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A Visualization System using Positive Reinforcement Theory to Develop Problem-Solving Skills and Self-Esteem in Young College-Educated Farmers(ระบบวิชวลไลเซชันตามทฤษฎีการเสริมแรงทางบวก เพื่อพัฒนาทักษะการคิดแก้ปัญหาและส่งเสริมความภาคภูมิใจในตนเองของเกษตรกรรุ่นใหม่)

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ระบบวิชวลไลเซชันตามทฤษฎีการเสริมแรงทางบวก เพื่อพัฒนาทักษะการคิดแก้ปัญหาและส่งเสริมความภาคภูมิใจในตนเองของเกษตรกรรุ่นใหม่

A Visualization System using Positive Reinforcement Theory to Develop Problem-Solving Skills and Self-Esteem in Young College-Educated Farmers

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บทคัดย่อ

การวิจัยครั้งนี้มีวัตถุประสงค์เพื่อพัฒนาระบบวิชวลไลเซชันตามทฤษฎีการเสริมแรงทางบวก (VSPR) เพื่อพัฒนาทักษะการคิดแก้ปัญหาและส่งเสริมความภาคภูมิใจในตนเองของเกษตรกรรุ่นใหม่ โดยมีวิธีดำเนินการวิจัย 4 ระยะ คือ (1) ศึกษาสภาพปัญหาการเรียนการสอนจากคณาจารย์ด้านเกษตรศาสตร์ 10 ท่าน และศึกษาความพร้อมและความต้องการในการเรียนรู้ของนิสิตนักศึกษาระดับปริญญาตรีสาขาเกษตร 432 คน เพื่อนำไปใช้ในการพัฒนาต้นแบบซอฟต์แวร์ (2) พัฒนาต้นแบบซอฟต์แวร์ (3) ทดลองใช้กับกลุ่มตัวอย่างนิสิตนักศึกษาระดับปริญญาตรีสาขาเกษตร และ (4) ศึกษาความคิดเห็นจากผู้เชี่ยวชาญเกี่ยวกับ VSPR และต้นแบบซอฟต์แวร์ ผลการวิจัย พบว่า ต้นแบบซอฟต์แวร์ระบบวิชวลไลเซชันตามทฤษฎีการเสริมแรงทางบวก ประกอบด้วย 4 องค์ประกอบ ได้แก่ (1) โครงสร้างระบบ (2) เนื้อหา (3) เทคนิควิชวลไลเซชัน และ (4) ประเมินผล และมีขั้นตอนหลัก 4 ขั้น ได้แก่ (1) ขั้นคำแนะนำ (2) ขั้นเสนอสถานการณ์ปัญหา (3) ขั้นกิจกรรมการแก้ปัญหา (4) ขั้นสรุปผล และจากผลการทดลองโดยใช้ค่า *t*-test พบว่า นิสิตนักศึกษาระดับปริญญาตรีสาขาเกษตรมีทักษะการคิดแก้ปัญหาและความภาคภูมิใจในตนเองสูงขึ้นอย่างมีนัยสำคัญที่ 0.01 และ 0.01 ตามลำดับ

คำสำคัญ: ระบบ / วิชวลไลเซชัน / การเสริมแรงทางบวก / ทักษะการคิดแก้ปัญหา / ความภาคภูมิใจในตนเอง / เกษตรกรรุ่นใหม่

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Abstract

This paper proposes a technique called the Visualization System using Positive Reinforcement Theory (VSPR) to develop problem-solving skills and self-esteem in young college-educated farmers. The research comprised four major steps (1) interviews with 10 faculty members from university Agricultural departments to identify current problems in the classroom, as well as 432 undergraduate students from Agricultural departments in order to generate opinions, suggestions and requirements with regard to development of VSPR software, (2) development of VSRP prototype software, (3) testing VSRP prototype software with undergraduate students from university Agricultural departments, and (4) interviews with experts in order to solicit opinions and suggestions about VSPR and the prototype software. The resulting VSPR prototype software consists of four elements: (1) system structure, (2) content, (3) visualization technique, and (4) evaluation, as well as four steps: (1) suggestions, (2) presentation of problem scenario, (3) problem-solving activities and (4) summary. The t-test results of the VSPR prototype software showed significant improvement with regard to problem-solving skills and self-esteem in undergraduate students from university Agricultural departments at 0.01 and 0.01 consecutively.

KEYWORDS: VISUALIZATION / SYSTEM / POSITIVE REINFORCEMENT / PROBLEM-SOLVING SKILLS / SELF-ESTEEM / YOUNG COLLEGE-EDUCATED FARMERS

Introduction

In Thailand, one of the top agricultural producing countries, the agricultural and farming sector has always played a major role in driving the national economy, not only by offering job opportunities for locals, but also by making Thailand a major food supplier for the global population. Currently the national output of agricultural and farming product is declining along with the number of workers. Since the dwindling numbers of farmers who comprise this important sector of the Thai economy are ill-equipped to deal with the challenges they currently face, of the federal government has

increasingly relied on subsidies paid to farmers and agricultural businesses to support this economic sector (Office of Agricultural Economics, 2011). The result of a study from the Institute of Population and Social Research, Mahidol University showed that the number of farmers decreased continually from 2003 to 2011. Moreover one study estimated that farmers will comprise only 20% of the Thai population by 2020 (Rungratthawatchai, 2011). This reduction in the number of farmers will soon have a major impact on national food security for both the medium and long terms (Center for Applied Economics Research, Kasetsart University, 2011).

Colleges and universities contribute to the potential workforce for the agricultural and farming sector by equipping students with the skills required to solve existing and future problems, and to create self-reliance with respect to agriculture and farming. This training should, in addition, create motivation, self-esteem, and pride among agricultural and farming sector workers. Students can act as role models in this regard and help other farmers with this sort of personal development (Songkram, 2010). A study from Kasetsart University showed that there is an estimated 5-8% annual reduction in new students enrolling in the study of agriculture and related areas (Tonsri, 2013). Moreover, new graduates from Agricultural departments often change their career paths, leading them to employment in positions (such as industrial labor) where knowledge of agriculture is not required, meaning that these students are wasting both time (Jantra, 2013; Tanner & Tanner, 1975) and educational resources of colleges and universities teaching agriculture Analysis shows that the underlying reasons for these negative trends in Thai agriculture are the attitudes of young people towards agricultural jobs. They believe that these jobs are difficult and financially frustrating, forcing those working in this economic sector to face many obstructions and rely on the

uncertainty of weather (Tonsri, 2013). To change the attitudes of these young people, it will be important for them to know that there are solutions for all the agricultural-related problems, and that these problems can be solved, so that these young people are able to feel confident and develop self-esteem connected to the work they will do in this area.

Employing the Visualization System using Positive Reinforcement Theory (VSPR) to develop problem-solving skills and self-esteem is an idea that relies on combining a learning system with positive reinforcement theory. This idea targets higher education students, following a campaign to develop young, well-educated farmers' problem-solving skills and self-esteem to ensure long term sustainability for Thai agriculture.

Objective

This study aims to utilize VSPR to develop problem-solving skills and self-esteem in young college-educated farmers. The objectives were as follows:

1. To study the current problems existing in agricultural class rooms as well as the requirements and the readiness of the students.

2. To study experts' opinions related to the use of VSPR to develop problem-solving skills and self-esteem in young college-educated farmers.

3. To create a VSPR prototype software that can be used to develop problem-solving skills and self-esteem in young college-educated farmers.

4. To study the results and improvements among students after being trained with VSPR to develop their problem-solving skills and self-esteem.

Methodology

This work involved research and development targeted on the creation of VSPR for the purpose of developing problem-solving skills and self-esteem in young college-educated farmers. The work consisted of five development steps, as follows:

Step 1: Structured interviews were conducted to collect information about current problems in agricultural areas from 10 faculty members selected from the Agricultural departments of 10 different colleges and universities in Thailand. The purpose of interviews was to elicit information about current problems in the classroom, and opinions and suggestions related to the prototype software. The interviews revealed that students lack discipline, motivation to learn, skill to solve problems systematically, and self-esteem. Next, the study investigated the readiness and requirements of undergraduate students studying in Agricultural departments. This step was carried out with a sample of 432 students from 10 different colleges and universities in Thailand. The students were asked both closed-ended and open-ended questions about the requirements for the prototype software. The closed-ended questions were in the form of check lists since these responses can be easily evaluated through the use of a standard rating scale. The open-ended questions were related to the students' requirements for the prototype software. The study found that rewards are an important factor in positive reinforcement. Most of the students indicated that they were ready to use on-line based software and that they understand the basics of using a computer. The last set of interviews was carried out with experts in learning technologies and software. The purpose of these interviews was to confirm the software flow, structure, embedded learning techniques to be used in the software, and evaluation methods.

Step 2: Development of the VSPR prototype software to develop problem-solving skills and self-esteem in young college educated farmers was undertaken. Firstly, from the information gathered in the Step 1 interviews was used to develop system requirements. Then, the prototype software was developed based on Apache and PHP-based web applications. Next, the prototype software was tested by five experts; three agricultural experts and two computer systems experts. After the tests, the experts completed qualitative questionnaires to evaluate both content and media, with responses divided into 5 levels (4.50 - 5.00 = Best, 3.50 - 4.49 = Good, 2.50 - 3.49 1.50 - 2.49 = Average, 2 = Fair, 1.00 - 1.49 =Poor). The average scores were 4.6 for content and 4.63 for media. Using feedback from the experts, the software prototype was then improved before moving on to step 3.

Step 3: The VSPR prototype software was tested with agricultural students using three steps. The purpose of the tests carried out in the first and second steps was to evaluate the VSPR prototype software. The purpose of last step was to evaluate the effectiveness of the software in helping students to develop problem-solving skills and self-esteem. The first step was one-to-one, with only three students performing the test separately, while researchers investigated the effectiveness of the software via observation and interview. The results showed that all three students were able to effectively use the software. The students were also satisfied with the learning methods, activities and techniques incorporated with the software. The second step involved small-group testing, which was done with a group of five students, with the effectiveness of the software evaluated by observation and questionnaires. Responses were divided into five levels (Best 4.50-5.00, Good 3.50-4.49, Average 2.50-3.49, Fair 1.50-2.49 and Poor 1.00-1.49). The average score of 4.64 points showed that the students were able to effectively use

the software. The last step, field testing, was carried out with 15 students to evaluate how effectively problem-solving skills and self-esteem were developed after students were trained with the prototype software. The evaluation was done using pretest and post-test evaluation, carried out before and after training with the prototype software. Both the pre-test and post-test consisted of 25 analytical questions designed by experts in the field of study. Later, the scores from the pre-test and post-test of each individual student were used for statistical comparison. The results, as shown on Table 1 and Table 2, were analyzed by using t-test dependence, and it was found that the group of 15 students showed improved problem-solving skills and self-esteem, as expected.

Table 1 Summary of problem-solving skills

Experiment	*N*	*M*	*SD*	t	Sig.
Pretest	15	18.20	2.484	8.919	.000**
Posttest	15	19.87	2.326		

Table 2 Summary of self-esteem

Experiment	*N*	*M*	*SD*	t	Sig.
Pretest (285)	15	202.27	14.270	11.965	.000**
Posttest (285)	15	239.27	13.541		

Note. ** Statistically significant level at 0.01

Step 4: The interviews with the experts involved structured interviews and questionnaires with five experts: three from the agricultural area and two coming from the learning systems area. The structured interviews were focused on opinions and suggestions related to VSPR and the prototype software. The questionnaires were focused on evaluating the efficiency of

VSPR and the prototype software. The results were divided into five levels (Best 4.50-5.00, Good 3.50-4.49, Average 2.50-3.49, Fair 1.50-2.49 and Poor 1.00-1.49). Based on the experts' interviews and questionnaires, VSPR was confirmed to be effective in developing problem-solving skills and self-esteem, based on the students at average rating of 4.63. Moreover, the VSPR prototype software was found to be helpful in developing problem-solving skills and self-esteem, based on the average rating of 4.60.

Research Design, Research Framework, Population and Sampling and Research Instrument

The Research design for this study was set up as an experiment to evaluate VSPR techniques for developing problem-solving skills and self-esteem. The experiment was carried out using a ***research framework*** that targeted the evaluation effect of computer software that had been developed based on three fundamental theories: (1) Learning system (2) Positive reinforcement (3) Visualization techniques.

The result of the experiment was analyzed using a pre-test and post-test to evaluate the improvement of

(1) Problem-solving skills and (2) Self-esteem development

The ***population*** for the study was 41,021 undergraduate students from Agricultural departments at universities in Thailand. The ***sampling*** for our study comprised 15 third and fourth year undergraduate students majoring in Agricultural Extension and Development, in the Agricultural Department of Kasetsart University who were selected using a cluster random sampling method. The ***Research instrument*** used in this study included a pre-test, web application software, and a post-test. The web application

software delivered VSPR to help students develop their problem-solving skills and self-esteem, while the results of the pre-test and post-test were used to evaluate effectiveness of VSRP technique.

Result

The VSPR prototype software to develop problem-solving skills and self-esteem is a model consisting of learning elements, learning procedures, and output. The model is shown in Figure 1. The interface display of the prototype software is shown in Figure 2.

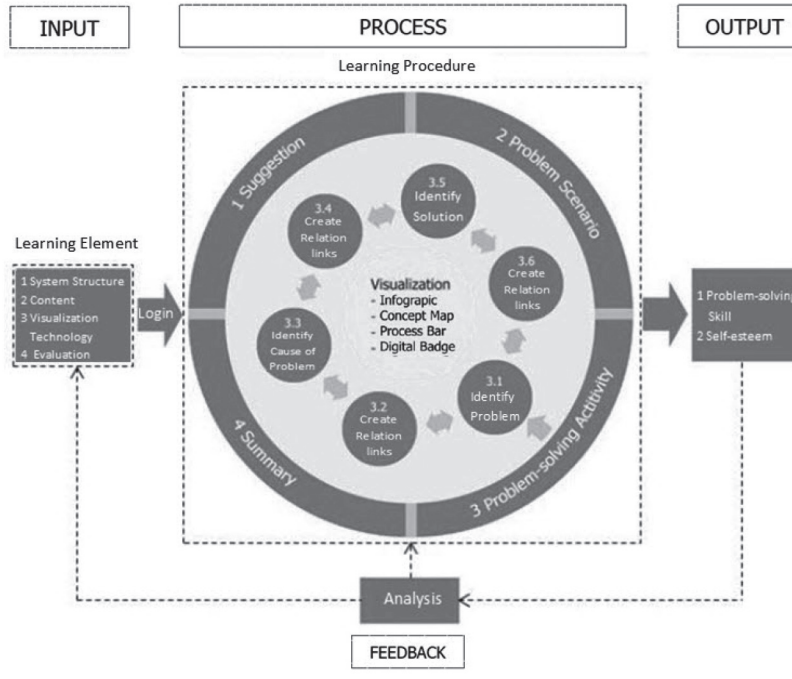

Figure 1 Learning Element and Learning Procedure VSPR Prototype Software to Develop Problem-Solving Skills and Self-esteem

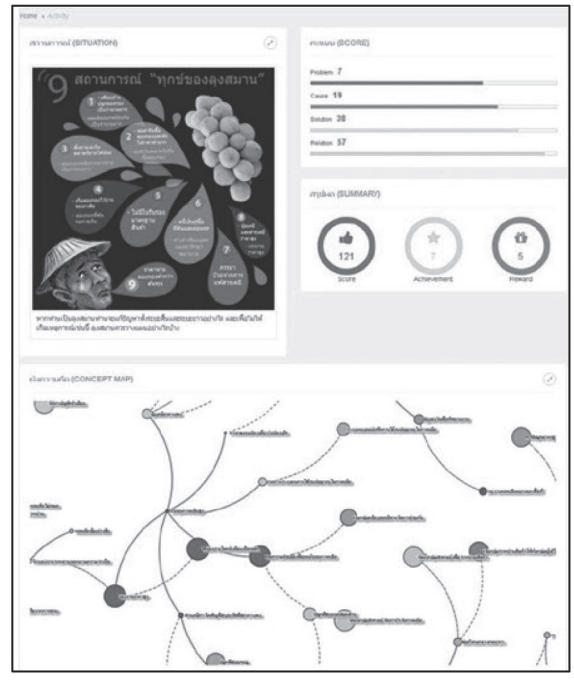

Figure 2 Interface Display of VSPR Prototype Software

The organization of the VSPR prototype software to develop problem-solving skills and self-esteem consists of four elements: (1) System Structure, (2) Content, (3) Visualization Technique, and (4) Evaluation

1. System Structure

The structure of the VSPR prototype software to develop problem-solving skills and self-esteem was designed based on a problem-solving framework which includes problem, cause and solution. The relationships between the problem, cause and solution are divided in to different categories; for example, (1) indicate the cause of the problem, such as ***cause A*** is the origin of ***problem A***, (2) develop potential solutions to the problem, such as ***solution A*** solves the cause of the problem at ***cause A***, (3) identify similarity in meaning, such as ***cause B*** has a similar meaning as ***cause A***, and (4) a part of, such as the ***solution D*** is a part of ***solution E.*** The structure is illustrated as in Figure 3.

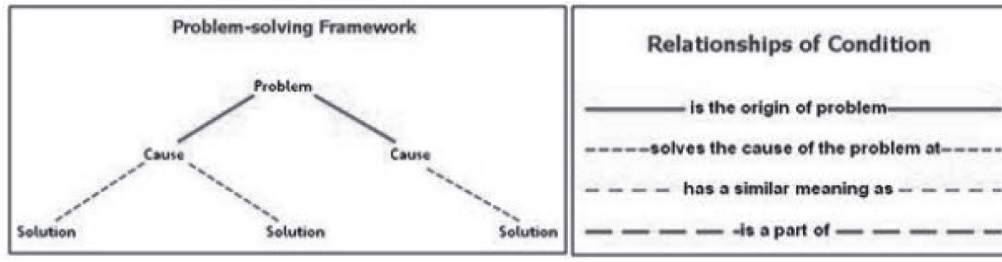

Figure 3 VSPR Software System Structure

2. Content

The content in the VSPR prototype software to develop problem-solving skill and self-esteem was consists of (1) learning instruction, (2) problem scenarios, and (3) suggestion statements.

2.1 Learning instruction includes learning purposes, learning procedures, a prototype software manual, reward conditions, and supplemental related information for reference from other sources.

2.2 Problem scenario was designed from selected actual situations. The selected situations came with clear solutions, supported reliable research work and good recommendations from experts in the agricultural area. The selected situations were processed using analysis and synthesis methodologies to create the ***problem scenarios*** included in the prototype software. Finally, the problem scenarios were evaluated by five experts from the agricultural area for compatibility, integrity and consistency with research goals by using the Index of Consistency, IOC. The problem scenarios were evaluated and found to have a high level of suitability, IOC = 0.76. In addition, the evaluation result was used to improve the problem scenarios.

2.3 Suggestion statements were designed based on the problem scenarios. The suggestion statements resulted from analysis and synthesis methodology applied to the problems. The causes and solutions connected

to the problems will be stored in the database for reference. The suggestion statements were later evaluated by three experts from the agricultural area by using the Index of Consistency. The results showed that the suggestion statements were suitable for use, with IOC = 0.98.

3. Visualization Technique

Visualization technique in the VSPR prototype software to develop problem-solving skills and self-esteem was designed based on related research work, suggestions from experts and requirements identified by students, and consisted of three steps (1) presentation of a problem scenario, (2) presentation of solutions, and (3) presentation of positive reinforcement.

Presentation of Problem scenario was done using an infographic based on the data from problem scenario to help students understand the overall situation easily. An example of this infographic presentation of problem scenario is shown in Figure 4.

Figure 4 Infographic presentation of a problem scenario

Presentation of solution was done using a concept map. The concept map projected the solution idea into a diagram. An example of the concept map is shown in Figure 5.

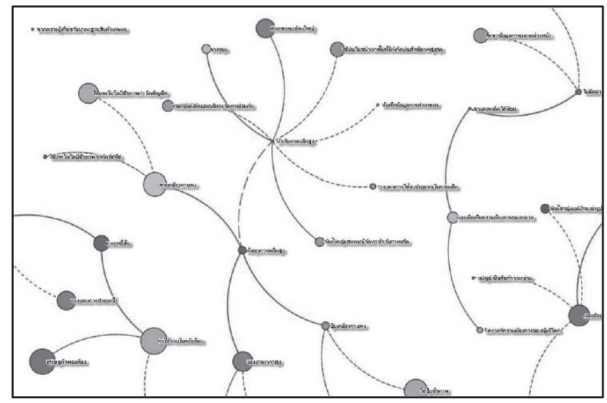

Figure 5 Concept map projecting solution idea

Presentation of positive reinforcement was done based on token economy (Kazdin, 1977). When the students performed targeted behaviors, they were rewarded with tokens. The forms of tokens were (1) scores given automatically by the software when the students identified problems, causes, solutions or relationships. Scores were represented as a progress bars, as shown in figure 6, and (2) digital badges given automatically by the software when the students finished all the problems, with conditions, as shown in figure 7.

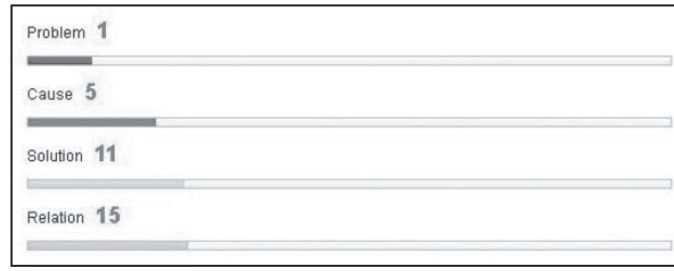

Figure 6 Progress bars represent the achievements of the students

Figure 7 Representative Digital Badges given to successful students

4. Evaluation

Evaluation in VSPR to develop problem-solving skills and self-esteem was divided into two parts: (1) Evaluation of the solution methodology was done using authentic assessment to measure effectiveness of problem-solving skills by identifying problems, causes, solutions and relationships, and (2) Evaluation of self-esteem was done using reflective thinking to analyze the students' feelings during and after software use.

Procedures of VSPR included: (1) Suggestions, (2) Presentation of problem scenarios, (3) Problem-solving activities, and (4) Summary. Details were as follows.

Step 1: Suggestions

Students completed the registration form before starting the learning system, which started with (1) the goal of the learning system, (2) learning procedures and prototype software manual to make sure that the students understood how to use software, (3) rewards and conditions, to make sure that the students understood conditions required by the learning system in order to get rewards such as scores, badges (stars) and other rewards, and (4) additional information, which provides a channel for the students to explore additional knowledge before moving to the next step.

Step 2: Presentation of problem scenarios

The software system presented problem scenarios to students by using pictures and dialogs describing the agricultural situation. Then, the students studied and analyzed each problem for solutions before moving onto the next step.

Step 3 Problem-solving activities

The students performed problem-solving activities. The activities included (1) identifying the problem, (2) creating relationship links, (3) identifying causes of the problem, (4) creating additional relationship links, (5) identifying solutions, and (6) creating more relationship links. After completing all the activities, students were able to move onto the next step.

Step 4 Summary

The students completed a questionnaire related to their experience and abilities in problem-solving gathered by the software system. The purpose of this questionnaire was to give each student a chance to evaluate their activities through reflective thinking. The last page of the software output showed the summary of the problems, causes, solutions and their relationships.

In summary, the VSPR prototype software consists of four elements and four steps. The four elements are (1) system structure, (2) content, (3) visualization technique, and (4) evaluation. The four steps are (1) suggestion, (2) presentation of problem scenarios, (3) problem-solving activities, and (4) summary. VSPR is designed to cover all four elements and four steps in order to achieve the highest level of efficiency.

Conclusion

This study has achieved the research objective based on the outcomes achieved by the sampled undergraduate students from Agricultural departments.

1. The current problem in the in the agricultural class rooms from the faculty members' point of view is that students lack discipline, motivation to learn, skill to solve problems systematically, and self-esteem. The rewards offered in this program are important elements of the positive reinforcement. Most of the students were ready to use on-line based software and able to understand the basics of computer use.

2. The opinions from experts' confirmed the design of the software flow, structure, embedded learning technique to be used in the software, and evaluation methods. Moreover, the experts' opinions confirmed that VSPR was likely to help develop problem-solving skills and self-esteem in undergraduate students from Agricultural departments.

3. The VSPR prototype software was created, and then tested by groups of students from Agricultural departments. The testing results show that the students enhanced their problem-solving skills and self-esteem, as expected.

4. The statistical comparison shows that the VSPR prototype software is correlated to an improvement in the test scores from the pre-test and post-test, given before and after training with the VSPR prototype software, respectively. The results show that the VSPR prototype software is effective in helping to develop problem-solving skills and self-esteem in undergraduate students from Agricultural departments.

Discussion

The four steps of VSPR are designed to help students successfully solve problems. The students are enabled to analyze problems and causes, as well as to collect necessary information and search for solutions. Therefore, the students also develop their self-esteem as a result of successfully solving the problems. The more problems they solved, the higher self-esteem can be expected to rise (Coopersmith, 1981). Also, the VSPR supports problem-solving ability as a crucial skill. Individuals who are able to solve problems faster and more efficiently are more likely to be successful in both work life and social life (Jantra, 2013; Tanner & Tanner, 1975). Therefore, to promote success among students, they should be trained with appropriate and effective learning activities which stimulate their problem-solving skills (Lackney, 2002). In addition, VSPR helps to promote self-esteem in these young future farmers. Self-esteem is an elemental factor for human beings, allowing each person to realize his or her own value (Walz & Bleuer, 1992). One researcher, Cooper Smith, found that a person who often completes his tasks successfully gains self-esteem to a greater degree than another person who less successfully completes his tasks. Therefore, success in task achievement is a key factor in promoting self-esteem (Coopersmith, 1981). Creating more success is a method for increasing one's self-esteem (Bruno, 1983). In order for these young future farmers to be successful, they need to be correctly trained.

The findings of this research are congruent with the Learning System Theory (Malithong, 2000) supported by Visualization Technique (Sittibanjerd, 2009) and positive reinforcement (Skinner, 1971).

In addition, the VSPR is a process which integrates four elements: (1) input, comprising system structure, content, visualization technique, and evaluation, (2) procedures, comprising suggestions, presentation of problem scenarios, problem-solving activities, and summary, (3) output, comprising the development of problem-solving skills and self-esteem, and (4) feedback, involving analysis of the results. These four elements for system learning make up the process designed to achieve the learning objectives (Malithong, 2000).

Visualization technique is a part of the cognitive system, which plays an important role by presenting information and data using graphics (Sittibanjerd, 2009). The information can be presented using graphs, diagrams or pictures, using colors and symbols to help the learner to interpret the data (Ware, 2004). In addition, the graphical presentation helps the human brain to recognize and understand information more easily (Diehl, 2007). Moreover, it reduces the gap between humans and data to speed up the learning process (Keim, 2002). In conjunction with this, positive reinforcement techniques offer a high performance reinforcement method to strengthen targeted behavior in humans. Positive reinforcement given after a learner executes targeted behavior encourages the frequency of repeating that targeted behavior in the future (Skinner, 1971). The technique enhances personal confidence and enthusiastic feelings in the learner. This helps create positive relationships among others, leading to long term successs (Potter, 1998).

In summary the essential elements in the design of the VSPR include:

1) In the suggestions step, learning instruction should be clear and precise because it provides the direction, process and conditions that students follow.

2) In the presentation of problem scenarios, the scenarios should be clear and precise, and the story should be complete in detail and accompanied by good illustrations.

3) In the problem-solving activities step, problem-solving activities should be designed to be user friendly and to avoid confusion.

4) In the summarizing step, the questionnaire designed to promote reflective thinking should be designed to let the students express their true feelings.

5) Overall, graphics should be neat, with high-quality composition to attract the students to the learning system.

Suggestion

VSPR shows potential to create positive attitudes among higher education agricultural students. This is expected to enhance the abilities of these agricultural and farming workers in the future. Similar methodology can be applied to other professions, including teachers, rural health professionals, or military and police officers in area of conflict. VSPR has the potential to help instill positive and constructive attitudes in students so they will be prepared and proud to work in such positions in the future.

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