challenging task (i.e., less support or higher complexity level), a step size of zero means repeating a comparable task (i.e., same level of support and same complexity level), and a negative step size means a recommendation to select a simpler task (i.e., higher level of support or lower level of complexity). This kind of task-selection algorithm, based on performance and mental effort scores, has proven to lead to an effective learning path in studies on adaptive, personalized task selection (e.g., Camp et al., 2001; Corbalan et al., 2008; Kalyuga, 2006; Salden et al., 2006a) (Kostons et al., 2012, p. 125).

For example, a performance score of 4 and a mental effort score of 3 would result in a step size of +2, which essentially indicates that the next learning task should be of two levels higher than the previous task.

Table IV-12. Determining desirable task selection step size using performance and mental effort Scores

Performance	4-5	+2	+1	0
	2-3	+1	0	1
	0-1	0	1	2
		1, 2, 3	4, 5, 6	7, 8, 9
		Mental effort		

Task selection accuracy was calculated using the desirable step size and the step size chosen by the participant. If a participant received a performance score of 3 and a mental effort score of 8 on a 1.2 task with difficulty level 1 (the change of seasons) and high interactivity, it is desirable for him/her to choose a 1.1 task—one level lower than the previous 1.2 task—because of the jump size of -1. However, if a participant chose a 2.1 task—one level higher. the task selection accuracy was the absolute difference (+2) between the desirable step size (-1) and the step size (+1) chosen by the participant: $|(-1)-(+1)| = +2$. The lower the task selection accuracy, the better. The desirable step size was calculated after the experiment, and the participants were not informed of the recommended step size during the program.

1.5.2. The Research Model Evaluation

In evaluating the model, path analysis was performed to verify the effect of the LTSS strategy on task selection accuracy, academic achievement, and self-directed learning ability. There is evidence that the application of LTSS strategy has a direct effect on task selection accuracy, which, in turn, has a significant influence on academic achievement and self-directed learning ability. However, it was difficult to find studies about the direct effect of LTSS strategy on academic achievement and self-directed learning ability. Therefore, this study was conducted to (1) examine if the usage of LTSS strategy directly affects task selection accuracy, (2) check if task selection accuracy has a significant influence on academic achievement and self-directed learning ability, and (3) find out if the usage of LTSS strategy has an indirect effect on academic achievement and self-directed learning ability.

The overall model fit presents the extent to which the hypothesized model fit the empirical data; the χ^2statistics were used, along with the four fit indices recommended by Hu and Bentler (1998). The fit indices include comparative fit index (CFI), non-normed fit index (NNFI), and root mean square error of approximation (RMSEA). A good fit would be evidenced by nonsignificant chi-square test results, and values less than .05 for SRMR, greater than .90 for CFI and NNFI, and less than .08 for RMSEA.

2. Effects of LTSS Strategies on Task Selection Decision Making

2.1. Participants

The participants comprised 27 sixth grade elementary school students in Seoul, South Korea, of whom 16 were male and 11, female. They were randomly assigned to either of two groups; one group had LTSS strategies and the other did not. There were 14 participants in the group with LTSS strategies and 13 in the other group. Students participated in a class meeting, which used a computer program as part of their regular science subject matter.

2.2. Procedure

Forty-minute experiments were conducted in computer classrooms at the participants' school; each participant had access to a computer terminal. The participants were given directions on how to use the programs. They took written tests on prior knowledge and self-directed learning readiness before starting the program. During the program, participants in both conditions could choose from eight tasks until they decided to finish the program. After each task, they were asked to take a four-item task selection decision-making test.

2.3. Measures

2.3.1.Task-selection decision making

A questionnaire (Iyengar & Lepper, 2000) was designed to examine the participants' affective responses to the choice-making process. They were asked to rate the task selection decision-making process after each task. All items called for rating on a Likert scale, ranging from 1 (not at all) to 7 (extremely). The questionnaire examined the participants' perceptions of the task selection decision-making process. Specifically, participants were asked about the extent to which they felt the choice-making process had been enjoyable ("How much did you enjoy making the choice?"), difficult ("Did you find it difficult to make your decision?"), frustrating ("How frustrated did you feel when making the choice?"), or satisfying ("How satisfied were you when you made a decision?").

2.4. Data Analysis

Differences in the task selection decision making between the group with LTSS strategies and the one without were analyzed by one-way ANOVA with SPSS 18.0.

3. Optimality of LTSS Strategies

After completing the e-learning program, the group with LTSS strategies and the group without LTSS strategies were told to evaluate and liberally discuss the strengths, weaknesses, and desired improvements of the task-selection process in the program. They were asked the following question to assess the LTSS e-learning program: What were the strengths, weaknesses, and desired improvements of the task-selection process in LTSS e-learning program? Groups with LTSS strategies were further asked to evaluate and liberally discuss the nine individual LTSS strategies.

CHAPTER V. RESULTS

The purpose of this study was to develop and validate learners' task selection supporting (LTSS) strategies. The research questions of this study were as follows. (1) What are learners' task selection supporting strategies and guidelines? (2) What are the effects of task selection supporting strategies and guidelines? (2-1) What are the effects of task selection supporting strategies and guidelines on task selection accuracy, self-directed learning abilities and learning achievement? (2-2) What are the effects of task selection supporting strategies and guidelines on task selection decision making? and (2-3) What are the optimal learners' task selection supporting strategies? To achieve its purpose, this study followed two steps:

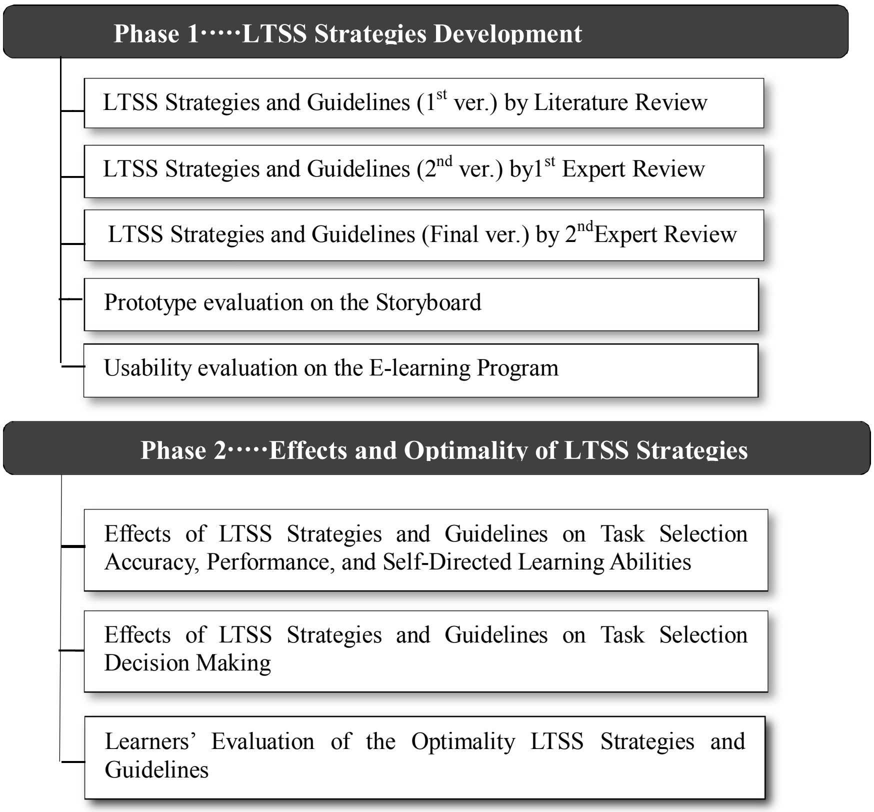


Figure V-1. List of research results

Research 1. Learners' Task Selection Supporting Strategies Development

1. LTSS Strategies and Guidelines (1st version)

LTSS strategies and guidelines were developed based on Reigeluth and Stein's (1983) theory-building methodology. Reigeluth and Stein (1983) suggested 3 steps to develop strategies and guidelines (the 4th step, developing the model, was excluded because it was outside of the scope of this research). The first step is to 'develop formative hypotheses'. The formative hypotheses are as follows: if learners' task selection supporting strategies(LTSS) are applied, learners' task selection accuracy, self-directed learning abilities, and achievement will be improved. The second step is to 'discover, describe and classify related variables'. Based on the literature review, the variables related to LTSS strategies are identified. The first version of the LTSS strategies and guidelines are shown in Table V-1. Strategies and guidelines were divided into cognitive, meta-cognitive, and motivational strategies, which included 4, 4, and 3 strategies, respectively.

Table V-1. LTSS strategies and guidelines (1st version)

		Strategies	Guidelines
Cognitive Strategies	Strategies for Reducing **Cognitive Load**	• Provide fading guidance	• Provide guidance on self-assessment and planning in beginning and have them 'fade' later. • Have the learners decide independently whether guidance is provided.
		• Make sure the learner possesses fundamental prior knowledge before learning	• Conduct diagnostic tests and have learners accumulate prior knowledge before learning (Mayer & Moreno, 2010). • Provide immediate feedback for diagnostic testing so that learners can immediately confirm the results of the diagnostic tests.
		• Use completion strategy	• Have the learners select between completion problems and conventional problems in self-assessment
		• The number of tasks learners can choose should be provided	• Provide a different number of task options according to the 'diagnostic test' results.
Meta-Cognitive Strategies	Strategies for enhancing **Meta-Cognition**	• Provide learners with reflection prompts for task selection after selecting a task	• After selecting a task, have learners fill out the reflection prompt on task selection. • Have learners select the reason they chose the task.
		• Have learners self-assess their learning process	• Provide a tool to self-assess whether they achieved necessary knowledge after the task.
		• Provide ipsative feedback on the score of the 'interim test'	• Provide immediate feedback on the 'interim test'. • Make cumulative 'interim test' scores visible after learning each task.
		• Have the learner establish plans for the next task	• Based on the accumulated feedback for the interim test, provide tools that allow the learner to select the next task.

Motivational Strategies	Strategies for enhancing **Autonomy**	• Have learners set their own learning goals	• Let learners select their own learning goals among learning goals that correspond to program difficulty levels 1 to 4.
	Strategies for enhancing **Relevance**	• Have learners share learning objectives	• Let all students see learning objectives set by other learners.
	Strategies for enhancing **Competency**	• Provide metadata to learners	• Provide metadata (information about the task: level of difficulty, interaction level) in advance. • Give learners the right to view metadata.

2. LTSS Strategies and Guidelines (2nd version)

2.1. Validation Results (1st expert review)

Experts were asked to review the validity of LTSS strategies and guidelines. The validation process followed two main steps. First, the strategy development process was validated. Second, overall strategies and each of the strategies and guidelines were validated.

Table V-2. Results of validation of the LTSS strategies development process

	Experts' Evaluation					M	CVI	IRA
	A	B	C	D	E			
Appropriate Application of Literature Review	5	5	4	5	5	4.8	5/5=1	5/5=1
Appropriate Terminology	5	5	4	4	4	4.4	5/5=1	
Appropriate Interpretation and Summary of Literature	5	5	5	5	5	5	5/5=1	
Logical Organization	4	5	4	5	5	4.6	5/5=1	
Comprehensive Literature Review	5	5	5	5	5	5	5/5=1	

The results of the validation of the strategy development process are shown in Table IV-2. The average ranged from 4.4 to 5. The CVI (Content Validity Index) was 1, which is higher than .80, confirming that the strategies are all valid. IRA (Inter-Rater Agreement) was assessed to determine the extent to which the experts were reliable in their ratings. The IRA was acceptable, with a total IRA= (5/5=1.0), confirming that this result had high reliability.

Experts rated the item "Appropriate Terminology" with the lowest score (M=4.4) due to the term 'competence'. In this study, competence-enhancing strategies were developed to improve self-determined motivation. Experts B, C, and D all noted that 'competence' as used in this study was confused with the concept of competence as discussed in lifelong education. To resolve this problem, it was advised that the concept of competence be clearly defined.

Table V-3. Validation of the overall LTSS strategies (1st version)

	Experts' Eval.					M	CVI	IRA
	A	B	C	D	E			
Validity	5	5	5	5	5	5	5/5=1	5/5 =10
Explanation	5	5	4	4	5	4.6	5/5=1	
Usability	5	5	5	5	5	5	5/5=1	
Universality	5	4	5	5	5	4.8	5/5=1	
Understanding	5	5	5	4	5	4.8	5/5=1	
Strategy-guideline connection	5	5	4	5	5	4.8	5/5=1	

After validating the strategy development process, the overall strategies were validated, as shown in Table Ⅴ-3. The experts assessed the strategies' validity, explanations, usability, universality, understanding, and the strategy-guideline connection. The average ranged from 4.6 to 5. The CVI (Content Validity Index) was 1, which is higher than .80, confirming that the strategies are all valid. All IRA (Inter-Rater Agreement) was 1, confirming that this result had high reliability.

The experts rated the 'explanation' item of the overall strategies with relatively lower scores (M=4.6). Specifically, experts C and D proposed that the degree of explanation would be increased if the strategies were classified according to the different stages of self-directed learning rather than into cognitive, meta-cognitive, and motivational domains. They commented that classifying strategies according to the stage of self-directed learning would better show the relationship between self-directed learning and the strategies.

The results of the validation of each of the LTSS strategies and guidelines are shown in Table Ⅴ-5. The experts validated each of the strategies and guidelines. The average ranged from 3.6 to 5. One of the items had a CVI score of 0.60, which was less than 0.80. This means that the content of this item was not valid and must be modified. The IRA (=0.91) was acceptable.

Table V-4. Experts' validation of the 1st ver. LTSS strategies

		Strategies	Experts' Eval. A	B	C	D	E	M	CVI	IRA
Motivational Strategies	Strategies for enhancing **Autonomy**	• Have learners set their own learning goals	5	5	5	5	5	5	5/5=1	
	Strategies for enhancing **Relevance**	• Have learners share learning goals	5	5	4	4	4	4.4	5/5=1	
	Strategies for enhancing **Competency**	• Provide metadata to learners	5	3	4	4	5	4.2	4/5=.80	
Meta-Cognitive Strategies	Strategies for enhancing **Meta-Cognition**	• Provide learners with reflection prompt on task selection after selecting a task	3	4	4	3	4	3.6	**3/5=.60**	
		• Have learners self-assess their learning process	5	3	5	4	4	4.2	4/5=.80	
		• Provide ipsative feedback on the score of the 'interim test'	5	5	5	5	5	5	5/5=1	8/11= 0.72
		• Have learners establish plans for the next task	5	5	5	5	5	5	5/5=1	
Cognitive Strategies	Strategies for reducing **Cognitive Load**	• Provide fading guidance	5	4	4	5	4	4.4	5/5=1	
		• Ensure that the learner possesses fundamental prior knowledge	5	5	4	5	5	4.8	5/5=1	
		• Use completion strategy	5	5	4	4	4	4.4	5/5=1	
		• The number of tasks learners can choose should be provided	5	5	5	5	5	5	5/5=1	

Table V-5. Experts' comments on the 1st ver. LTSS strategies (restructuring)

Experts' Comments	Revision
• Do not classify strategies and guidelines into cognitive, meta-cognitive, and motivation strategies but rather classify them according to the five stages of the self-directed learning process (Experts B, C, D).	The strategies were rearranged according to the five stages of the self-directed learning process.
• Number each of the strategies and guidelines (Experts A, D).	The strategies were numbered according to the stages of the self-directed learning process (1Stage:1.1~4 Stage:4.5).
• Insert reference literature for each strategy and guideline (Expert E).	Reference literature was added for the strategies and guidelines.

The experts' comments were classified into two categories: "restructuring" and "elaborating." Table V-5 shows a summary of the comments related to "reconstructing". First, three experts recommended the need to reclassify strategies according to the five stages of the self-directed learning process. According to their advice, the strategies were reclassified into five stages of a self-directed learning process rather than into cognitive, meta-cognitive and motivation domains. Second, it was recommended that each of the strategies and guidelines should be numbered. Accordingly, these strategies and guidelines were numbered from 1.1 to 4.5 and from 1.1.1. to 4.5.2. Third, the experts recommended that reference literature should be included in the strategies to clearly provide the basis, even though reference literature was already provided in the theoretical background. Based on these recommendations, the reference literature was included in the strategies and guidelines.

Table V-6. Experts' comments on the 1st ver. LTSS strategies (elaborating)

Experts' Comments	Revision
• More clearly classify strategies and guidelines (all experts).	Guidelines were specified in greater detail.
• In the strategy "Provide learners with reflection prompt on task selection after selecting a task", elaborate on the reflection prompt (Experts A and D).	Add the guideline ("Have learners select the reason why they chose them: - it is associated with my goals, - it is associated with the previous task, -it is associated with the current task: level of difficulty, learning methods, content").
• Elaborate on the guidelines of the strategy "Have learners share learning goals" (Expert D).	Add the guideline ("Make it possible to see one's own learning objective as well as others' by clicking on 'my learning objective' and 'friends' learning objectives'").
• In the strategy "Have learners self-assess their learning process," clarify when self-assessment comes before and after the task performance (Experts B and E).	Add the phrase to the strategy ("Have learners self-assess their learning process <u>after completing the task</u>").
• Clarify when metadata are provided in "Provide metadata to learners" (Expert B).	Add the phrase to the strategy ("Provide metadata to learners <u>prior to making task selection</u>").

Table V-6 shows the experts' comments related to "elaborating". The experts noted that the strategies and guidelines should be more clearly classified to differentiate strategies and guidelines. Instructional *strategy* was defined by Dick, Carey, and Carey (2002) as the process of sequencing and organizing content, specifying learning activities, and deciding how to deliver the content and activities. Guidelines include specific prescriptions that do not appear in strategies (Reigeluth and Carr-Chellman, 2009). That is, strategies are more general than guidelines, making it possible to apply them in many different domains. In contrast, guidelines are prescriptions that are specific to a situation and can be immediately applied. According to this advice by the experts, specific details were added to the guidelines.

The experts noted that the meaning was not clear for some of the strategies. Based on this advice, specific phrases were inserted to clarify the meaning. For example, we added the phrase “Provide metadata to learners prior to making task selection.”. Table V-7 shows the 2nd version strategies and guidelines, revised based on the 1st expert review

Table V-7. LTSS strategies and guidelines (2nd version)

	Strategies	Guidelines
1. Diagnose the status	1.1. Ensure that learners possess fundamental prior knowledge before learning [Cognitive strategy]	1.1.1. Conduct diagnostic tests and have learners accumulate prior knowledge before learning (Mayer & Moreno, 2010). 1.1.2. Provide immediate feedback for diagnostic tests so that learners can immediately confirm the results of diagnostic tests.
	1.2. Have learners set their own learning goals (Moos & Azevdo, 2008) [Motivational strategy]	1.2.1. Allow learners to select their own learning goals among learning goals that correspond to program difficulty levels 1 to 4 (Moos & Azevdo, 2008; Roll et.al, 2007).
	1.3. Have learners share learning goals (Katz & Assor, 2003, 2007) [Motivational strategy]	1.3.1. Let all students see learning goals set by other learners (Katz &Assor, 2003, 2007). • Make it possible to see one's own learning objective as well as others' objectives by clicking on 'my learning objective' and 'friends' learning objectives' items.
2. Select the task& Perform the task	2.1. Provide metadata to learners prior to making task selection (Bell & Kozlowski, 2002; Kicken et al., 2008) [Cognitive strategy]	2.1.1. Provide metadata (information about the task: level of difficulty, interaction level) in advance. 2.1.2. Give learners the right to view metadata (Kicken et al., 2008).
	2.2. The number of tasks learners can choose should be provided (Schwartz, 2004). [Cognitive strategy]	2.2.1. Provide a different number of task options according to the diagnostic check results (Kalyuga et al., 2003).

	2.3. Provide learners with reflection prompt on task selection after selecting a task (van Merriënboer & Sluijsmans, 2009) [Meta-cognitive strategy]	2.3.1. After selecting a task, have learners fill out the reflection prompt on task selection (van Merriënboer & Sluijsmans, 2009; Moos & Azevdo, 2008). 2.3.2. Have learners select the reason why they chose them. • it is associated with my goals • it is associated with the previous task • it is associated with the current task: level of difficulty, learning method, content

3. Assess the task	3.1. Have learners self-assess their learning process after completing the task [Meta-cognitive strategy]	3.1.1. Provide a tool for self-assessing whether learners achieved necessary knowledge after the task (Tatsuoka, Corter, & Tatsuoka, 2004).
	3.2. Provide ipsative feedback on the score of the 'interim test' (Harlen & James, 1997) [Meta-cognitive strategy]	3.2.1. Provide immediate feedback on the 'interim test'. • Make cumulative 'interim test' scores visible after learning each task (Harlen & James,1997).
	3.3. Have learners establish plans for the next task (Loyens, Magda & Rikers, 2008). [Meta-cognitive strategy]	3.3.1. Based on the accumulated feedback for the 'interim test', provide tools that allow the learner select the next task.
	3.4. Provide fading guidance (Renkle, 2005) [Cognitive strategy]	3.4.1. Provide guidance on self-assessment and planning at the beginning and have them 'fade' later (Renkl, 2005) 3.4.2. Have the learners decide independently whether guidance is provided.
	3.5. Use completion strategy (Paas & van Merriënboer, 1994) [Cognitive strategy]	3.5.1. Have the learners select between completion problems and conventional problems in the self-assessment (Paas & van Merriënboer, 1994).

3. Final ver. LTSS Strategies and Guidelines

3.1. Validation Results (2nd Expert Review)

The experts were asked to review the validity of LTSS strategies and guidelines. The validation process followed two main steps. First, overall strategies and guidelines were validated. Second, each of the strategies and guidelines was validated.

Table V-8. Validation of the overall LTSS strategies (2nd version)

	Experts' Evaluation							M	CVI	IRA
	A	B	C	D	E	F	G			
Validity	5	5	5	4	5	5	5	4.7	5/5=1	4/6 =0.6
Explanation	5	5	4	4	5	4	5	4.5	5/5=1	
Usability	5	5	5	4	5	5	4	4.7	5/5=1	
Universality	5	4	5	**3**	5	5	5	4.7	4/5=.80	
Understanding	5	5	5	4	5	5	5	4.8	5/5=1	
Strategy-guideline connection	5	5	4	**3**	5	5	5	4.5	4/5=.80	

First, the overall validation of the LTSS strategies and guidelines is shown in Table V-8. Seven experts assessed the strategies' validity, explanation, usability, universality, understanding, and the strategy-guideline connection. The average ranged from 4.5 to 4.8. Although the 'universality' and 'strategy-guideline connection' items had CVI scores of 0.8, the items are regarded as having valid content because this number is higher than 0.8. However, IRA was lower than 0.8, which suggests that these items may need to be modified. Related comments on the LTSS strategies and guidelines are shown in detail in Tables V-9~V-10.

Table V-9. Experts' validation of the 2nd ver. LTSS strategies

Strategies and Guidelines		Experts' Eval. A	B	C	D	E	F	G	M	CVI	IRA
1.1	1.1.1	5	4	5	3	5	5	5	4.8	4/5=0.8	8/16 =0.5
	1.1.2.	5	4	5	3	5	5	5	4.7	4/5=0.8	
1.2	1.2.1.	5	5	5	4	4	5	5	4.7	5 / 5 = 1	
1.3	1.3.1.	5	4	5	3	5	5	5	4.8	4/5=0.8	
2.1	2.1.1.	5	5	5	4	5	5	5	4.7	5 / 5 = 1	
	2.1.2.	5	5	5	4	5	5	5	4.7	5 / 5 = 1	
2.2	2.2.1.	5	4	4	5	5	5	5	4.5	5 / 5 = 1	
2.3	2.3.1.	5	5	5	5	5	5	4	4.8	5 / 5 = 1	
	2.3.2.	5	5	5	5	5	5	5	5.0	5 / 5 = 1	
4.1	4.1.1.	5	5	5	3	5	5	5	5.0	4/5=0.8	
4.2	4.2.1.	5	5	5	5	5	5	4	4.8	5 / 5 = 1	
	4.2.2.	5	5	5	5	5	5	5	5.0	5 / 5 = 1	
4.3	4.3.1.	5	5	5	3	4	5	5	4.5	4/5=0.8	
4.4	4.4.1.	5	5	5	3	5	5	5	4.5	4/5=0.8	
	4.4.2.	5	5	4	3	5	5	5	4.4	4/5=0.8	
4.5	4.5.1.	5	4	4	3	4	4	5	4.0	4/5=0.8	

The results of the validation of each of the strategies and guidelines are shown in Table V-9. The experts validated each of the strategies and guidelines. The average ranged from 4.4 to 5. The IRA was acceptable, with all of the strategies IRA=0.5. The CVI score was 0.80 for strategies 4.4 and 4.5, which was lower than that of the others. A score of 0.80 means that the item has valid content and does not need to be modified. However, one expert commented that strategy 4.4 and strategy 4.5 do not have a direct relationship with task selection and are general strategies rather than strategies for task selection. This issue is discussed in the next phase.

Table V-10. Experts' comments on the 2nd ver. LTSS strategies (deleting)

Experts' Comments	Revision
• Strategy 4.4 "Provide fading guidance" and strategy 4.5 "Provide completion strategy" do not have a direct relationship with task selection. They should be deleted (Expert D).	It was difficult to consider these two strategies as directly supporting task selection, so they were deleted.

The experts' comments were classified into two categories: "Deleting" and "Elaborating." Table V-10 shows the summarized comments related to "Deleting". Expert D noted that Strategy 4.4, "Provide fading guidance", and Strategy 4.5, "Provide completion strategy", do not have a direct relationship to task selection, in contrast with the other strategies. The experts suggested that these two strategies reduce the extraneous load caused by other task selection supporting strategies and do not have a direct effect on task selection. This important comment helped to clarify the direction of this study. This view was regarded as valid, and the two strategies were deleted.

Table V-11 shows the experts' comments related to "Elaborating" with respect to strategies and guidelines. The experts recommended that the guidelines for Strategies 2.1 and 2.2. should be elaborated. According to these comments, the strategies and guidelines were revised, as shown in Table V-11.

Table V-11. Experts' comments on the 2nd ver. LTSS strategies (elaborating)

Experts' Comments	Revision
• Add more detailed explanation to guideline 2.1.1. It is difficult to understand the meaning of 'the right to view metadata' (Expert B).	Add the phrase to the guideline ("Display example screenshot of tasks when moving the mouse over").
• Elaborate on the guidelines for strategy 2.2. Explain how the task selection option would differ according to the results of the diagnostic test (Expert C).	Add guideline 2.2.2 ("Tasks with levels of difficulty 1 and 2 are provided in the 'basic' task selection screen, and tasks with levels of difficulty 1, 2, 3 and 4 are provided in the 'intense' task selection screen. Subsequently, learners choose either basic or intense tasks based on the diagnostic check results").
• Elaborate on the guidelines for strategy 4.3. Explain the conditions that must be fulfilled before learners complete the learning (Experts A and B).	Add guideline 4.3.2 ("When completing the learning, have the learner check whether the 3 steps below were fulfilled. -The learning goals they set were achieved. -One of the intense level 3 or 4 courses was learned. -The learner got more than 4 out of 5 questions correct in the interim test after completing intense level 3 and 4 courses").

2.4. Final ver. LTSS Strategies and Guidelines

The final version of LTSS strategies and guidelines, revised by the 2nd expert review, was as follows. The learning process reflecting the final version of strategies and guidelines is shown in Figure V – 2.

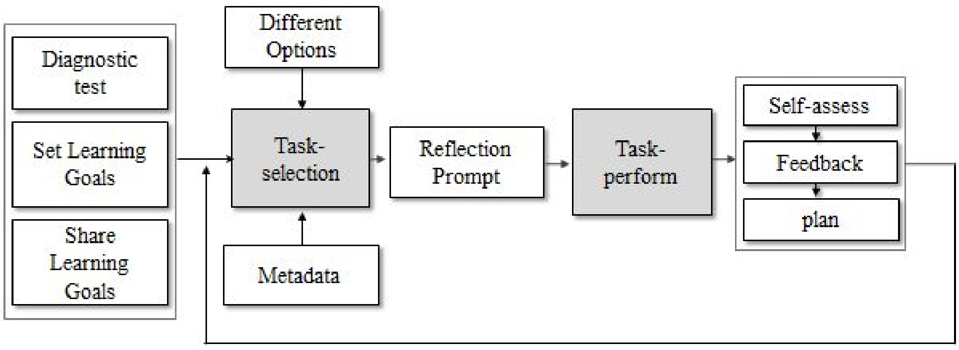


Figure V-2. Learners' learning process in the e-learning program reflecting the LTSS strategies

Learners take the diagnostic test before selecting a task and then set learning goals in accordance with the results of the test. As the goals set at this point are shared among learners, you can check other people's learning goals whenever you want. When selecting a task, various task options and metadata on the task are provided. After task selection, you reflect on why you chose the task. You carry out the task, self-assess its implementation and receive feedback on it. A fter developing the plan for the next task, you then select the next task.

Table V-12 shows the LTSS strategies corresponding to cognitive, meta-cognitive, and motivational areas. The overall LTSS strategies and guidelines are shown in Table V-13.

Table V-12. LTSS strategies (final version)

Self-directed learning process	Strategies supporting learners' task selection		Cognitive	Meta-cognitive	Motivational : Autonomy	Motivation al: Competency	Motivational :Relatedness
Diagnose the status	1.1	Ensure that learners possess fundamental prior knowledge before learning	•				
	1.2	Have learners set their own learning goals			•		
	1.3	Have learners share learning goals					•
Select the task & ***Perform*** the task	2.1	Provide metadata to learners prior to making task selections				•	
	2.2	The number of tasks learners can choose should be provided differently	•				
	2.3	Provide learners with reflection prompt on task selection after selecting a task		•			
Assess the task	3.1	Have learners self-assess their learning process after completing the task		•			
	3.2	Provide ipsative feedback on the score of the 'interim test'		•			
	3.3	Have learners establish plans for the next task		•			

Table V-13. LTSS strategies and guidelines (final version)

	Strategies	Guidelines
1. Diagnose the status	1.1. Ensure that learners possess fundamental prior knowledge [Cognitive strategy]	1.1.1. Conduct diagnostic test and get learners to accumulate prior knowledge before learning (Mayer & Moreno, 2010). 1.1.2. Provide immediate feedback for diagnostic test so that learners can immediately confirm the diagnostic test's result.
	1.2. Have learners set their own learning goals (Moos & Azevdo, 2008) [Motivational strategy]	1.2.1. Let learners select their own learning goals among learning goals that correspond to program difficulty levels 1 to 4 (Moos & Azevdo, 2008; Roll et al, 2007). • Beginners have difficulty creating learning goals themselves, so have them select one learning objective from many.
	1.3. Have learners share learning goals (Katz & Assor, 2003, 2007) [Motivational strategy]	1.3.1. Let all students see learning goals set by other learners (Katz & Assor, 2003, 2007). • Make it possible to see one's own learning objective as well as others' objectives by clicking on 'my learning objective' and 'friends' learning objectives'.
2. Select the task& Perform	2.1. Provide metadata to learners prior to task selection (Bell & Kozlowski, 2002; Kicken et al.2008) [Motivational strategy]	2.1.1. Provide metadata (information about the task: level of difficulty, interaction level) in advance. 2.1.2. Give learners the right to view metadata (Kicken et al., 2008). • Display example screenshot of tasks when moving the mouse over.
	2.2. The number of tasks learners can choose should be provided	2.2.1. Provide a different number of task options according to the diagnostic check results (Kalyuga et al., 2003).

	Schwartz, 2004) [Cognitive strategy]	2.2.2. Tasks with levels of difficulty 1 and 2 are provided in the 'basic' task selection screen, and tasks with levels of difficulty 1, 2, 3 and 4 are provided in the 'intense' task selection screen. Subsequently, learners choose either basic or intense tasks based on the diagnostic check results.
	2.3. Provide learners with reflection prompt on task selection after selecting a task (van Merriënboer & Sluijsmans, 2009) [Meta-cognitive strategy]	2.3.1. After selecting a task, have learners fill out the reflection prompt on task selection (van Merriënboer & Sluijsmans, 2009; Moos & Azevdo, 2008). 2.3.2. Have learners select the reason they chose them. • it is associated with my goals • it is associated with the previous task • it is associated with current task: level of difficulty, learning methods, content

3. Assess the task	3.1. Have learners self-assess their learning process after completing the task (Kicken et al., 2008) [Meta-cognitive strategy]	3.1.1. Provide a tool for self-assessing whether learners achieved necessary knowledge after the task (Tatsuoka, Corter, & Tatsuoka, 2004).
	3.2. Provide ipsative feedback on the score of the 'interim test'. (Harlen & James, 1997) [Meta-cognitive strategy]	3.2.1. Provide immediate feedback on the 'interim test'. Make cumulative 'interim test' scores visible after learning each task (Harlen & James, 1997).
	3.3. Have the learner establish plans for the next task (Loyens, Magda & Rikers, 2008) [Meta-cognitive strategy]	3.3.1. Based on the accumulated feedback for the 'interim test', provide tools that allow the learner to select the next task. 3.3.2. When completing the learning, have the learner check whether the 3 steps below were fulfilled. • The learning goals they set were achieved. • One of the intense level 3 or 4 courses was learned. • The learner got more than 4 out of 5 questions correct on the interim test after completing intense level 3 and 4 courses.

Strategy 1.1. Ensure that the learner possesses fundamental prior knowledge before learning. [Cognitive strategy]

If the learner has basic prior knowledge before the lesson, he or she will be able to choose an adequate task. Beginners, in particular, tend to choose learning tasks they prefer rather than tasks that are necessary. This tendency ultimately has a negative effect on the learning process (Kicken et al., Brand-Gruwel, & van Merriënboer, 2008; Koston, van Gog, & Paas, 2009). Furthermore, according to the pre-training principle of Cognitive Load Theory, if the learner lacks prior knowledge for a learning task, he or she may experience a cognitive load when choosing a task (Mayer, Mautone, & Prothero, 2002; Pollack et al, 2002). Thus, it is necessary for the learner to have sufficient prior knowledge before choosing a learning task. A diagnostic test may be conducted for this purpose. When conducting a diagnostic test, the learner is able to check the test results immediately because immediate feedback is provided.

For example, prior to learning, the learner's level is diagnosed by a diagnostic test. Using 4 levels of difficulty, a total of 12 questions (3 questions per difficulty level) are provided. A five-point scale is used, and the answers can be checked by clicking on the "CONFIRM" button. Diagnostic test results are displayed when all 12 questions are answered. The diagnostic test results are classified into two categories, BASIC (questions 1-6) and INTENSE (questions 7-12). They indicate the number of questions the learner answered correctly in each category. The learner chooses the basic or intense stage him/herself according to the diagnostic test results. Selected screenshot of the 'diagnostic test' are shown in FigureV-3 and Figure V-4.

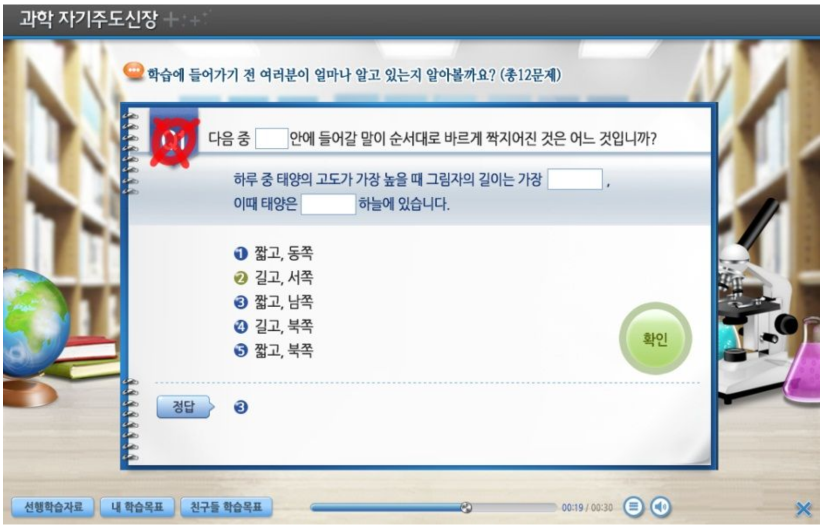


Figure V-3. A selected screenshot of the 'diagnostic test'

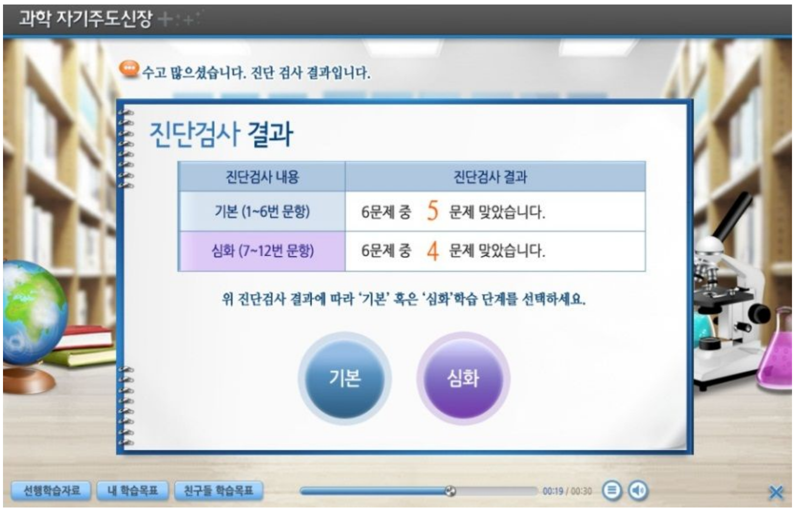


Figure V-4. A selected screenshot of the 'diagnostic test result'

Strategy 1.2. Let learners set learning goals themselves (Moos & Azevdo, 2008) [Motivation strategy]

If the learner selects a task after personally setting the goals of the lesson, he or she can more easily identify learning tasks that are related to those goals. Because choosing a learning task based on one's own learning goals is a self-determined choice, the learner experiences a sense of autonomy (Assor, Kaplan, & Roth, 2002). Self-determination theorists (SDT, Ryan, 1993; Ryan & Deci 2000) assume that people experience a sense of autonomy when they realize their personal goals. According to self-determination theory, if the autonomy of the learner is satisfied, school activities can become intrinsic motivations, even if most school activities motivate extrinsically (Assor, Kaplan, & Roth, 2002; Katz & Assor, 2003). Thus, it is important for the learner to personally set goals before choosing a task. However, because it is difficult to set one's own learning goals with low prior knowledge, it is necessary to allow the learner to personally choose from the learning goals on a form by providing working examples (Clark, Nguyen, Sweller, 2006) of the learning goals.

For example, after the BASIC and INTENSE learning goals are suggested, the learner chooses the learning goal. Selected learning goals are saved, and the learner's goal can be seen anytime by clicking the "MY LEARNING GOALS" button at the bottom of the screen.

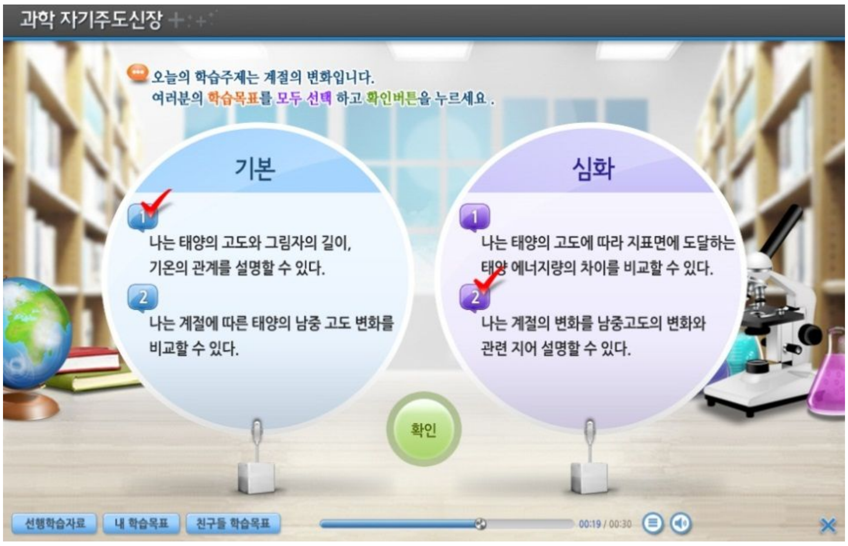


Figure V-5. A selected screenshot of the 'learning goal setting'

Strategy 1.3. Have learners share learning objectives (Katz & Assor, 2003, 2007) [Motivation strategy]

When learning goals are shared by learners, they can make a self-determined choice. According to self-determination theory, if the need for relatedness is satisfied, the learner is able to make a self-determined choice. The need for relatedness and the effect of choice may seem to have little to do with one another, but for Asians, the motivation for choice increases with an increase in relatedness (Katz & Assor, 2007). In other words, for Asians, self-determination motivation does not increase by simply providing the right to choose. Even if one makes one's own choices, motivation increases when one's decision does not deviate from the group's common objective (Iyengar & Lepper, 1999; Katz & Assor, 2003). Therefore, it is necessary for learners to compare their learning goals with their peers to satisfy the need for relatedness and to enhance self-determination.

For example, friends' learning goals are shared, and these learning goals can be seen by clicking the "FRIENDS' LEARNING GOALS" button at the bottom of the screen. A selected screenshot of 'learner's learning goal setting' and 'friends' learning goals' is shown in Figure V-6.

Figure V-6. A selected screenshot of the ‘friends’ learning goals’

Strategy 2.1. Provide metadata to learners prior to making task selections (Bell & Kozlowski, 2002; Kicken et al., 2008) [Cognitive strategy]

If metadata related to the learning task are provided to the learner before the learner chooses a task, then the learner can easily choose a suitable task. In other words, metadata on learning tasks, which include difficulty, learning methods, and sample screens, allow the learner to easily understand which learning task is suitable. If the learner has difficulty understanding the tasks when choosing one, the learner may experience a cognitive load (Bell & Kozlowski, 2002; Kicken, Brand-Gruwel, & van Merriënboer, 2008). It is necessary to provide learners with detailed and structured information on the characteristics of the learning tasks from which they can choose (Schwartz, 2004) to reduce cognitive load. Furthermore, according to a study by Flowerday et al. (2004), an empty choice (choosing a packet without knowing its content) cannot improve the learner’s motivation because this choice is not made on the basis of the learner's interests, values or goals. Therefore, it is necessary to provide information on the learning tasks prior to selection. A screenshot of the task could provide task information visually and could help learners to easily envision the task content.

For example, to provide metadata to learners, a program was developed so that learners could see the content to be learned by moving the mouse over the task button in the 'basic' and 'intense' stages. A 'click' mark was added to the task button so that learners could easily identify the click button, as shown in Figure V-7.

Figure V-7. A selected screenshot of the 'metadata in the basic stage of task selection'

Strategy 2.2. The number of tasks learners can choose should be provided (Schwartz, 2004) [Cognitive strategy]

The number of learning tasks from which the learner may choose must be provided based on the level of prior knowledge the learner retains. According to the expertise reversal effect, the level of cognitive load the learner experiences during the learning process differs between learners because the organizational knowledge structures (schemas) of learners differ based on their level (Plass, Kalyuga and Leutner, 2010). That is, learners with high prior knowledge do not experience difficulty even with numerous task selection options, but learners with low prior knowledge may experience difficulty. Even if the learner has a high level of prior knowledge, a large number of task selections hinders selection. Even if the learner chooses, the results reveal a decrease in satisfaction (Haynes, 2009; Iyengar & Lepper, 2000; Shah & Wolford, 2007; Tversky & Shafir, 1992). In other words, providing learners with excessive selections can actually lessen their satisfaction. Therefore, it is necessary to provide an appropriate number of options. In this study, 8 task selection options and 4 task options were provided to help learners make selections according to their level.

The task selection screen is divided into the 'basic stage task selection screen' and the 'intense stage task selection screen'. According to the diagnostic test results above, Figure V-8 is displayed if the learner selects the 'basic' stage, and Figure V-9 is displayed if the 'intense' stage is selected. In both the 'basic' and 'intense' stages, the tasks are divided by learning methods depending on the level of difficulty and interaction. The 'basic' stage includes 1 to 2 stages of difficulty, and tasks for each level of difficulty are divided into 'listen to explanation', which has a low level of interaction, and 'learn by yourself', which has a high level of interaction. There are 1 to 4 stages of difficulty for the 'intense' stage. Similar to the 'basic' stage, the tasks for each level of difficulty are divided into 'listen to explanation' and 'learn by yourself'.

Figure V-8. A selected screenshot of the 'basic stage task selection' screen

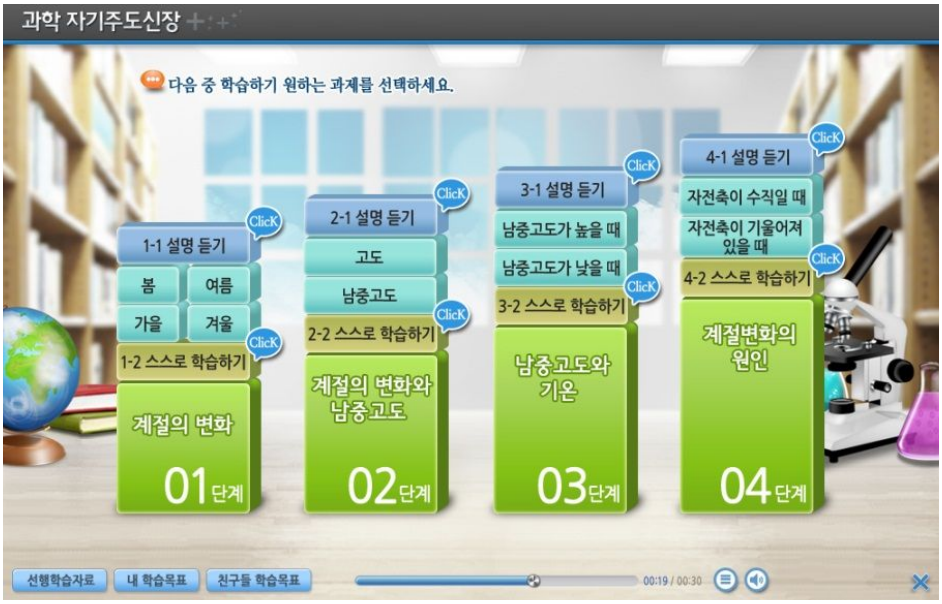


Figure V-9. A selected screenshot of the 'intense stage task selection' screen

Strategy 2.3. Provide learners with reflection prompts on task selections after selecting a task (van Merriënboer & Sluijsmans, 2009) [Meta-cognitive strategy]

Reflection prompts ask learners why they chose the task after the choice is made and allow them to reflect on their task selection. If learners respond to the questions about why they chose a task after selecting it, this information can be helpful for the acquisition of sequential skills in the self-direction stage and can facilitate induction (Butler & Winnie, 1995; Seale & Cann 2000; Winne & Stockley, 1998). Furthermore, by reflecting on the task selection process, the learner is able to choose a more meaningful task instead of a random selection. Because learners are still novices at this time and need help to reflect, it is advisable to provide task selection reasons as working examples and then allow the learners to choose.

The reasons for task selections can be classified into the 3 categories of goals, prior tasks and current tasks: 'it is associated with my goals', 'it is associated with the previous task', and 'it is associated with the current task: level of difficulty, learning method, content'. A screenshot is shown in Figure V-10.

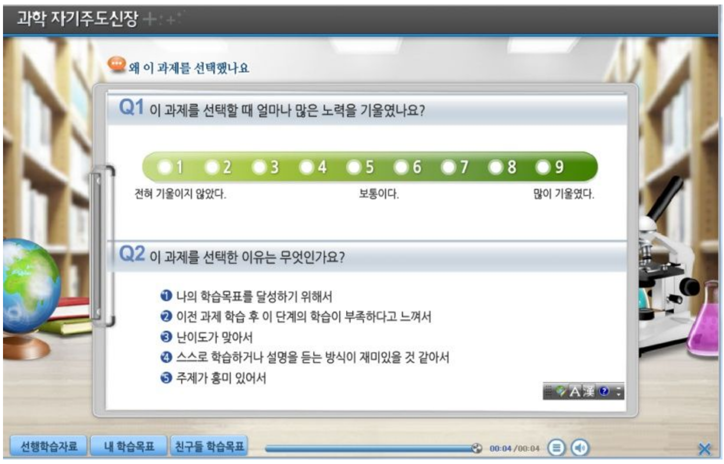


Figure V-10. A selected screenshot of the 'reflection on the task selection'

Strategy 3.1. Have learners self-assess their learning process after completing the task (Kicken et al., 2008; Sadler 1983) [Meta-cognitive strategy]

The activity of evaluating the process after performing the learning task enables learners to identify their strengths and weaknesses (Kicken et al., 2008; Sadler 1983). Through this type of self-assessment, learners reflect on their learning process and are subsequently able to understand which learning task is necessary. In a meta-analysis of the effects of feedback in computer-based instruction, Azevedo and Bernard (1995) concluded that inviting learners to evaluate their own actions seems more effective than frame-by-frame immediate feedback because it helps to develop responsible and autonomous learners who are capable of controlling their performance and learning processes (Lew et al., 2010; van Kraayenoord & Paris, 1997). Therefore, it is necessary to help learners self-assess to identify their strengths, weaknesses, and areas for improvement and to select an appropriate task.

Learners are able to self-assess if programs provide them with tools for assessment. In the self-assessment stage, questions that allow the learner to reflect on the task performance process are provided. There are 4 types of self-assessment questions based on the 1 to 4 stages of difficulty, as shown in Figure V-11.

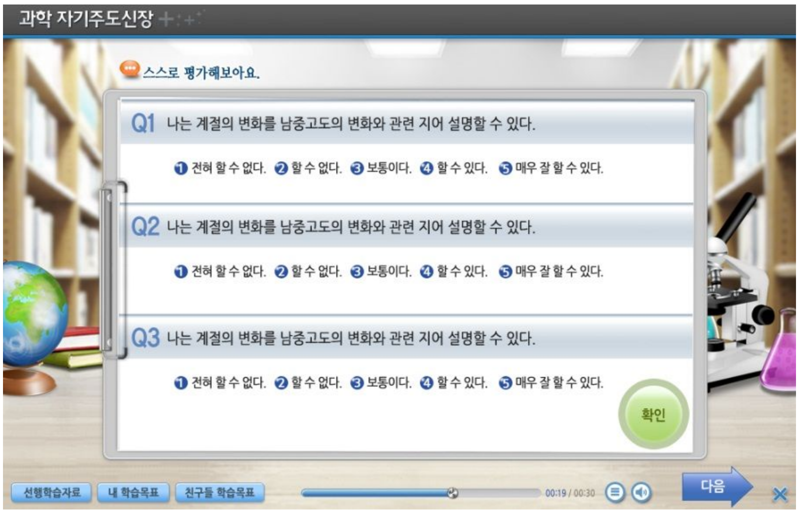


Figure V-11. A selected screenshot of the 'self-assessment'

Strategy 3.2. Provide ipsative feedback on the score of the 'interim test after the learner's task' (Harlen & James, 1997) [Meta-cognitive strategy]

The accumulated 'interim test' results could help learners compare the quality of their performance over time (Harlen & James, 1997). The goal of the evaluation is not to provide corrective feedback or a pass/fail decision to the learners but to let them know that the quality of their performance changes over time (van Merriënboer and Sluijsmans, 2009). In this way, learners can continually check their status through ipsative feedback. Even if their scores are lower than those of the other students, learners can improve their motivation by focusing on their development process.

For all tasks, an interim test follows learning. The cognitive load for the task performance is measured first, and then 5 assessment questions with two-point scales are provided, as shown in Figure V-12.

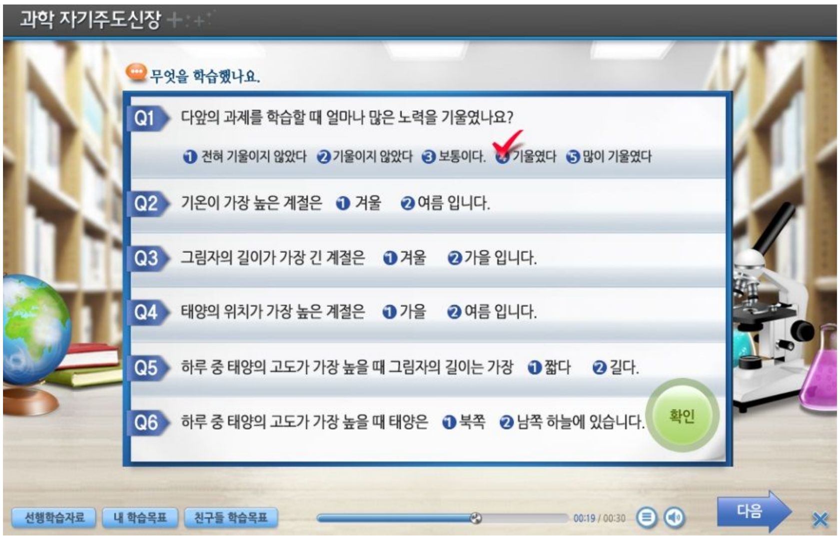


Figure V-12. A selected screenshot of the ‘interim test’

On the ipsative feedback and planning screen, the scores for the ‘interim test’ received after each task are displayed, as shown in Figure V-13. Based on this result, learners can confirm the stages and learning methods where they were weak and choose the next task.

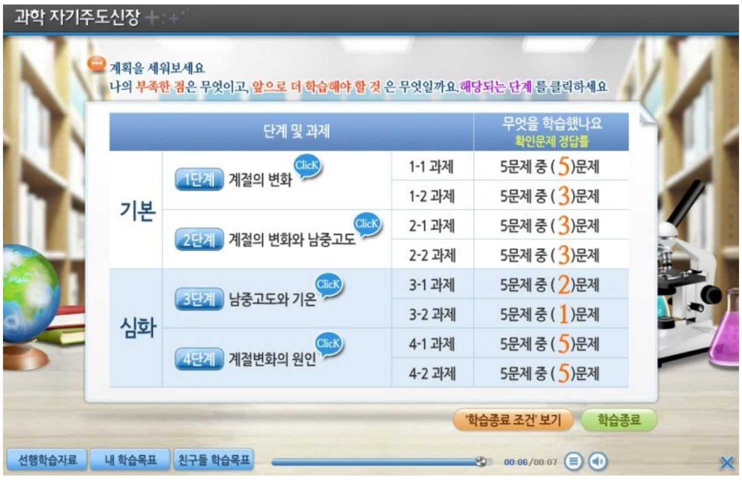


Figure V-13. A selected screenshot of the 'ipsative feedback and planning'

Strategy 3.3. Have learners establish plans for the next task him/herself (Loyens, Magda & Rikers, 2008) [Meta-cognitive strategy]

If the learner plans what he or she is to learn before choosing a learning task, then the learner will be able to choose a more adequate task. Understanding what is lacking and establishing a plan beforehand is helpful for choosing a learning task. The self-analysis and evaluation in these planning processes allows learners to make more reasonable decisions rather than choices based on intuition (Candy, 1991). Establishing plans in this way is important for self-directed learning and allows learners to make better decisions (Loyens, Magda & Rikers, 2008).

For instance, the learner clicks on the stage he or she wants to learn based on the ipsative feedback results. If learners wish to terminate the learning, they press the 'terminate learning' button. After the 'learning termination condition' button is pressed, information on learning termination conditions is provided (see Figure V-14**).** The first learning termination condition identifies whether 'my learning goals' have been met. The second condition identifies whether the 'intense stage task' has been learned, and the third condition identifies whether the learner answered 4 or more of the 5 interim test questions correctly. If all 3 of these conditions are met, a phrase appears that informs the learner that he or she can terminate learning.

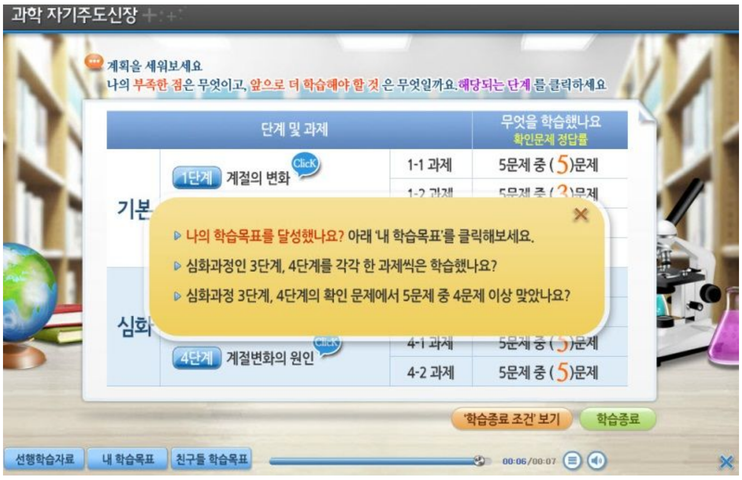


Figure V-14. A selected screenshot of the 'learning termination condition'

Once the terminate learning button is pressed, self-assessment questions appear. These questions ask whether the 3 learning termination conditions are met, as shown in Figure V-15. If the learner answers YES to all 3 questions, the screen goes to the learning termination page, as shown in Figure V-16. If the learner answers NO to any of the 3 questions, the screen returns to the planning screen.

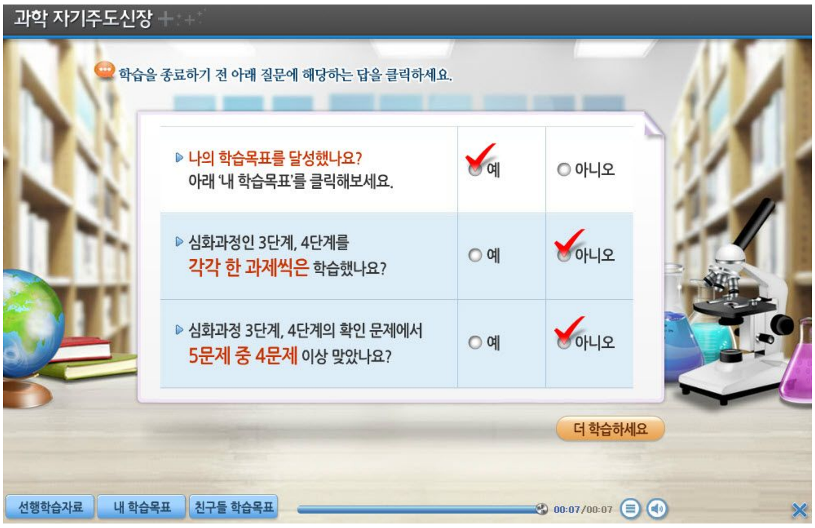


Figure V-15. A selected screenshot of the self-assessment of whether the learning termination conditions are met

4. Prototype Evaluation on the Storyboards

Experts were asked to validate whether strategies are appropriately reflected in the storyboards. Experts assessed the storyboards by comparing strategies and storyboards. The results of the storyboard validation are shown in Table V-14. The majority of the LTSS strategies received high scores of 4 and 5. CVI and IRA were both 1, and the content validity and reliability were both shown to be high. Thus, each strategy is well reflected on the storyboard.

Table V-14. Results of prototype evaluation of storyboards

Strategies supporting learners' task selection		A	B	C	D	CVI	IRA
1.1	Ensure that learners possess fundamental prior knowledge before learning	5	5	5	5	5/5=1	IRA 9/9=1
1.2	Have learners set their own learning goals	5	5	5	5	5/5=1	
1.3	Have learners share learning goals	5	4	5	5	5/5=1	
2.1	Provide metadata to learners prior to making task selections	5	5	5	5	5/5=1	
2.2	The number of tasks learners can choose should be provided	5	5	4	5	5/5=1	
2.3	Provide learners with reflection prompt on task selection after selecting a task	5	5	5	5	5/5=1	
3.1	Have learners assess their learning process after completing the task	5	4	5	5	5/5=1	
3.2	Provide ipsative feedback on the score of the 'interim test'	5	5	5	5	5/5=1	
3.3	Have learners establish plans for the next task	5	5	5	5	5/5=1	

The experts commented on corrections to the aspects of 'reflecting user characteristics' and 'screen design'. The details are shown in Table V-15 and Table V-16 below.

Table V-15. Comments on the storyboards (User characteristic reflections)

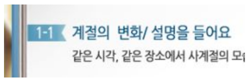
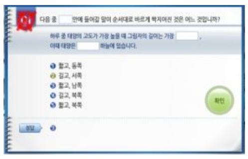
Experts' Comments	Revision	Examples
• Use sentences that can be easily understood by elementary school children (Expert A).	As seen from the screen on the right, "listen to the explanation" was changed to the friendlier expression "let's listen to the explanation" in the "perform the task" screen.	
• Add music that elementary school children will feel familiar with in the background (Expert C).	Soft music was played on the 'access the task' screen.	
• Use characters that elementary school children might like (Expert D).	Similar to the screen on the right, student characters were inserted in the 'introduction' screen.	

Table V-16. Comments on the storyboards (Screen design)

Experts' Comments	Revision	Examples
• In the task selection screen, provide visual increases in the levels of difficulty from 1 through 4 (Expert A).	Similar to the screen on the right, levels 1 through 4 were expressed in stair steps on the task selection screen, and increases in the level of difficulty were shown visually.	
• Make the color of the phrase that needs to be emphasized different (Expert C).	Different colors were used for important phrases.	
• Do not include a lot of information on one screen. In the diagnostic test, have the students solve one question on each screen (Expert D).	Similar to the screen on the right, one question was to be solved on each screen in the diagnostic test.	

5. Usability Evaluation of the Developed e-Learning Program

5.1. Experts' Usability Evaluation of the Developed e-Learning Program

Experts were asked to test the usability of the developed e-learning program. The results of the usability of the e-learning program, which was evaluated by 3 experts, are shown in the following table. Experts evaluated the e-learning program using ten categories (ease of use, navigation, cognitive load, mapping, screen design, knowledge space compatibility, information presentation, media integration, aesthetic appreciation, overall functionality). The majority of the experts gave high scores of 4 and 5. CVI and IRA were both 1, and the content validity and credibility were both high. Thus, the program's usability was generally high.

All of the experts gave a score of 3 for the navigation category and noted that movement within the program was not easy. This program was designed to follow a series of steps: 'diagnose the status-select the task-perform the task-assess the task'. Therefore, learners cannot adjust the order of these steps. For example, after completing a task, learners must go through the step of evaluating the task. In other words, learners are not given the option of selecting the task evaluation step. Some experts suggested that this characteristic hinders free navigation. There is a need to develop a program that addresses this issue, which is addressed in the discussion section.

Table V-17. Results of experts' usability evaluation of the LTSS e-learning program

No.	Usability Evaluation Questions	Experts' Eval.			CVI	IRA
		A	B	C		
1	**Ease of Use** Is the program easy for users to use?	5	5	4	3/3=1	IRA 9/10 =0.9
2	**Navigation** Is the program easy to navigate to one that is perceived?	3	5	3	2/3= 0.6	
3	**Cognitive Load** Does the program require mental effort to use the program?	5	4	5	3/3=1	
4	**Mapping** Does the program track and graphically represent to the user his or her path through the program?	5	5	5	3/3=1	
5	**Screen Design** Is the program designed well for learners to remember what they learned?	5	5	4	3/3=1	
6	**Knowledge Space Compatibility** Does the program have the compatible network of concepts and relationships that compose the mental schema a user possesses about a given phenomena topic or process?	5	5	5	3/3=1	
7	**Information Presentation** Is the information contained in the knowledge space of an interactive program presented in an understandable form?	4	5	5	3/3=1	
8	**Media Integration** How well does an interactive program combine different media to produce an effective whole?	5	4	4	3/3=1	
9	**Authentic Appreciation** Does the program have beauty or elegance?	5	4	4	3/3=1	
10	**Overall Functionality** Does the program satisfy the specific intended use that exists in the mind of the users?	5	5	5	3/3=1	

5.2. Learners' Usability Evaluation of the Developed e-Learning Program

Learners evaluated the usability of the e-learning program in two phases after completing the program. First, the learners assessed the e-learning program in terms of the nine items summarized in the table below on a scale of 1-5. The questionnaire used for the survey was based on the nine design elements for the design of user interfaces for digital textbooks in the classroom, which was developed by Lim, Song and Lee (2012). Second, the learners were asked to liberally discuss the advantages, weaknesses and desired improvements of the e-learning program. The three questions used to assess the LTSS e-learning program were 1) What are the major advantages of the LTSS e-learning program? 2) What are the weaknesses of the LTSS e-learning program? 3) What improvements do you think should be made to the LTSS e-learning program?

Table V-18. Results of learners' usability evaluation of the LTSS e-learning program

No.	Usability evaluation item	M	SD
1	Agreement with user's expectations	3.8	0.8
2	Consistency	4.4	0.4
3	Convenience of operations	3.5	1.1
4	Minimization of memory load through screen design	3.8	0.6
5	Error prevention	3.4	0.7
6	Advice and help information	4.4	0.4
7	Feedback	4.2	0.3
8	Aesthetic design	4.3	0.5
9	User control	4.6	0.2

The assessment results are illustrated in Table V-18. The average scores for the nine assessment items ranged from 3.4 to 4.6. The "convenience of operations" item scored the lowest, at 3.5, whereas the "user control" category scored the highest, at 4.6. The results reflect the learners' opinions.

Next, the learners freely discussed the advantages, weaknesses and desired improvements of the LTSS e-learning program. The answers were categorized based on the usability assessment criteria suggested by Lim, Song and Lee (2012). The advantages of the LTSS e-learning program mentioned by the learners are shown in Table V-19. Of the criteria of Lim, Song and Lee (2012), the learners cited advantages of the e-learning program with respect to seven criteria, with the exception of "Consistency" and "Error prevention." The highest response frequency was for the "Advice and help information" item, at 28%, followed by 25% for "User control" and 15% for "Agreement with user's expectations."

Table V-19. Results of learners' evaluations of the LTSS e-learning program (Strengths)

No.	Item	Learners' Comments (Strengths)	%
1	Agreement with user's expectations	• Improve self-directed learning ability as anticipated.	15
2	Convenience of operations	• Convenient to use and operate.	13
3	Minimization of memory load through screen design	• Easy to understand the explanation due to the accompanying pictures.	10
4	Advice and help information	• Explanation is easy to understand. • Abundant data are provided. • Key points are well highlighted.	28
5	Feedback	• It is nice to see the feedback immediately after solving the problems.	4
6	Aesthetic design	• Design is stylish.	1
7	User control	• Good to learn on my own.	25
		Other	5

* No opinion was provided by learners on the "Consistency" and "Error prevention" items.

The weaknesses and desired improvements identified by the learners are summarized in Table V-20. The learners expressed opinions on six of the Lim, Song and Lee (2012) criteria, with the exception of "Consistency" and "Aesthetic design." The implications of the weaknesses and desired improvements are discussed in Chapter V.

Table V-20. Results of learners' evaluations of the LTSS e-learning program (Weaknesses & Improvements)

No.	Item	Learners' Comments (Weaknesses)	Learners' Comments (Improvements)
	Agreement with user expectation	• Not many options for learning modes. - Only "Listening to lecture" and "Self-study" are available.	Would be better if the content was more interesting with the use of cartoons, etc.
		• Problem questions are not intriguing.	More difficult problems need to be added, and it would be nice to have a final test to recap.
		• The themes are confined to the change of seasons. -Cannot move to another theme.	More themes should be developed.
2	Convenience of operations	• Cannot return to the previous page if an incorrect button is pressed.	"Move backward" button should be added.
3	Minimization of memory load through screen design	• The learning screen is too small, making it hard to read the content.	The screen size needs to be bigger.
4	Error prevention	• Some technical errors were found. For instance, "100" points displays as "0" points.	There should be no errors on the screen showing the scores for a learner's task performance.
5	Advice and help information	• The explanation for the "self-study" mode is insufficient.	Further explanation should be provided in greater detail in the 'self-study' mode.
6	Feedback	• Explanation of wrong answers is insufficient.	Explanations should be provided for why an answer is wrong.

* No comments were made on the "Consistency," "Aesthetic design" and "User control" items.

Research 2. Effects and Optimality of Learners' Task Selection Supporting Strategies

In research 2, effects and optimality of LTSS strategies were investigated: Effects of LTSS strategies on task-selection accuracy, learning achievement, and self-directed learning abilities, effects of LTSS strategies on task-selection decision making, and optimality of LTSS strategies.

1. Effects of LTSS Strategies on Task Selection Accuracy, Learning Achievement, and Self-Directed Learning Abilities

A controlled test was performed to investigate the effects of LTSS strategies and guidelines on task selection accuracy, learning achievement, and self-directed learning abilities. For the process, 1) a hypothesis was formulated, 2) a research model was established, and 3) the hypothesis and model were verified.

1.1. Hypotheses and Research Model

This study suggests that there will be differences in task selection accuracy, learning achievement, and self-directed learning abilities between the group that learned the program using applications of LTSS strategies and guidelines and the group that learned the program without applications of LTSS strategies and guidelines. The experimental group that learned the program with applications of LTSS strategies and guidelines will have greater task selection accuracy compared to the control group (for task selection accuracy, a lower score indicates greater task selection accuracy).

In other words, compared to the control group, the experimental group that uses applications of cognitive, meta-cognitive and motivational strategies should be able to choose tasks that are appropriate for learners. It is expected that this task selection accuracy will ultimately have a significant impact on learners' achievements and self-directed learning. To examine these differences between the experimental group and control group, hypotheses were formulated, and a research model was established based on these hypotheses. Finally, the statistical significances of these hypotheses and the research model were verified.

Hypothesis 1: Learners' task selection supporting strategies and guidelines will have a significantly positive effect on learners' task selection accuracy.

Hypothesis 2. Learners' task-selection accuracy will have a significantly positive direct effect on learners' achievement.

Hypothesis 3. Learners' task-selection accuracy will have a significantly positive direct effect on self-directed learning abilities.

Hypothesis 4. Self-directed learning abilities will have a significantly positive direct effect on learners' achievement.

Hypothesis 5. The provision of LTSS strategies will have a significantly indirect effect on learners' achievement and self-directed learning abilities.

The primary purpose of this study is to examine the impact of LTSS strategies and guidelines on task selection accuracy, learning achievement, and self-directed learning abilities. Based on the theoretical rationale provided in the hypotheses above, we developed a research model that posits processes by which LTSS strategies and guidelines exert their effects. This model is presented in Figure V-16.

The first path occurs when LTSS strategies are hypothesized to increase task selection accuracy. Task selection accuracy results in increasingly self-directed learning abilities and learning achievement. This means that the provision of LTSS strategies has a direct effect on task selection accuracy and an indirect effect on self-directed learning abilities and learning achievement

According to this model, learners provided with LTSS strategies will make more accurate task selections than learners who are not provided with LTSS strategies. Learners with high task selection accuracy will have highly self-directed learning abilities and achievement.

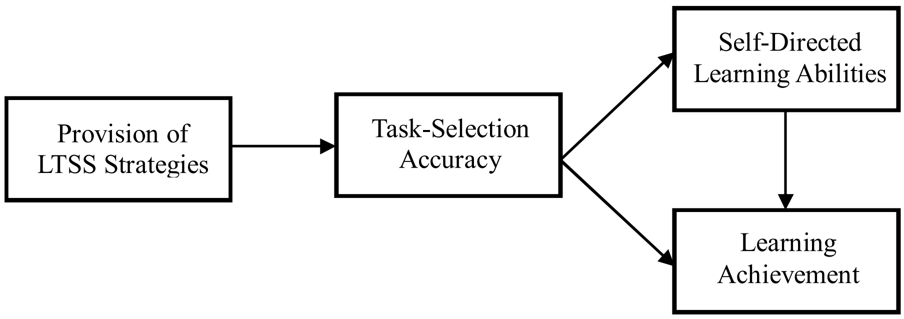


Figure V-16. Research model

1.2. The Effects of Learners' Task Selection Supporting Strategies and Guidelines on Task Selection Accuracy, Learning Achievement, and Self-Directed Learning Abilities

The means, standard deviations, and intercorrelations of the variables are displayed in Table V-21. We used Pearson's Product Moment Correlations to examine the intercorrelations among the constructs. As expected, the results show statistically significant negative correlations between the "provision of LTSS strategies and guidelines" and "task-selection accuracy" and between "task-selection accuracy" and "learning achievement." There is a positive correlation between "learning achievement" and "self-directed learning abilities," which is theoretically consistent. However, "task-selection accuracy" is not correlated with "self-directed learning abilities."

Table V-21. Means, standard deviations, and intercorrelations

Variable	*M*	*SD*	1	2	3	4
1. Provision of LTSS strategies and guidelines	.48	.50	-			
2. Task selection accuracy	1.30	.96	-.167*	-		
3. Learning achievement	8.06	1.97	-.011	-.137**	-	
4. Self-directed learning abilities	124.82	19.29	.071	.052	.163*	-

*Correlation is significant at the 0.05 level
**Correlation is significant at the 0.01 level

This section describes the estimation of the model tested in the current study through the path analysis approach, which investigates the effects of learners' task selection supporting strategies and guidelines on task selection accuracy, learning achievement, and self-directed learning abilities**.**

Step 1: Estimation of the Research Model

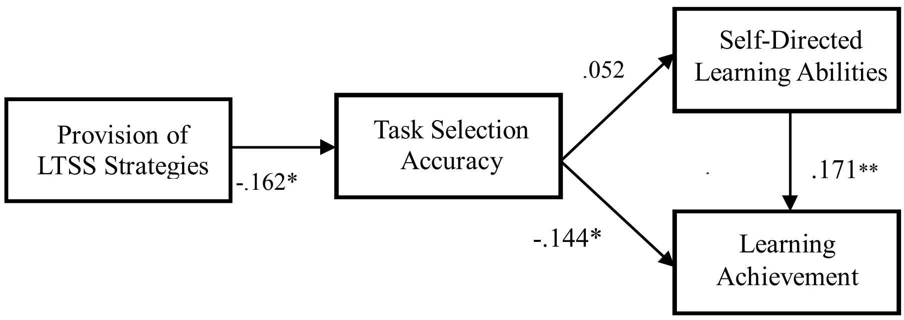


Figure V-17. Summary of standardized parameter estimates among variables

The first step of the analysis attempted to estimate the research model. The research model assumed that the provision of LTSS strategies would have a significant effect on task selection accuracy, self-directed learning abilities, and learning achievement. To assess the predicted relationships between variables, we tested a path model (Figure V-18) using AMOS.

Table V-22. Fit indices of research model

	χ^2	*df*	*p*	*Q*	GFI	CFI	NFI	RMSEA
Fit Indices	2.158	2	.340	1.079	.995	.989	.894	.018

Based on the fit indices, the hypothesized model fit the data quite well, as shown in Table Ⅴ-23. The chi-square value for the present model was 2.158 (*df*=2, *p*>.340), indicating that the observed and model-implied correlation matrices were not significantly different. Additionally, the goodness of fit (GFI) and comparative fit (CFI) indices all reached optimal levels of .90 and higher (.995 and .989, respectively). Finally, the Root Mean Square Error of Approximation (RMSEA) value for the present model was .018, clearly falling within optimal levels (<.05). Thus, the first step of the analysis revealed a high fit of the research model.

Table V-23. Results of path analysis of research model

			B	*SE*	β	*t*	*p*
Provision of LTSS Strategies	→	Task-Selection Accuracy	-.311	.124	-.162	-2.512	.012*
Task-Selection Accuracy	→	Learning Achievement	-.297	.132	-.144	-2.250	.024*
Task-Selection Accuracy	→	Self-Directed Learning Abilities	1.051	1.132	.052	.801	.423
Self-Directed Learning Abilities	→	Learning Achievement	.018	.007	.171	2.676	.007**

With respect to the predictive paths, most predictions (hypotheses 1, 2, and 4) were well supported by the data, as shown in Table Ⅴ-24. 'Task selection accuracy' was significantly negatively predicted by 'provision of LTSS strategies and guidelines' (β= -.162, *t* =-2.512), and 'achievement' was predicted by 'task selection accuracy' (β= -.144*,* *t* =-2.250). Learners who had higher 'self-directed learning abilities' showed higher 'learning achievement' (β= -.171, *t* =2.676). However, 'self-directed learning abilities' was not predicted by 'task selection accuracy' (β= 0.52, *t* =.801).

Table V-24. Results of direct effect, indirect effect and overall effect

		Direct Effect		Indirect Effect		Overall Effect	
		B	β	*B*	β	*B*	β
Provision of LTSS Strategies	Task-Selection Accuracy	-.311	-.162*			-.311	-.162*
Provision of LTSS Strategies	Self-Directed Learning Abilities			-.327	-.008	-.327	-.008
Provision of LTSS Strategies	Learning Achievement			.087	.022	.087	.022
Task-Selection Accuracy	Self-Directed Learning Abilities	1.051	.052			1.051	.052
Task-Selection Accuracy	Learning Achievement	-.297	-.144*	.018	.009	-.278	-.135
Self-Directed Learning Abilities	Learning Achievement	.018	.171**			.018	.171*

The present outcome also indicated that the provision of LTSS strategies had a nonsignificant indirect effect (β=-.008, *p*>.05) on self-directed learning abilities and a nonsignificant indirect effect (β=.022, *p*>.05) on learning achievement. The verification of the hypotheses shows that hypotheses 1, 2, and 4 were accepted, but hypotheses 3 and 5 were rejected.

2. Effects of LTSS Strategies on Task-Selection Decision Making

Table V-25 presents the mean scores and standard deviations for the two groups for the measure of task selection decision making. To understand how the provision of LTSS strategies affected task selection decision making, we conducted a one-way analysis of variance with the provision of LTSS strategies.

Table V-25. Mean scores and standard deviations for learners with LTSS groups and learners without LTSS groups for task selection decision making

Provision of LTSS Strategies	Group with LTSS strategies			Group without LTSS strategies		
	N	*M*	*SD*	*N*	*M*	*SD*
Satisfaction	14	4.71	1.46	13	5.80	1.08
Frustration	14	1.70	1.13	13	1.86	1.15
Difficulty	14	2.02	1.39	13	1.96	1.02
Enjoyment	14	5.26	1.81	13	5.73	0.76

Are groups with LTSS strategies more likely to be satisfied and less likely to be frustrated in the decision-making process than groups without LTSS strategies? A one-way ANOVA revealed no differences in frustration ($F(1, .17) = .13$, n.s.), difficulty ($F(1, .02) = .01$, n.s.), or enjoyment ($F(1, 1.4) = .74$, n.s.), suggesting that groups with LTSS strategies are not more likely to be satisfied and less likely to be frustrated than groups without LTSS strategies during the decision-making process. Interestingly, however, there was a significant difference in satisfaction between the two groups ($F(1, 4.02) = 8.79$, $p<.05$). Learners with LTSS strategies ($M= 5.80$, $SD= 1.08$) had higher satisfaction scores for the decision-making process than learners without LTSS strategies ($M = 4.71$, $SD = 1.46$).

Table V-26. Result of one-way ANOVA of task selection decision making

		Sum of Squares	*df*	Mean Square	*F*	*p*
Satisfaction	Between Groups	8.024	1	8.024	4.799	.038
	Within Groups	41.802	25	1.672		
	Total	49.826	26			
Frustration	Between Groups	.178	1	.178	.135	.716
	Within Groups	32.920	25	1.317		
	Total	33.099	26			
Difficulty	Between Groups	.024	1	.024	.016	.900
	Within Groups	37.981	25	1.519		
	Total	38.006	26			
Enjoyment	Between Groups	1.489	1	1.489	.748	.395
	Within Groups	49.754	25	1.990		
	Total	51.243	26			

3. Optimality of LTSS strategies

Learners evaluated the whether the task selection process and LTSS strategies were effective. Learners' evaluations of the task selection process and LTSS strategies were conducted in two phases. First, learners with LTSS strategies and without LTSS strategies evaluated the task selection decision-making process for e-learning programs. Second, learners with LTSS strategies were asked to evaluate the nine individual LTSS strategies.

Learners with and without LTSS strategies evaluated the task selection decision-making process for e-learning programs. The evaluation results are illustrated in Table V-27. The advantages of the task selection process for the e-learning program mentioned by learners with LTSS strategies and learners without LTSS strategies are shown in Table V-27. Learners cited the strength of the e-learning program with respect to three criteria. Their answers were categorized based on the highest response frequency.

Table V-27. Learners' evaluations of the task selection process (strength)

No.	Strength	Groups with LTSS Strategies (%)	Groups without LTSS Strategies (%)
1	Easy to select the learning task I want to study	54	32
2	Easy to identify the learning task level	33	15
	Other	4	8
	None	9	45

Table V-28. Learners' evaluations of the task selection process (weakness and improvements)

No.	Weakness	Improvements	Groups with LTSS Strategies (%)	Groups without LTSS Strategies (%)
1	Difficult to select appropriate tasks because of lack of information on my level	More information on the learner's level should be added	0	32
2	Difficult to identify the content of the learning task before clicking each task	More explanation on the learning task should be added	0	22
3	Too many options on the task selection screen	Numbers of task selection options should be reduced	15	21
4	The learners are not evaluating themselves; the programs should do the evaluating		4	8
5	Difficulty levels should be wider			
	None		81	27

As a main weakness in selecting tasks, learners with LTSS strategies said, 'There are too many task selection options in the task selection screen'. In contrast, learners without LTSS strategies said, "It is difficult to select appropriate tasks because of the lack of information on my level", "It is difficult to identify the content of the learning tasks before clicking each task" and "There are too many options on the task selection screen." The majority of the students (32%) responded that it was difficult to select tasks because they lacked sufficient information on their learning level. Learners without LTSS strategies mentioned weaknesses of and possible improvements to the process of selecting tasks, as described below.

> "I wish I knew my level so I could select the right task. I didn't have much information to find out my level. I wish we had a test through

which we could realize our levels, even in a simple way." (Learner A, without LTSS strategies)
"Beginners like me wouldn't understand what it is like. I wish there was guidance to let us know what we need and what levels we are in." (Learner B, without LTSS strategies)

Next, learners were asked to evaluate the strengths and weaknesses of individual LTSS strategies. The results are shown in Table Ⅴ-29.

Table V-29. Learners' evaluations of the individual LTSS strategies

Strategy No.	Strength	Weakness & Improvements
1.1.Ensure that learners possess fundamental prior knowledge	• Let the learner easily understand the level of his or her prior knowledge	Questions with a higher level of difficulty are added in the diagnostic test
1.2.Have learners set their own learning goals	• Provides an opportunity to think about the learning goals	The learning goals are more segmented. It is recommended that the learner does not set up the learning goal; the program should automatically designate the learning content according to the diagnostic test results
1.3.Have learners share learning goals	• Allow learners to view the learning goals of different friends	It would be good if the learning goals were not shared
2.1.Provide metadata to learners prior to task selection	• The contents of the learning task can be identified beforehand	The screen should be bigger so that the learner can click on the picture without clicking on the letters
2.2.The number of tasks learners can choose should be provided	• Either basic or intense may be chosen	The levels of difficulty between basic and intense should be wider

2.3. Provide learners with reflection prompt on task selection after selecting a task	• Have the learner think about why he or she chose the task again	Add an etc. column to the question columns Delete this question
3.1. Have learners self-assess their learning process after completing the task	• Allow the learner to evaluate his or her level	Increase self-assessment questions The learners are not evaluating themselves; the programs should do the evaluating
3.2. Provide ipsative feedback on the score of the 'interim test'	• Allows the learner to check his or her cumulative score	Correct error
3.3. Have the learner establish plans for the next task	• Learners can make plans by themselves	Allow cumulative plans to be viewed

1.1 Ensure that learners possess fundamental prior knowledge before learning. One of the strengths of the strategy was that learners found it helpful to determine their level of prior knowledge. For the weaknesses and points of improvement, learners suggested that it would be good if problems with a higher level of difficulty were added. The learners' comments are as follows.

> "The contents were vaguely known to me, so it was good for me to clearly know them through the diagnostic test."
> "I hope that more difficult questions will be added in the diagnostic test. It was less fun because only basic level questions appeared."

1.2. Have learners set their own learning goals. One of the strengths of the strategy was that learners appreciated the opportunity to think about their learning goals. For the weaknesses and points of improvement for this strategy, the learners felt that the learning goals should be more segmented and that learners should not set the learning goals themselves; instead, the program should automatically set the goals according to the level of the learner. Many learners suggested that the program should automatically set the learning goals. The related comments are as follows.

> "I wish that I did not have to the set the learning goals, but instead the program would set the learning goals automatically according to the results of the diagnostic test. I don't know which learning goal is the proper one for me. I was a bit confused."

1.3. Have learners share learning goals. One of the strengths of the strategy was that the learners said that it was fun to see the learning goals of their friends. For the weaknesses and points of improvement, the learners wished that an individual's learning goal would only be revealed to that person and that the learning goals would not be shared. The learners' comments related to this issue are as follows.

> "I disliked my friends seeing my learning goal. I just want mine not to be viewed by others. I wish this function was removed."

2.1. Provide metadata to learners prior to task selection. One of the strengths of the strategy was that the learners appreciated knowing the learning content before clicking on the task. For the weaknesses and points of improvement, the learners felt that it would be good if the screen were bigger and if the learners could click on the picture without clicking on the letters. The comments related to this issue are as follows.

> "If you bring up the mouse, the picture appears. The picture was small, so you couldn't see it very well. I wish the picture was a little bigger. Still, it was much better than having no picture at all."
> "Normally, you would click on a picture, but here you had to click on the letters 'Click', so it was confusing. It would be better to click on a picture."

2.2. The number of tasks learners can choose should be provided. One of the strengths of the strategy was that it was convenient for the learners to be able to choose basic or intense levels. For the weaknesses and points of improvement, the learners felt that the difficulty difference between basic and intense was too small. The learners' comments related to this issue are as follows.

> "Because it was divided into basic and intense, it was good to choose the one that suited my level."
> "The difficulty difference between basic and intense was too small. I wish there was huge difference between them. Then, it would be fun to go up the stages."

2.3. Provide learners with a reflection prompt for task selection after selecting a task. One of the strengths of the strategy was that learners appreciated being able to think about why they chose a task. For the weaknesses and points of improvement, the learners suggested that it would be good to have an "etc." column among the selection columns. The learners also wondered why this question existed at all.

> "Being able to think about why I chose the task after choosing the task seems to be better."
> "I don't know why this is necessary. It was tiresome because it was repeated every time I finished the tasks."

3.1. Have learners self-assess their learning process after completing the task. One of the strengths of the strategy was that the learners could evaluate their level. For the weaknesses and points of improvement, the learners felt that the number of questions should be increased and that the program should perform the evaluation rather than the learners themselves. The learners' comments related to this issue are as follows.

> "It was good because I was able to think about whether I knew or not one more time."
> "I wish I wouldn't have to do the evaluation myself but the program would just do the evaluation by itself. I think that is more accurate."

3.2. Provide ipsative feedback on the score of the ‘interim test’. One of the strengths of the strategy was that the learners could check their cumulative abilities. For weaknesses and points of improvement, learners felt that it would be good if the feedback score error were removed.

> "It was good to see all the tests I took all at once. You can see which tasks received high scores and which tasks received low scores."
> "Sometimes the actual score and the accumulated score are different. I wish this error wasn't there."

3.3. Have learners set up plans for the next task. One of the strengths of the strategy was that the learners could establish a plan before choosing the actual task. For the weaknesses and points of improvement, the learners suggested that it would be good to be able to see the cumulative plans. The learners’ comments related to this issue are as follows.

> "It was easy to make a plan because you could see the accumulated scores. For tasks with low scores or tasks you haven't done yet, you can simply do them again."
> “It would be good to also see the accumulated plans. It would be good also to have tools to set up plans in more detail.”

Chapter VI. DISCUSSION

The purposes of this study are to develop learners' task selection support (LTSS) strategies and investigate the effects and optimality of LTSS strategies. The two research questions are as follows. (1) What are the LTSS strategies? (2) What are the effects of these LTSS strategies ? This question includes (2-1) what are the effects of LTSS on task-selection accuracy, self-directed learning abilities, and learning achievement? (2-2) what are the effects of LTSS strategies and guidelines on task-selection decision making? and (2-3) what are the optimal LTSS strategies?

This study consisted of two phases of research. In Research I, LTSS strategies were developed based on a literature review. In order to internally validate the LTSS strategies, the strategies were reviewed twice by experts. Next, an e-learning program was developed based on the final version of the LTSS strategies, and experts and learners performed a prototype evaluation of the storyboard as well as a usability evaluation of the e-learning program. In Research 2, first, the effects of the LTSS strategies on task-selection accuracy, learning achievement, and self-directed learning abilities were investigated, followed by the effects on task-selection decision making. Finally, strengths, weaknesses, and suggested improvements to the LTSS strategies were investigated according to learner evaluations.

This chapter summarizes the previous chapters and discusses the implications of the main research findings. First, Section 1 discusses the rational for a development study on LTSS strategies and guidelines. Section 2 presents implications of the research findings. Finally, Section 3 points out limitations of the study and recommends future research topics.

1. Rationale for the Development Study on LTSS Strategies

Task selection is an important process in self-directed learning. By selecting appropriate tasks, learners improve their self-directed learning abilities, ultimately enhancing their learning achievements. However, selecting one's own learning tasks has both advantages and disadvantages, as a matter of course. To minimize the disadvantages and help learners make appropriate task selections, this study designed strategies to support learners' task selection in self-directed learning. The rationale for the developmental study on LTSS strategies is summarized below.

1.1. Integrated LTSS Strategies in Self-Directed Learning in Consideration of Cognitive, Meta-cognitive, and Motivation Domains

Researchers have proposed several strategies to support learners' selection of tasks (e.g., Corbalan, Kester, Merrienböer, 2009; Kicken et al., 2009; Kostons, van Gog, & Paas, 2010). Given these various proposals, there is a need to create an integrated strategy that takes into account learners' cognitive, meta-cognitive, and motivation factors in task selection.

This article described LTSS strategies and guidelines, which specify all necessary information to effectively enhance learners' task selection. The mechanism presented in the LTSS strategies and guidelines is based on cognitive, metacognitive, and motivation explanations reported in the literature. These explanations are applied to overcome the negative outcomes of learners' task selection. According to the strategies and guidelines, learners can make an accurate task selection if they participate in the LTSS e-learning program, which provides various supports in the stages of self-determined learning (SDL): 1) diagnose status, 2) select and perform a task, and 3) assess the task. After selecting and performing one or more tasks, learners are expected to follow the SDL stages effectively. By performing more and more tasks, the learners engage in increasingly self-directed learning and gain the skill of making effective task selections without support or guidance.

1.2. Analysis of Direct and Indirect Effects of LTSS Strategies

To date, no studies have verified that integrated LTSS strategies have a significant direct effect on learners' task-selection accuracy and, further, that they have an indirect effect on learning achievements. In order for learners to learn autonomously, they should figure out what they need and choose the most appropriate task for themselves. The learners are required to distinguish between which task is the most appropriate or not for themselves in consideration of task characteristics (e.g., type of task, complexity level, the amount of support)

Some researchers (e.g., Brockett & Hiemstra, 1991; Williams, 1996; Zimmerman, 1994) even believe that learners' control over task selection has a positive effect on their self-directed learning abilities. That is, self-controlled activities such as task selection are the precondition of self-directed learning (Kicken et al., 2008).

Moreover, by constantly selecting tasks and performing them, learners improve their learning achievements (Corbalan, Kester, & van Merriënboer, 2008; Salden et al., 2004). Therefore, it is expected that task selection will enhance learners' learning achievements in terms of competence and cognitive load. In other words, when learners select appropriate tasks based on their competence and cognitive load, their actions have a positive effect on their learning achievements. Under this hypothesis, this study investigated whether integrated LTSS strategies have a significant direct effect on learners' task-selection accuracy and, further, whether they have a significant indirect effect on their learning achievements or self-directed learning abilities.

2. Implications of the Research Findings

2.1. Development of the LTSS Strategies and Guidelines

2.1.1. Changes to the LTSS strategies and guidelines

The LTSS strategies and guidelines were modified through primary and secondary reviews by experts. The largest change made through the primary review was the reconstruction of LTSS strategies. Three experts advised that the strategies should be reclassified according to the five stages of the self-directed learning process. Following their advice, the strategies were reclassified into these five stages, rather than into cognitive, meta-cognitive, and motivation domains, as they had been previously. The new classification more clearly shows the relationship between self-directed learning and LTSS strategies.

The largest change made through the secondary review was the deletion of Strategies 4.4 and 4.5. An expert pointed out that Strategy 4.4 "Provide fading guidance" and Strategy 4.5 "Provide completion strategy" do not directly relate to task selection, in contrast with the other strategies. The experts suggested that these two strategies are aimed at reducing extraneous load. Their comments played an important role in clarifying the direction of this study. The view was regarded as valid, and the two strategies were deleted accordingly.

2.1.2. Usability evaluation

In their usability evaluations of the e-learning program, learners mostly cited program strengths in response to survey items about "advice and help information" and "user control." Regarding these two items, learners reported that the e-learning program explains the learning contents well enough for them to understand easily, with the key points arranged well. This result may be attributed to the program's inclusion of both high-interactive tasks ("learn by yourself") and low-interactive tasks (“listen to explanations”).

Tasks with high interactivity are effective because they allow students to explore complex interactions among dynamic variables that model real-life situations (Park, Lee, & Kim, 2008). According to the interactivity effect (Betrancourt, 2005), students can more easily comprehend the information depicted in a task when the device gives them some control over the task pace. On the other hand, tasks with low interactivity are effective for low-level learners because the students do not need prior knowledge to fully understand each segment. Thus, both high- and low-interactive tasks can aid learners’ comprehension. In addition, learners in this study indicated that the e-learning program has a great strength in the area “user control.” Because the program is designed for learners to select their own learning tasks, it properly supports learners’ self-control.

Learners reported the weaknesses of the e-learning program as the following: “lack of many learning methods to select from,” “questions are too simple,” and “topics are confined to the change of seasons.” These findings indicate it is necessary to add higher-level learning methods and contents to this program for learners with higher prior-knowledge levels. Moreover, some learners complained that the program did not have a ‘‘Return” button; this function should be added for user convenience.

2.2. The Effects of LTSS Strategies on Task Selection, Learning Achievement, and Self-Directed Learning Abilities

2.2.1. Relations with LTSS strategies and learners’ task-selection accuracy

This experiment showed that, in line with our Hypothesis 1, LTSS strategies had a direct effect on learners’ task-selection accuracy. The finding indicates that each of the LTSS strategies has a positive effect on learners’ task-selection accuracy when combined with another strategy. Previous studies proposed strategies corresponding to one or two aspects in the cognitive, meta-cognitive, and affective domains (e.g., Corbalan, Kester, Merrienböer, 2009; Kicken et al., 2009; Kostons, van Gog, & Paas, 2010). Yet for learners to make appropriate task selections, it is insufficient for them to solve only one or two cognitive, meta-cognitive, or affective problems. This study extends the prior research by proposing an integrated approach that combines the cognitive, meta-cogntive, and affective approaches. Further, Kostons, van Gog, and Paas's (2012) study on task-selection accuracy suggested that task-selection modeling can improve task-selection accurary. This study extends their research by showing that cognitive, meta-cognitive, and affective strategies can lead to the improvement of task-selection accuracy.

2.2.2.Relations with learners' task-selection accuracy and learning achievement

The study results verified Hypothesis 2 "Task-selection accuracy will have a significant positive effect on learning achievements." In other words, by constantly selecting and carrying out tasks, learners greatly improved their learning achievements. Salden's (2004) study on task-selection accuracy suggested that dynamic task selection, through the combination of mental effort and performance, is significantly more efficient than non-dynamic task selection. The results of this study correspond with this finding and others like it (Corbalan, Kester, & van Merriënboer, 2009). Moreover, it demonstrates that measuring competence and cognitive load can be one of the best methods of assessing learners' task-selection accuracy.

2.2.3. Relations with learners' task-selection accuracy and self-directed learning abilities

Based on the results of analysis, the study rejected Hypothesis 3 "Learners' task-selection accuracy will have a significant effect on their self-directed learning abilities." It was found that learners' task-selection accuracy does not have a significant effect on their self-directed learning abilities. Some researchers (e.g., Brockett & Hiemstra, 1991; Williams, 1996; Zimmerman, 1994) believe that learners' control over task selection improves their self-directed learning abilities. That is, self-controlled activities such as task selection are the precondition of self-directed learning (Kicken et al., 2008).

However, this study found that learners' task-selection accuracy does not have a significant effect on their self-directed learning abilities. The reasons were analyzed as follows: Firstly, self-directed learning ability does not generally improve in such a short period of time. Thus, improving task-selection accuracy will not always lead to an immediate improvement in self-directed learning abilities. Secondly, self-directed learning is affected by several other variables in addition to task-selection accuracy. To enhance learners' self-directed learning abilities, therefore, it is needed to consider integrating those variables. However, it is clear that self-controlled activities such as task selection are the precondition of self-directed learning (Kicken et al., 2008).

2.2.4. Relations with self-directed learning abilities and learning achievement

The study results verified Hypothesis 4 "Self-directed learning abilities will have a significant positive effect on learners' achievement." This finding is consistent with those of previous studies (Hoban & Sersland, 1996; Redding, Eisenman, & Rugulo, 1999; Long & Morris, 1996). Likewise, individuals who demonstrate higher levels of self-directed learning readiness are more likely to be independent and responsible for their own learning (Knowles, 1990).

2.2.5. Relations with provision of LTSS strategies, self-directed learning abilities, and learning achievement

The study partially verified Hypothesis 5 "The provision of LTSS strategies indirectly improves learners' self-directed learning abilities and achievements." It was found that the provision of LTSS strategies did not have an indirect effect on learners' self-directed abilities, but it did have an indirect effect on their learning achievements.

The reason the provision of LTSS strategies did not indirectly affect learners' self-directed learning abilities is associated with Hypothesis 3. Since the accuracy of learners' task selection did not affect their self-directed learning abilities, as predicted by Hypothesis 3, the provision of LTSS strategies failed to have an indirect effect on learners' self-directed learning abilities. Particularly speaking, self-directed learning is not an ability that is likely to improve greatly within the short term; thus, future research should investigate the same potential effects in a longitudinal study.

On the other hand, LTSS strategies were found to have an indirect effect on learners' pre-learning achievements. This finding indicates LTSS strategies ultimately have a positive effect on learning achievements and that learners increase the accuracy of their task selection through the use of cognitive, meta-cognitive, and motivation strategies.

2.3. The Effects of LTSS strategies on Task-Selection Decision Making

Were learners who used LTSS strategies more apt to show high levels of satisfaction and enjoyment and low levels of difficulty and frustration? No empirical evidence was found to support this claim. Interestingly, learners without LTSS strategies rather showed higher satisfaction after selecting each task than their counterparts who had been given LTSS strategies. This finding presents the possibility that more information might interfere with learners' satisfaction after task selection. As learners with LTSS strategies have more information than learners without them do, they feel more responsible for their choices, resulting in dissatisfaction with their decision (see Iyengar & Lepper, 2000).

To begin, learners with LTSS strategies were constantly provided a diagnostic test and information related to their learning level, such as ipsative feedback, unlike learners without LTSS strategies. Learners with LTSS strategies knew their Basic and Intense scores as well as the total score through the diagnostic test, and through the ipsative feedback, they could easily find out which of their tasks had a lower or higher score and which tasks they should supplement. In addition, unlike the learners without LTSS strategies, they exercised deep self-reflection while setting learning goals, self-assessments, and plans at the same time. Through such activities, the learners were able to check their own statuses and comprehend their levels more easily. They frequently received information about their learning performance, which appeared to increase their sense of responsibility in task selection.

This finding is consistent with Iyengar and Lepper's (2000) finding that participants in the extensive choice condition reported feeling less satisfied and having more regrets about the choices they made than limited choice participants did, even though the participants in the extensive choice condition also reported experiencing the decision-making process as more enjoyable. Their greater dissatisfaction with their decisions may be attributed to feeling unsure or feeling burdened by the responsibility of distinguishing good from bad decisions (Gilovich & Medvec, 1995).

2.4. Optimality of LTSS Strategies and Guidelines

Through Strategy 1.1 “Make the learner possess fundamental prior knowledge before learning,” learners could choose tasks that were necessary for them, instead of other tasks that they simply preferred, by acquiring relevant knowledge before performing a task (Kicken, Brand-Gruwel, & van Merriënboer, 2008; Koston, van Gog, & Paas, 2009). Results of the learners’ evaluation of Strategy 1.1 showed that this study helped learners acquire basic knowledge of tasks. This finding supports pretraining theory (Mayer, Mathias, & Wetzell, 2002; Mayer, Mautone, & Prothero, 2002; Pollack et al., 2002), which argues that giving learners essential prior knowledge reduces the cognitive load on task selection.

Strategy 1.2 “Make learners set their own learning goals” encouraged learners to make a self-determined choice after formulating goals by themselves. When a goal is formulated, it is easier for learners to judge which tasks are related to the goal. The learners’ evaluation comments indicated that this strategy encouraged them to think about their learning goals and aided them in their task selection. Therefore, learners may be prompted to make self-determined choices by establishing their own learning goals and selecting the next task. This result supports previous research findings that when students believe their learning tasks are related to their personal goals, they have a greater sense of autonomy in their studying (see self-determination theory in Ryan, & Deci, 2000 & Ryan, 1993).

Strategy 1.3 “Make learners share learning objectives” helped learners make a related enhancing choice. In the learner evaluations, participants reported that they were interested in knowing their friends’ learning goals, and some even suggested that more information should be shared. Therefore, a learner’s relatedness may be increased to enhance self-determination motivation when his or her learning goals are compared with those of peers. This finding is consistent with research showing that for Asians, self-determination motivation does not increase by simply giving individuals the right of choice and even if one makes his or her own choices, one's motivation increases when one's decision does not deviate from the group's common objective (Iyengar & Lepper, 1999; Katz & Assor, 2007).

Strategy 2.1 "Provide metadata to learners prior to their task selections" helped learners easily decide which task they would select. In this study, a screen capture was shown to learners as the metadata. Learners commented that these metadata helped them understand the content of the task. Further, the metadata helped them more easily envision the task content when compared to other information. This finding is consistent with those of previous studies (Bell & Kozlowski, 2002; Kicken, Brand-Gruwel, & van Merriënboer, 2008) showing that if the task content, level of difficulty, and learning methods are provided to them, learners might not feel cognitive load when selecting tasks.

Strategy 2.2 "The number of tasks learners can choose should vary" helped learners by providing an appropriate number of options, because providing too many options can actually hinder selection. Learners also commented that choosing between Basic and Intense reduced the cognitive load on task selection. This finding supports the expertise reversal effect (Plass, Kalyuga, & Leutner, 2010), which states that learners with low prior knowledge experience difficulty even with many task selection options. The finding is also consistent with the idea that providing excessive selection options can hinder selection (Haynes, 2009; Iyengar & Lepper, 2000; Shah & Wolford, 2007; Tversky & Shafir, 1992).

Strategy 2.3 "Provide learners with a reflection prompt after they select a task" encouraged learners to evaluate their task selection. Asking learners to respond to questions about why they chose a specific task can help their acquisition of sequential skill in the self-direction stage and facilitate induction (van Merriënboer & Sluijsmans, 2009). Learners also commented that this strategy encouraged them to consider once again about why they chose the task. Through the continuous practice of reflecting on their task selection, they learned to select more appropriate tasks.

Strategy 3.1 “Make learners self-assess their learning process after completing the task,” enabled learners to select tasks knowing their own strengths and weaknesses, as determined by self-assessment (Kicken et al., 2008; Sadler 1983). This finding is consistent with the argument (Lew et al., 2010; van Kraayenoord & Paris, 1997) that, because self-assessment includes both reflection and evaluation and it helps to make learners have a responsibility and autonomy that controlling their performance and learning processes.

Strategy 3.2 “Provide ipsative feedback on the interim test’s task score” allowed learners to compare the quality of their performance over time (Harlen & James, 1997). The learner evaluations also indicated that this ipsative feedback made the learners focus on their learning development process and provided an objective evaluation of their learning status.

Strategy 3.3 “Make the learner set up plans for the next task him/herself” prompted learners to create a plan for overcoming insufficiencies in their learning and to choose an appropriate task. The learners reported that this strategy helped them to form plans by themselves. The finding supports the assertion of Loyens, Magda, and Rikers (2008) that learners were able to make better decisions when they set up plans for the next task.

Despite the advantages described above, learners also pointed out weaknesses and gave suggestions for improvement of the LTSS strategies. As shown in Table VI-1 below, the weaknesses and suggested improvements can be largely divided into two groups: opinions in favor of “More Choices and Higher Difficulty” and those advocating “Fewer Choices.”

Table VI-1. Optimal LTSS strategies

Opinions in Favor of More Choices and Higher Difficulty	Opinions in Favor of Fewer Choices
• Questions with a higher level of difficulty should be added to the diagnostic test. (Strategy 1.1) • The learning goals should be more segmentalized (Strategy 1.2) • The level of difficulty between Basic and Intense should be wider. (Strategy 2.2) • The number of self-assessment questions should be increased. (Strategy 3.1)	• Learners should not set their own learning goals, but instead the program should automatically designate the learning contents according to the diagnostic test results. (Strategy 1.2) • Learners should not evaluate themselves; rather, the program should perform the evaluations. (Strategy 3.1)

In the category "More Choices and Higher Difficulty," some learners expressed the opinion that learning goals should be segmentalized to broaden the range of choices, or that the number of self-assessment questions should be increased and questions with a higher level of difficulty should be added to the diagnostic test so that they might choose an Intense course with a higher level of difficulty when selecting tasks. In the category "Fewer Choices," however, other learners expressed the opinion that, not learners themselves, but the program should automatically choose learning goals according to the diagnostic test results, and it should even evaluate learner levels in place of learners' self-assessment.

As shown above, learner opinions were largely divided into two opposite categories, advocating either increasing or decreasing the range of choices. Therefore, in future developments, it is recommended to create a program with different selection ranges, in consideration of learners' varying levels of self-directed learning ability. The interview data indicated that learners had more difficulty selecting tasks than choosing learning methods. This difficulty should be reduced by further research on the effectiveness of shared control, through which the program determines the difficulty of future tasks, while learners choose learning methods.

3. Limitations of the Research and Direction of Future Research

First, it should be pointed out that this study did not assess the long-term effect of learners' academic achievements or self-directed learning abilities. Thus, future studies should investigate whether the effect of the LTSS strategies fades over time and if so, at what intervals training should be repeated. Additionally, the learners participated in e-learning just once during this study. It is recommended to verify the effectiveness of LTSS strategy use with a group of learners who have used the e-learning program over the course of a semester.

Second, the effect of LTSS strategies should be studied in terms of individualization. Many previous studies have investigated individualized learning methods, but in most of these studies, the program determined what learning contents were most appropriate for learners. However, the most effective method of individualization is to allow the learners themselves to judge what learning contents they need.

Granting learners control over their own learning tasks is believed to foster self-directed learning skills and to result in personalized trajectories (Hannafin, 1984). Rather than having all learners follow the same instruction or practice schedule, which is often targeted at the average learner, personalized instruction allows learners who have difficulty with a task or topic to start at a lower level of complexity or receive more support. Such personalized instruction is expected to enhance student motivation and learning outcomes.

Accordingly, it recommended to investigate individualization from a different point of view, given that the most effective method of individualized learning is for learners to determine what content is most necessary or appropriate for them. Therefore, future studies should examine the development of LTSS strategies from the standpoint of individualized teaching.

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APPENDIXES

Appendix A	:	Project Checklist
Appendix B	:	The 1st Validation Package
Appendix C	:	The 2nd Validation Package
Appendix D	:	Prototype Evaluation on Storyboards
Appendix E	:	Usability Evaluation on the e-learning Program
Appendix F	:	Self-Directed Learning Readiness Test
Appendix G	:	Prior Knowledge Test
Appendix H	:	Learning Achievement Test

Appendix A: Project Checklist

Project Checklist

Documentation of Events

Strategies Development	The Due Date
• Conduct literature review	September 10, 2011
• Develop the 1st ver. LTSS strategies	October 8, 2011

1st Expert Review

• Develop 1st expert review package	
• Conduct interviews	
- Expert A	November 18, 2011
- Expert B	November 24, 2011
- Expert C	November 26, 2011
- Expert D	November 21, 2011
- Expert E	November 24, 2011
• Reflect experts' comment and develop 2nd ver. LTSS strategies	

2nd Expert Review

• Develop 2nd expert review package	
• Conduct interviews	
- Expert A	January 17, 2012
- Expert B	January 27, 2012
- Expert C	January 10, 2012
- Expert D	January 23, 2012
- Expert E	January 30, 2012
- Expert F	December 26, 2011
- Expert G	December 20, 2011
• Reflect experts' comment and develop final ver. LTSS strategies	

Prototype Evaluation on Storyboards

• Test the prototype on storyboards	
- Expert A, B, C, D	Finished on February 20, 2011

Product Usability Documentation

• Develop e-learning program	February 27, 2012
• Develop e-learning program usability documentation	February 27, 2012
• Test the usability of e-learning program	

- Expert A	March 1, 2012
- Expert B	March 1, 2012
- Expert C	March 5, 2012
- Learners	April 16, 2012 -April 21, 2012

Effects and Optimality of LTSS Strategies

Effects of LTSS Strategies

• Develop control test package	April 3, 2012
• Conduct control test	April 16, 2012 -April 21, 2012 June 28, 2012
• Document control test data	April 27, 2012 June 29, 2012

Optimality of LTSS Strategies

• Develop learners' evaluation package	June 25, 2012
• Conduct learners' evaluation	June 28, 2012
• Document learners' evaluation data	June 29, 2012

Appendix B: 1st Validation Package

1st Expert Review
on Learners' Task Selection Supporting Strategies
in Web-Based Self-Directed Learning

Let me first thank you for your time and effort in assisting me with this research. Your expertise and suggestions will provide me with a wealth of information. The purpose of this evaluation is to validate a proposed Learners' Task Selection supporting Model in a Web-based Self-Directed Learning Environment. ALL ANSWERS WILL BE KEPT IN THE STRICTEST CONFIDENCE. YOUR ANSWERS WILL BE ONLY USED TO ACHIEVE THE PURPOSE OF THIS STUDY. Again, thank you for sharing your time and opinions.

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Name	
Highest level of education	
Major(s)	
Affiliation /Position	
Self-directed learning research experience	_______ (number of years)
Online learning & online learning system development research experience	_______ (number of years)
Model, principle and strategy development research experience	_______ (number of years)

- Strategy deduction process omitted
- Instructions omitted

LTSS Strategies and guidelines (1st ver.)

		Strategies	Guidelines
Cognitive Strategies	Strategies for Reducing **Cognitive Load**	• Provide fading guidance	• Provide guidance on self-assessment and planning in beginning and have them 'fade' later. • Have the learners decide independently whether guidance is provided.
		• Make sure the learner possesses fundamental prior knowledge before learning	• Conduct diagnostic tests and have learners accumulate prior knowledge before learning (Mayer & Moreno, 2010). • Provide immediate feedback for diagnostic testing so that learners can immediately confirm the results of the diagnostic tests.
		• Use completion strategy	• Have the learners select between completion problems and conventional problems in self-assessment
		• The number of tasks learners can choose should be provided	• Provide a different number of task options according to the 'diagnostic test' results.
Meta-Cognitive Strategies	Strategies for enhancing **Meta-Cognition**	• Provide learners with reflection prompts for task selection after selecting a task	• After selecting a task, have learners fill out the reflection prompt on task selection. • Have learners select the reason they chose the task.
		• Have learners self-assess their learning process	• Provide a tool to self-assess whether they achieved necessary knowledge after the task.
		• Provide ipsative feedback on the score of the 'interim test'	• Provide immediate feedback on the 'interim test'. • Make cumulative 'interim test' scores visible after learning each task.
		• Have the learner establish plans for the next task	• Based on the accumulated feedback for the interim test, provide tools that allow the learner to select the next task.

Motivational Strategies	Strategies for enhancing **Autonomy**	• Have learners set their own learning goals	• Let learners select their own learning goals among learning goals that correspond to program difficulty levels 1 to 4.
	Strategies for enhancing **Relevance**	• Have learners share learning objectives	• Let all students see learning objectives set by other learners.
	Strategies for enhancing **Competency**	• Provide metadata to learners	• Provide metadata (information about the task: level of difficulty, interaction level) in advance. • Give learners the right to view metadata.

Validity of the Process Drawing Model and Strategies

1=strongly disagree, 2=disagree, 3=neither disagree or agree, 4=agree, 5=strongly agree

	Item	1	2	3	4	5
Comprehensive Literature Review	Is various literature searched to draw a model and a strategy for the subject choice?	1	2	3	4	5
Appropriate Terminology	Do the selected terms explain the meaning of the design for the subject choice?	1	2	3	4	5
Appropriate Interpretation and Summary of Reviewed Literature	Is the preceding study appropriate as basic data to develop a model and a strategy of the subject choice?	1	2	3	4	5
Logical organization	Is the strategy for the subject choice design logically organized?	1	2	3	4	5
Appropriate Reflection of Literature Review	Are the results of the preceding study properly reflected in the model and strategy of the subject choice?	1	2	3	4	5

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Comments

Validity of the LTSS Strategies

1=strongly disagree, 2=disagree, 3=neither disagree or agree, 4=agree, 5=strongly agree

	Item	1	2	3	4	5
Validity	Does this strategy provide activities and procedures necessary for the process of subject choice?	1	2	3	4	5
Explanation	Does this strategy help to plan the process of subject choice?	1	2	3	4	5
Usability	Is this strategy useful to design the process of subject choice?	1	2	3	4	5
Universality	Can this strategy be universally used to design the process of subject choice?	1	2	3	4	5
Understanding	Does this strategy make it easy to understand the activities and procedures for the process of subject choice in self-directed learning?	1	2	3	4	5
Model-strategy connection	Is the model properly connected to the strategy?	1	2	3	4	5
Strategy-guideline connection	Is the strategy properly connected to the guidelines?	1	2	3	4	5

Comments

Appendix C: The 2^{nd} Validation Package

2nd Expert Review onLearners' Task Selection supporting Design Model in Self-Directed Learning

Let me first thank you for your time and effort in assisting me with this research. Your expertise and suggestions will provide me with a wealth of information. The purpose of this evaluation is to validate a proposed Learners' Task Selection supporting Model in a Web-based Self-Directed Learning Environment. ALL ANSWERS WILL BE KEPT IN THE STRICTEST CONFIDENCE. YOUR ANSWERS WILL BE ONLY USED TO ACHIEVE THE PURPOSE OF THIS STUDY. Again, thank you for sharing your time and opinions.

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Name	
The highest levelof education	
Major(s)	
Affiliation /Position	
Self-directed learning research experience	_______ (number of years)
Online learning & Online learning system development research experience	_______ (number of years)
Model, principle and strategy development research experience	_______ (number of years)

- Instructions omitted

LTSS strategies and guidelines (2nd version)

	Strategies	Guidelines
1. Diagnose the status	1.3. Ensure that learners possess fundamental prior knowledge before learning [Cognitive strategy]	1.3.1. Conduct diagnostic tests and have learners accumulate prior knowledge before learning (Mayer & Moreno, 2010). 1.3.2. Provide immediate feedback for diagnostic tests so that learners can immediately confirm the results of diagnostic tests.
	1.4. Have learners set their own learning goals (Moos & Azevdo, 2008) [Motivational strategy]	1.3.1. Allow learners to select their own learning goals among learning goals that correspond to program difficulty levels 1 to 4 (Moos & Azevdo, 2008; Roll et.al, 2007).
	1.4. Have learners share learning goals (Katz & Assor, 2003, 2007) [Motivational strategy]	1.3.2. Let all students see learning goals set by other learners (Katz &Assor, 2003, 2007). • Make it possible to see one's own learning objective as well as others' objectives by clicking on 'my learning objective' and 'friends' learning objectives' items.
2. Select the task& Perform the task	2.2. Provide metadata to learners prior to making task selection (Bell & Kozlowski, 2002; Kicken et al., 2008) [Cognitive strategy]	2.2.1. Provide metadata (information about the task: level of difficulty, interaction level) in advance. 2.2.2. Give learners the right to view metadata (Kicken et al., 2008).
	2.3. The number of tasks learners can choose should be provided (Schwartz, 2004). [Cognitive strategy]	2.4.1. Provide a different number of task options according to the diagnostic check results (Kalyuga et al., 2003).

	2.5. Provide learners with reflection prompt on task selection after selecting a task (van Merriënboer & Sluijsmans, 2009) [Meta-cognitive strategy]	2.5.1. After selecting a task, have learners fill out the reflection prompt on task selection (van Merriënboer & Sluijsmans, 2009; Moos & Azevdo, 2008). 2.5.2. Have learners select the reason why they chose them. • it is associated with my goals • it is associated with the previous task • it is associated with the current task: level of difficulty, learning method, content

3.Assess the task	3.6. Have learners self-assess their learning process after completing the task [Meta-cognitive strategy]	3.6.1. Provide a tool for self-assessing whether learners achieved necessary knowledge after the task (Tatsuoka, Corter, & Tatsuoka, 2004).
	3.7. Provide ipsative feedback on the score of the 'interim test' (Harlen & James, 1997) [Meta-cognitive strategy]	3.7.1. Provide immediate feedback on the 'interim test'. • Make cumulative 'interim test' scores visible after learning each task (Harlen & James,1997).
	3.8. Have learners establish plans for the next task (Loyens, Magda & Rikers, 2008). [Meta-cognitive strategy]	3.8.1. Based on the accumulated feedback for the 'interim test', provide tools that allow the learner select the next task.
	3.9. Provide fading guidance (Renkle, 2005) [Cognitive strategy]	3.9.1. Provide guidance on self-assessment and planning at the beginning and have them 'fade' later (Renkl, 2005) 3.9.2. Have the learners decide independently whether guidance is provided.
	3.10. Use completion strategy (Paas & van Merriënboer, 1994) [Cognitive strategy]	3.10.1. Have the learners select between completion problems and conventional problems in the self-assessment (Paas & van Merriënboer, 1994).

Validity of the LTSS Strategies

1=strongly disagree, 2=disagree, 3=neither disagree or agree, 4=agree, 5=strongly agree

	Item	1	2	3	4	5
Validity	Does this strategy provide activities and procedures necessary for the process of subject choice?	1	2	3	4	5
Explanation	Does this strategy help to plan the process of subject choice?	1	2	3	4	5
Usability	Is this strategy useful to design the process of subject choice?	1	2	3	4	5
Universality	Can this strategy be universally used to design the process of subject choice?	1	2	3	4	5
Understanding	Does this strategy make it easy to understand the activities and procedures for the process of subject choice in self-directed learning?	1	2	3	4	5
Model-strategy connection	Is the model properly connected to the strategy?	1	2	3	4	5
Strategy-guideline connection	Is the strategy properly connected to the guidelines?	1	2	3	4	5

Comments

Appendix D: Prototype Evaluation on Storyboards

Prototype Evaluation on the Storyboards

On a scale from 1 to 5, please rate whether the following 9 strategies have been adequately reflected in the storyboard, where 1 = not reflected at all and 5 = very well reflected.

Self-directed learning process		**Strategies supporting learners' task selection**	1---2---3---4---5				
Diagnose the status	1.1	Make learners possess fundamental prior knowledge before learning.	1	2	3	4	5
	1.2	Make learners set their own learning goals	1	2	3	4	5
	1.3	Make learners share learning goals	1	2	3	4	5
Select the task & ***Perform*** the task	2.1	Provide metadata to learners prior to making task selections	1	2	3	4	5
	2.2	The number of tasks learners can choose should be provided differently	1	2	3	4	5
	2.3	Provide learners with reflection prompt on task-selection after selecting a task	1	2	3	4	5
Assess the task	3.1	Make learners self-assess their learning process after completing the task.	1	2	3	4	5
	3.2	Provide an ipsaptive feedback on the score of 'interim test'	1	2	3	4	5
	3.3	Make the learner set up plans for the next task.	1	2	3	4	5

Appendix E: Usability Evaluation on the e-learning Program

Usability Evaluation on the e-Learning Program for Experts

Answer each question on a scale of 1 to 5, with 1 being unsatisfactory/insufficient and 5 being very satisfactory/convenient.

Number	Questions	Usefulness low----------high				
		1	2	3	4	5
1	**Ease of Use** Is the program easy for users to use?	1	2	3	4	5
2	**Navigation** Is the program easy to navigate to one that is perceived?	1	2	3	4	5
3	**Cognitive Load** Does the program require mental effort to use the program?	1	2	3	4	5
4	**Mapping** Does the program track and graphically represent to the user his or her path through the program?	1	2	3	4	5
5	**Screen Design** Is the program designed well for learners to remember what they learned?	1	2	3	4	5
6	**Knowledge Space Compatibility** Does the program have the compatible network of concepts and relationships that compose the mental schema a user possesses about a given phenomena topic or process?	1	2	3	4	5
7	**Information Presentation** Is the information contained in the knowledge space of an interactive program presented in an understandable form?	1	2	3	4	5
8	**Media Integration** how well does an interactive program combine different media to produce an effective whole?	1	2	3	4	5
9	**Authentic Appreciation** Does the program have beauty or elegance?	1	2	3	4	5
10	**Overall Functionality** Does the program satisfy the specific intended use that exists in the mind of the users?	1	2	3	4	5

Usability Evaluation on the e-Learning Program for Leaners

Answer each question on a scale of 1 to 5, with 1 being unsatisfactory/insufficient and 5 being very satisfactory/convenient.

Number	Questions	Usefulness low----------high				
		1	2	3	4	5
1	**User Expectation** Is each function of the program well structured for users to find what they want easily?	1	2	3	4	5
2	**Consistency** Is each function of the program consistent?	1	2	3	4	5
3	**Operation Consistency** Is the program convenient to operate?	1	2	3	4	5
4	**Screen Design** Is the program designed well for learners to remember what they learned?	1	2	3	4	5
5	**Program Error** Are there fewer program errors when learning?	1	2	3	4	5
6	**Advice** Does the program provide proper advice and help?	1	2	3	4	5
7	**Feedback** Does the program provide proper feedback when learning?	1	2	3	4	5
8	**Authentic Design** Is the screen design aesthetically pleasing?	1	2	3	4	5
9	**User Control** Is the program easy for users to control?	1	2	3	4	5

Appendix F: Self-Directed Learning Readiness Test

Self-Directed Learning Readiness Test

1=strongly disagree, 2=disagree, 3=neither disagree or agree, 4=agree, 5=strongly agree

Items	1	2	3	4	5.
1. I try to learn as long as I live.	1	2	3	4	5
2. I do not necessarily try to understand something I do not know.	1	2	3	4	5
3. I like learning something new.	1	2	3	4	5
4. I believe the teacher should tell students specifically what to do during class time.	1	2	3	4	5
5. When I need certain information, I know where to look for it.	1	2	3	4	5
6. I can learn things on my own better than most people.					
7. I want to have a say in deciding what I learn and how I learn.	1	2	3	4	5
8. I can tell whether I am learning something correctly or not.	1	2	3	4	5
9. There is so much that I want to learn that even 24 h in a day is too short for me.	1	2	3	4	5
10. If I am determined to learn something, I can always manage my time regardless of how busy I am.	1	2	3	4	5
11. I sometimes do not understand what I have read.	1	2	3	4	5
12. I know when I need to learn more about something.	1	2	3	4	5
13. I look up to people who are always learning something new.	1	2	3	4	5
14. I believe I can teach myself whatever I want to learn, without the help of others.	1	2	3	4	5
15. I enjoy finding the answers to a certain question.	1	2	3	4	5
16. I like problems with definite answers rather than those that have many answers.	1	2	3	4	5
17. I am very curious about everything.	1	2	3	4	5
18. I do not have problems with basic learning abilities.	1	2	3	4	5
19. Regardless of the results, I like to start new things.	1	2	3	4	5
20. I am good at coming up with unique ways to do certain tasks.	1	2	3	4	5
21. I like to think about future events.	1	2	3	4	5
22. Finding out about something that I want to know is what I do better than anybody else does.	1	2	3	4	5
23. When I decide to do something, I can do it on my own.	1	2	3	4	5
24. I like to discuss and share opinions.	1	2	3	4	5
25. I like to approach problems in my own way.	1	2	3	4	5
26. I have a strong desire to learn something new.	1	2	3	4	5
27. The more I learn, the more interesting this world seems.	1	2	3	4	5
28. Learning is fun.	1	2	3	4	5
29. It is more effective to use the method I have always been using rather than always trying a new learning method.	1	2	3	4	5
30. Learning is entirely my responsibility, not that of others (e.g., the teacher or people around me).	1	2	3	4	5
31. I never think that I am too old to learn something new.	1	2	3	4	5
32. I always study well either in a classroom or by myself.	1	2	3	4	5
33. Those that lead others are the people who are always learning.	1	2	3	4	5

Appendix G: Prior Knowledge Test

Prior Knowledge Test

1. **Which of the following is the correct pair of answers for (   )?**

When the sun's altitude is the highest during the day, shadows are (   ), and the sun is in the (   ).

1) Shortest, East
2) Longest, West
3) Shortest, South
4) Longest, North
5) Shortest, North

2. When is the sun's altitude the highest?

1) 10:30
2) 11:30
3) 12:30
4) 13:30
5) 14:30

3. When are shadows the shortest?

1) 10:30
2) 11:30
3) 12:30
4) 13:30
5) 14:30

4. **When is the sun's meridian transit altitude the highest?**

1) June
2) July
3) August
4) September

5. **When is the sun's meridian transit altitude the lowest?**

1) December
2) January
3) February
4) March
5) April

6. **During which seasonal divisions of the lunar calendar is the sun's meridian transit altitude the highest?**

1) Spring equinox
2) Summer solstice
3) Autumnal equinox

4) Winter solstice
5) First day of summer

7. When is the quantity of solar energy reaching a certain area the smallest?

1) Spring equinox
2) Summer solstice
3) Autumnal equinox
4) Winter solstice
5) First day of summer

8. When is the length of a day the longest?
1) March
2) June
3) August
4) September
5) December

9. **Which of the following is incorrect?**
1) The month of June has the longest day.
2) The month of September has the shortest night.
3) The month of December has the shortest day.
4) During the summer, the average monthly temperature is the highest.
5) During the winter, the average monthly temperature is the lowest.

10. Which of the following remains unchanged because the earth revolves around the sun while its axis of rotation is tilted?

1) Latitude
2) Length of the day
3) Average monthly temperature
4) Length of shadows
5) Sun's meridian transit altitude

11. Which of the following occurs if the earth revolves around the sun while its axis of rotation is vertical?

1) Changes in seasons
2) Changes in lengths of shadows
3) Changes in lengths of the day and night
4) Changes in the sun's meridian transit altitude
5) Constancy in the time of the sunrise

12. Which season is it in New Zealand when it is summer in Korea?

1) Spring
2) Summer
3) Autumn
4) Winter
5) Early summer

Appendix H: Learning Achievement Test

Learning Achievement Test

1. At what time is the sun's altitude the highest during the day?

1) Around 21:00
2) Around 11:00
3) Around noon
4) Around 14:00
5) Around 17:00

2. Which of the following is correct when describing temperature changes on a fine day?

1) There are no particular changes during the day.
2) Temperature gradually decreases and hits the lowest around noon.
3) Temperature gradually increases and hits the highest around 1400–1500.
4) Temperature is the highest in the morning, gradually decreases, and hits the lowest at 1900.
5) Temperature remains low constantly in the morning and increases around 1400–1500.

3. If the sun's altitude is high, the quantity of solar energy reaching an area of the same size is…

1) Small
2) Large
3) Constant both when the altitude is low and high
4) Not related to the sun's altitude
5) Indeterminate

4. In which of the following seasonal divisions of the lunar year is the length of the daytime the longest?

1) Summer solstice
2) Winter solstice
3) Spring equinox
4) Clear and balmy season
5) End of hibernation

5. Which of the following is correct when the latitude is high?

1) The sun's altitude decreases, and the temperature decreases.
2) The sun's altitude decreases, and the temperature increases.
3) The sun's altitude increases, and the temperature increases.
4) The sun's altitude increases, and the temperature decreases.
5) The sun's altitude is constant, and the temperature decreases.

6. Which of the following occurs when the axis of rotation of the earth is not tilted?

1) The night never ends.
2) The lengths of the day and the night are the same.
3) The seasons change once every two years.
4) The time of the sunrise is different the whole year.
5) The day never ends.

7. What season is it in Australia when it is winter in Korea?

1) Winter
2) Summer
3) Spring
4) Autumn
5) Early winter

8. How long does it take for the earth to rotate around the sun once?

1) 24 hours
2) 60 seconds
3) 24 months
4) 12 months
5) 36 months

9. Which of the following is correct when the sun is at a high altitude?

1) Shadows become shorter, and the temperature decreases.
2) Shadows become shorter, and the temperature increases.
3) Shadows become shorter, and the temperature remains the same.
4) Shadows become shorter, and the temperature increases.
5) Shadows become shorter, and the temperature remains the same.

10. When is the sun due south during the day?

1) Around 09:00
2) Around 11:00
3) Around noon
4) Around 15:00
5) Around 17:00

11. Which of the following is correct about the sun's altitude?

1) It is the angle of the surface and the sun.
2) It is the size of the sun in the sky.
3) If the latitude is lower, the altitude of the sun becomes lower.
4) If the sun's altitude is high, shadows become longer.
5) If the sun's latitude is high, the temperature increases.

12. Why does the sun's meridian transit altitude change according to the season?

1) Because the earth rotates
2) Because the temperature changes
3) Because the length of the day changes
4) Because the moon rotates around the earth
5) Because the earth revolves while its axis is tilted

국 문 요 약

Summary in Korean

자기주도 이러닝 학습에서
학습자의 과제 선택 지원 전략 개발 연구

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Ⅰ. 서론

학습자 스스로 자신에게 적절한 학습과제를 선택할 수 있는 능력은 자기주도학습의 전제조건으로 (Kicken, Brand-Gruwel, & van Merriënboer, 2008), 이러한 능력 향상을 위해 학습자들에게 학습과제에 대한 선택권을 제공하는 것은 자기주도 학습능력 신장의 핵심적인 부분으로 간주되어 왔다(Brockett & Hiemstra, 1991; van Merriënboer & Sluijsmans, 2009; Williams, 1996),

학습자가 적절한 학습과제를 선택을 하게 되면 '과제선택의 정확도'가 높아지는데(Camp, 2001; Corbalan, Kester, & van Merriënboer, 2008, Kostons, van Gog, & Paas, 2012; Salden, Paas, Broers, & van Merriënboer, 2004). 적절한 과제 선택으로 학습자의 '과제선택의 정확도'가 올라간다면, 그것은 궁극적으로 학업 성취와 자기주도학습능력을 향상시킬 수 있을 것이다(Corbalan, Kester, & van Merriënboer, 2008).

하지만 학습자들에게 선택권을 제공하는 것이 과연 효과적인지에 대해서는 아직 논쟁의 여지가 있다. 여러 연구들은 학습자들에게 선택권을 주는 것이 내적 동기부여, 과제 수행능력 및 자기 만족감을 증가시킨다고 보고 한다(Deci, 1975, 1981; Deci & Ryan, 1985; Glass & Singer, 1972a, 1972b; Langer & Rodin,1976; Rotter, 1966; Schulz & Hanusa, 1978; Taylor, 1989; Taylor & Brown, 1988). 하지만 또 다른 연구들은 학습자들에게 선택권을 제공하는 것이 아무런 영향도 미치지 못하고(D'Ailly, 2004; Parker & Lepper, 1992; Reeve, Nix, & Hamm, 2003), 심지어 부정적인 영향을 미친다고 지적한다(Flowerday, Schraw, & Stevens, 2004; Iyengar & Lepper, 1999, 2000).

선택의 부정적 영향은 인지적, 메타인지적, 동기적 차원으로 구분될 수 있는데 여러 차원에 걸쳐 이러한 부정적인 결과들이 야기되는 이유 중 하나는 학습자들이 스스로 선택을 통제할 수 있는 준비가 되어있지 않기 때문이다. 따라서 선택의 긍정적 효과를 유지하고, 선택이 야기하는 문제점들을 최소화하면서 학습자들이 스스로 자신에게 적절한 과제를 선택하여 '과제선택의 정확도'를 높이도록 돕는 것이 필요하다. 이에 본 연구에서는 자기주도학습에서 학습자의 과제선택을 지원하는(Learners' Task Selection Strategy:LTSS) 전략을 개발하고 그 효과성 및 개선점을 확인하고자 하였다.

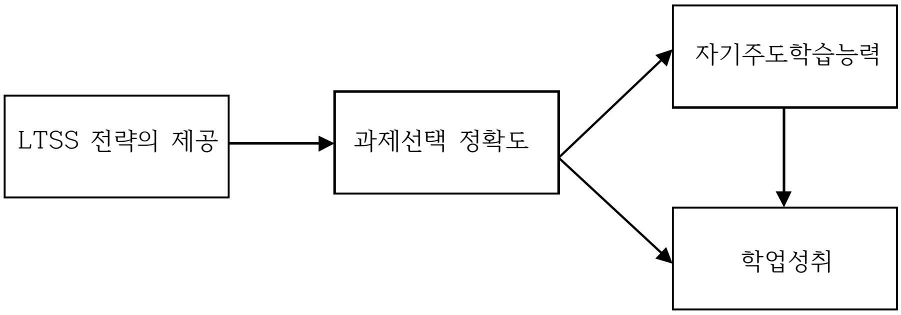
Ⅱ. 연구문제

연구문제 1. 자기주도학습에서 학습자의 과제선택을 지원하는 전략은 무엇인가.
연구문제 2. 자기주도학습에서 학습자의 과제선택을 지원하는 전략의 효과성 및 개선점은 무엇인가.
연구문제 2-1. 자기주도학습에서 학습자의 과제선택을 지원하는 전략이 학습자의 과제선택정확도, 자기주도학습준비도, 학업성취에 미치는 영향은 무엇인가.

연구문제 2-2. 자기주도학습에서 학습자의 과제선택을 지원하는 전략이 과제선택 의사결정에 미치는 효과는 무엇인가.

연구문제 2-3. 자기주도학습에서 학습자의 과제선택을 지원하는 전략의 개선점은 무엇인가.

Ⅲ. 이론적 모형 및 가설



[그림 1] 연구 모형

가설 1. LTSS 전략의 제공은 학습자의 과제 선택 정확도에 유의미한 직접적인 영향을 미칠 것이다.

가설 2. 과제선택 정확도는 학습자의 학업성취에 유의미한 직접적인 영향을 미칠 것이다.

가설 3. 과제선택 정확도는 학습자의 자기주도학습능력에 유의미한 직접적인 영향을 미칠 것이다.

가설 4. 자기주도학습능력은 학습자의 학업성취에 유의미한 직접적인 영향을 미칠 것이다.

가설 5. LTSS 전략의 제공은 학습자의 학업성취와 자기주도학습능력에 유의미한 간접적인 영향을 미칠 것이다.

Ⅲ. 연구방법

1. 연구 1: 자기주도학습에서 학습자의 과제선택 지원 전략 개발

연구 1에서는 문헌 분석을 바탕으로 자기주도학습에서 과제선택을 지원하는 전략을 도출한 후, 1차, 2차 전문가 리뷰를 거쳐 전략들을 타당화하였다. 구체적으로 Reigeluth(1983)의 전략개발방법과 Levy와 Ellis(2006)의 문헌조사방법에 따라 1차 버전 전략이 도출되었고 도출된 1차 버전 전략들은 5명의 전문가 리뷰를 바탕으로 수정되어 2차 버전 전략이 개발되었다. 2차 버전 전략들은 7명의 전문가 리뷰를 바탕으로 다시 수정되어 최종 전략이 도출되었다. 최종 전략이 반영된 이러닝 프로그램을 개발하기 위해 분석(과제분석, 학습자 분석, 환경분석), 설계 및 개발 ('도입' 화면 설계, '진단' 화면 설계, '과제선택 및 과제수행' 화면 설계, '과제평가' 화면 설계)을 하였으며, 최종적으로 실행 및 평가 (4명의 전문가에 의한 스토리보드 프로토타입 테스트, 3명의 전문가 및 27명 학생에 의한 이러닝 프로그램 사용성 평가)를 실시하였다.

2. 연구 2: 자기주도학습에서 학습자의 과제선택 지원 전략의 효과성

연구 2 는 연구 2-1, 연구 2-2, 연구 2-3으로 나뉘어 진행되었다. 연구 2-1은 서울 소재 D 초등학교 6학년 9개반 236명이 참여하였고, 참여 학생들은 각 반 안에서 자기주도학습에서 LTSS 전략이 반영된 이러닝 프로그램을 학습한 실험집단과 LTSS 전략이 반영되지 않은 이러닝 프로그램을 학습한 통제집단에 무선 할당되었다. LTSS 전략이 반영된 프로그램은 연구 1에서 개발된 최종 9가지

LTSS 전략이 과제 선택 및 수행 과정에 포함되었으며, LTSS 전략이 반영되지 않은 프로그램은 LTSS 전략이 없이 과제 선택 및 수행과정이 반복된다. 과제 선택 정확도는 '기대되는 과제선택 점프 사이즈(Jump Size)'와 '학습자가 실제로 선택한 과제선택 점프 사이즈' 간의 절대적 차이(Kostons, van Gog, & Paas, 2012)로 분석되었고, 이때 '기대되는 과제선택 점프 사이즈'는 이전 과제수행시 실시된 '중간평가(Interim Test)'와 '인지부하' 점수를 바탕으로 계산되었다(Salden et al., 2004). 자기조절학습 능력은 West 와 Bentley (1990)가 개발한 문항으로 측정하였고, 학업성취는 '계절의 변화'에 관한 12문항 검사지로 측정하였다. LTSS 전략의 효과를 분석하기 위한 방법으로는 경로분석을 사용하였다.

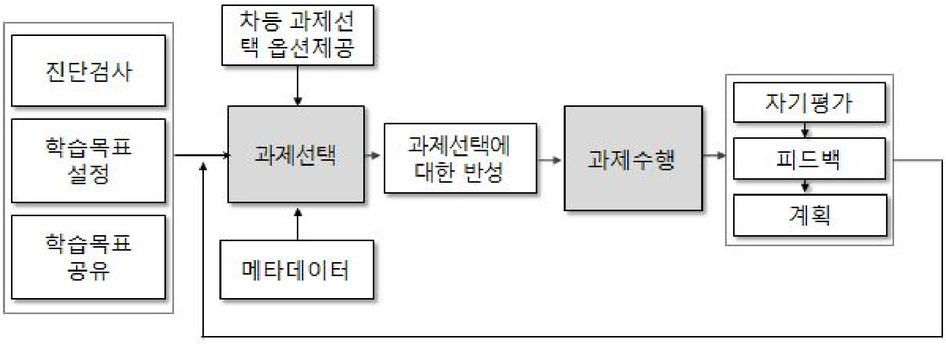
연구 2-2는 서울 소재 Y 초등학교 6학년 27명이 참여하였고, 참여학생들은 실험집단과 통제집단에 무선으로 할당되었다. 과제선택 의사결정은 Iyengar와 Lepper(2000)의 선택의사결정 시의 정의적 반응을 확인하는 문항으로 측정하였다. LTSS 전략의 효과를 분석하기 위한 방법으로 일원변량분석을 사용하였다.

연구 2-3은 연구 2-2와 동일한 학생들이 참여하였고, 실험집단과 통제집단 학생 모두 과제선택 과정의 장점, 단점, 개선점에 대해 기술하였으며, 실험집단 학생들은 추가로 9가지 LTSS 전략 각각의 장점, 단점, 개선점에 대해 기술하였다.

Ⅳ. 연구결과

1. 연구 1: 자기주도학습에서 과제선택 지원 전략 개발

최종적으로 도출된 과제선택지원 전략과 가이드라인은 다음 [그림 2]와 <표 1>과 같다.



[그림 2] LTSS 전략이 반영된 이러닝 프로그램에서 학습자의 학습과정

<표 1> 자기주도 이러닝 학습에서 학습자의 과제선택을 지원하는 전략

	LTSS 전략	가이드라인
1. 자신의 수준 진단	1.1. 학습에 들어가기 전 학습자들이 충분한 사전지식을 갖추게 하라 (Mayer & Moreno, 2010). [인지적 전략]	1.1.1. 진단검사를 실시하여 학습하기 전 학습자들이 기본적인 사전지식을 갖추게 하라 (Mayer & Moreno, 2010). 1.1.2. 진단검사 결과에 대한 즉각적인 피드백을 제공하여 학습자들이 자신의 수준을 바로 확인할 수 있게 하라.
	1.2. 학습자 스스로 자신의 학습목표를 설정하게 하라 (Moos & Azevdo, 2008). [동기 전략]	1.2.1. 과제 난이도 1-4 로 나누어진 학습목표 중에서 학습자 본인에게 가장 적합한 학습목표를 스스로 선택하게 하라(Moos & Azevdo, 2008; Roll et.al, 2007). • 초보자들의 경우, 스스로 학습목표를 설정하는 것을 어려워하기 때문에, 여러 학습목표 예 중에서 선택하게 한다.
	1.3. 학습자들 간에 학습목표가 공유되게 하라. (Katz & Assor, 2003, 2007). [동기 전략]	1.3.1. 학습자들의 다른 학습자들의 학습목표를 볼 수 있게 하라 (Katz & Assor, 2003, 2007). • '나의 학습목표'와 '친구들 학습목표' 아이콘을 클릭하면 자신의 학습목표 뿐만 아니라 같은 반 다른 친구들의 학습목표를 볼 수 있게 하라.

2. 과제 선택 및 수행	2.1. 과제를 선택하기 전 학습자에게 과제에 대한 메타데이터를 제공하라 (Bell & Kozlowski, 2002; Kicken et al.2008). [Motivation strategy]	2.1.1. 학습자에게 과제의 난이도, 상호작용성 정도와 같은 과제에 대한 정보를 학습자에게 제공하라. 2.1.2. 학습자들에게 메타데이터 보기 선택권을 제공하라. 학습자가 원할 경우 볼 수 있게 하라(Kicken et al.,2008). • 과제 아이콘을 마우스 오벼 하면 과제의 내용을 미리 볼 수 있게 하라.
	2.2. 학습자들이 선택할 수 있는 과제의 숫자는 학습자마다 다르게 제공되어야 한다 (Schwartz, 2004). [Cognitive strategy]	2.2.1. 진단검사 결과에 따라 과제선택시 선택옵션의 수를 다르게 제공하라 (Kalyuga et al., 2003) 2.2.2. '기초'화면에서는 난이도가 1,2,인 과제들만 보이고, '심화' 화면에서는 난이도가 1, 2, 3, 4 인 화면이 모두 보인다. 학습자들은 진단검사 결과를 바탕으로 '기본' 혹은 '심화' 화면을 선택한다.
	2.3. 과제 선택 후 학습자들에게 과제선택을 되돌아 볼 수 있는 기회를 제공하라(van Merriënboer&Sluijsmans, 2009)[Meta-cognitive strategy]	2.3.1. 과제를 선택한 후에 '과제선택에 대한 반성적 고찰' 질문지에 응답하게 하라. (van Merriënboer & Sluijsmans, 2009; Moos & Azevdo, 2008) • 왜 이 과제를 선택했는지 생각해보게 하라. 나의 학습목표가 잘 반영되어있어서, 이전과제와 연관되어 있어서, 현재 과제의 난이도, 학습방법, 내용 등이 마음에 들어서

3. 과제수행 평가	3.1. 과제를 수행한 후에 학습자 스스로 자신의 학습과정을 평가하게 하라 (Kicken et al.,2008). [Meta-cognitive strategy]	3.1.1. 과제를 학습한 후에 필요지식을 제대로 학습했는지를 평가하는 툴을 제공하라 (Tatsuoka, Corter, & Tatsuoka, 2004)
	3.2. 과제수행 결과에 대한 누적 피드백을 제공하라 (Harlen & James, 1997). [Meta-cognitive strategy]	3.2.1. 과제수행 시 실시된 '중간평가' 결과에 대한 즉각적인 피드백을 제공하라, 학습자들이 '중간평가' 결과를 쉽게 찾아볼 수 있게 하라. (Harlen& James,1997).

3.3. 다음 과제선택을 위한 계획을 세우라 (Loyens, Magda & Rikers, 2008). [Meta-cognitive strategy]	3.3.1. '중간평가'에 대한 누적 피드백을 바탕으로 학습자가 다음 과제를 선택할 수 있게 하라. 3.3.2. 학습을 마칠 때, 아래와 같은 3 가지 조건이 충족되었는지 확인하라. • 학습목표가 성취되었는가. . • 심화 3,4 단계 중 적어도 하나이상은 학습했는가. • 심화 3, 4 단계의 과제를 수행한 후, 실시된 '중간평가'에서 5 문제 중 4 문제 이상 맞았는가.

전략 1.1. 과제를 선택하기 전 학습자가 기본적인 사전지식을 갖추게 하라. 만약 학습자가 기본적인 사전지식을 가지고 있다면, 학습자는 보다 적절한 과제 선택을 할 수 있을 것이다. 초보자들일수록 자신에게 필요한 과제보다는 자신이 선호하는 과제를 선택하는 경향이 있기 때문에 초보자들일수록 더욱 자신의 수준을 파악하는 것이 필요하다(Koston, van Gog, & Paas, 2009; Kicken, Brand-Gruwel, & van Merriënboer, 2008). 또한 사전연습원리(Pre-Training Principle)에 의하면 학습과제에 대한 지식이 부족할 경우, 인지부하가 발생할 수 있기 때문에 학습과제를 선택하기 전 기본적인 사전지식을 습득하는 것이 필요하다(Pollack et al, 2002; Mayer, Mautone, & Prothero, 2002).

전략 1.2. 학습자 스스로 학습목표를 설정하게 하라 (Moos & Azevdo, 2008) . 만약 학습자가 자신의 학습목표를 세운다면, 학습자는 자신의 학습목표와 연관된 과제를 쉽게 찾을 수 있을 것이다. 자신의 목표에 기반에 기반하여 학습과제를 선택하는 것은 자기결정선택(self-determined choice)이며, 학습자는 이때 자율성을 경험한다. 자기결정이론(self-determination theory)에 따르면 학습자가 자신의 목표, 흥미에 부합하는 선택을 할 때 학습자는 자율성(Autonomy)를 경험하고, 이러한 자율성이 충족되면 자기결정성 동기가 향상된다(Assor, Kaplan, & Roth, 2002; Ryan & Deci 2000). 따라서 학습자가 스스로 학습목표를 설정하는 것은 적절한 과제

선택에 도움이 된다.

전략 1.3. 학습자들간에 학습목표가 공유되게 하라(Katz & Assor, 2003, 2007). 학습자들간에 학습목표가 공유된다면 학습자들은 보다 자기결정동기에 기반한 선택을 할 수 있을 것이다. 자기결정이론에 따르면, 자신의 목표가 집단의 공동목표 안에 포함되는 관련성(Relevance)이 충족될 때, 학습자들의 자기결정성 동기가 향상된다(Katz & Assor, 2007). 특히 아시아인들의 경우, 단순히 선택을 제공한다고 동기가 올라가는 것이 아니라 자신의 목표가 공동의 목표에서 벗어나지 않을 때 자기결정성동기가 올라간다. (Iyengar & Lepper, 1999; Katz & Assor, 2003). 따라서 학습목표 공유를 통해 학습자의 관련성을 높이고, 궁극적으로 자기결정된 선택(Self-Determined Choice)를 할 수 있도록 도와야 할 것이다.

전략 2.1. 과제 선택을 하기 전 학습자에게 메타데이터를 제공하라 (Bell & Kozlowski, 2002; Kicken et al., 2008). 과제선택 시 학습자에게 과제에 관한 메타데이터가 주어진다면 학습자는 보다 적절한 과제를 선택할 수 있을 것이다. 과제에 대한 메타데이터가 부족하면 학습자는 과제선택 시 인지부하를 경험할 수 있기 때문에(Bell & Kozlowski 2002; Kicken et al., 2008), 과제에 대한 안내가 필요하다. 특히 내용을 모르고 하는 선택(Empty Choice)은 학습자의 흥미, 목표, 가치에 기반한 선택이 아니기 때문에 과제선택시의 동기를 저해할 수 있다(Flowerday et al., 2004). 따라서 과제선택 시 학습자에게 과제에 대한 메타데이터를 제공하는 것은 적절한 과제선택에 도움이 된다.

전략 2.2. 학습자가 선택할 수 있는 과제의 수는 학습자에 따라 다르게 제공되어야 한다(Schwartz, 2004). 학습자가 선택할 수 있는 과제의 수는 학습자의 사전지식 수준에 따라 다르게 제공되어야 한다. 전문성 역전 이론(Expertise Reversal Effect)에 따르면, 학습자마다 자신의 도식수준이 다르기 때문에 과제선택 시에 겪는 인지부하가 다를 수 있다. 하지만 사전지식 수준이 높은 학습자라도 일정수준 이상의 옵션은 선택을 방해하고, 선택후의 만족도를 떨어뜨리기 때문에

10 개 이하의 옵션을 제공하는 것이 바람직하다 (Haynes, 2009; Iyengar & Lepper, 2000; Shah & Wolford, 2007; Tversky & Shafir, 1992).

전략 2.3. 과제를 선택한 후에 학습자들이 과제선택에 대한 반성적 성찰을 하게 하는 것이 필요하다(van Merriënboer & Sluijsmans, 2009). 과제선택에 대한 반성적 성찰은 학습자들이 왜 이 과제를 선택했는지를 스스로 되돌아보는 활동으로 이러한 활동이 반복되면 학습자는 무작위 선택보다는 의미 있는 과제를 선택할 수 있다(van Merriënboer & Sluijsmans, 2009). 이러한 전략은 이러닝 환경에서 학습자의 반성적 사고를 촉진하는데 도움이 되며(Butler & Winnie, 1995; Seale & Cann, 2000; Winne & Stockley, 1998), 이것은 추후 자기주도학습의 과제 선택단계에 해당한 기술을 습득하도록 도울 것이다.

전략 3.1. 과제를 수행한 후에 학습자 스스로 자기를 평가하게 하라 (Kicken et al., 2008; Sadler, 1983). 과제를 수행한 후에 학습과정을 평가하는 활동을 통해 학습자들은 자신의 강점과 약점을 알 수 있다. 이러한 자기평가를 통해 학습자들은 자신의 학습과정을 되돌아보고 자신에게 필요한 과제가 무엇인지를 이해하게 된다. 컴퓨터기반 학습에서 피드백에 관한 메타분석 결과들도 학습자가 스스로 평가하게 하는 활동이 다른 피드백들보다 더 효과적이라는 것을 보여준다(Azevedo & Bernard, 1995; Lew, et al., 2010; van Kraayenoord & Paris , 1997).

전략 3.2. 학습자의 과제수행 결과에 대한 누적 피드백을 제공하라 (Harlen & James, 1997). 학습자들에게 누적피드백을 제공하면 학습자들은 수행결과의 질을 지속적으로 비교할 수 있다 (Harlen & James, 1997). 이러한 누적 피드백의 목적은 단순히 성공/실패를 알려주는 것에 있지 않고, 시간에 따른 수행 질의 변화를 보여주는 데 있다 (van Merriënboer & Sluijsmans, 2009). 비록 학습자의 점수가 다른 학습자들에 비해 낮더라도 학습자들은 자신의 발달에만 초점을

맞춤으로써 동기가 부여될 수 있고, 이러한 피드백을 통해 자신의 상태를 더 정확히 파악하여 적절한 과제를 선택할 수 있을 것이다.

전략 3.3. 학습자들로 하여금 다음 과제에 대한 계획을 세우게 하라(Loyens, Magda, & Rikers, 2008). 만약 학습자가 과제를 선택하기 전에 자신이 무엇을 해야할 지 계획을 세운다면 보다 적절한 과제를 선택할 수 있을 것이다. 계획과 같이 자신을 분석하고 평가하는 활동을 통해 학습자들은 자신의 부족한 부분을 파악하여 학습자들은 보다 합리적인 결정을 할 수 있다(Candy, 1991). 이처럼 계획을 세우는 것은 자기주도학습에서 중요한 활동이며, 계획을 통해 바람직한 의사결정을 위한 대안을 탐색한다(Loyens, Magda, & Rikers, 2008).

연구 2: 자기주도학습에서 과제선택지원 전략의 효과 및 개선점

연구 2-1에서 연구모형의 모델 적합도는 통계적으로 합당한 것으로 나타났다 $(\mathrm{GFI} = .995, \mathrm{CFI} = .989, \mathrm{RMSEA} = .018)$. 연구모형의 경로계수 값을 살펴보면 가설 1인 LTSS 전략의 제공이 학습자의 과제 선택 정확도에 미치는 효과($\beta = -.162,\ p < .05$), 가설 2인 과제 선택 정확도가 학습자의 학업성취에 미치는 효과($\beta = -.144,\ p < .05$), 가설 4인 자기주도학습능력이 학습자의 학업성취에 미치는 효과($\beta = .171,\ p < .01$)는 유의미한 것으로 나타나 가설 1,2,4는 채택되었고, 이외 가설 3, 5는 기각되었다. 연구 2-2에서 실험집단은 통제집단에 비해 과제선택 의사결정의 4가지 항목 중 좌절감, 어려움, 흥미도 점수에서는 유의미한 차이가 없었지만, 만족도 점수에서는 실험집단이 통제집단보다 낮게 나타났다($F(1, 4.02) = 8.79, p < .05$). 연구 2-3에서 통제집단 학습자들이 실험집단 학습자에 비해 과제 선택이 더 어렵고, 적절한 과제 선택을 위한 추가적인 도움이 필요하다고 응답했다. 이외 실험집단 학습자들은 추가로 9가지 전략의 개선점에 대해 진술했다.

V. 논의 및 결론

본 연구에서는 자기주도학습에서 과제선택을 지원하는 전략들을 개발한 후, 그 전략들이 과제선택정확도에 긍정적 영향을 미치고, 과제선택정확도는 다시 학업성취 향상에 유의미한 효과를 미치는 것을 검증하였다.

본 연구의 의의는 먼저, 인지, 메타, 정의적 영역을 통합적으로 고려한 과제선택 지원 전략들을 개발하였다는데 있다. 지금까지 이루어진 과제선택 지원 전략 연구들은 인지, 메타인지, 정의적 영역 중 한 두 가지 영역에 국한되어(eg. Kostons, van Gog, & Paas, 2010; Corbalan, Kester, van Merriënboer, 2009; Kicken et al., 2009), 인지적, 메타인지적, 동기적 차원의 문제들을 통합적으로 해결하는 전략들을 제시하지 못했다.

또한 본 연구에서 개발된 과제선택 지원 전략들은 과제를 선택하는 단계를 넘어 자기주도학습 3단계(자신의 수준 진단-과제 선택 및 수행-과제수행 평가) 전체로 확장되어 적용될 수 있다. 이러한 전략들은 교수설계자가 이러닝 프로그램을 설계할 때 과제선택 단계를 중심으로 자기주도학습 전 과정을 설계할 수 있도록 돕는다.

더욱이 본 연구에서는 과제선택 지원 전략의 사용이 과제선택의 정확도에 영향을 미치고, 과제선택의 정확도가 다시 학업성취에 영향을 미치는 경로를 확인하였다. 지금까지 과제선택 지원 전략, 과제선택의 정확도, 학업성취로 연결되는 경로를 확인한 연구는 찾기 힘들다. 본 연구 결과, 과제선택을 지원하는 전략은 학업성취에 직접적으로 영향을 미치지 못하지만, LTSS 전략이 정확한 과제선택을 돕고, 그것이 궁극적으로 학업성취를 향상시킨다는 것을 확인하였다. 이러한 결과는 일차적으로 LTSS 전략의 효과성을 보여주며, 나아가 정확한

과제선택이 학업성취에 영향을 미치는 중요 변인으로 '과제선택정확도'에 대한 지속적인 연구가 필요함을 보여준다. 비록 본 연구에서 과제선택정확도가 자기주도학습능력에 미치는 영향은 확인하지 못하였지만, 추후 장기적 연구를 통해 이를 확인할 필요가 있다.

이와 더불어 본 연구는 실제 수행과 만족도 간의 차이에 대한 시사점을 제공한다. 본 연구에서 과제선택 시의 다양한 정보제공이 과제선택의 정확도를 높이었고, 질적 분석 결과에서도 실험집단은 과제선택지원 전략들이 과제선택 시에 도움이 되며, 과제선택이 상대적으로 어렵지 않다고 보고 했지만, 실험집단의 과제선택 후의 만족도는 통제집단 보다 낮았다. 이처럼 실험집단이 과제선택 의사결정 변인 중 만족도에서 더 낮은 점수를 얻은 것은 실험집단이 비록 더 많은 정보를 얻었지만, 오히려 자신들의 선택에 대해 더 많은 책임감을 느끼고 결국이 그것이 상대적으로 낮은 만족감을 가져 온 것으로 해석할 수 있다(Iyengar & Lepper, 2000). 이것은 수행결과와 만족도간의 역전관계를 보여주며, 향후에도 이와 관련된 연구가 필요하다.

마지막으로 본 연구결과는 전자교과서의 도입으로 자기주도학습이 강조되고 있는 교육현장에 바로 적용이 가능한 교육적 시사점을 제공한다. 전자교과서의 궁극적 목적은 학습자의 자기주도학습능력을 신장시키는 것으로, 전자교과서의 도입과 함께 학습자 스스로 과제를 선택하여 학습하는 활동이 더욱 강조되고 있다(Heo & Choi, 2009; The Ministry of Education, Science and Technology, 2008). 따라서 디지털 교과서와 같은 web 2.0 시대에 발맞추어 전자교과서가 제대로 활용될 수 있도록 학습자들을 지원하는 전략들이 어느 때보다 필요한 때이며, 본 연구에서 개발된 전략들은 이에 기여할 수 있을 것으로 기대된다.

국 문 초 록

Abstract in Korean

자기주도 이러닝 학습에서 학습자의 과제 선택 지원 전략 개발 연구

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본 연구의 목적은 자기주도학습에서 학습자의 과제선택을 지원하는 전략을 개발하고 그 효과성 및 개선점을 확인하는 것이다. 이러한 연구 목적을 성취시키기 위하여 다음과 같은 2가지 연구문제가 설정되었다. 첫 번째 연구문제는 자기주도학습에서 학습자의 과제선택을 지원하는 전략을 개발하는 것이며, 두 번째 연구문제는 자기주도학습에서 학습자의 과제선택을 지원하는 전략의 효과성 및 개선점을 확인하는 것이다. 두 번째 연구문제는 3가지의 하위 연구문제로 구성되어있다. 첫째, 자기주도학습에서 학습자의 과제선택을 지원하는 전략이 학습자의 과제선택정확도, 자기주도학습준비도, 학업성취에 미치는 영향을 확인하였고, 둘째, 자기주도학습에서 학습자의 과제선택을 지원하는 전략이 과제선택 의사결정에 미치는 효과를 검증하였으며, 셋째, 자기주도학습에서 학습자의 과제선택을 지원하는 전략의 개선점을 확인하였다.

연구 1에서는 자기주도학습에서 과제선택을 지원하는 전략을 개발하기 위해 문헌분석을 바탕으로 해당 전략을 도출한 후, 1차, 2차 전문가 검토를 거쳐 전략들을 타당화하였다. 그 후, 최종 전략들이 반영된 이러닝 프로그램을 개발하고, 프로토타입 테스트와 사용성 평가를 통해 이러닝 프로그램을 타당화 하였다. 연

구2에서는 자기주도학습에서 과제선택을 지원하는 전략이 과제선택정확도, 자기주도학습 준비도, 학업성취, 과제선택 의사결정에 미치는 효과를 검증하고자 하였다. 먼저, 연구 2-1에서는 자기주도학습에서 과제선택을 지원하는 전략이 과제선택정확도, 자기주도학습 준비도, 학업성취에 미치는 영향을 살펴보기 위해 초등학교 6학년 236명 학생을 대상으로 최종 전략들이 반영된 이러닝 프로그램을 적용하고 그 효과성을 검증하였다. 경로분석을 실시한 결과 자기주도학습에서 과제선택을 지원하는 전략은 학습자의 과제선택 정확도에 유의미한 영향을 미친 것으로 나타났으며, 과제선택정확도는 학업성취에 유의미한 영향을 미치는 것으로 확인되었다. 연구 2-2에서는 자기주도학습에서 과제선택을 지원하는 전략이 학습자의 과제선택 의사결정에 미치는 영향을 알아보기 위해 초등학교 6학년 27명을 대상으로 그 효과를 확인하고자 하였다. 일원변량분석 결과 자기주도학습에서 과제선택을 지원하는 전략이 학습자의 과제선택 의사결정에는 유의미한 영향을 미치지 않는 것으로 나타났다. 연구 2-3에서는 자기주도학습에서 과제선택을 지원하는 전략의 개선점을 확인하기 위해 초등학교 6학년 27명을 대상으로 질적 자료를 수집하여 '과제선택지원 전략도 학습자가 선택하기', '과제의 종류와 범위도 학습자가 스스로 선택하기' 등의 개선점을 확인하였다.

본 연구는 자기주도학습에서 과제선택을 지원하는 전략을 개발하고, 그 전략이 학습자의 과제선택 정확도 및 학업성취에 긍정적 영향을 미치는 효과를 확인하였으며, 과제선택지원 전략의 개선점을 파악하여 추후 학습자의 과제선택을 지원하는 전략이 나아가야 할 방향을 확인분석 하였다는 데 그 의의가 있다.

주요어 : 자기주도학습, 과제선택, 과제선택정확도, 자기주도학습준비도, 학업성취, 과제선택 의사결정

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