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Cognitive Style and Task Complexity for Interface Design : Decision Support for Swine Farm

양돈 농가의 의사결정 지원을 위한 인터페이스 개발: 인지양식과 과업복잡성을 중심으로

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Abstract

Cognitive Style and Task Complexity for Interface Design : Decision Support for Swine Farm

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Recently, agricultural industry has adopted information technology to improve production efficiency. As the information environment becomes more and more saturated, information system users' decision-making performance declines because of information overload occurs. User interface is one of possible way of increasing users' decision-making performance. This study examines the effects of interface designs that are matched or mismatched with cognitive styles and the effects of interaction between task complexity and decision-making performance. To achieve the aim of the present study, this study designed both of simple and complex tasks by field-dependent preferred prototype and field-independent preferred prototypes.

The prototype used for this study was developed to resemble the systems that are used in the swine-farming industry. The results showed that a match/mismatch between the user interface and the cognitive style had a significant effect on task time but not on task score. Furthermore, no significant interaction effect of task complexity was found for both the task score and the task time.

Keyword: Cognitive Style, Task Complexity, User Interface, Decision-making, Information System, Agriculture, Swine Farm

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1. Introduction

1.1 Study background

Recently, the importance of precision in farming has increased because the agricultural industry has adopted information technology to improve production efficiency (Batte & Arnholt, 2003). Information technology has had a particularly significant effect on the agricultural industry. There are many information systems available to enable livestock conditions to be monitored by farmers. Farmers can collect relevant data through these systems and thus improve cost efficiency within their businesses (Banhazi, Babinszky, Halas, & Tscharke, 2012).

The swine-farming industry is no exception to this trend. In particular, pigs are easily affected by environmental conditions compared to other livestock species (Pearce et al., 2013). Swine breeders are trying, therefore, to control swine-farm conditions in more precise and effective ways. Recently, many Korean swine farmers have accepted internet of things (IoT) technology for managing their farms more efficiently (Jang, Lee, & Choe, 2014).

The use of information systems, however, does not always lead to increased work efficiency. As the information environment becomes more and more saturated, users may start to find the data-searching process confusing (Davenport & Beck, 2001). In addition, the layout of information within a system can be complicated, with too much data appearing on the screen, leading to information overload for the user (Yigitbasioglu & Velcu, 2012). The user's decision-making performance declines when information overload occurs (Chewning Jr. & Harrell, 1990).

Additionally, systems which are currently used in the agricultural sector have often been developed without any consideration for user-friendliness (McCown, Carberry, Hochman, Dalgliesh, & Foale, 2009).

Increased development within the field of interface design may provide a solution and improve decision-making performance (Tufte, 1985). A well-designed user interface can positively influence users' decision-making performance (Tegarden, 1999), enabling users to search information resources more effectively (White & Iivonen, 2001).

People gather, analyze, and interpret information in different ways (Harrison & Rainer Jr., 1992). The various methods that individuals employ to organize and process such information have been labeled *cognitive styles*. It has been found that each cognitive style is associated with a different level of decision-making performance (Riding & Sadler-Smith, 1997). Nevertheless, cognitive styles are often ignored by interface designers. To address this gap in interface design, it is crucial that research is carried out to ensure that user interfaces are compatible with users' cognitive styles.

To address this limitation, this study aims to design an intuitive user interface for use in swine farm management systems by taking both users' cognitive styles and the issue of task complexity into account.

Specifically, this study examines decision-making performance and cognitive load for potential users who are involved in animal husbandry, animal biotechnology, and veterinary science, and are interested in farming. By designing the user interface based on previous studies, and then examining the potential users' decision-making performance and cognitive load, this study hopes to recommend a user interface design for the agricultural sector, especially the swine-farming industry.

1.2 Purpose of the research

This paper attempts to analyze the effect of interface design, based on cognitive styles and task complexity, on users' decision-making performance. Taking cognitive styles theory and task complexity theory into account, a user interface was designed to verify the effect of interface design on users' decision-making performance and cognitive load. To achieve this goal, the study addressed the following questions:

RQ1: Is decision-making performance affected by the matching or mismatching of user interface design with cognitive styles?

RQ2: Is cognitive load affected by the matching or mismatching of user interface design with cognitive styles?

RQ3: In relation to task complexity differences, what is the difference in the effect of matching or mismatching of the user interface design with cognitive styles on users' decision-making performance?

In summary, this study examines the effect of interface design on users' decision-making performance and cognitive load. Using theories about cognitive style and task complexity drawn from previous studies, an interface was designed to verify the effect of each cognitive style and the matched or mismatch of interface design with cognitive style.

2. Literature Review

2.1 Cognitive load theory

Cognitive load theory is an instructional theory that provides a link between the human cognitive structure and problem-solving processes. Each individual has a cognitive architecture with a limited capability for processing information, and this limitation can cause cognitive load (Paas, Van Gog, & Sweller, 2010). The theory suggests a framework of instructional design for conceptualizing working memory and long-term memory, which play a key role in human cognitive architecture (Sweller, 2004).

Working memory is the location of recurring mental activity with a limited capacity for processing information (Miller, 1956). Working memory cannot store every item of information and has difficulty with certain types of information processing such as recalling, combining, or comparing it with other information. Miller's study (1956) suggested that working memory has the capacity to save about five to nine items of newly-acquired information and can process about two to four items of that same information. By contrast, the long-term memory can save larger quantities of information, more permanently than working memory. The information stored in long-term memory is stored in the form of structures which are called schemas (Gick &

Holyoak, 1983). When people process unfamiliar information, schemas can help to decrease the load on the working memory by comparing the information with previously-acquired schemas.

However, cognitive schemas which have been saved in the long-term memory and recovered for comparison with the new information are treated in the working memory. There are three main types of cognitive load which influence working load: *intrinsic cognitive load*, *extraneous cognitive load*, and *germane cognitive load*.

Intrinsic cognitive load occurs because of the inherent complexity of learning new material (Sweller, 1994). Learners save the perceived information in the shape of schemas in their long-term memory and incur intrinsic cognitive load when they deal with the intrinsic complexity of the information. The amount of intrinsic cognitive load is determined by the interaction of the various elements of information (Bannert, 2002). For example, in the case of learning mathematics, learning the mathematical symbols involves low element complexity because symbols such as plus and minus can be learned separately. By contrast, calculating liner differential equations involves relatively high element complexity because it requires a knowledge of functions and equations.

Extraneous cognitive load is generated by the way the information (i.e., the learning material) is presented (Chandler & Sweller, 1991). When learners receive information in an inappropriate format, extraneous cognitive load causes adverse effects on educational attainment (Paas, Tuovinen, Tabbers, & Van Gerven, 2003). Hence, this type of cognitive load can be modified by changing the learning materials or teaching method.

Intrinsic cognitive load and extraneous cognitive load are inseparably linked. If the intrinsic cognitive load of coursework is low, there will be no difficulty in dealing with a high extraneous cognitive load resulting from the design of the learning material, because the total cognitive load is within the working memory's capacity.

A further type of cognitive load is germane cognitive load. Unlike intrinsic or extraneous cognitive load, germane cognitive load does not represent an obstacle for learners. Germane cognitive load affects the processing and composition of schemas (Sawicka, 2008). Germane cognitive load is caused by the learner's effort to understanding the material (Renkl & Atkinson, 2003). As previously mentioned, a schema is a compilation of knowledge from the learner's previous experience. The effort to understand information increases the cognitive load and the effort affects the structuring of the schema

(Sweller, Van Merrienboer, & Paas, 1998). Thus, germane cognitive load seems to increase differently from other cognitive loads.

In summary, human memory consists of long-term memory and short-term memory. Human memory has a limited capacity for cognition. Therefore, if a certain task demands more effort than the working memory has the capacity to deal with, cognitive load will hinder the successful completion of that task. One possible way to reduce cognitive load is to develop instructional systems that consider the working memory's capacity.

2.2 Cognitive fit theory

The basic concept of cognitive fit is drawn from problem-solving theory. Cognitive fit refers to the task of solving problems and suggests that the way the task is presented affects task performance (Umanath & Vessey, 1994; Vessey, 1991).

Task performance is the outcome of the interaction between the problem-solving task and the problem representation format. The problem representation format relates to the complexity in the task environment, and this complexity is lowered when the problem-solving process of problem representation format (Vessey, 1991).

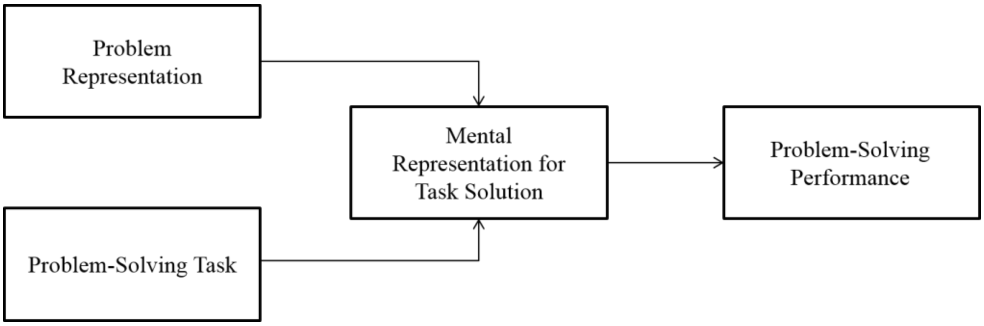

Figure 1. Basic model of cognitive fit theory (Vessey, 1991)

Figure 1 shows the basic cognitive fit model originally suggested by Vessey (1991). This model posits that problem-solving performance is the result of interaction between problem representation and the problem-solving task. According to the basic model of cognitive fit theory, problem representation and the problem-solving task are elements of a problem-solving process involving a mental representation which is the outcome of a correspondence between the elements of the problem-solving process. Vessey (1991) interprets the mental representation for task solution as “the way the problem is represented in human working memory”. A mental representation includes a knowledge or perception of how to solve the task (Chandra & Krovi, 1999). Mental representation for task solution affects the working memory, the decision-making process (Kelton, Pennington, & Tuttle, 2010), and cognitive style (Archer, Head, Wollersheim, & Yuan, 1996).

Based on the cognitive fit theory, the level of fit between the data presentation format and the problem-solving task affects task-completion performance. Therefore, a presentation format that improves the performance of one task may not improve the performance of a different task (Zhu & Watts, 2010). Originally, cognitive fit theory was developed to explain the conflicting results of tasks which involved comparing the problem representation formats of graphs and tables (Vessey, 1991). Nowadays, cognitive fit theory is being applied in various fields such as e-commerce (Hong, Thong, & Tam, 2004), decision support systems (Erskine, Gregg, Karimi, & Scott, 2018), and social media analytics (Zhu & Watts, 2010).

2.3 Cognitive Style

Cognitive style suggests that each person uses different means of understanding and compiling information (Rayner & Riding, 1997). An individual's cognitive style refers to the ways in which he or she collects, judges, and comprehends information (Harrison & Rainer Jr., 1992). This notion is important because the same information may be processed and interpreted in various ways according to individuals' different cognitive styles (Vessey & Galletta, 1991). Therefore, cognitive styles explain why individuals perform differently on the same tasks. A previous study has examined the effects of different cognitive styles upon perception, learning, task-solving abilities, and decision-making skills (Kirton, 2004).

A number of different cognitive styles have been identified by various researchers; for example, field dependent versus field independent (Witkin, Moore, Goodenough, & Cox, 1977), verbal versus visual (Riding & Ashmore, 1980), scanning versus focusing (Gardner, 1961), holistic vs. analytic (Richard Riding & Sadler-Smith, 1992), and others

A cognitive style approach has been applied to issues within the field of education (Witkin et al., 1977). In this field, cognitive styles and learning styles are interchangeable. Usually, cognitive style is more evident in academic research papers, whereas learning style is more apparent in practical use (Liu & Ginther, 1999). In the previous literature, both cognitive styles and learning styles have been seen to affect ways of processing or organizing information (Riding & Cheema, 1991).

In addition, studies relating to business organizations have placed significant emphasis on cognitive style because of the potential impact of differences in employees' cognitive styles on work performance

(Kirton, 1976). It was discovered that managers who recognize their employees' cognitive styles can find ways to increase both their work performance and productivity. It can be argued, therefore, than an understanding of cognitive style is crucial to the improvement of business outcomes and decision-making performance (Volkema Gorman, 1998).

2.4 Task complexity

People carry out various tasks in the course of their lives and complexity is one of the characteristics of tasks (Liu & Li, 2012). Task complexity is regarded as a crucial factor in human achievement and behavior (Payne, 1976).

When conducting an information- and design-related study, it is important to give some thought to task complexity. According to information-processing principles, if task complexity increases, the person carrying out the task must select new ways of processing the information and these choices will affect decision-making outcomes. (Bettman, Johnson, & Payne, 1988). Moreover, the importance of task complexity is not confined to design-related matters; it can also be relevant when establishing task-related aims or assessing task performance (Campbell, 1991).

In terms of motivation theories, task complexity has a moderate effect on the completion of difficult tasks (Wood, Mento, & Locke, 1987). Task complexity concerns the number of actions that need to be completed and the unique information cues that an individual has to deal with in order to complete the task (Wood, 1986). A previous study found that, as task complexity increases, the demands of information processing and the load on the cognitive source increase (Klemz & Gruca, 2003). Performing a task with high complexity, involving the risk of information overload, will eventually decrease concentration on the task (Speier, Valacich, & Vessey, 1999). In addition, high task complexity skews performers' judgment (Bonner, 1994).

In previous studies, many different aspects of task complexity were considered important. For example, Pierce and Dunham's (1976) study suggested that task complexity has psychological significance and affects task identity. The researchers emphasize certain psychological dimensions of tasks, such as the *task place* between the task and the individual. In a similar vein, Campbell and Gingrich (1986) stress the importance of observing the task-doer and the task when judging task complexity. Additionally, people's perceptions of task complexity have been seen to have objective characteristics. Objective complexity defines a task's complexity in terms of its objective task qualities. Objective task characteristics that contribute to task complexity include the information load, information diversity, and the rate of information change (Payne, 1976).

3. Theoretical Framework

3.1 The relationship between cognitive styles and interface design

Because computers and the Internet are now major elements of everyday life, the importance of user interfaces has increased (Calvary et al., 2003). A user interface is the communication medium between systems and users, so the user interface is an important part of any system (Chalmers, 2003; Hasan & Ahmed, 2007). Systems are types of software that are used to operate computers and other devices. Systems involve invisible codes, but provide user interfaces with graphical elements that can be viewed on screens. Computers can communicate with users via user interface elements such as menus, icons, graphically-portrayed data, screen layout, and alert messages. Even a system that employs advanced technology is useless if the user does not understand it.

When developing an information system with a user interface, the elements of the interface present information that is contained in the system. People have their own cognitive styles due to their different ways of processing, understanding, and reorganizing information (Felder & Spurlin, 2005) and information might be understood differently by users depending on their cognitive styles (Vessey & Galletta, 1991).

Previous studies have largely focused on the education field. Riding and Sadler-Smith (1992) examined students' learning performance based on their cognitive styles and the information presentation format. They divided cognitive styles into holistic–analytic dimensions. Their results showed that the presentation format can have an impact on learning performance. They suggested that learning materials which consider cognitive styles may improve the effectiveness and efficiency of learning. In Pillay and Wilss' (1996) study, they suggested ways of enhancing students' learning performance with computer assisted instruction (CAI). Their study examined the effect of instructional material that was matched or mismatched with students' cognitive styles. Cognitive styles were divided into four types; holistic, analytic, verbal, and visual. They found that students who were given learning materials that matched their cognitive styles performed better than students with mismatched learning materials. Another study examined the relationship between cognitive styles and e-learning, focusing on the students' emotions (Huang, Hwang, & Chen, 2016). The researchers assumed that emotion is a factor that affects learning performance. The study's results indicated that, in cases where students received e-learning materials which matched their cognitive styles, the students experienced more positive emotions than students who received mismatched materials.

Although many studies concluded that learning materials that match cognitive styles affect performance positively, they have not always showed significant results. Massa and Mayer (2006) investigated the interaction between multimedia instruction and cognitive styles. They supposed that the matched group would perform better in the multimedia environment than the mismatched group, but they found that there was no significant effect of matched or mismatched multimedia instruction in relation to participants' cognitive styles.

Previous studies have insisted that performance can be affected by learning materials regardless of whether or not they match individuals' cognitive styles. These studies were mainly conducted in the field of education and few concerned the agricultural sector. Hence, our study applies the concept of materials that are matched or mismatched with individuals' cognitive styles to determine the effects on performance, especially with regard to systems used in the agricultural sector.

3.2 The influence of task complexity on performance

Task complexity is one of the features that impact the relationship between the problem representation format and problem-solving performance. According to Wood (1986), task complexity is one of the main factors affecting human performance. Thus, it is important to identify the complexity of the task. Many previous studies have defined the complexity of tasks according to task characteristics (Campbell, 1988; Schwab & Cummings, 1976; Steinmann, 1976). This study uses Campbell's (1988) definition of task complexity as its theoretical basis. Campbell (1988) established four characteristics of a complex task. The first characteristic of a complex task is multiple paths, meaning that, when there are many paths to a preferred outcome, task complexity increases. The second characteristic is multiple outcomes. If the required outcomes of a task increase, the task complexity also increases. The third characteristic is the friction between paths. The complexity of a task may increase when the achievement of one desired result conflicts with another desired result. The final characteristic is uncertainty, which can increase task complexity by expanding the possible paths to achievement of the desired outcomes.

Furthermore, Campbell (1988) emphasized that the complexity of a task must be considered because it relates to the interaction between the task doer and the task properties. Task complexity has an impact on the task doer's memory workload (Jacko & Salvendy, 1996). For high task complexity, the task doer requires more information (Klemz & Gruca, 2003). According to Norman and Bobrow (1975), when the amount of information exceeds the memory's capacity for processing information, performance is moderated. Compared with the level of task complexity, inadequate user interfaces have a greater influence on complex tasks than simple tasks (Mittelstädt, Brauner, Blum, & Ziefle, 2015). In the field of human-computer interaction, task complexity has been identified as important. Jacko and Ward (1996) studied the relationship between task complexity and performance using a hierarchical menu. Their study showed that, as the components of an interface increased, the increase became a threat to short-term memory and exerted a negative effect on decision-making performance. Xu et al. (2008) examined the impact of the presentation format, task complexity, and the degree of training on performance in dealing with computerized emergency operating procedures (EOPs). According to their results, task complexity has a significant effect on subjects' operation performance. Both skilled and unskilled participants needed more time and had a higher error rate when completing high-complexity tasks than when completing low-complexity tasks. In summary, task complexity affects an individual's information processing ability and decision-making approach (Payne, 1976).

The cognitive styles and task complexity literature has provided the theoretical framework for this study. However, few of the studies have verified the effect of interface designs that are matched or mismatched with cognitive styles or the effect of task complexity on decision-making performance in an agricultural context. Therefore, we have employed the concepts of cognitive styles and task complexity in order to verify the effect of user interface design on decision-making performance using prototypes based on systems used in the swine-farming industry.

4. Research Model and Development of Hypotheses

According to the previous studies and conceptual framework, this study proposes the following research model (Figure 2).

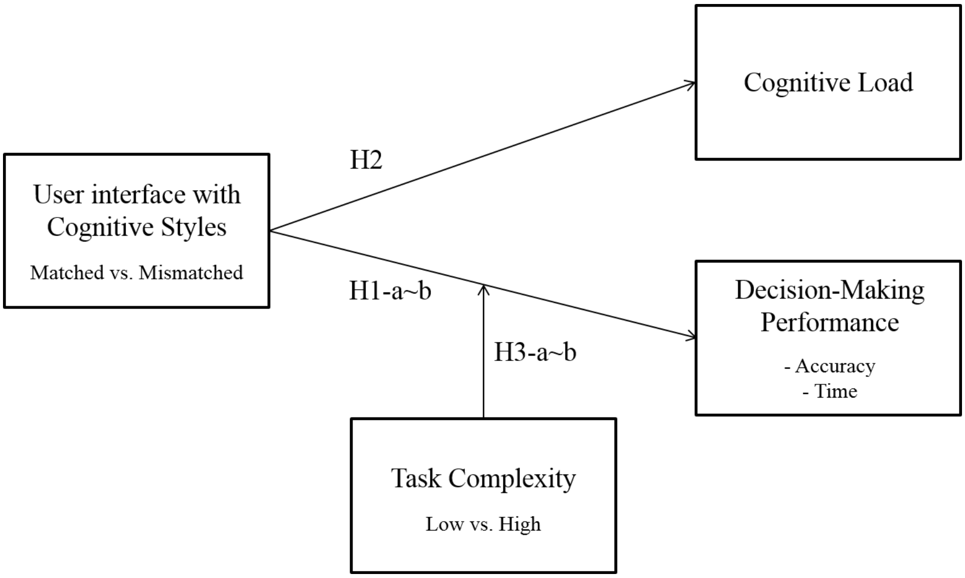

Figure 2. Research model for the present study

A variety of studies have verified the relationship between cognitive style and user interface design. Ford and Chen (2001) examined whether learning performance was affected by online systems that considered cognitive styles. They designed the different stimuli with either breadth or depth first design. With regard to cognitive styles, field-dependent individuals were found to have superior performance under breadth conditions. By contrast, field-independent individuals were found to perform better under depth conditions. For each cognitive style, when individuals used an online system that matched their cognitive style, they obtained better results. Also, Ford (1995) verified the effect of concurrence between cognitive styles and learning systems on performance and efficiency. When conditions matched the cognitive styles of field-dependent people, the design incorporated a holistic designed stimulus. When conditions matched the cognitive styles of field-independent people, the design incorporated a serialistic designed stimulus. The results showed that matched conditions led to higher performance than did mismatched conditions.

The way information is presented affects decision-making performance (Tan & Benbasat, 1990; Tractinsky & Meyer, 1999). Cognitive fit theory supported the many studies which verified the relationship between information presentation and decision-making performance. Speed and accuracy are widely used variables for assessing decision-making performance (Dennis & Carte, 1998; Speier, 2006; Umanath & Vessey, 1994). Therefore, this study assumes that users can achieve better decision-making performance when the user interface design is matched with their cognitive style. Based on previous studies, we suggest the following hypotheses:

H1-a: User interface designs that match cognitive styles will yield higher task completion scores than mismatched ones.

H1-b: User interface designs that match cognitive styles will facilitate faster task completion times than mismatched ones.

As previously mentioned, people obtain better results when the learning situation matches their cognitive styles. When the situation matches their style, people can find and process information in their preferred ways (Riding & Sadler-Smith, 1997). Cognitive overload is caused when people receive too much information to process or when they cannot easily find the desired information (Sweller, 1994). It seems likely that cognitive load may decrease if conditions match the individual's cognitive style and the user interface. Based on this assumption, this study hypothesizes as follows:

H2: User interface designs that match cognitive styles will yield a lower cognitive load than mismatched ones.

Previous studies have suggested that the level of task complexity also affects decision-making performance (Paquette & Kida, 1988; Speier, Vessey, & Valacich, 2003; Topi, Valacich, & Hoffer, 2005).

Cognitive load theory focused on human working memory, cognitive load, and design insights (Sweller, 2004). According to Johnson and Payne (1985), cognitive load increases with increased task complexity, leading to a decrease in decision-making performance. Task complexity also plays an important role in information systems in the interaction between the information systems' structure and system users' performance (Jacko, Salvendy, & Koubek, 1995). In particular, with regard to information presentation, task complexity is related to the interaction between information systems and users (Xu et al., 2008). Therefore, this study formulates the following hypotheses:

H3-a: User interface designs that match cognitive styles will moderate task complexity scores.

H3-b: User interface designs that match cognitive styles will moderate the time taken to complete tasks relative to the tasks' complexity.

5. Research Methodology

5.1 Experiment design

The aim of this study was to determine whether the concurrence between cognitive style and interface design had any effect on decision-making performance and cognitive load.

To verify the hypotheses, this study used a 2 x 2 experimental design, with one inter-subject factor and one intra-subject factor. The inter-subject factor was the *concurrence between cognitive styles and interface design* at two levels (matched or mismatched). The intra-subject factor was *task complexity* (simple or complex). Thus, all subjects performed a simple task and a complex task.

5.2 Concurrence between cognitive styles and interface design

The method of determining matches between cognitive styles and interface design was driven by theory. Field-independent individuals have a tendency to finding information that they need in whole information. By contrast, field-dependent individuals have a tendency to process information holistically. Cognitive styles have typically been assessed using tasks in which subjects locate a simple figure within complex figures. The group embedded figures test (GEFT) and hidden figures test (HFT) (French, Ekstrom, & Price, 1963) are commonly used to identify individuals' cognitive styles. This study used the HFT instrument to assess subjects' cognitive styles in relation to field dependence and independence. Participants were required to find five simple figures within complex shape configurations. In the HFT, 32 complex configurations are split into two sets of 16 complex configurations each. To score the HFT, the number of correct and incorrect answers are counted to produce a total score. Participants' total scores were determined to establish their cognitive styles. Field-dependent individuals typically have more difficulty finding figures than field independent individuals. This tendency, field-independent individuals usually score higher than field dependent individuals.

The prototype used for this study was developed to resemble the systems that are used in the swine-farming industry. This study applied the results of previous studies that examined the relationship between cognitive styles and user interface design (Chen et al., 2003; Chen & Macredie, 2002; Yang, Hwang, & Yang, 2013). Table 1 shows the summary of these previous studies. The studies' stimuli details vary, but all were analyzed using an internet environment and applied cognitive styles.

Table 1. Summary of implications for interface designs that matched users' cognitive styles

Environment	Author	Field Independence	Field Dependence
Web-based application interface design based on cognitive styles	Chen and Macredie (2002)	Prefer to work independently with inner construction	Need guidance from exterior support
		Enjoy creating their own construction to establish information	Inactive to rely on the construction presented by the material
		Prefer to use the alphabetical index	Prefer to use the navigation map
Web directory design guidelines based on cognitive styles	Chen, Magoulas, and Dimakopoulos (2005)	Organizing by alphabetical order	Provide extra direction
		Fewer key subject categories, and with many stages of subcategories	Provide users with an outline of the available information
		Present the results first	Decrease misunderstanding and help users to select then subject categories simply
		Black and white colors	Provide a high contrast mixture
Interface design principle based on cognitive styles	Yang et al. (2013)	Simpler interface	More complex interface
		Less information presented at the same time	More information presented at the same time
		Providing commonly used functions and links to the resources related to the present learning material	Providing links to show the entire functions of the whole learning material

5.3 Task complexity

Task complexity characteristics followed Campbell's (1988) definition. He claimed that there were three approaches: (1) general psychological, (2) interaction between task and task doer, and (3) the task complexity's objective characteristics. We accommodated the object task complexity. According to Campbell (1988), who approached task complexity from an objective standpoint, information load, information multiplicity, or information exchange rate can cause task complexity to increase. He asserted that one of the characteristics of objective task complexity is multiple paths. Multiple paths mean there are several ways to achieve a desired aim. This study designed simple and complex tasks that incorporated the characteristic of multiple paths.

On a swine farm, farmers make decisions in different ways. For example, if the pig house's temperature is lower than the pigs need, the farmer will try to increase the temperature. The farmer can solve this problem by operating heat lamps, reducing the minimum ventilator rate, or operating heat pads. Similarly, we designed a complex test with a number of different options for completing the task. In the simple test, there were fewer possible ways of completing the task. To resemble the business support systems used in the swine-farming industry, we designed the task with four categories: pig breeding management, environmental management, feeding management, and disease control. For each category, we designed two types of tasks: a simple task and a complex task. Participants had to consider more factors in order to complete the complex task than the simple task.

5.4 Experimental procedure

Based on previous studies, the present study applied recommended elements for user interfaces. Figure 3 shows the design principles which this study used in order to develop user interface designs for each cognitive style.

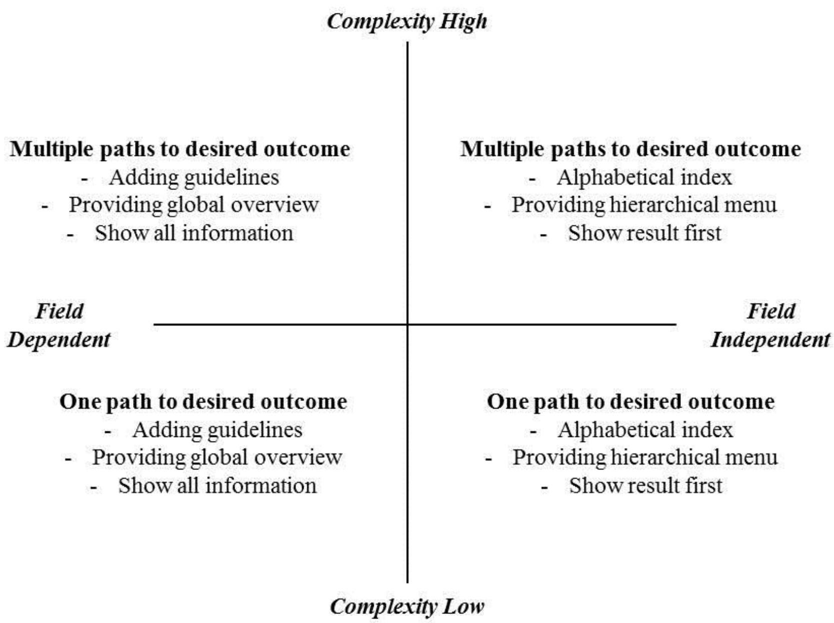

Figure 3. Interface design principles used to develop an interface for each cognitive style

Both prototypes included the same options for completing the tasks. To complete the simple task, only one factor needed to be considered but, in the case of the complex task, there were various factors to consider. Two types of user interfaces for cognitive styles were designed. The field-dependent preferred prototype was designed to provide guidelines, offer a global overview, and show all the information at once (Figure 4). By contrast, the field-independent preferred prototype was designed with a hierarchical menu in Korean alphabetical order and showing exact results first (Figure 5).

Figure 4. Example of a field-dependent preferred prototype design

Figure 5. Example of a field-independent preferred prototype design

The independent variable was whether participants completed the tasks under matched or mismatched conditions. Matched conditions can be described as field-independent participants using a field-independent preferred user interface or field-dependent participants using a field-dependent preferred user interface. Mismatched conditions can be described as a field-independent participant using a field-dependent preferred user interface or a field-dependent participant using a field-independent preferred user interface.

Drawing on the previous studies' results, the dependent variables selected for this study were decision-making performance and cognitive load. Decision-making performance was related to task outcomes and the time taken to complete tasks. The task score depended on the number of correct answers. Task time was measured for each task. We measured cognitive load using the NASA-TLX (task load index). NASA-TLX was developed by Hart and Staveland (1988) for measuring perceived workload. NASA-TLX is one of the most widely-used instruments for the subjective measurement of cognitive load (Fischer, Lowe, & Schwan, 2008; Hilbert & Renkl, 2009; Smith et al., 2017). Demographic factors such as gender and grade were used as control variables. Also, knowledge of the swine-farming industry, cognitive style, the interface type that participants were given, and attendance at a premier research university were used as control variables. Attendance at a strong research university was used as a control because such a university provides professional research programs for training students. A strong research university contributes to the research field through collaborative research with various companies and public institutions. The undergraduate students from such a university had more opportunity to applying apprenticeships in research labs to training about graduate course. Hence, this study controlled for attendance at a premier research university.

Participants assigned to the two types of interface design took turns in using a field-dependent preferred interface design and a field-independent preferred interface design. For example, if the first participant was given a field-independent preferred user interface, the second participant was given a field-dependent preferred user interface. The experiment used an online survey format to enable participants to access the experiment through a simple uniform resource locator (URL) address.

Participants were given the task question and the URL address. Participants could simulate using an internet browser such as Internet Explorer, Chrome, Firefox, and so on. Since the screen size can affect user performance (Chen et al., 2003; Maniar, Bennett, Hand, & Allan, 2008), we prevented participants from accessing the experiment via a mobile device. They were required to complete the task by accessing the URL. They cannot move on to the next task without answering or clicking on the embedded URL. After completing the tasks, participants were required to undergo a NASA-TLX assessment in order to analyze the cognitive load. After finishing the NASA-TLX assessment, participants were required to take the HFT test in order to determine each person’s cognitive style.

6. Data Analysis and Results

6.1 Data collection

This study conducted an experiment to collect data and examine the study's hypotheses. Participants were recruited using advertisements asking for help in evaluating swine farm management systems, which were posted on the university's website. A total of 171 subjects responded, but 25 were excluded because: (1) four participants provided answers that were irrelevant to the task, (2) three participants took longer than two hours per question. (3) five participants took less than 90 seconds to complete all the tasks, and one participant took more than 3 hours and 30 minutes. Therefore, this study analyzed data from 156 participants.

HFT was used to determine participants' cognitive styles. Their average score was 0.08 (*SD* = 7.41). The separate scores varied from study to study. In this study, we calculated the median of the participants' separate scores. Participants who scored lower than 0 were classified as field dependent and those with higher scores were classified as field independent. Table 2 shows the number of participants with each cognitive style and the concurrence of the interface with their cognitive style.

Table 2. Number of cognitive style classifications

		Cognitive Styles	
		Field Independence	Field Dependence
Interface relevance	Match	42	39
	Mismatch	37	38
	Sum	79	77

6.2 Demographic information

The subjects' demographic characteristics are shown in Table 3. All the subjects in this study were undergraduate students. Their average age was 22.69 (*SD* = 2.46). Fifty-nine percent of the subjects were male and the majority of the subjects were sophomores. Fifty-six percent of the subjects had some knowledge of the swine-farming industry and the majority of subjects had no family engaged in the pork industry.

Table 3. Participants' demographic information

		N	%
Gender	Male	93	59.6
	Female	63	40.4
Degree	First grade	3	1.9
	Second grade	48	30.8
	Third grade	43	27.6
	Fourth grade	40	25.6
	More than fourth grade	22	14.1
Pig industry knowledge	No	88	56.4
	Yes	68	43.6
Family engaged in pig industry	No	149	95.5
	Yes	7	4.5
University	Premier research university	46	70.5
	Others	110	29.5

6.3 Descriptive statistics for the major variables

The aim of this study was to investigate whether the match or mismatch of a user interface with the participant's cognitive style is related to the participant's decision-making performance and cognitive load. The effects of the relevance of cognitive style were analyzed using SPSS®.

Table 4 shows the descriptive statistics for the major variables. A correct answer counted as one point per question for both the simple and complex tasks. The average task completion score was 5.79. The average score for the simple task was higher than for the complex task. The time taken to complete a task was measured in seconds and the average time taken to complete all the tasks was 16 minutes. Subjects took much longer to complete complex tasks than simple tasks. Cognitive load was checked with six subscales. Each of scale rated a scale from one to twenty.

Table 4. Descriptive statistics for the major variables

Variable	**Min**	**Max**	**Mean**	**St. dev**
Total score	0.00	8.00	5.79	1.83
Simple task score	0.00	4.00	2.96	1.07
Complex task score	0.00	4.00	2.84	1.06
Total time	92.00	6696.00	983.79	742.69
Simple task time	59.00	3371.00	420.46	352.12
Complex task time	27.00	6282.00	563.33	598.63
Mental demand	59.00	20.00	11.12	5.48
Physical demand	1.00	20.00	5.24	4.56
Temporal demand	1.00	20.00	8.01	5.22
Performance	1.00	20.00	12.74	5.08
Effort	1.00	20.00	13.83	4.32
Frustration	1.00	20.00	9.26	5.82

6.4 Correlation analysis.

This study performed a correlation analysis of the relationship between the major variables. The results of the correlation analysis are shown in Table 5. The correlation between age and degree was 0.616, showing strong correlation. This is because students usually enter university in their early twenties. If these two variables were used in regression analysis, they would cause multicollinearity so, in this study, only the degree variable was used in the regression analysis.

Table 5. Correlation analysis results for the major variables

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1)	Sex	1											
(2)	Age	.306**	1										
(3)	Degree	-.071	.616**	1									
(4)	Knowledge	.091	.000	.023	1								
(5)	Family	-.011	-.086	-.039	.184**	1							
(6)	University	.017	.150**	.223**	-.030	-.072	1						
(7)	Interface type	-.076	-.090	-.176**	.011	.034	-.048	1					
(8)	Cognitive style	.044	.049	-.078	.023	-.025	-.068	.038	1				
(9)	Matched with cognitive style	.071	.209**	.195**	.070	.023	.088	-.025	-.012	1			
(10)	Total score	.047	-.077	.074	.035	.135*	.123*	-.044	-.389**	-.010	1		
(11)	Total time	-.104	-.164**	.032	-.040	-.030	-.116*	.031	-.199**	-.147**	.339**	1	
(12)	Cognitive load	-.024	.091	.106	-.223**	-.182**	.335**	-.077	.136*	.126*	-.214**	-.139*	1
** and * indicate significance at the 1% and 5% levels, respectively													

6.5 Hypothesis test

This study's goal was to verify the effect of the match or mismatch of a user interface with a user's cognitive style. To achieve this goal, the study performed a regression analysis and Table 6 shows the variables that were used in the regression analysis.

Table 6. Description of the variables

Variables		
Dependent Variables	Task score	Correct answer for each question= 1 Incorrect answer for each question = 0 (total number of questions = 8)
	Task time	Seconds
	Cognitive load	20-point Likert scale (1 = very low load, 20 = very high load)
Independent Variables	Matched with cognitive style	Mismatch = –1 Match = 1
	Task complexity	Simple task = –1 Complex task = 1
	Matched with cognitive style* Task complexity	Mismatch*Simple task = 1 Mismatch*Complex task = –1 Match*Simple task = –1 Match*Complex task = 1
Control variables	Gender	Male = 1 Female = 0
	degree	First grade = 1 Second grade = 2 Third grade = 3 Fourth grade = 4 More than fourth grade = 5
	Knowledge	Have prior knowledge of the pig = 1 No prior knowledge of the pig = 0
	family	Have family working in pig industry = 1 No family working in pig industry = 0
	university	Premier research university = 1 Others = 0
	Cognitive style	Field independent = 1 Field dependent = 2
	Interface type	Field independent preferred= 1 Field dependent preferred = 2

6.5.1 Task score

To analyze the effect of the match or mismatch of a user interface design with a user's cognitive style on the task completion score, a regression analysis was performed as follows:

$$Y_{score} = a + b_1 * X_{matched\ with\ cognitive\ style} + b_2 * X_{task\ complexity} + b_3 * X_{matched\ with\ cognitive\ style * task\ complexity} + b_4 * X_{Gender} + b_5 * X_{degree} + b_6 * X_{knowledge} + b_7 * X_{family} + b_8 * X_{university} + b_9 * X_{interface\ type} + b_{10} * X_{cognitive\ style} + b_{11} * X_{time\ per}$$

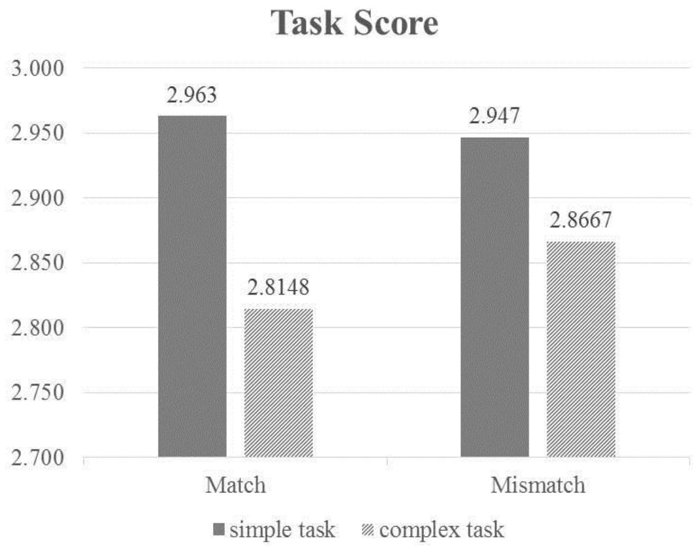

Figure 6. Mean task completion scores for matched and mismatched

The means of the task completion scores for the two groups are illustrated in Figure 6. The simple task completion score was higher when participants completed the task using an interface that matched their cognitive style.

The results of the regression analysis of the task completion scores is shown in Table 7. There was no significant difference in the task completion scores between the independent variables. Also, the effect of the interaction between the task completion scores and task complexity was not significant.

Table 7. Regression analysis results (*y* = task score)

	Coefficient				
	B	S. E.	Stand. B.	*t*	*p*-value
(Intercept)	3.483	.342		10.182	.000
Match	-.017	.058	-.016	-.303	.381
Match * complexity	-.012	.056	-.011	-.211	.417
Task complexity	-.116	.059	-.109	-1.966	.025*
Time	.002	.001	.183	3.223	.001**
Gender	.146	.116	.068	1.260	.104
Degree	.019	.055	.019	.338	.368
Knowledge	.045	.116	.021	.389	.349
Family	.608	.276	.118	2.202	.014*
University	.244	.127	.105	1.917	.028*
Cognitive style	-.639	.114	-.301	-5.613	.000**
Interface type	-.050	.114	-.023	-.435	.332
R^2 = 0.169, adj R^2 = 0.139					

**, * indicate significance at1%, 5% levels, respectively

6.5.2 Time

To analyze the effect of the match or mismatch of a user interface design with cognitive styles on the time taken to complete the tasks, a regression analysis was performed as follows:

$$Y_{time} = a + b_1 * X_{matched\ with\ cognitive\ style} + b_2 * X_{task\ complexity} + b_3 * X_{matched\ with\ cognitive\ style*task\ complexity} + b_4 * X_{Gender} + b_5 * X_{degree} + b_6 * X_{knowledge} + b_7 * X_{family} + b_8 * X_{university} + b_9 * X_{interface\ type} + b_{10} * X_{cognitive\ style}$$

The means of time taken for the two groups are illustrated in Figure 7. Participants finished tasks faster when they used the interface that matched their preferred cognitive style.

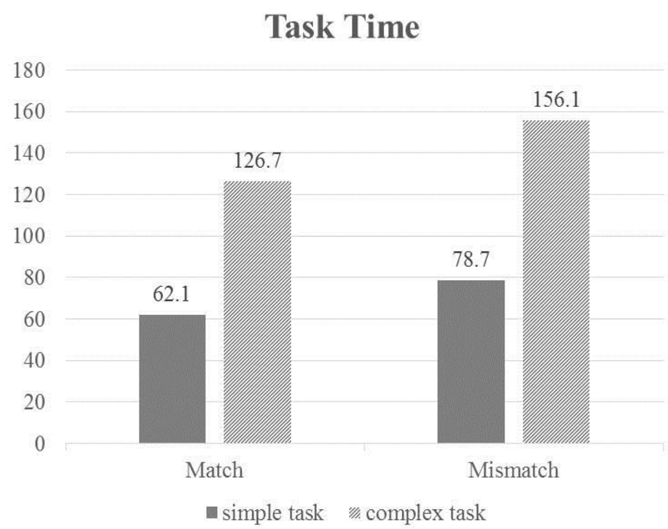

Figure 7. Mean time taken per task for matched and mismatched interfaces

The results of the regression analysis for time taken are shown in Table 8. Participants completing tasks under matched conditions finished their tasks more quickly than under mismatched conditions (H1-b, one-tailed test, $p < 0.05$), but the effect of the interaction between task time and task complexity was not significant.

Table 8. Regression analysis results (y = time per task)

	Coefficient				
	B	S. E.	Stand. B.	*t*	*p*-value
(Intercept)	139.318	37.685		3.697	.000
Match	-11.174	6.468	-.095	-1.728	.043*
Match * complexity	-3.181	6.300	-.027	-.505	.307
Task complexity	35.500	6.300	.302	5.635	.000**
Gender	-14.387	13.040	-.060	-1.103	.135
Degree	6.649	6.213	.061	1.070	.143
Knowledge	-6.771	13.014	-.029	-.520	.302
Family	-14.325	31.071	-.025	-.461	.323
University	-25.459	14.243	-.099	-1.788	.037*
Cognitive style	-32.870	12.676	-.140	-2.593	.005*
Interface type	9.307	12.856	.040	.724	.235
$R^2 = 0.138$, adj $R^2 = 0.109$					

**, * indicate significance at1%, 5% levels, respectively

6.5.3 Cognitive load

To analyze the effect of the match or mismatch of a user interface design with cognitive styles on cognitive load, a regression analysis was performed as follows:

$$Y_{cognitive\ load} = a + b_1 * X_{matched\ with\ cognitive\ style} + b_2 * X_{Gender} + b_3 * X_{degree} + b_4 * X_{knowledge} + b_5 * X_{family} + b_6 * X_{university} + b_7 * X_{interface\ type} + b_8 * X_{cognitive\ style}$$

The means of the cognitive load for the two groups are illustrated in Figure 8. Participants experienced a greater cognitive load when they used the interface that matched their preferred cognitive style.

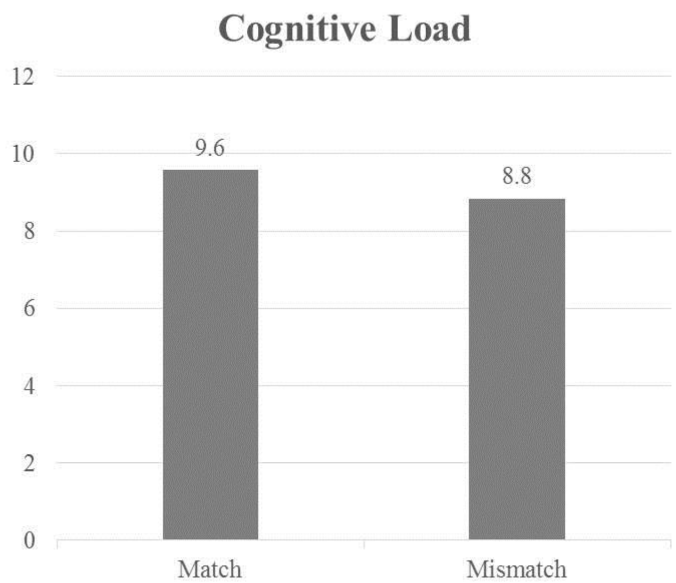

Figure 8. Mean cognitive load for matched and mismatched interfaces

The results of the regression analysis of cognitive load is shown in Table 9. There was no significant difference in cognitive load between the independent variables.

Table 9. Regression analysis results (*y* = cognitive load)

	Coefficient				
	B	S. E.	Stand. B.	*t*	*p*-value
(Intercept)	8.281	1.266		6.541	.000
Match	.334	.217	.115	1.538	.063
Gender	-.185	.438	-.031	-.422	.337
Degree	.036	.209	.013	.171	.432
Knowledge	-1.169	.437	-.200	-2.674	.004*
Family	-1.664	1.044	-.119	-1.594	.057
University	2.007	.478	.316	4.194	.000**
Cognitive style	.957	.426	.165	2.248	.013*
Interface type	-.339	.432	-.059	-.785	.217
R^2 = 0.216, adj R^2 = 0.173					

**, * indicate significance at1%, 5% levels, respectively

7. Discussion

7.1 Summary of findings

The main purpose of this study was to investigate the effects of interface designs that are matched or mismatched with cognitive styles and the effects of interaction between task complexity and decision-making performance. To verify our hypotheses, a 2 x 2 experiment was conducted and 156 responses were analyzed. The data was analyzed using regression analyses. The results showed that the match or mismatch of an interface with cognitive style had no effect on the task completion score, but did affect the time taken by participants to complete the task. In addition, there was no significant effect on cognitive load. Task complexity had a significant effect on both the task score and the time taken to complete the task, but the interaction effects were not significant for task score and time taken. Table 10 illustrates the results of the hypotheses tests.

Table 10. Hypotheses test results.

	Hypothesis	Support
H1-a	*User interface designs that match cognitive styles will yield higher task completion scores than mismatched ones.*	Not Supported
H1-b	*User interface designs that match cognitive styles will facilitate faster task completion times than mismatched ones.*	**Supported**
H2	*User interface designs that match cognitive styles will yield a lower cognitive load than mismatched ones.*	Not Supported
H3-a	*User interface designs that match cognitive styles will moderate task complexity scores.*	Not Supported
H3-b	*User interface designs that match cognitive styles will moderate the time taken to complete tasks relative to the tasks' complexity.*	Not Supported

H1-a and H1-b relate to the effects of interfaces matched or mismatched with users' cognitive styles on decision-making performance. As shown in Table 10, an interface matched or mismatched with a user's cognitive style had a significant effect on the time taken to complete the task, but the hypothesis related to the task score (H1-a) was not supported.

H2 related to the effects of interfaces matched or mismatched with users' cognitive styles on cognitive load. Interfaces matched or mismatched with cognitive styles had a no significant effect on cognitive load.

H3-a and H3-b relate to the effects of interaction between task complexity and decision-making performance. There was no significant interaction effect on either task score or time taken to complete the task.

7.2. Academic Contributions

First, the present study is one of the first to examine the effect of a user interface based on cognitive styles on decision-making performance in the field of agriculture. With developments in information and communication technology (ICT), precision livestock farming has attracted increasing interest for increasing productivity and efficiency considering the sustainability of resources and animal welfare (Berckmans, 2006; Wathes, Kristensen, Aerts, & Berckmans, 2008; Werkheiser, 2018). Many studies on precision livestock farming have mainly investigated backend systems such as database systems, network protocols, and integration with other modules (Debauche et al., 2018; Eastwood, Chapman, & Paine, 2012; Ojha, Misra, & Raghuwanshi, 2015). Human-computer interaction and hypermedia learning are currently active and vibrant research fields in the context of a user interface with an individual's cognitive styles with learning material. This is because a user interface is an important element to consider when developing information systems (Nikander et al., 2015). However, user interface design in the field of agricultural information systems has attracted less interest.

Therefore, this study contributes to the improvement of agricultural information systems by investigating user interface design based on cognitive styles.

Second, this study applied the notion of cognitive styles to the user interface of an agricultural information system. According to this notion, people process information quickly when it is presented in their preferred cognitive style. This study's results indicate that users finished their tasks quickly when they were offered a user interface with their preferred cognitive style. Similarly, an agricultural information system with a user interface based on users' preferred cognitive styles can improve their decision-making efficiency.

Third, this study supports the argument for the existence of the dilemma related to the speed-accuracy tradeoff. Existing literatures on decision-making performance argued that decision-makers often face a dilemma related to the speed-accuracy tradeoff (Chittka, Skorupski, & Raine, 2009; Rinkenauer, Osman, Ulrich, Müller-Gethmann, & Mattes, 2004; Wickelgren, 1977). This tradeoff explains the fact that if people complete a task quickly, they make mistakes more often than when they complete the task slowly. This study's participants may also have experienced the dilemma related to the speed-accuracy tradeoff. This study's results showed that participants who were offered a user interface with their preferred cognitive style finished both simple and complex tasks quickly. However, the score was not significantly affected by a match between participants' cognitive style and the user interface design. This study assumed that the speed-accuracy tradeoff might explain the obtained results.

A user interface designed based on participants' preferred cognitive style should make it easier for them to find information without having to spend more cognitive effort. However, less cognitive effort can result in intuition-based decision-making (Calabretta, Gemser, & Wijnberg, 2017). Intuition refers to making a decision or judgment based on one's gut feeling (Blackler & Popovic, 2015; Hodgkinson, Langan-Fox, & Sadler-Smith, 2008). Intuitively processing information can reduce the decision-making effort (Salas, Rosen, & Diaz Granados, 2010). However, intuition is the product of knowledge gained from experience (Diefenbach & Ullrich, 2015). This study's participants did not have enough experience to develop a suitable intuition about the information systems used in the swine industry. Therefore, this study presumed that as the speed of acquiring information using the interface itself is increasing, the speed of problem-solving and the possibility of making a mistake are both increased.

Lastly, this study's findings contribute to improving the usability of agricultural information management systems. For the last 20 years, ICT has been incorporated in the field of agriculture to increase farm productivity;

however, ICT is not yet widely used in this field. One reason is that farmers have relatively low educational attainment and face difficulties in using unfamiliar technologies (Cen & Zhang, 2010). In addition, farmers mainly work in rural areas that have poorer information and communication infrastructure than cities (Skerratt, 2010). The lack of infrastructure and low interest in ICT often limits the understanding and use of agricultural information systems (Zhang, Wang, & Duan, 2016).

Overall, even if systems are well developed, if a user does not realize their usefulness or necessity, they will remain useless. One possible way of improving system usability and accessibility is designing a user interface by considering human factors (Tory & Moller, 2004). In this context, this study investigated the influence of a user interface based on cognitive styles, one such human factor, on decision-making performance. The results indicate that designing a user interface based on cognitive styles, for example, with an intuitive layout, can be one of the possible ways to increase the usability of agricultural information systems.

7.3. Practical Suggestions

This study has implications for improving users' decision-making performance through user interface design for agricultural and general information systems.

First, this study suggests the importance of the user interface as a factor that can increase decision-making performance in the field of agricultural. Studies on enhancing performance through a user interface based on cognitive styles have been actively carried out mainly in the field of educational psychology (e.g., Hederich-Martínez & Camargo-Uribe, 2016; Mebane & Johnson, 2017). Most previous studies on agricultural information systems have focused on system elements other than interfaces to improve the system utilization. However, poor user interfaces have often been noted as a problem in agricultural information systems (e.g., McCown, 2002; Lindblom et al., 2017; Devitt, 2018). The present study's results highlight user interface research as one way to enhance the effectiveness of agricultural information systems.

Second, the present study proposes the need to design user interfaces differently depending on users' cognitive styles. This study's results show that users can make faster decisions when using an interface that matches their cognitive style. These findings can serve as a guide for interface design to improve efficiency in the field of agriculture. Specifically, users in this field could make faster decisions when using interfaces that match their cognitive style.

In particular, fast decision-making in livestock production is important because it is directly related to farm productivity. For example, suppose that temperatures have dropped at a swine farm. A farmer may face difficulties in recognizing the current situation at the farm if the information system used is complex. In turn, this could hamper quick control of the heating equipment or ventilation fan and could result in the swine contracting a dangerous disease. In other words, if farmers face difficulties in understanding the information provided by the system in real time, the effectiveness of this system in increasing productivity will be reduced.

In swine farms as well as other livestock industries, controlling the breeding environment is an important factor in increasing productivity (St-Pierre, Cobanov, & Schnitkey, 2003). Many livestock farmers use agricultural information systems to increase farm productivity. Such systems help farmers by providing functions such as real-time monitoring, accumulating environmental data from various sensors, and predicting values based on real-time data and desired bioresponses (Berckmans, 2017). Agricultural information systems with such functions can help farmers make decisions quickly by integrating farm data (Berckmans & Guarino, 2017).

Therefore, an effective approach to understand the data provided by agriculture information systems is needed to increase their usability; designing a suitable user interface can be one such approach. The user interface serves as a communication medium between the complex programming language and users. Therefore, the interface is crucial for developing a successful system. Improving the user interface design can enable decision-makers in the livestock industry to make the right decisions through an easier understanding of accumulated farm-related data (Sonka & Ifamr, 2014).

Third, this study can be applied to educational and agricultural systems as well as to other general information systems in which the importance of user platforms is emerging. Recently, various industries have tried to improve the effectiveness of information systems by improving their user interfaces. For example, as users are increasingly reading e-books through mobile devices, the book industry is focusing on effective user interfaces that can attract more readers (Wang, 2018). Researchers in the field of healthcare are investigating user interfaces as a way to prevent medical errors (Taieb-Maimon, Plaisant, Hettinger, & Shneiderman, 2018). The present study investigated user interfaces based on users' cognitive styles, and its results can be applied to design user interfaces in various industrial information systems. The cognitive style refers to a user's preferred information processing style; in other words, it refers to a characteristic and not an ability (Kim & Kim, 2015). In this context, this study can contribute to the design of user interfaces based on users' cognitive styles for general information systems to enable efficient decision-making.

7.4. Limitations and Future Study

Although this study provides useful findings, it has several limitations. First, experiments were conducted with potential users in their twenties. However, in reality, most agricultural industry workers are older than the twenties. A study by Ziefle, Schroeder, Strenk, and Michel (2007) reported conflicting results between the performance of young and old people. Further, Hanson (2010) suggested that older adults needs more time to search for information than younger adults. In other words, the effectiveness of the same interface can differ for users of different ages. Furthermore, farmers play different roles on a farm, and accordingly, they may require different user interfaces. Future studies should focus on farmers working in agricultural fields to increase the external validity.

Second, future studies should conduct experiments with devices of various screen sizes. The present study prohibits access through mobiles or tablets to control the bias arising from the screen size effect. The usage of smartphones and tablets has increased with developments in touch screen technology (Suhaib, 2018). Further, farmers usually wear work clothes and gloves when working on the farm for hygiene purposes. This would make it difficult to access information systems through a computer or a laptop. By contrast, smartphones and tablets are portable but have smaller screens than a computer. A small screen can hamper perceiving information (Ghose, Goldfarb, & Han, 2012). Therefore, future studies should investigate interface design for devices with different screen sizes.

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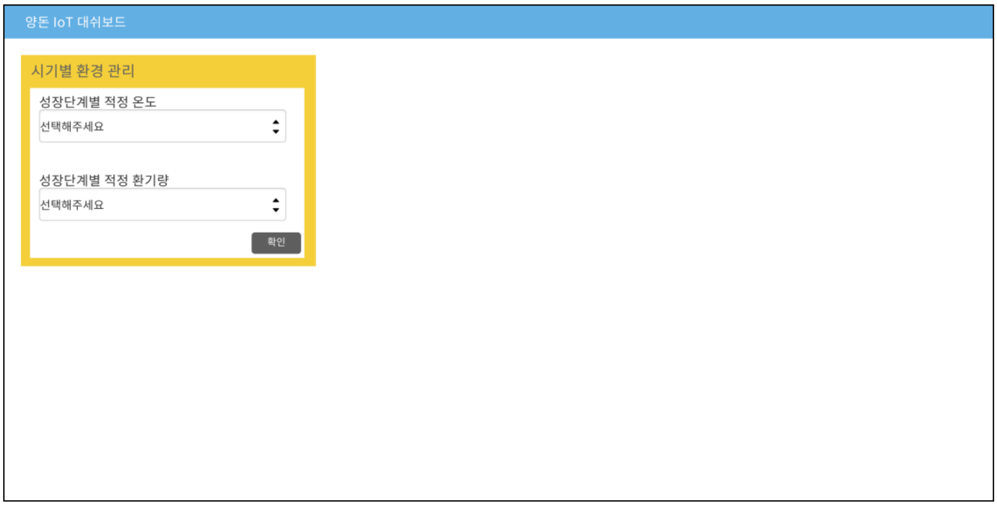
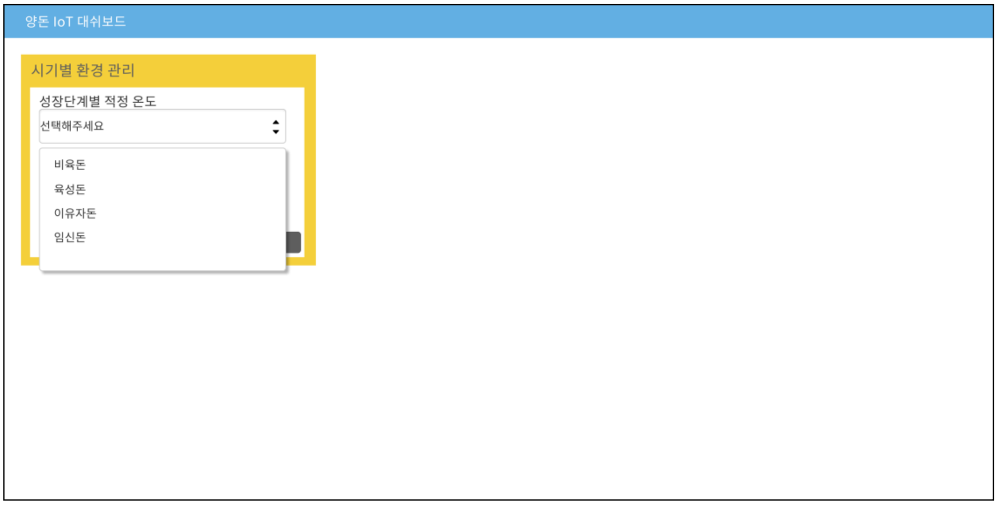
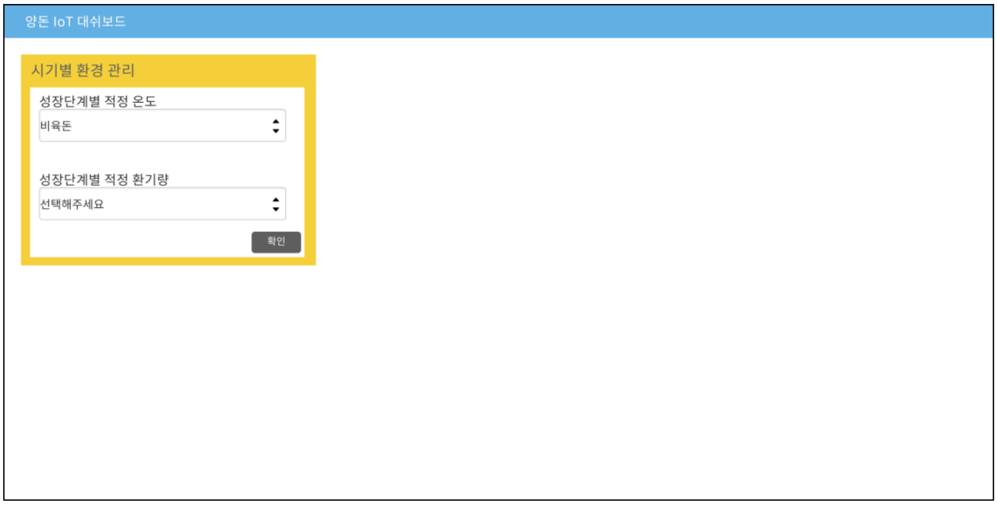
Appendix A. Interface Design: Simple Task 1 – Field Independent



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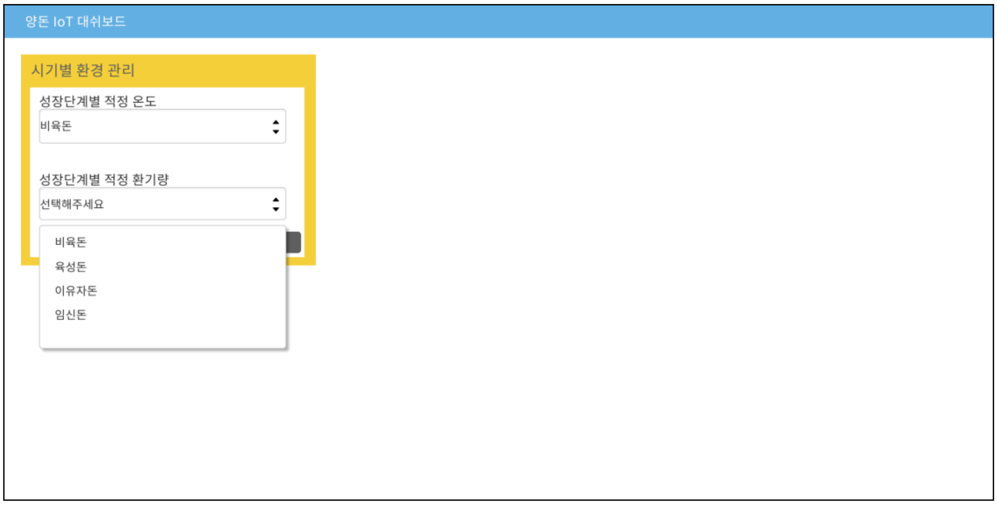
성장단계별 적정 환기량
선택해주세요
확인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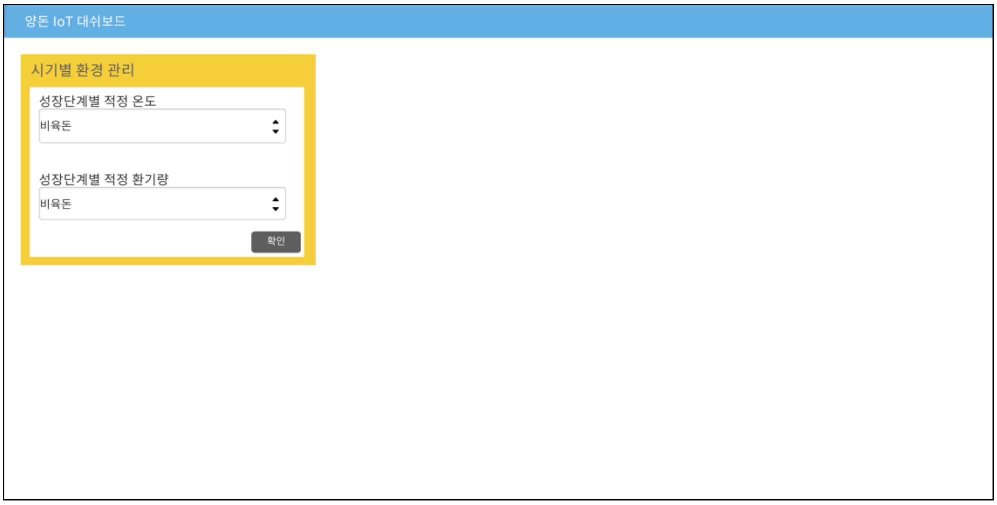
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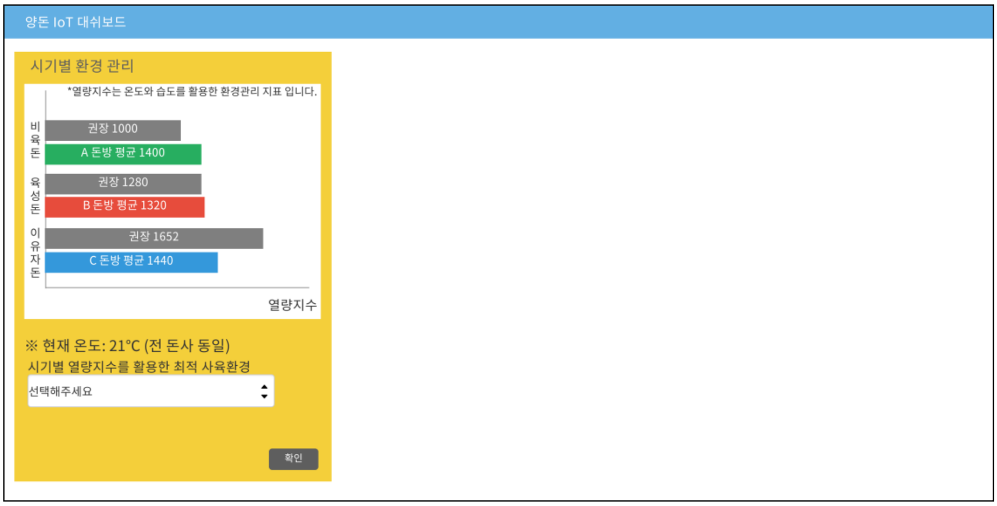
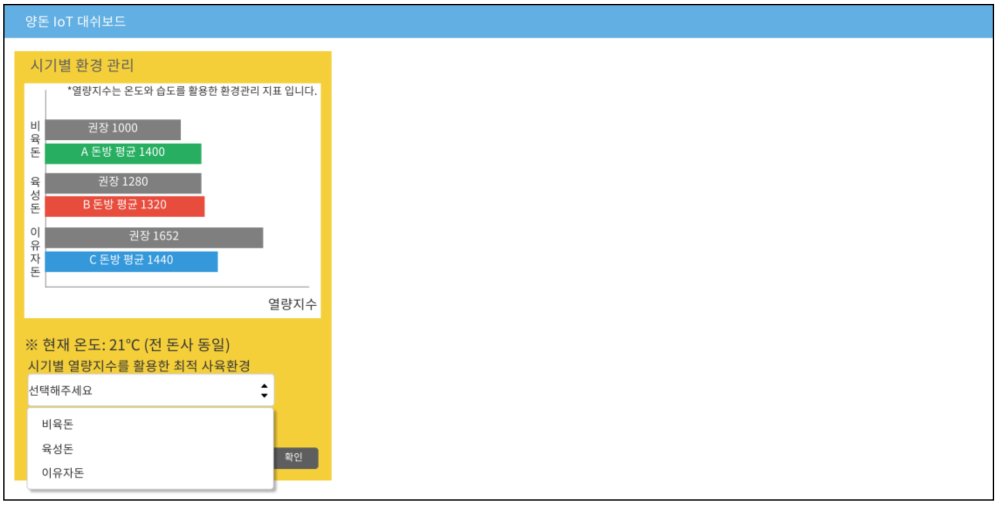
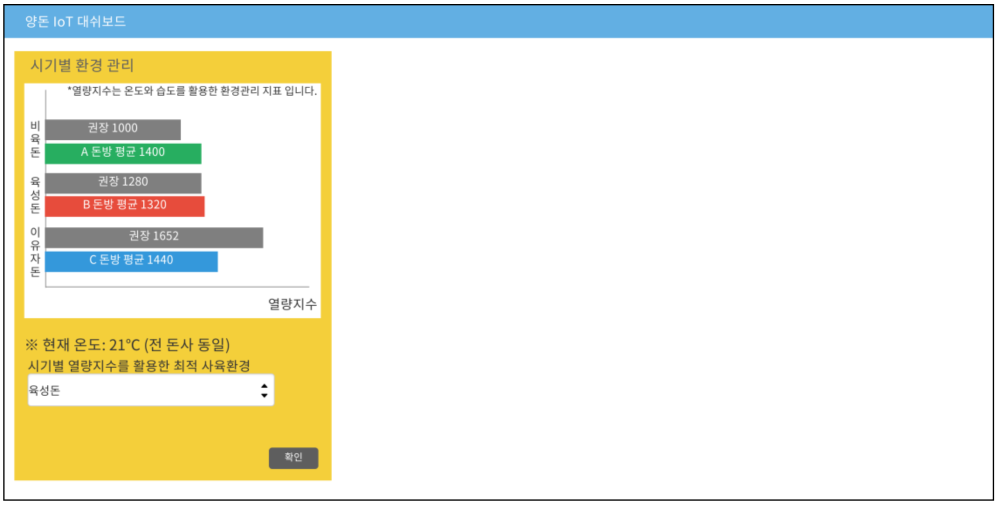
비육돈 적정온도
구분
체중
적정온도
비육돈
68.0~99.8 kg
17~21 ℃
비육돈 권장 환기량
구분
적정온도 시
적정온도 보다 낮음
적정온도 보다 높음
비육돈
35 cfm
-25=10 cfm
+85=120 cfm
시기별 환경관리 재선택

Appendix A. Interface Design: Simple Task 1 – Field Dependent

Appendix A. Interface Design: Complex Task 1 – Field Independent



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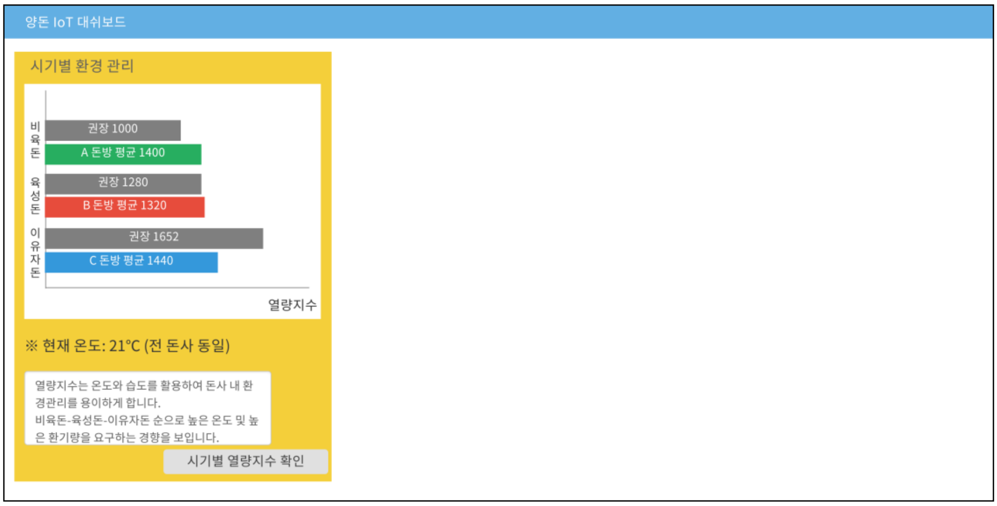
*열량지수는 온도와 습도를 활용한 환경관리 지표 입니다.
비육돈
권장 1000
A 돈방 평균 1400
육성돈
권장 1280
B 돈방 평균 1320
이유자돈
권장 1652
C 돈방 평균 1440
열량지수
※ 현재 온도: 21℃ (전 돈사 동일)
시기별 열량지수를 활용한 최적 사육환경
육성돈
확인


양돈 IoT 대쉬보드
시기별 환경 관리
*열량지수는 온도와 습도를 활용한 환경관리 지표 입니다.
비육돈
권장 1000
A 돈방 평균 1400
육성돈
권장 1280
B 돈방 평균 1320
이유자돈
권장 1652
C 돈방 평균 1440
열량지수
※ 현재 온도: 21℃ (전 돈사 동일)
시기별 열량지수를 활용한 최적 사육환경
육성돈
확인
온도와 습도에 따른 권장 열량지수
온도 / 습도 40 50 60 70 80
24 960 1200 1440 1680 1920
22 880 1100 1320 1540 1760
20 800 1000 1200 1400 1600
18 720 900 1080 1260 1440
시기 권장 온도 (℃) 권장 습도 (%)
육성돈 19-23 50-60
? 열량지수 = 온도 X 습도
에어컨 가동
에어컨을 가동하면 온도와 습도 모두 낮아지는 경향을 보입니다.
보일러 가동
보일러를 가동하면 온도는 상승하지만 습도는 낮아지는 경향을 보입니다.
보온등 가동
보온등을 가동하면 온도는 올라가지만 습도는 변화가 없는 경향을 보입니다.
스프링쿨러 가동
스프링쿨러를 가동하면 습도는 올라가지만 온도는 변화가 없는 경향을 보입니다.
시기별 열량지수 재선택

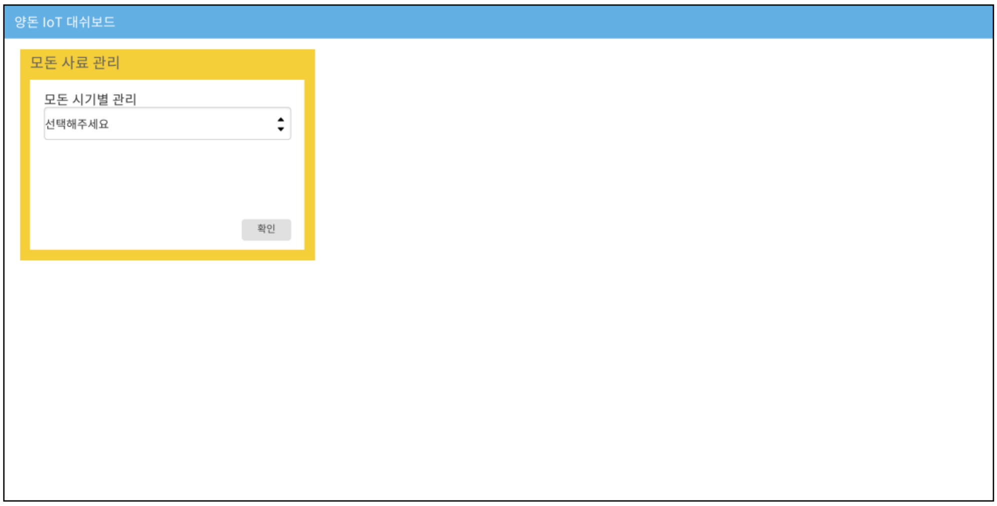
Appendix A. Interface Design: Complex Task 1 – Field Dependent

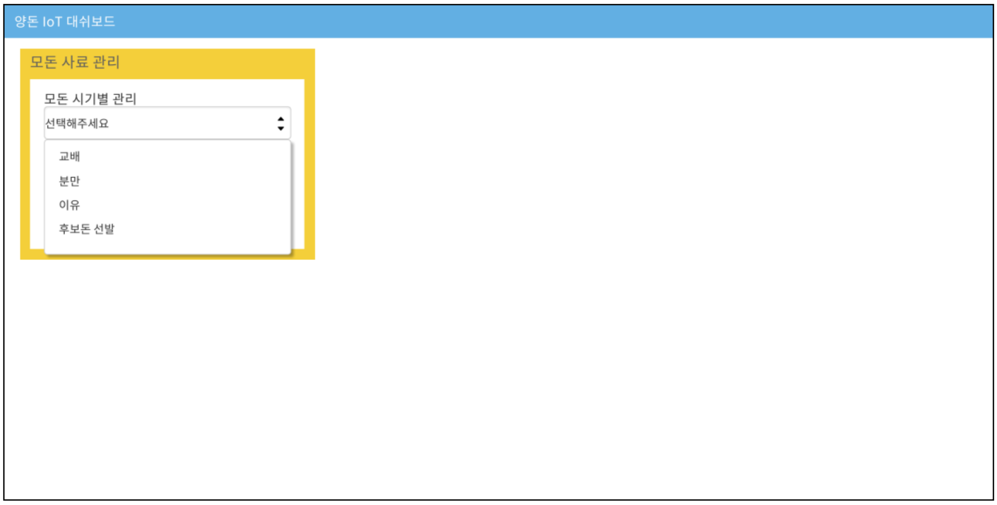


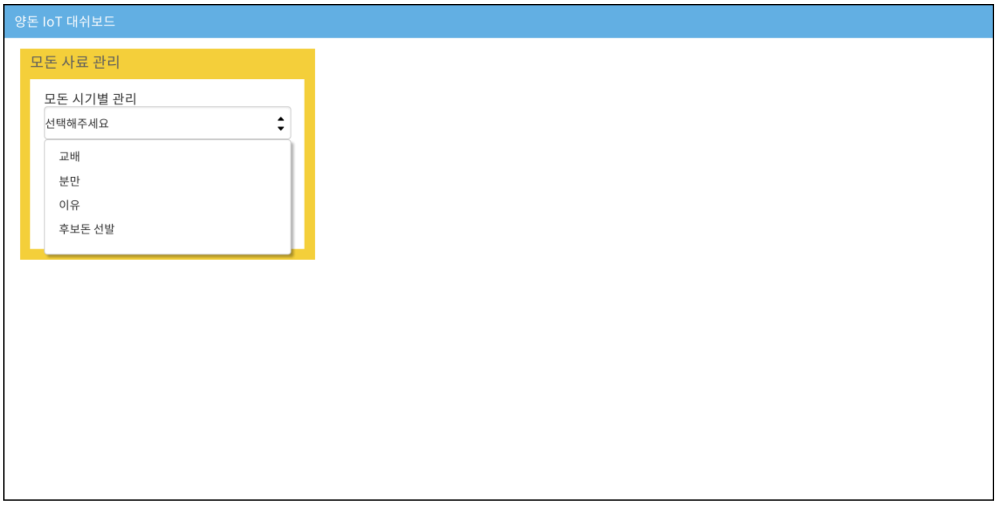
온도 / 습도	40	50	60	70	80
28	1120	1400	1680	1960	2240
26	1040	1300	1560	1820	2080
24	960	1200	1440	1680	1920
22	880	1100	1320	1540	1760
20	800	1000	1200	1400	1600
18	720	900	1080	1260	1440
16	640	800	960	1120	1280
14	560	700	840	980	1120

시기	권장 온도 (℃)	권장 습도 (%)
이유자돈	22-27	60-70
육성돈	19-23	50-60
비육돈	17-21	40-60

Appendix A. Interface Design: Simple Task 2 – Field Independent



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모돈 시기별 관리
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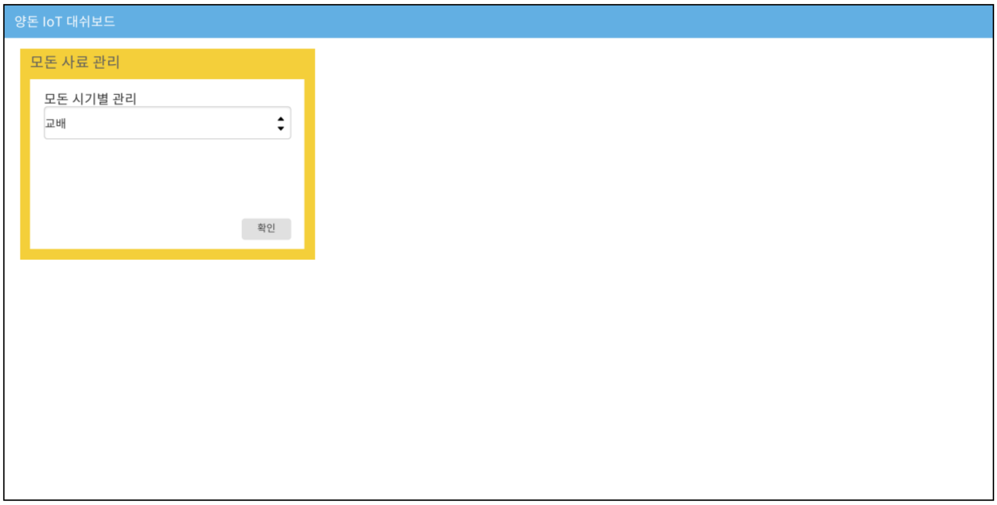
교배
분만
이유
후보돈 선발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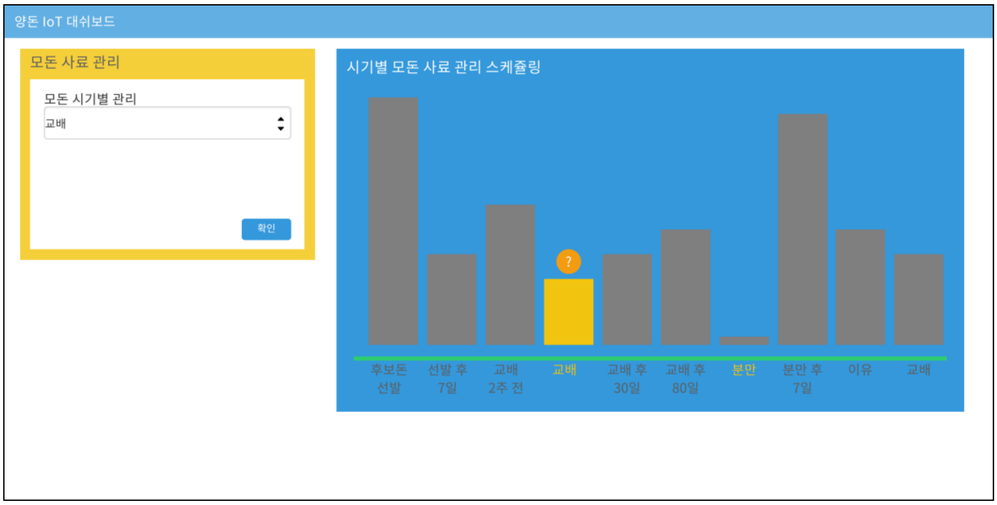
확인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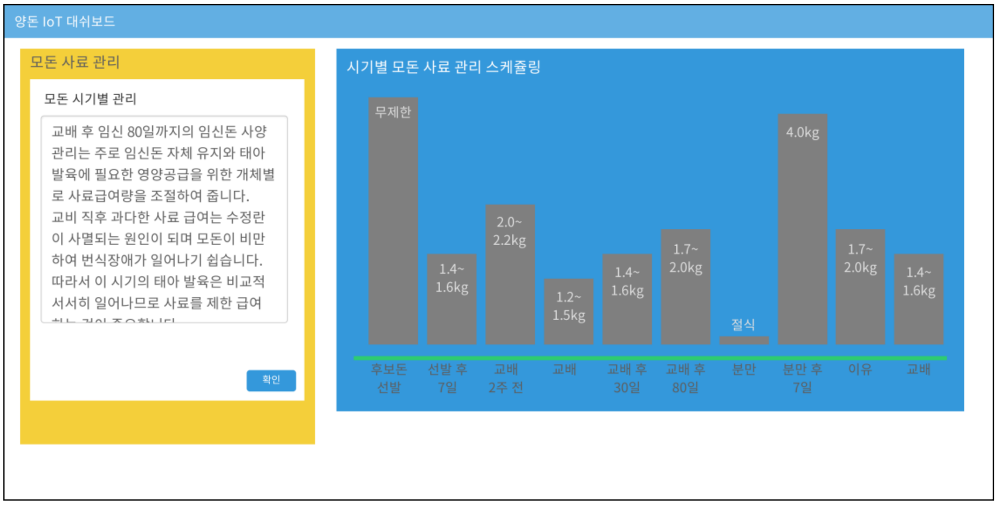
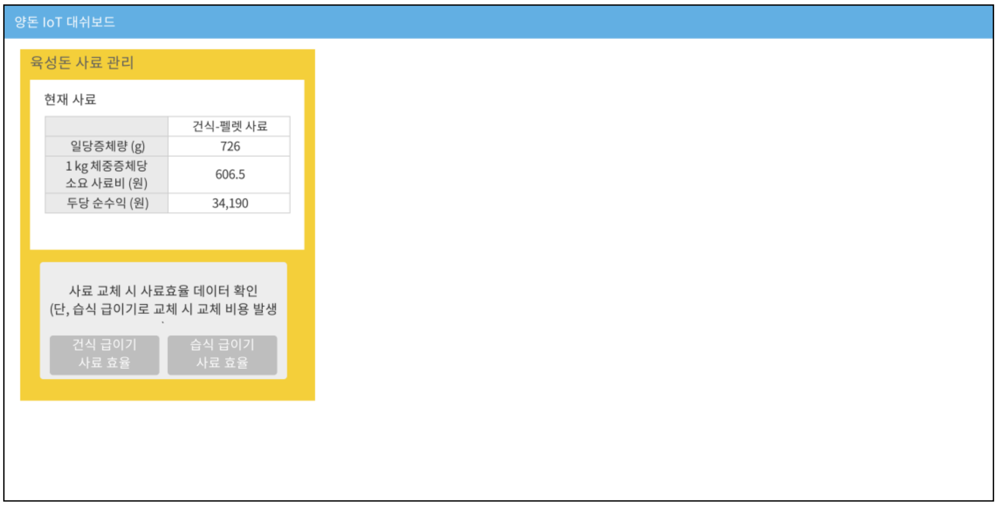
확인
시기별 모돈 사료 관리 스케쥴링
?
후보돈 선발
선발 후 7일
교배 2주 전
교배
교배 후 30일
교배 후 80일
분만
분만 후 7일
이유
교배

Appendix A. Interface Design: Simple Task 2 – Field Dependent



Appendix A. Interface Design: Complex Task 2 – Field Independent




양돈 IoT 대쉬보드
육성돈 사료 관리
현재 사료
건식-펠렛 사료
일당증체량 (g) 726
1 kg 체중증체당 소요 사료비 (원) 606.5
두당 순수익 (원) 34,190
사료 교체 시 사료효율 데이터 확인
(단, 습식 급이기로 교체 시 교체 비용 발생
건식 급이기 사료 효율
습식 급이기 사료 효율
건식 급이기 유지 시 사료 효율 데이터
건식-가루 사료 ?
건식-익스팬딩 사료 ?
일당증체량 (g) 731 733
1 kg 체중증체당 소요 사료비 (원) 631.2 635.7
두당 순수익 (원) 33,372 32,669
기존 사료와 비교 시
건식-가루 사료
기존 사료
일당증체량 (g) 731 726
1 kg 체중증체당 소요 사료비 (원) 631.2 606.5
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사료효율 재선택


양돈 IoT 대쉬보드
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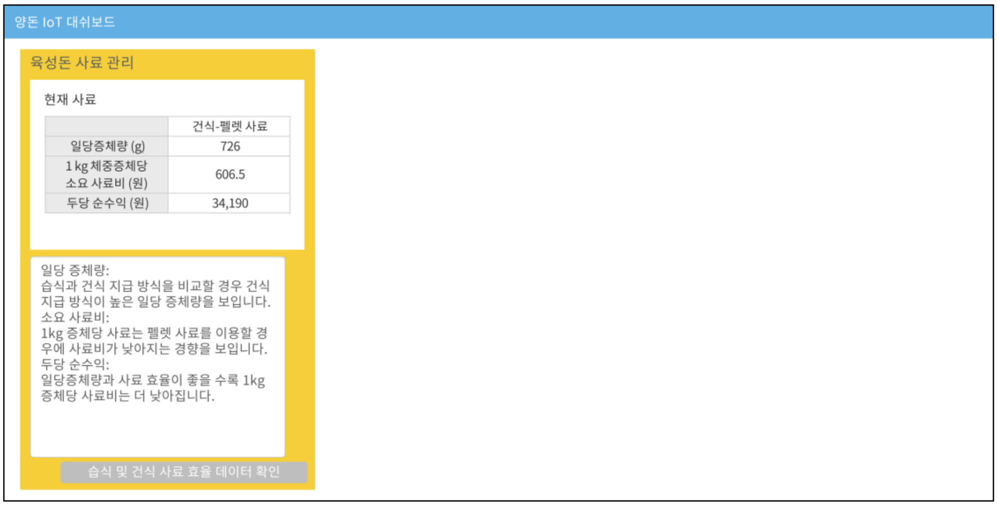
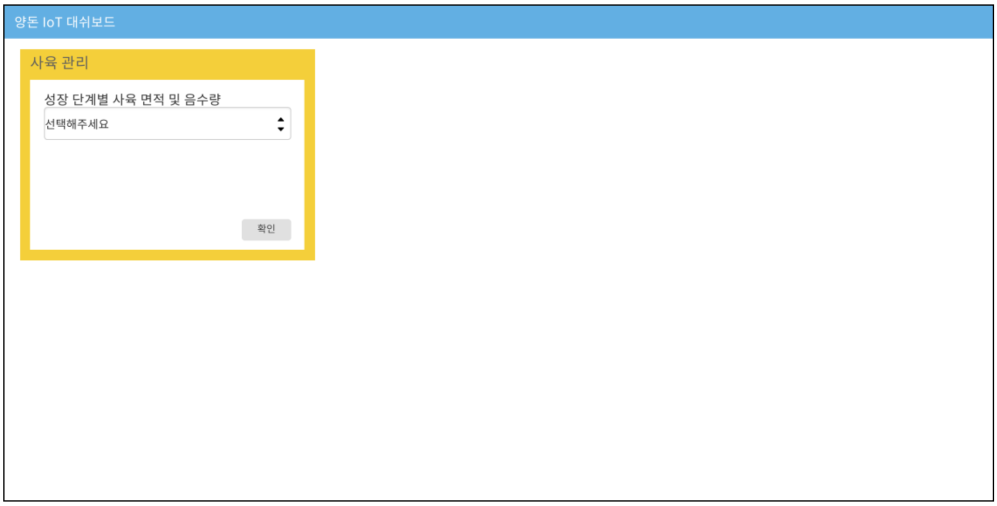
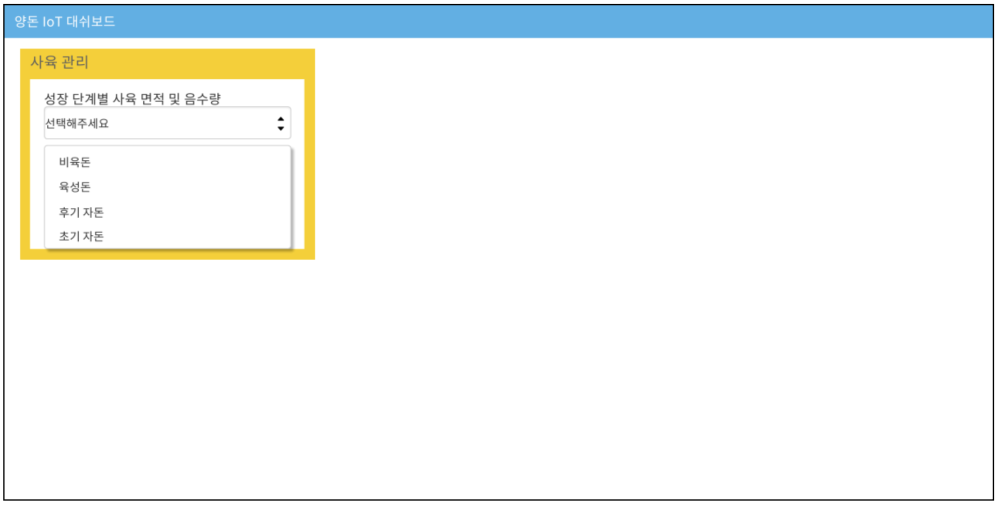
사료효율 재선택

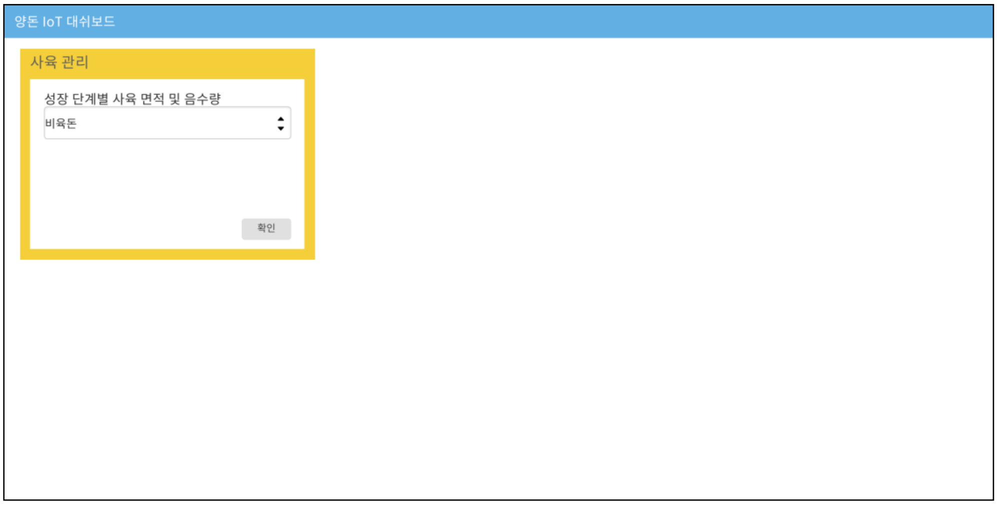
Appendix A. Interface Design: Complex Task 2 – Field Dependent



Appendix A. Interface Design: Simple Task 3 – Field Independent






양돈 IoT 대쉬보드
사육 관리
성장 단계별 사육 면적 및 음수량
비육돈
확인


양돈 IoT 대쉬보드
사육 관리
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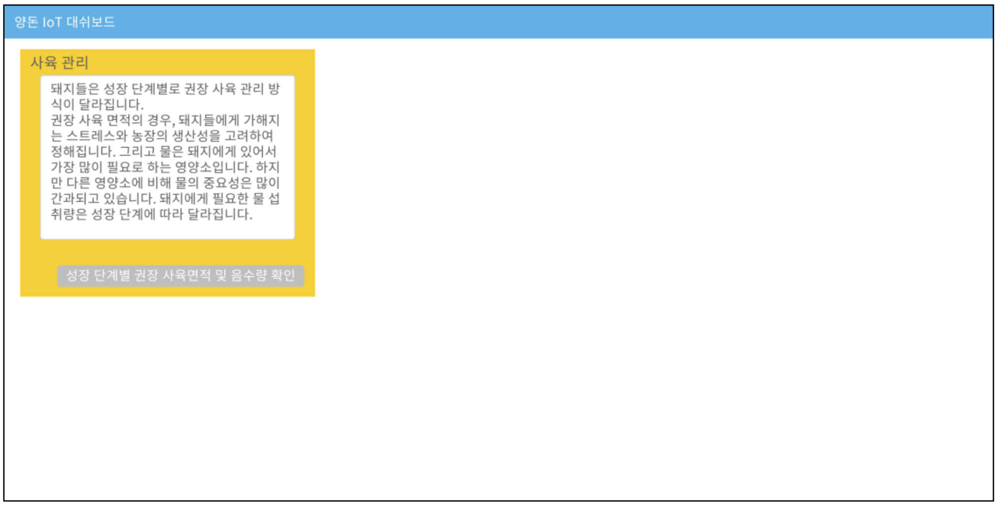
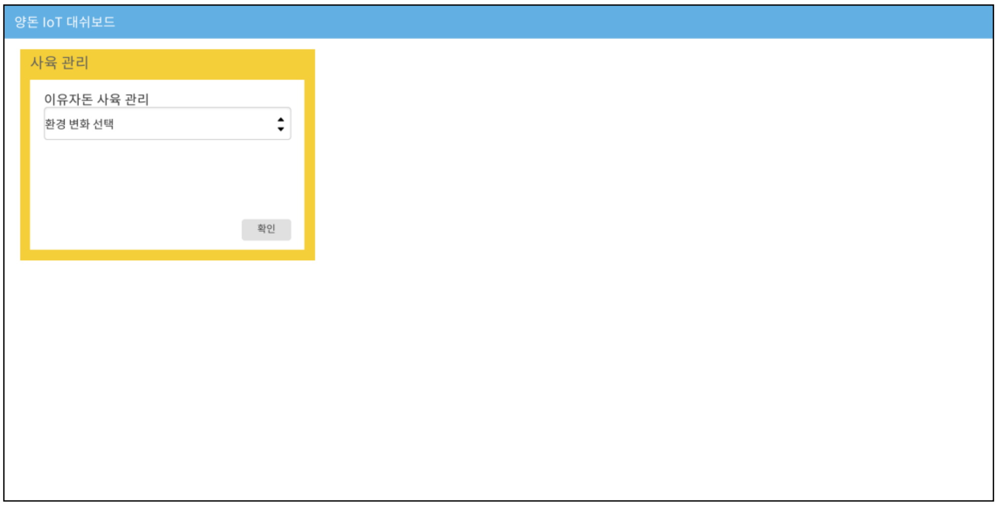
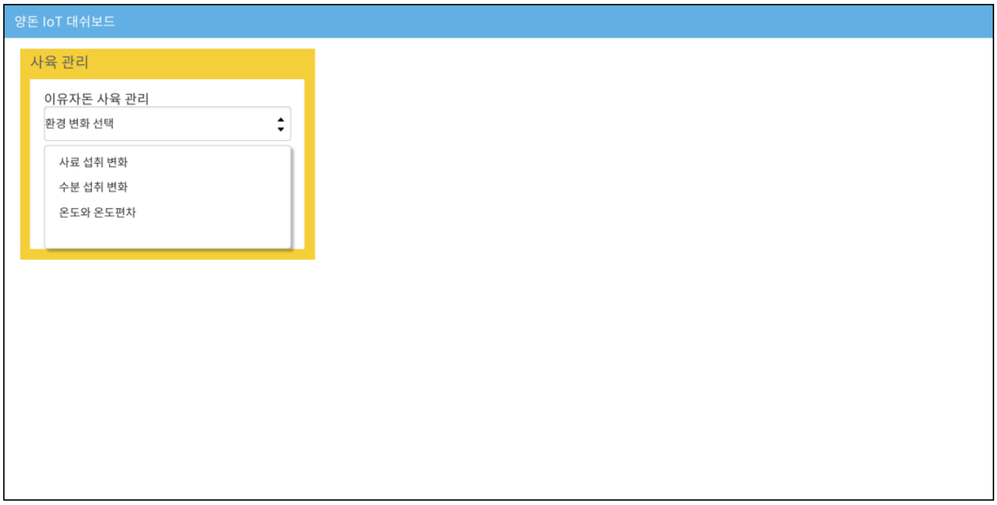
비육돈
확인
성장 단계
자돈
초기 20kg 미만
후기 20kg ~ 30kg 미만
육성돈
30kg ~ 60kg 미만
비육돈
60kg 이상
비육돈 권장 사육 면적 및 음수량
권장 사육 면적
0.8㎡ / 두
권장 음수량
12~20ℓ / 두
성장 단계 재선택

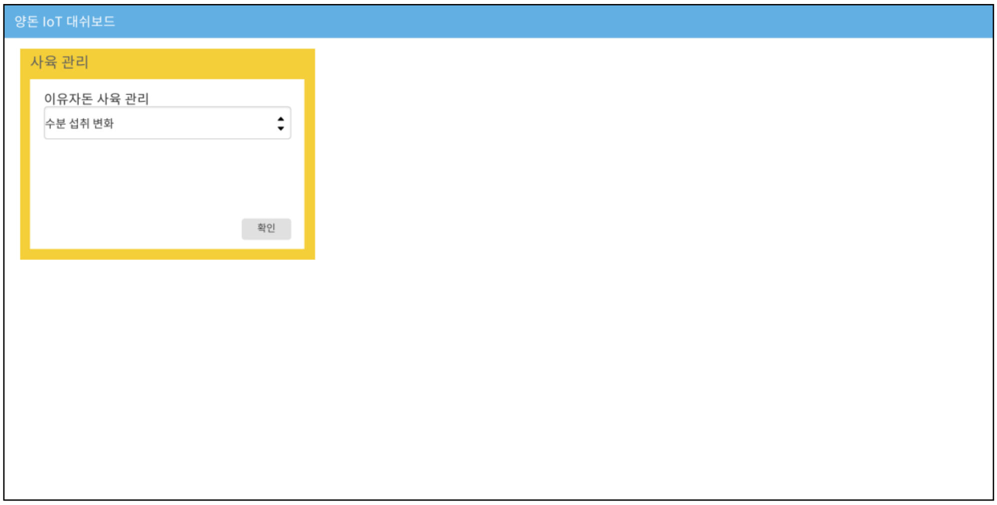
Appendix A. Interface Design: Simple Task 3 – Field Dependent



Appendix A. Interface Design: Complex Task 3 – Field Independent



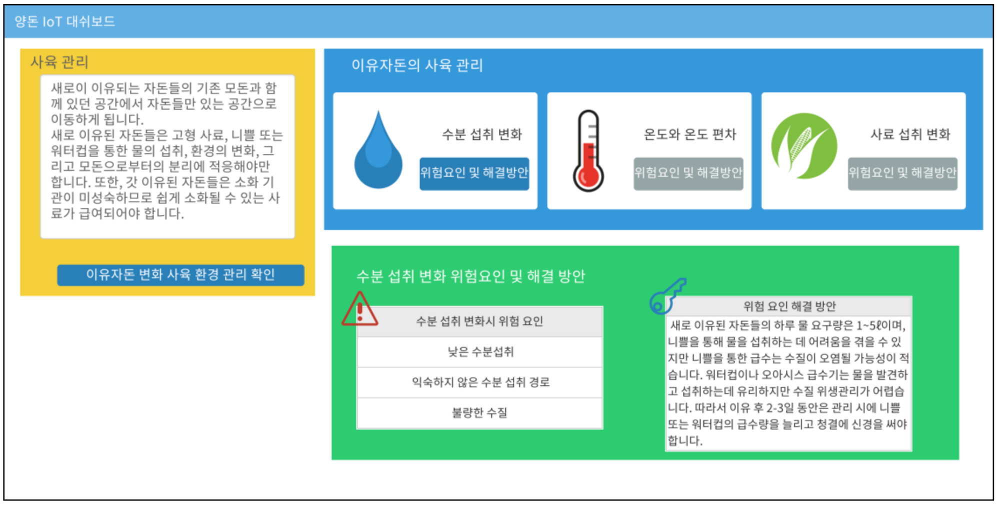



양돈 IoT 대쉬보드
사육 관리
이유자돈 사육 관리
수분 섭취 변화
확인

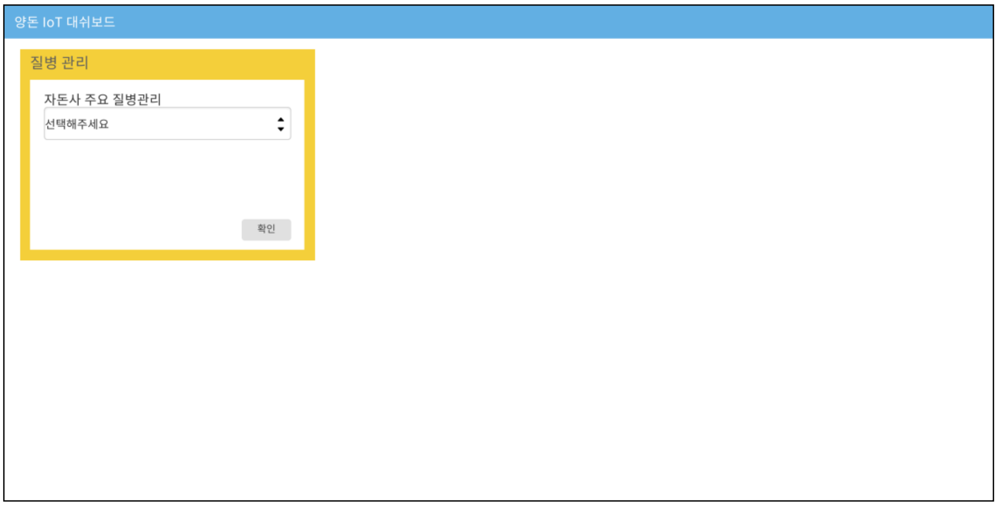

양돈 IoT 대쉬보드
사육 관리
이유자돈 사육 관리
수분 섭취 변화
확인
이유자돈의 사육 관리
이유자돈의 수분 섭취 변화
새로 이유된 자돈들은 이전과 달리 니쁠 또는 워터컵을 통해 물을 섭취하게 됩니다.
위험 요인 및 해결 방안 확인

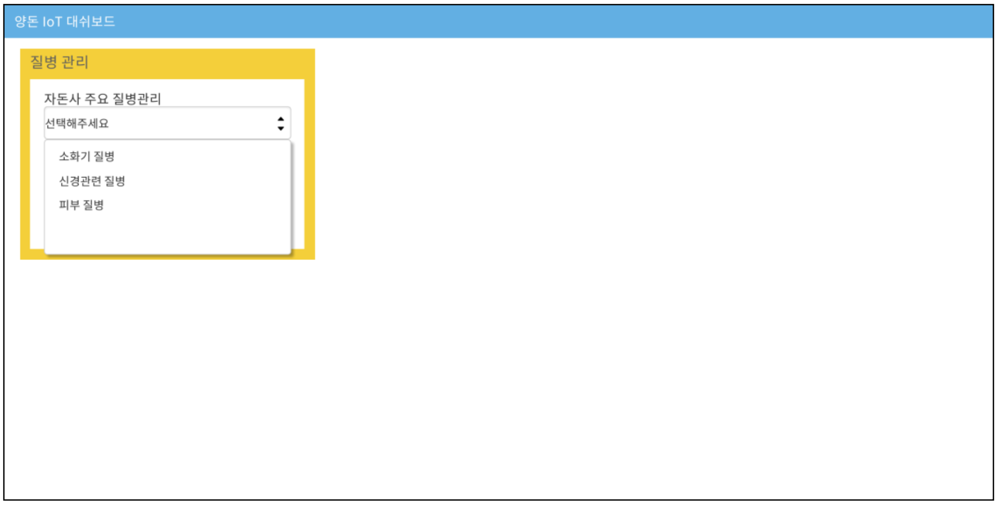

양돈 IoT 대쉬보드
사육 관리
이유자돈 사육 관리
수분 섭취 변화
확인
이유자돈의 사육 관리
이유자돈의 수분 섭취 변화
새로 이유된 자돈들은 이전과 달리 니쁠 또는 워터컵을 통해 물을 섭취하게 됩니다.
위험 요인 및 해결 방안 확인
위험 요인 및 해결방안
수분 섭취 변화시 위험 요인
낮은 수분섭취
익숙하지 않은 수분 섭취 경로
불량한 수질
새로 이유된 자돈들의 하루 물 요구량은 1~5ℓ이며, 니쁠을 통해 물을 섭취하는 데 어려움을 겪을 수 있지만 니쁠을 통한 급수는 수질이 오염될 가능성이 적습니다. 워터컵이나 오아시스 급수기는 물을 발견하고 섭취하는데 유리하지만 수질 위생관리가 어렵습니다. 따라서 이유 후 2-3일 동안은 관리 시에 니쁠 또는 워터컵의 급수량을 늘리고 청결에 신경을 써야 합니다.
환경 변화 재선택

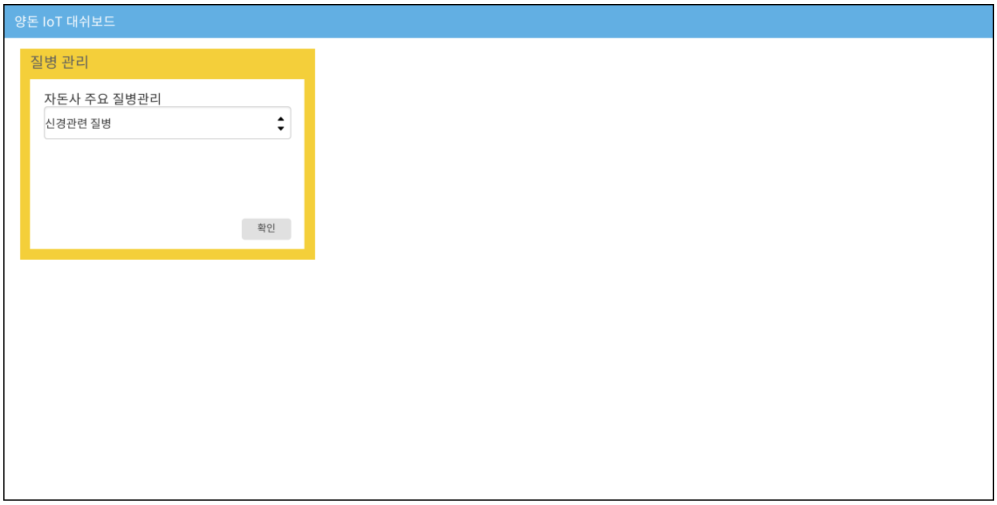
Appendix A. Interface Design: Complex Task 3 – Field Dependent


양돈 IoT 대쉬보드
사육 관리
새로이 이유되는 자돈들의 기존 모돈과 함께 있던 공간에서 자돈들만 있는 공간으로 이동하게 됩니다.
새로 이유된 자돈들은 고형 사료, 니쁠 또는 워터컵을 통한 물의 섭취, 환경의 변화, 그리고 모돈으로부터의 분리에 적응해야만 합니다. 또한, 갓 이유된 자돈들은 소화 기관이 미성숙하므로 쉽게 소화될 수 있는 사료가 급여되어야 합니다.
이유자돈 변화 사육 환경 관리 확인
이유자돈의 사육 관리
수분 섭취 변화
위험요인 및 해결방안
온도와 온도 편차
위험요인 및 해결방안
사료 섭취 변화
위험요인 및 해결방안
수분 섭취 변화 위험요인 및 해결 방안
수분 섭취 변화시 위험 요인
낮은 수분섭취
익숙하지 않은 수분 섭취 경로
불량한 수질
위험 요인 해결 방안
새로 이유된 자돈들의 하루 물 요구량은 1~5ℓ이며, 니쁠을 통해 물을 섭취하는 데 어려움을 겪을 수 있지만 니쁠을 통한 급수는 수질이 오염될 가능성이 적습니다. 워터컵이나 오아시스 급수기는 물을 발견하고 섭취하는데 유리하지만 수질 위생관리가 어렵습니다. 따라서 이유 후 2-3일 동안은 관리 시에 니쁠 또는 워터컵의 급수량을 늘리고 청결에 신경을 써야 합니다.

Appendix A. Interface Design: Simple Task 4 – Field Independent






양돈 IoT 대쉬보드
질병 관리
자돈사 주요 질병관리
신경관련 질병
확인


양돈 IoT 대쉬보드
질병 관리
자돈사 주요 질병관리
신경관련 질병
확인
자돈사 주요 신경관련 질병
글래서씨병
발열, 침울, 식불, 호흡곤란, 관절염 (통증과 파행)
치료방법
부종병
돌연사, 운동실조를 동반한 옆으로 누운 증상, 눈꺼풀의 부종
치료방법
연쇄상구균증
발열, 식욕부진, 침체와 함께 패혈증
치료방법


양돈 IoT 대쉬보드
질병 관리
자돈사 주요 질병관리
신경관련 질병
확인
자돈사 주요 신경관련 질병
글래서씨병
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치료방법
연쇄상구균증
발열, 식욕부진, 침체와 함께 패혈증
치료방법
치료방법
그룹당 임상 증상이 5두 이상 관찰되면 전체 투약을 한다.
글래서씨병은 일반적으로 암피실린 및 플로르페니콜에 감수성이 좋다.
주요질병 재선택


양돈 IoT 대쉬보드
질병 관리
자돈사 주요 질병관리
신경관련 질병
확인
자돈사 주요 신경관련 질병
글래서씨병
발열, 침울, 식불, 호흡곤란, 관절염 (통증과 파행)
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치료방법
치료방법
부종병의 발생은 불규칙적으로 일어나므로 사회적 및 환경적 스트레스 요소를 제거해 주는 것이 중요하다.
주요질병 재선택
연쇄상구균증
발열, 식욕부진, 침체와 함께 패혈증
치료방법


양돈 IoT 대쉬보드
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발열, 침울, 식불, 호흡곤란, 관절염 (통증과 파행)
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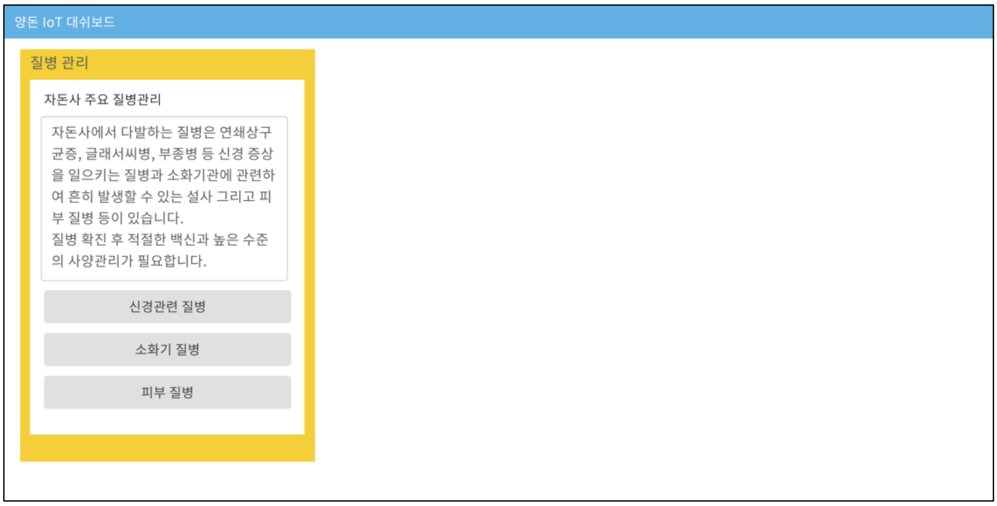
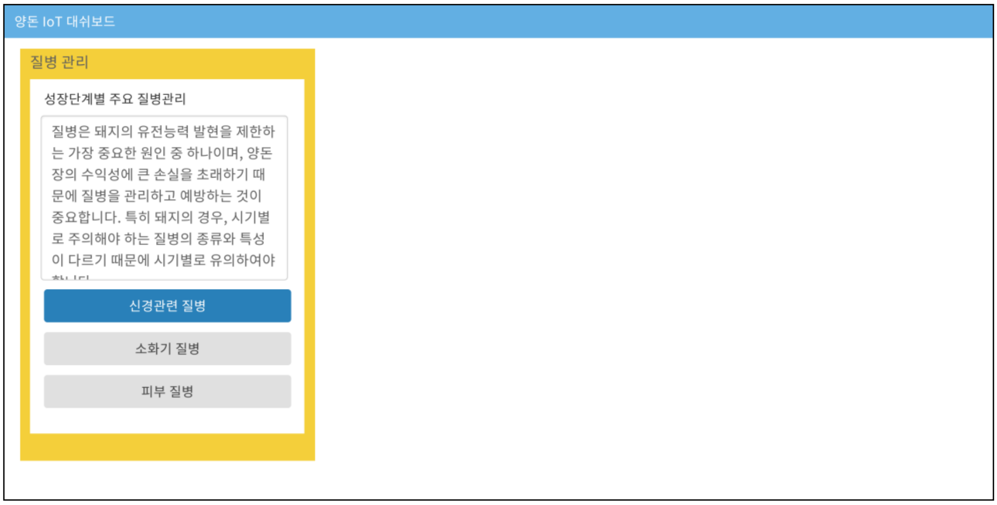
발열, 식욕부진, 침체와 함께 패혈증
치료방법
치료방법
발견 즉시 항생제를 주사한다.
연쇄상구균은 일반적으로 페니실린과 암피실린에 감수성이 좋다.
주요질병 재선택

Appendix A. Interface Design: Simple Task 4 – Field Dependent






양돈 IoT 대쉬보드
질병 관리
자돈사 주요 질병관리
자돈사에서 다발하는 질병은 연쇄상구균증, 글래서씨병, 부종병 등 신경 증상을 일으키는 질병과 소화기관에 관련하여 흔히 발생할 수 있는 설사 그리고 피부 질병등이 있습니다.
질병 확진 후 적절한 백신과 높은 수준의 사양관리가 필요합니다.
신경관련 질병
소화기 질병
피부 질병
신경관련 질병
연쇄상구균증
임상 증상
발열, 식욕부진, 침체와 함께 패혈증
치료 방법
발견 즉시 항생제를 주사한다.
연쇄상구균은 일반적으로 페니실린과 암피실린에 감수성이 좋다.
글래서씨병
임상 증상
발열, 침울, 호흡곤란, 관절염 (통증과 파행)
치료 방법
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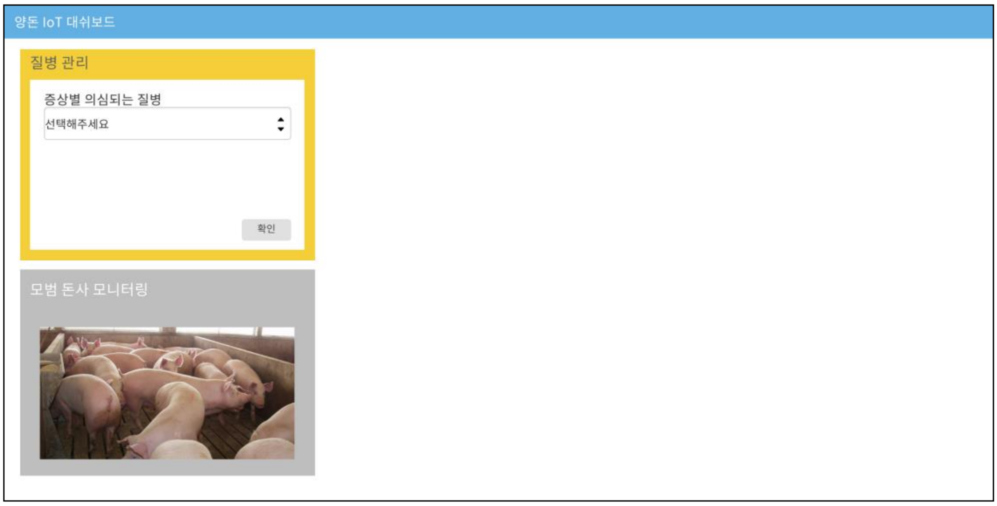
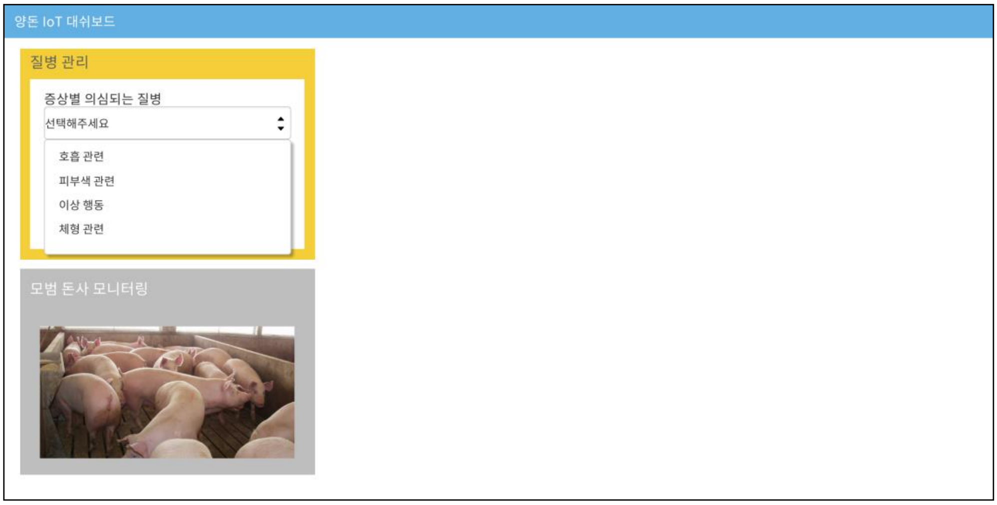
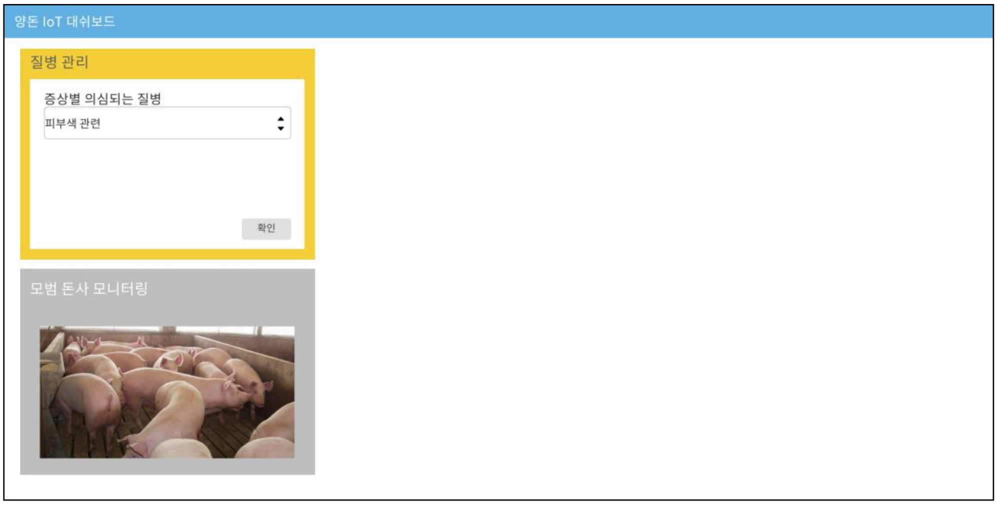
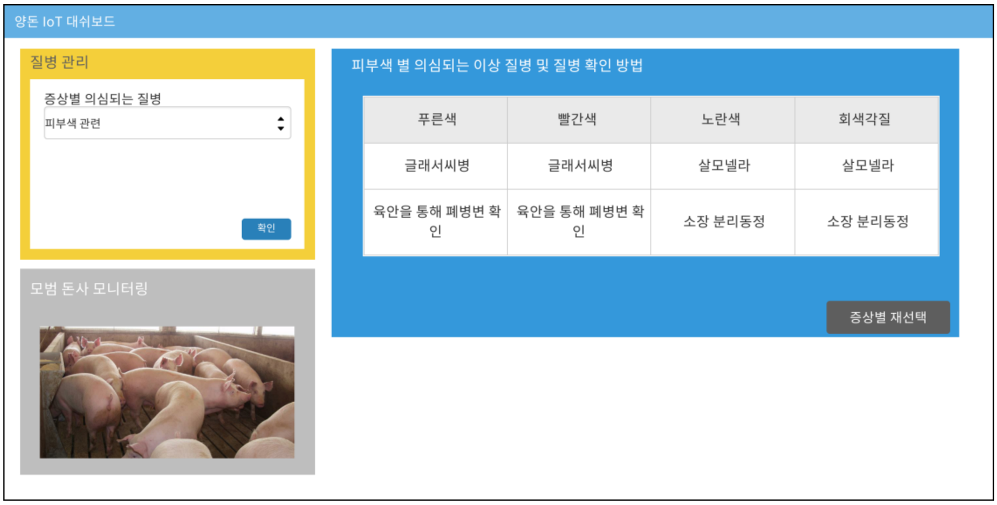
임상 증상
돌연사, 운동실조를 동반한 옆으로 누운 증상, 눈꺼풀의 부종
치료 방법
부종병의 발생은 불규칙적으로 일어나므로 사회적 및 환경적 스트레스 요소를 제거해 주는 것이 중요하다.

Appendix A. Interface Design: Complex Task 4 – Field Independent

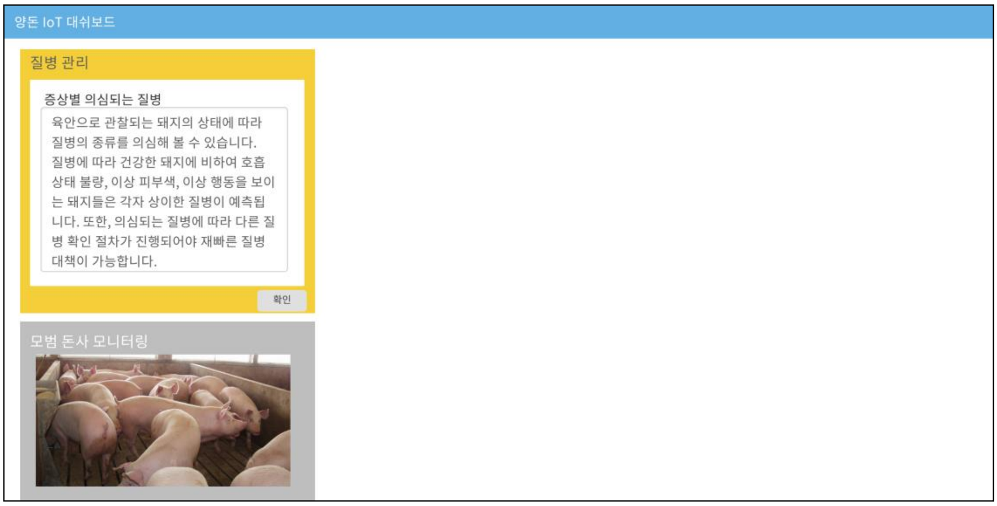




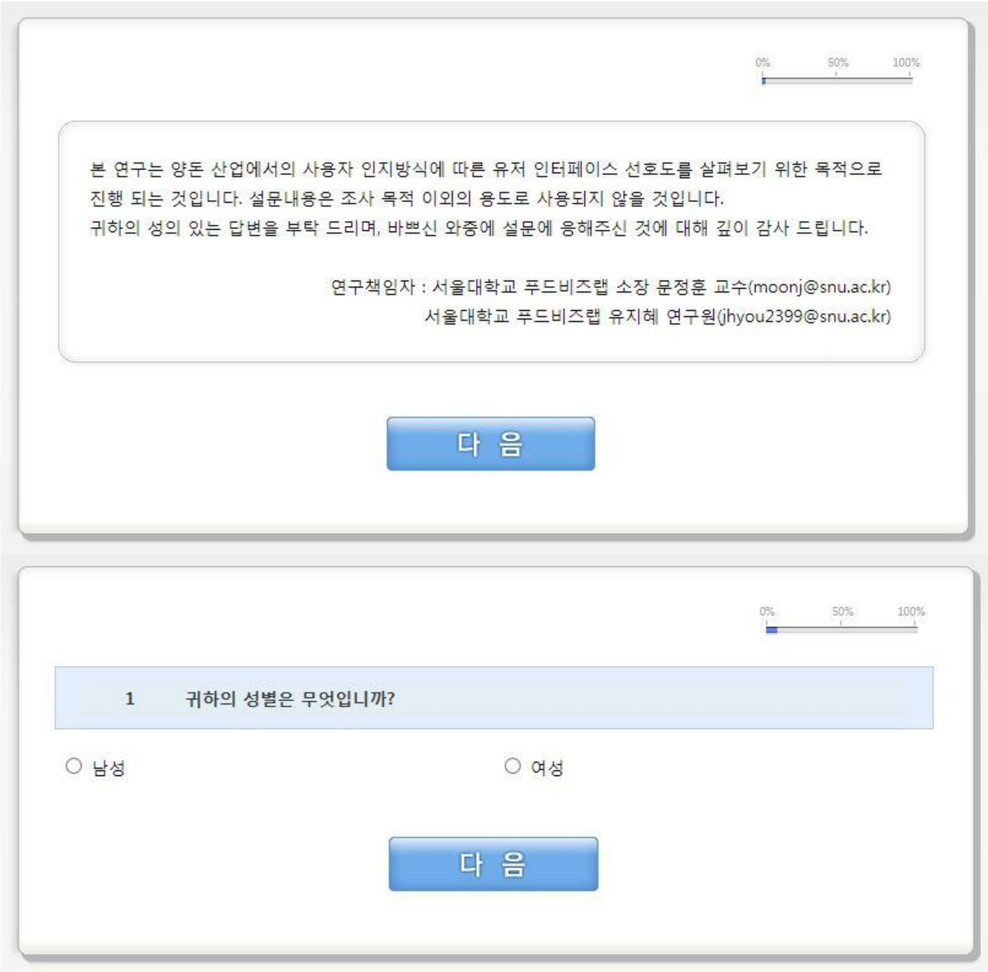

양돈 IoT 대쉬보드
질병 관리
증상별 의심되는 질병
피부색 관련
확인
모범 돈사 모니터링


양돈 IoT 대쉬보드
질병 관리
증상별 의심되는 질병
피부색 관련
확인
모범 돈사 모니터링
피부색 별 의심되는 이상 질병 및 질병 확인 방법
푸른색
빨간색
노란색
회색각질
글래서씨병
글래서씨병
살모넬라
살모넬라
육안을 통해 폐병변 확인
육안을 통해 폐병변 확인
소장 분리동정
소장 분리동정
증상별 재선택

Appendix A. Interface Design: Complex Task 4 – Field Dependent



Appendix B. Survey of Study



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본 연구는 양돈 산업에서의 사용자 인지방식에 따른 유저 인터페이스 선호도를 살펴보기 위한 목적으로 진행 되는 것입니다. 설문내용은 조사 목적 이외의 용도로 사용되지 않을 것입니다.
귀하의 성의 있는 답변을 부탁 드리며, 바쁘신 와중에 설문에 응해주신 것에 대해 깊이 감사 드립니다.

연구책임자 : 서울대학교 푸드비즈랩 소장 문정훈 교수(moonj@snu.ac.kr)
서울대학교 푸드비즈랩 유지혜 연구원(jhyou2399@snu.ac.kr)

다 음

0% 50% 100%

1 귀하의 성별은 무엇입니까?

○ 남성 ○ 여성

다 음

0% 50% 100%

2 귀하의 나이(연세)는 어떻게 되십니까? 만 나이로 기입해 주십시오.

만 [ ] 세

다 음

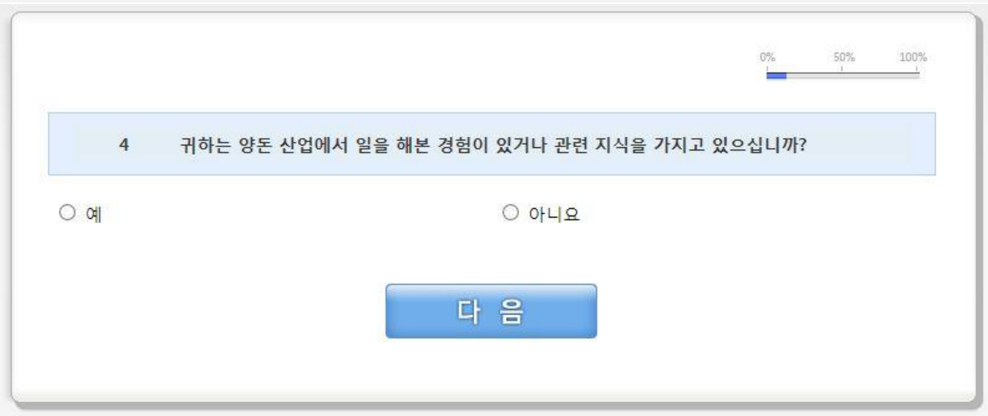
0% 50% 100%

3 귀하의 현재 학력은 어떻게 되십니까?

○ 대학교 2학년 ○ 대학교 3학년

○ 대학교 4학년 ○ 대학교 4학년 초과

다 음



0% 50% 100%

4 귀하는 양돈 산업에서 일을 해본 경험이 있거나 관련 지식을 가지고 있으십니까?

○ 예 ○ 아니요

다 음


0% 50% 100%
5 귀하의 가족 중 양돈 관련 산업에 종사하시는 분이 계십니까?
예
아니요
다 음


0% 50% 100%
다음에 주어지는 문제를 꼼꼼하게 읽고, URL에 접속하여 정답을 기입해 주시기 바랍니다.
다 음

Appendix C. Task Questionnaire: Simple Task 1

Appendix C. Task Questionnaire: Complex Task 1

0% 50% 100%

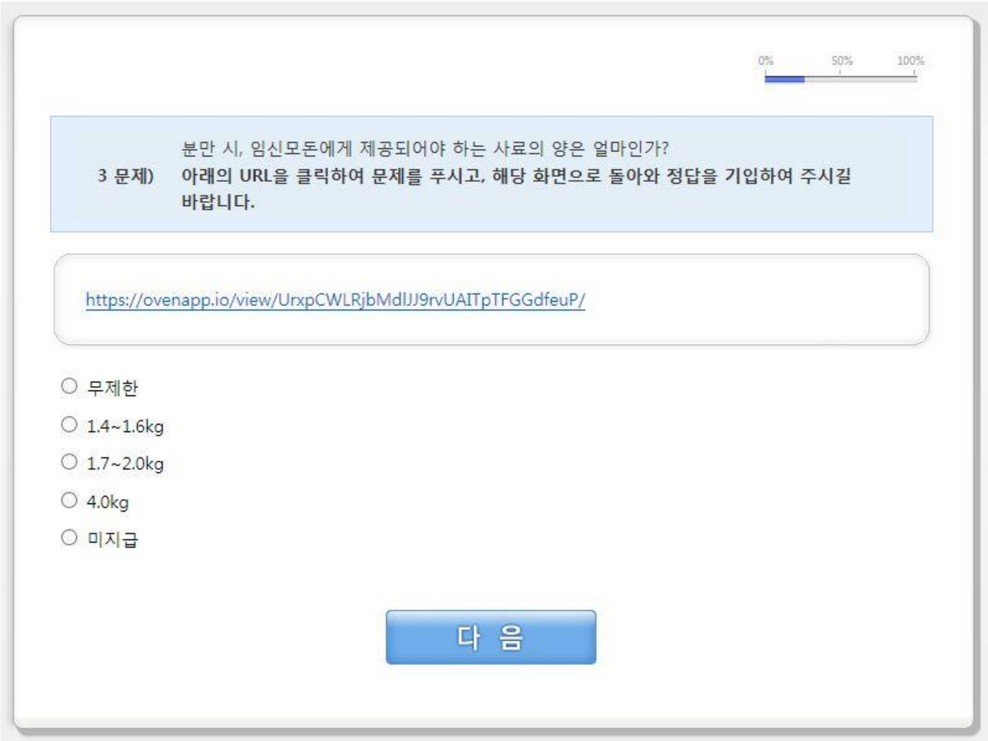
2 문제) 현재 A, B, C 돈방의 열량지수는 다음 화면에 제시된 값들로 측정되고 있다. 세 돈방의 온도는 모두 21℃ 이다. 제시된 열량지수를 참고하여 최적의 사육환경으로 돈방 환경을 구성하려고 한다면 A, B, C 돈방안에서 각각 어떠한 환경 관리 기기를 가동시켜야 하는가? (최적 환경이라면 환경 관리 기기를 작동 안 시킴)
아래의 URL을 클릭하여 문제를 푸시고, 해당 화면으로 돌아와 정답을 기입하여 주시길 바랍니다.

https://ovenapp.io/view/9eufVh9W6Za1MGtaYLumBt78o858YRyV/

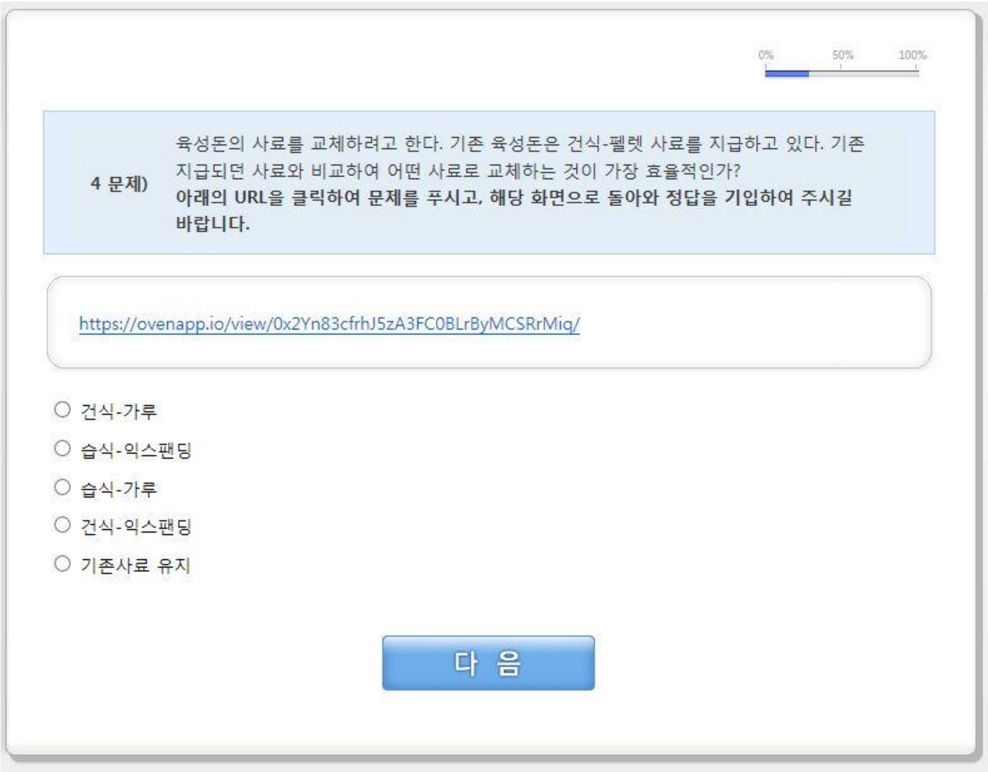
	A 돈방	B 돈방	C 돈방
○	에어컨	미가동	보온등
○	에어컨	보온등	스프링쿨러
○	보일러	미가동	보온등
○	미가동	스프링쿨러	에어컨
○	보일러	에어컨	미가동

다 음

Appendix C. Task Questionnaire: Simple Task 2



Appendix C. Task Questionnaire: Complex Task 2



0% 50% 100%

4 문제) 육성돈의 사료를 교체하려고 한다. 기존 육성돈은 건식-펠렛 사료를 지급하고 있다. 기존 지급되던 사료와 비교하여 어떤 사료로 교체하는 것이 가장 효율적인가?
아래의 URL을 클릭하여 문제를 푸시고, 해당 화면으로 돌아와 정답을 기입하여 주시길 바랍니다.

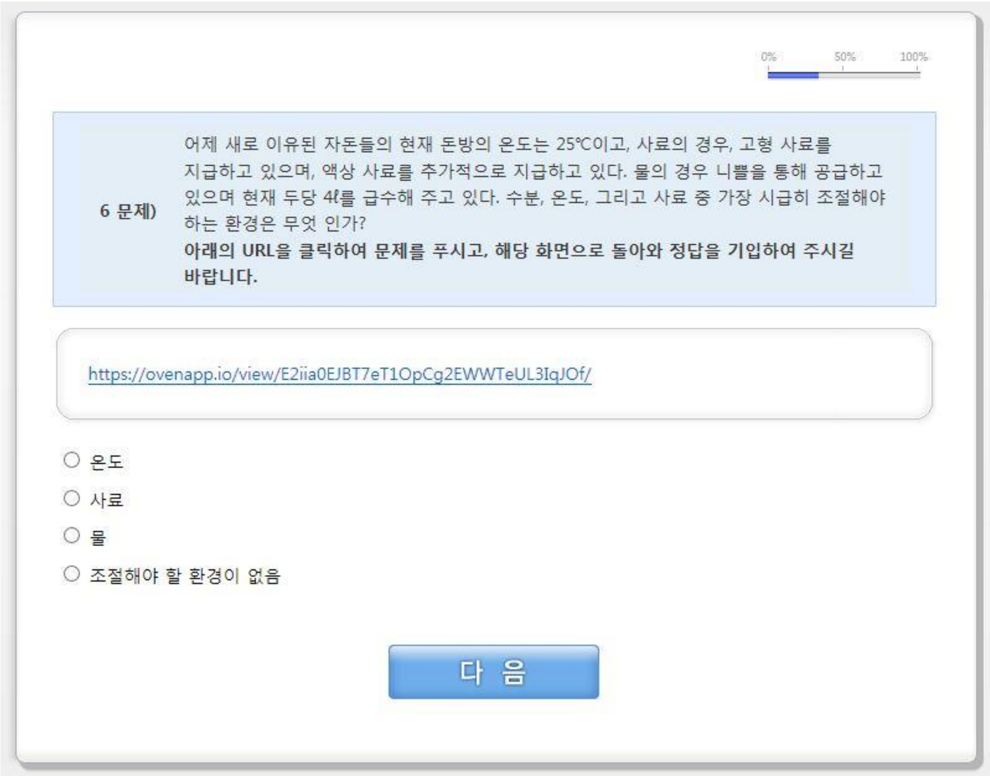
https://ovenapp.io/view/0x2Yn83cfrhJ5zA3FC0BLrByMCSRrMiq/

- ○ 건식-가루
- ○ 습식-익스팬딩
- ○ 습식-가루
- ○ 건식-익스팬딩
- ○ 기존사료 유지

다 음

Appendix C. Task Questionnaire: Simple task 3

Appendix C. Task Questionnaire: Complex Task 3



0% 50% 100%

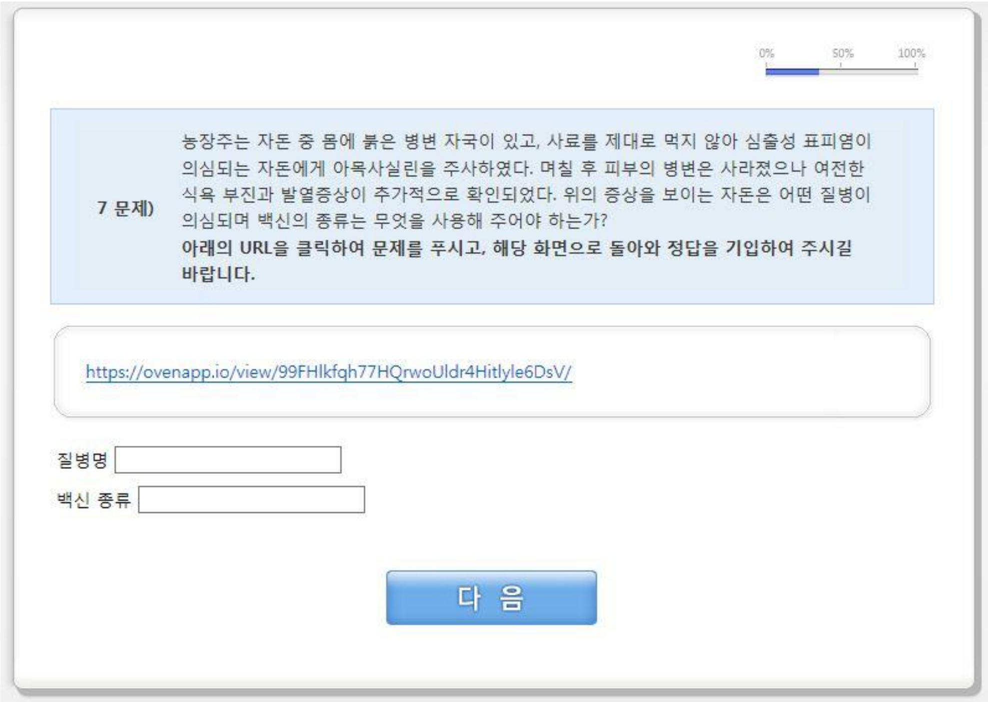
6 문제) 어제 새로 이유된 자돈들의 현재 돈방의 온도는 25℃이고, 사료의 경우, 고형 사료를 지급하고 있으며, 액상 사료를 추가적으로 지급하고 있다. 물의 경우 니쁠을 통해 공급하고 있으며 현재 두당 4ℓ를 급수해 주고 있다. 수분, 온도, 그리고 사료 중 가장 시급히 조절해야 하는 환경은 무엇 인가?
아래의 URL을 클릭하여 문제를 푸시고, 해당 화면으로 돌아와 정답을 기입하여 주시길 바랍니다.

https://ovenapp.io/view/E2iia0EJBT7eT1OpCg2EWWTeUL3IqJOf/

○ 온도
○ 사료
○ 물
○ 조절해야 할 환경이 없음

다 음

Appendix C. Task Questionnaire: Simple Task 4


0% 50% 100%

7 문제) 농장주는 자돈 중 몸에 붉은 병변 자국이 있고, 사료를 제대로 먹지 않아 심출성 표피염이 의심되는 자돈에게 아목사실린을 주사하였다. 며칠 후 피부의 병변은 사라졌으나 여전한 식욕 부진과 발열증상이 추가적으로 확인되었다. 위의 증상을 보이는 자돈은 어떤 질병이 의심되며 백신의 종류는 무엇을 사용해 주어야 하는가?
아래의 URL을 클릭하여 문제를 푸시고, 해당 화면으로 돌아와 정답을 기입하여 주시길 바랍니다.

https://ovenapp.io/view/99FHlkfqh77HQrwoUldr4Hitlyle6DsV/

질병명

백신 종류

다 음

Appendix C. Task Questionnaire: Complex Task 4

0% 50% 100%

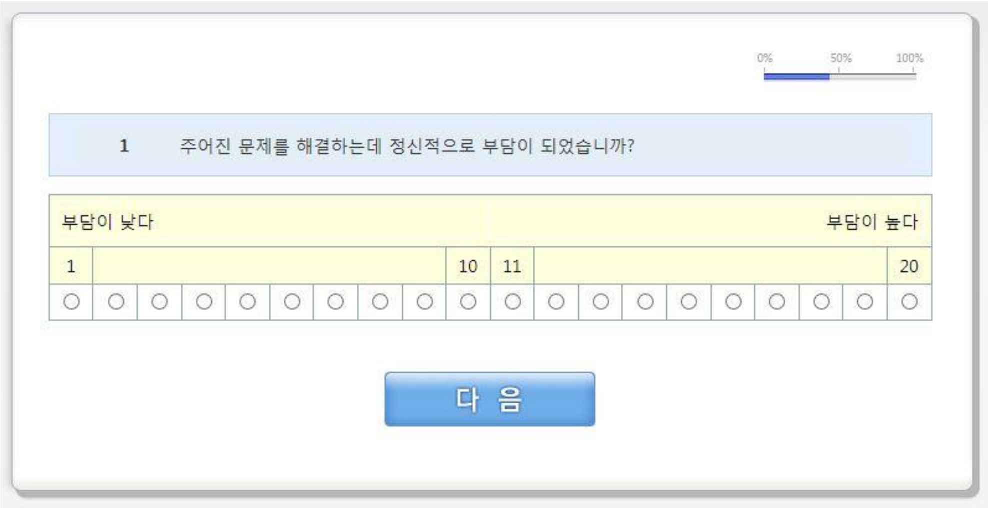
8 문제) 다음 모니터링 화면을 보고 의심되는 증상과 진단 방법이 올바른 것을 골라라.
아래의 URL을 클릭하여 문제를 푸시고, 해당 화면으로 돌아와 정답을 기입하여 주시길 바랍니다.

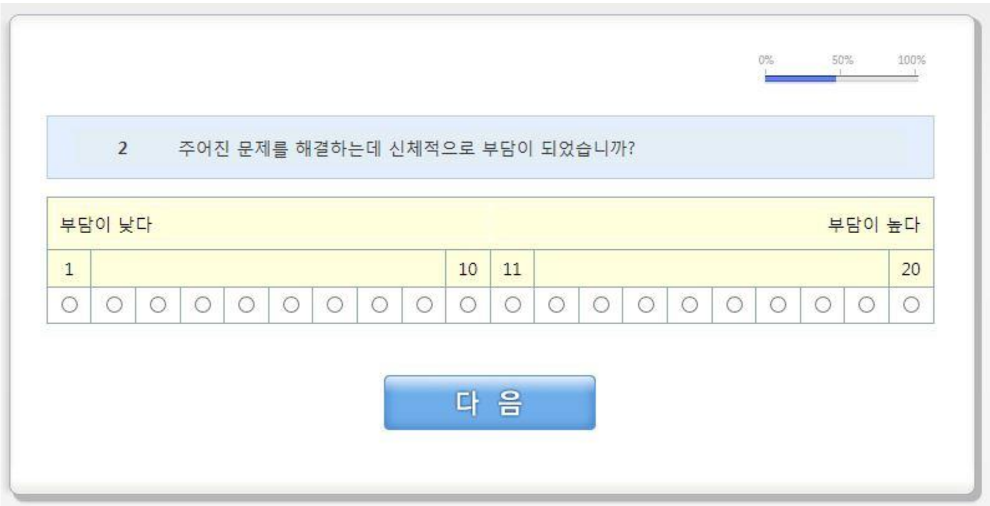
https://ovenapp.io/view/TfRt4vwt5k3dmcW8pGt4yhTf1yAOVSqa/

	증상	진단 방법
○	재채기	분리하여 소장 확인
○	회색 각질	육안으로 폐병변 확인
○	다리를 모으고 누움	분리하여 소장 확인
○	복부 쪼그라듦	육안으로 폐병변 확인
○	눈, 코 분비물	분리하여 소장 확인

다 음

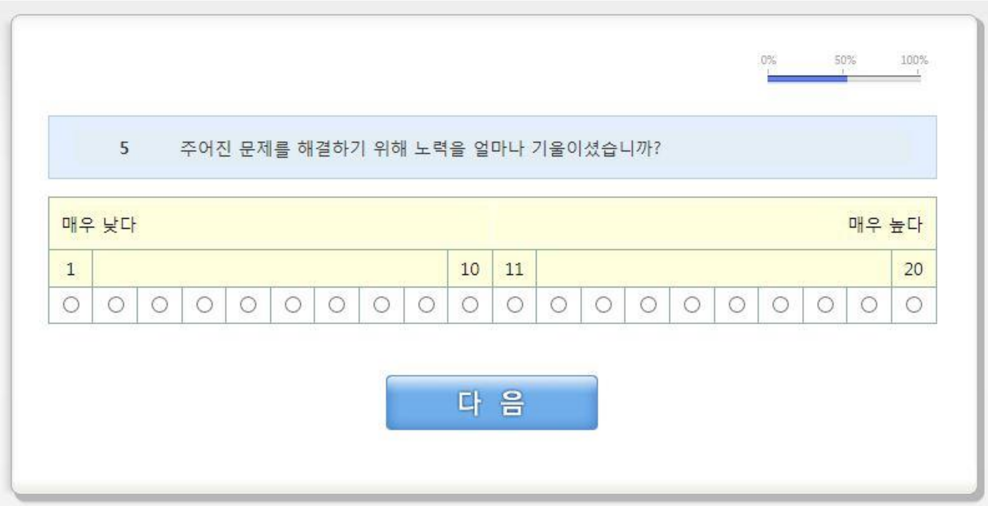
Appendix D. Survey of Study: Cognitive Load






0%
50%
100%
3 주어진 문제를 해결하는데 속도를 서두르셨습니까?
서두르지 않았다
서둘렀다
1
10
11
20
다 음


0%
50%
100%
4 주어진 문제를 해결하는데 성공적 이셨습니까?
성공적이지 않은 편
성공적
1
10
11
20
다 음



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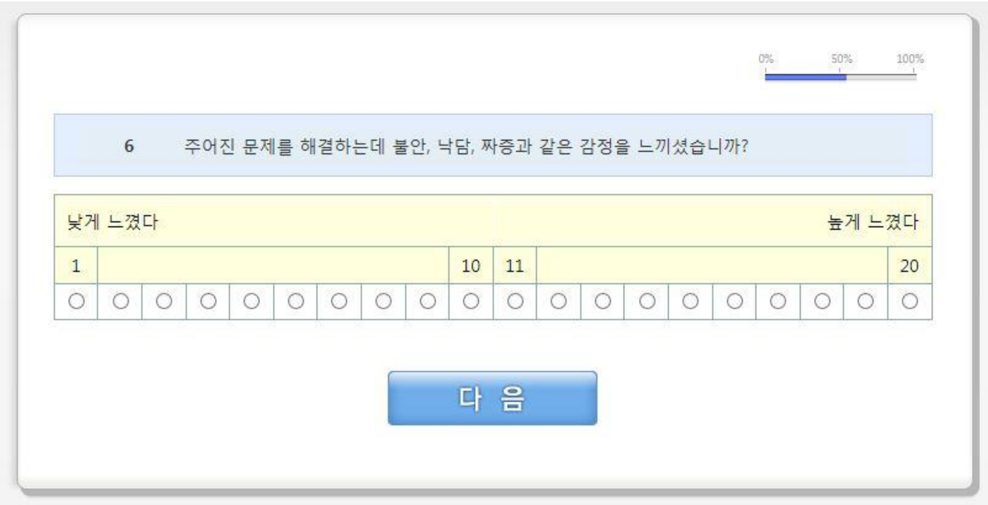
5 주어진 문제를 해결하기 위해 노력을 얼마나 기울이셨습니까?

매우 낮다																			매우 높다
1									10	11									20
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○

다 음



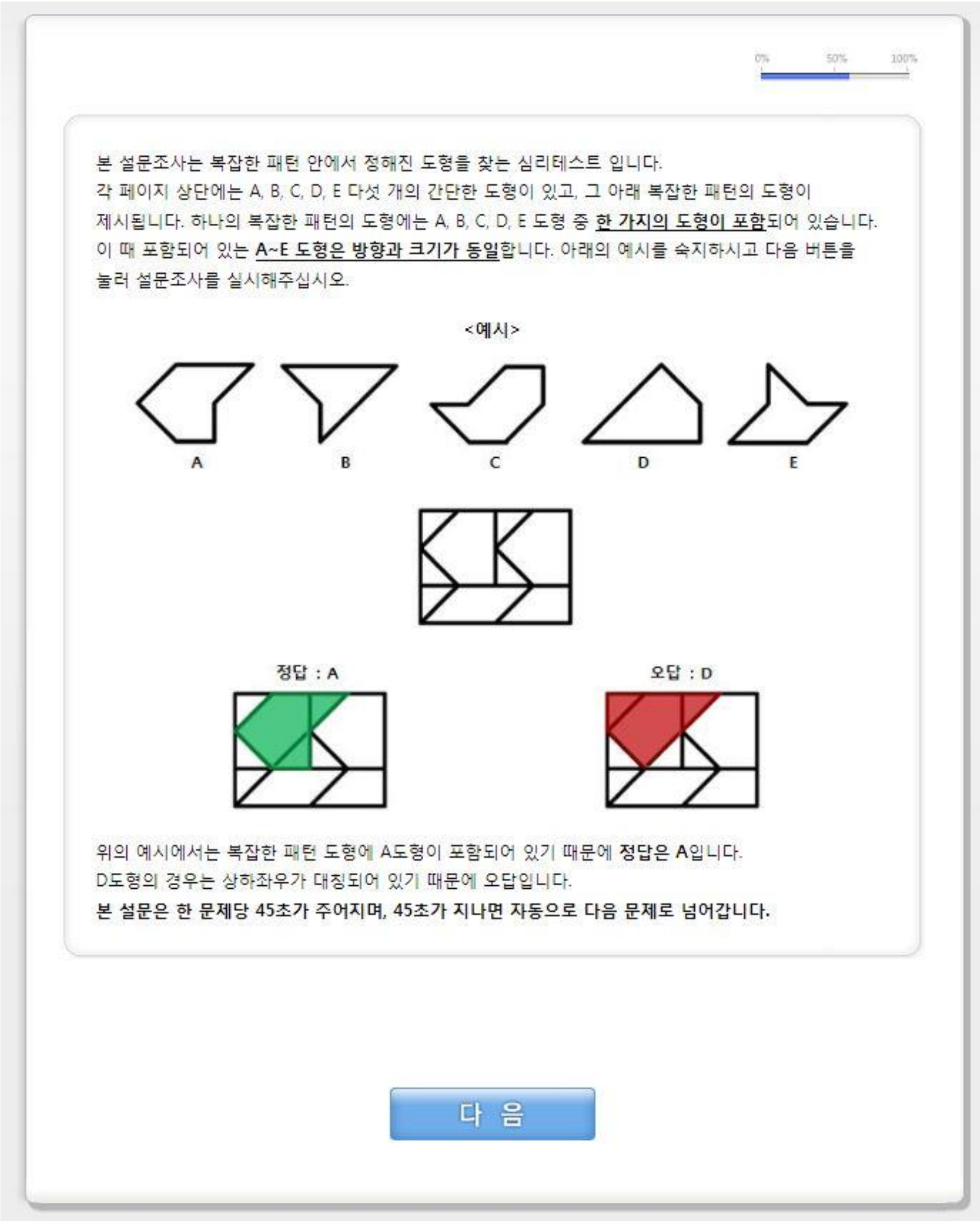
0% 50% 100%

6 주어진 문제를 해결하는데 불안, 낙담, 짜증과 같은 감정을 느끼셨습니까?

낮게 느꼈다																			높게 느꼈다
1									10	11									20
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○

다 음

Appendix E. Survey of Study: Hidden Figures Test

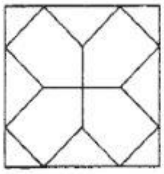


0% 50% 100%

1

복잡한 패턴의 도형은 총 16개 입니다. 설문을 진행하는데 12분이 주어집니다.
***오답을 선택하면 -1점 처리되므로, 도형을 찾지 못했을 경우에는 공란으로 비워두시기 바랍니다.**

하나의 복잡한 패턴의 도형에는 A, B, C, D, E 도형 중 **한 가지의 도형이 포함**되어 있습니다. 이 때 포함되어 있는 **A~E 도형은 방향과 크기가 동일**합니다. 어떤 도형이 포함되어 있는지 선택해 주세요.

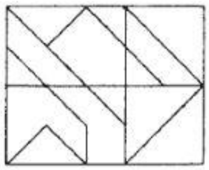


○A ○B ○C ○D ○E

다 음

0% 50% 100%

2 하나의 복잡한 패턴의 도형에는 A, B, C, D, E 도형 중 **한 가지의 도형이 포함**되어 있습니다. 이 때 포함되어 있는 **A~E 도형은 방향과 크기가 동일**합니다. 어떤 도형이 포함되어 있는지 선택해 주세요.

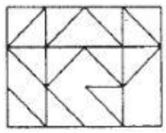


○A ○B ○C ○D ○E

다 음

0% 50% 100%

3 하나의 복잡한 패턴의 도형에는 A, B, C, D, E 도형 중 **한 가지의 도형이 포함**되어 있습니다. 이 때 포함되어 있는 **A~E 도형은 방향과 크기가 동일**합니다. 어떤 도형이 포함되어 있는지 선택해 주세요.

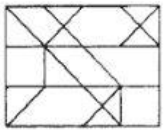


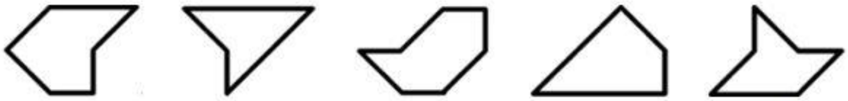
○A ○B ○C ○D ○E

다 음

0% 50% 100%

4 하나의 복잡한 패턴의 도형에는 A, B, C, D, E 도형 중 **한 가지의 도형이 포함**되어 있습니다. 이 때 포함되어 있는 **A~E 도형은 방향과 크기가 동일**합니다. 어떤 도형이 포함되어 있는지 선택해 주세요.



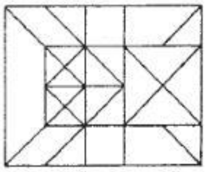


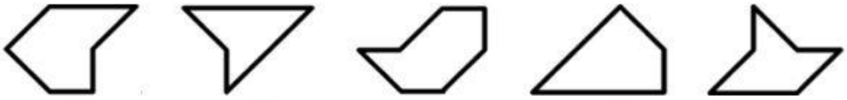
○A ○B ○C ○D ○E

다 음

0% 50% 100%

5 하나의 복잡한 패턴의 도형에는 A, B, C, D, E 도형 중 **한 가지의 도형이 포함**되어 있습니다.
이 때 포함되어 있는 **A~E 도형은 방향과 크기가 동일**합니다. 어떤 도형이 포함되어 있는지 선택해 주세요.





○A ○B ○C ○D ○E

다 음

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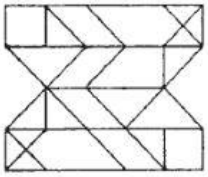
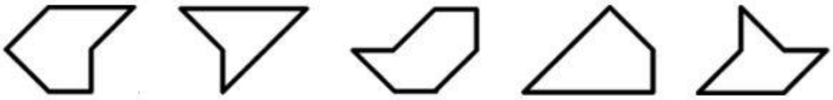
6 하나의 복잡한 패턴의 도형에는 A, B, C, D, E 도형 중 **한 가지의 도형이 포함**되어 있습니다. 이 때 포함되어 있는 **A~E 도형은 방향과 크기가 동일**합니다. 어떤 도형이 포함되어 있는지 선택해 주세요.





○A ○B ○C ○D ○E

다 음

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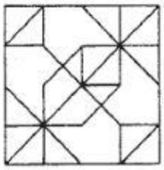
7 하나의 복잡한 패턴의 도형에는 A, B, C, D, E 도형 중 **한 가지의 도형이 포함**되어 있습니다. 이 때 포함되어 있는 **A~E 도형은 방향과 크기가 동일**합니다. 어떤 도형이 포함되어 있는지 선택해 주세요.



○A ○B ○C ○D ○E

다 음

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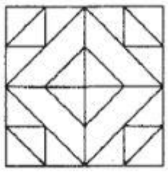
8 하나의 복잡한 패턴의 도형에는 A, B, C, D, E 도형 중 **한 가지의 도형이 포함**되어 있습니다. 이 때 포함되어 있는 **A~E 도형은 방향과 크기가 동일**합니다. 어떤 도형이 포함되어 있는지 선택해 주세요.



○A ○B ○C ○D ○E

다 음

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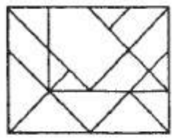
9 하나의 복잡한 패턴의 도형에는 A, B, C, D, E 도형 중 **한 가지의 도형이 포함**되어 있습니다. 이 때 포함되어 있는 **A~E 도형은 방향과 크기가 동일**합니다. 어떤 도형이 포함되어 있는지 선택해 주세요.

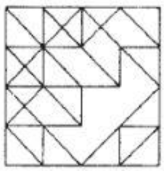


○A ○B ○C ○D ○E

다 음

0% 50% 100%

10 하나의 복잡한 패턴의 도형에는 A, B, C, D, E 도형 중 **한 가지의 도형이 포함**되어 있습니다. 이 때 포함되어 있는 **A~E 도형은 방향과 크기가 동일**합니다. 어떤 도형이 포함되어 있는지 선택해 주세요.

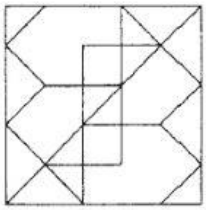


○A ○B ○C ○D ○E

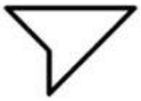
다 음

0% 50% 100%

11 하나의 복잡한 패턴의 도형에는 A, B, C, D, E 도형 중 **한 가지의 도형이 포함**되어 있습니다. 이 때 포함되어 있는 **A~E 도형은 방향과 크기가 동일**합니다. 어떤 도형이 포함되어 있는지 선택해 주세요.

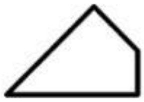


○A



○B

○C



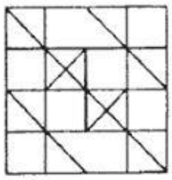
○D

○E

다 음

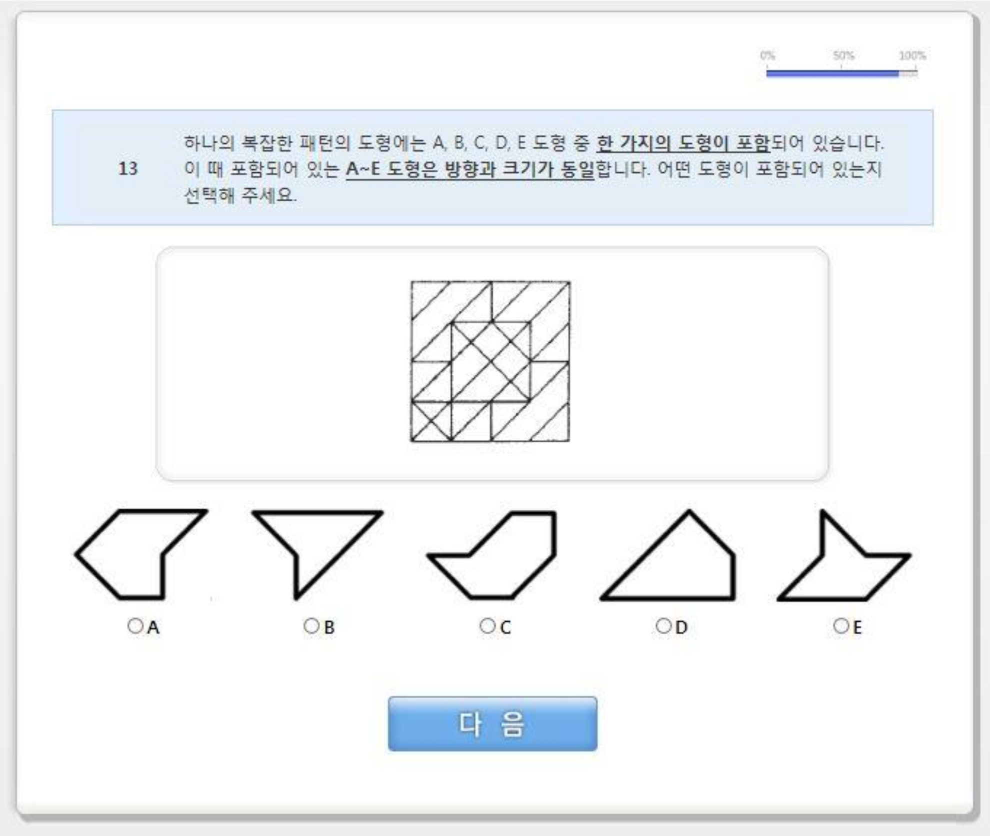
0% 50% 100%

12 하나의 복잡한 패턴의 도형에는 A, B, C, D, E 도형 중 **한 가지의 도형이 포함**되어 있습니다. 이 때 포함되어 있는 **A~E 도형은 방향과 크기가 동일**합니다. 어떤 도형이 포함되어 있는지 선택해 주세요.



○A ○B ○C ○D ○E

다 음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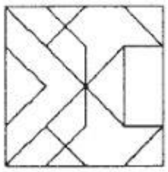
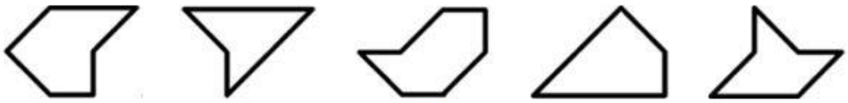
13
하나의 복잡한 패턴의 도형에는 A, B, C, D, E 도형 중 한 가지의 도형이 포함되어 있습니다.
이 때 포함되어 있는 A~E 도형은 방향과 크기가 동일합니다. 어떤 도형이 포함되어 있는지
선택해 주세요.
A
B
C
D
E
다 음

0% 50% 100%

14 하나의 복잡한 패턴의 도형에는 A, B, C, D, E 도형 중 **<u>한 가지의 도형이 포함</u>**되어 있습니다. 이 때 포함되어 있는 **<u>A~E 도형은 방향과 크기가 동일</u>**합니다. 어떤 도형이 포함되어 있는지 선택해 주세요.





○A ○B ○C ○D ○E

다 음

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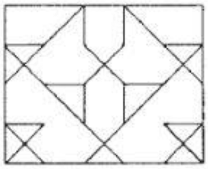
15 하나의 복잡한 패턴의 도형에는 A, B, C, D, E 도형 중 **한 가지의 도형이 포함**되어 있습니다. 이 때 포함되어 있는 **A~E 도형은 방향과 크기가 동일**합니다. 어떤 도형이 포함되어 있는지 선택해 주세요.



○A ○B ○C ○D ○E

다 음

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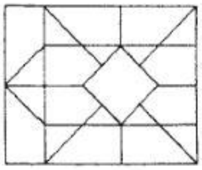
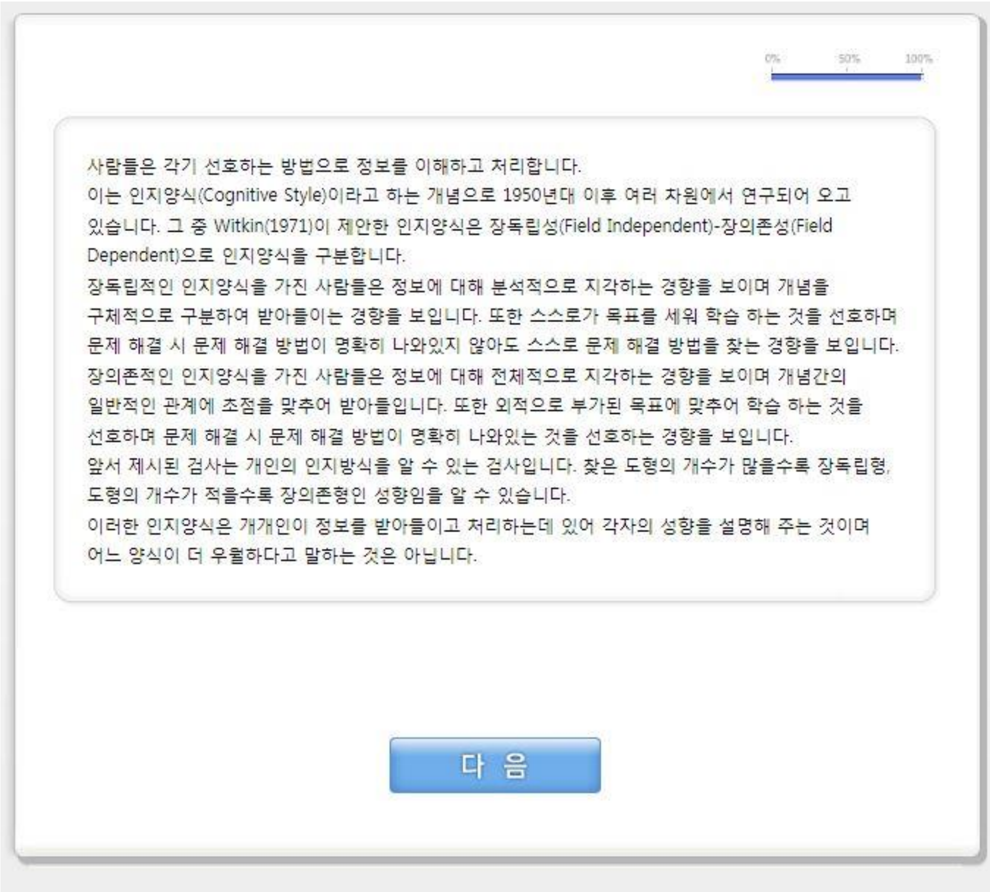
16 하나의 복잡한 패턴의 도형에는 A, B, C, D, E 도형 중 **한 가지의 도형이 포함**되어 있습니다. 이 때 포함되어 있는 **A~E 도형은 방향과 크기가 동일**합니다. 어떤 도형이 포함되어 있는지 선택해 주세요.



○A ○B ○C ○D ○E

다 음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사람들은 각기 선호하는 방법으로 정보를 이해하고 처리합니다.
이는 인지양식(Cognitive Style)이라고 하는 개념으로 1950년대 이후 여러 차원에서 연구되어 오고 있습니다. 그 중 Witkin(1971)이 제안한 인지양식은 장독립성(Field Independent)-장의존성(Field Dependent)으로 인지양식을 구분합니다.
장독립적인 인지양식을 가진 사람들은 정보에 대해 분석적으로 지각하는 경향을 보이며 개념을 구체적으로 구분하여 받아들이는 경향을 보입니다. 또한 스스로가 목표를 세워 학습 하는 것을 선호하며 문제 해결 시 문제 해결 방법이 명확히 나와있지 않아도 스스로 문제 해결 방법을 찾는 경향을 보입니다.
장의존적인 인지양식을 가진 사람들은 정보에 대해 전체적으로 지각하는 경향을 보이며 개념간의 일반적인 관계에 초점을 맞추어 받아들입니다. 또한 외적으로 부가된 목표에 맞추어 학습 하는 것을 선호하며 문제 해결 시 문제 해결 방법이 명확히 나와있는 것을 선호하는 경향을 보입니다.
앞서 제시된 검사는 개인의 인지방식을 알 수 있는 검사입니다. 찾은 도형의 개수가 많을수록 장독립형, 도형의 개수가 적을수록 장의존형인 성향임을 알 수 있습니다.
이러한 인지양식은 개개인이 정보를 받아들이고 처리하는데 있어 각자의 성향을 설명해 주는 것이며 어느 양식이 더 우월하다고 말하는 것은 아닙니다.
다 음

요약(국문초록)

Cognitive Style and Task Complexity for Interface Design: Decision Support for Swine Farm

양돈 농가의 의사결정 지원을 위한 인터페이스 개발 : 인지양식과 과업복잡성을 중심으로

정보통신기술이 발달함에 따라 농업에서도 생산성을 도모하기 위하여 데이터를 활용한 의사결정 시스템을 사용하는 농가가 증가하고 있다. 하지만 사용자가 처리할 수 있는 범위를 넘어선 정보는 정보 과부하를 일으켜 사용자의 의사결정 성과를 저해할 수 있는 위험이 있다. User Interface (유저 인터페이스)는 정보를 보다 효과적으로 전달하여 사용자의 의사결정을 도와줄 수 있는 매개체이다. 따라서 본 연구는 양돈산업에서 사용되고 있는 의사결정 지원 시스템을 바탕으로 사용자의 인지 양식과 일치하는

유저 인터페이스가 사용자의 의사결정 성과에 미치는 영향을 살펴보려고 한다. 본 연구의 목적을 달성하기 위해 인지 부하 이론과 인지 적합 이론을 토대로 하여 인지 양식과 과업의 복잡성을 적용한 두 종류의 유저 인터페이스 (Field Independence 선호 vs. Field Dependence 선호)를 설계하였다. 그 결과, 참가자 중 그들의 인지 양식과 일치하는 유저 인터페이스를 받은 참가자들은 인지 양식과 일치하지 않은 유저 인터페이스를 받은 사람에 비해 과업을 더 빠르게 해결하였다. 하지만, 과업의 복잡성은 참가자들의 인지 양식과 유저 인터페이스의 일치 여부에 따라 유의미한 조절변수로 작용하진 않았다.

주요어: 인지양식 (Cognitive Style), 과업복잡성(Task Complexity), 유저 인터페이스 (User Interface), 의사결정 (Decision-making), 정보 시스템 (Information System), 농업 (Agriculture), 양돈 농가 (Swine Farm)

학 번: 2016-29161