

Application of Concept Advanced Interpretive Structural Modeling to Evaluating Learning Effectiveness in Adventure Education

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In terms of experiential learning cycle theory, adventure education refers to developing various skills required for team building through a series of indoor or outdoor group activities at different levels. The purpose of this study was to apply concept advanced interpretive structural modeling to analyze and identify the learning concept hierarchy and hierarchical changes among adventure education participants. The participants' learning effectiveness was evaluated individually, and new approaches to evaluating adventure education were established. According to the overall data analysis, the participants were most proficient in the concept of contract value. Compared with the pre-test and the mid-test, the number of concepts in which the participants attained high mastery levels increased after the adventure education. However, the participants demonstrated a low mastery level in the concept of self-confidence in the pre-test, the mid-test and the post-test. Finally, practical suggestions regarding adventure education program design and related learning effectiveness evaluation were proposed.

Keywords: adventure education, learning effectiveness, concept advanced interpretive structural modeling

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Introduction

Adventure education is a training method distinct from conventional indoor static courses, and has been widely applied by companies as an educational training model in recent years. Specifically, adventure education refers to a method that was developed on the basis of the experiential learning cycle (ELC) theory: by hosting a series of indoor and outdoor activities in different levels, skills required for team building are developed among the team members, including trust building, effective communication, leadership skills, and decision-making capability (Tsai & Liao, 2001) . In adventure education, a guide only provides 5 trainees with directions and instructions when necessary. In most part of the team activity, trainees discuss, share, reflect on, and perceive specific contents in the activity, connecting such experience with reality, thus rendering the acquired experiences meaningful. The objective is to enable trainees to solve real life problems on the basis of similar experiences they gained in adventure education (Guo, Liao, & Shih, 2010). In addition, J.-T. Wu (2006) considered that a heavy and routine work lifestyle confines employees in thinking within the range of their existing experiences. However, exploratory learning enables organizational teams to participate in problem-solving activities. Through in-depth guidance, discussion, and sharing, participants clarify issues at work, specifically the internal and external operations and relationships of their organization. Thus, participants are stimulated to think out of the box. New perception produced from a series of guided activities aids participants in thinking out of the box and developing new behaviors that are independent from previous success experiences. To confront present and future challenges, participants improve themselves, becoming capable of creating competitive advantage for their organization.

An educational training evaluation involves confirming and acquiring training plans, as well as providing referential information for decision making; such evaluation is aimed at improving current situations. Furthermore, a training evaluation is a process of assessing the value of training and organizational performance, including evaluations on both lecturers and trainees. On the basis of specific criteria, an evaluation assesses training effects to enhance personnel quality, facilitate human resource development, increase work efficiency, and strengthen organizational functions. Conventional educational training evaluations mainly comprise five types of models: the four-level model (reaction, learning, behavior,

Application of Concept Advanced Interpretive Structural Modeling to Evaluating Learning Effectiveness in Adventure Education

results; Kirkpatrick (1998), the context, input, process, and product (CIPP) framework (Stufflebeam, 2003), the six-stage evaluation model (goal setting, program design, program implementation, immediate outcomes, intermediate or usage outcomes, and impacts and worth; (Brinkerhoff, 1998), the input, process, and output (IPO) model (input, process, and output; (Bushnell, 1990), and the return on investment (ROI; (Phillips, 1997).

However, these types of educational training evaluation cannot fully identify the learning concept hierarchy and its changes in individual trainees after they completed the training. Therefore, Lin (2005) proposed the concept advanced interpretive structural modeling (CAISM) to analyze the hierarchical structure of concept attributes in individualized test questions; thus, the test questions are not limited to binary scoring. CAISM analysis entails assessing the test data of trainees according to concept vector matching and fuzzy theory and using the hierarchical structure algorithm of interpretive structural modeling to present individualized concept hierarchical structures (CHSs) in numbers and graphics.

According to the aforementioned research background and motivation, this study applied CAISM analysis to identify the learning concept hierarchy and its changes observed among adventure education trainees, in order to achieve individualized evaluation of the training effect and establish a new approach for educational training evaluation.

Literature Review

Adventure Education

Definition

Adventure education facilitates individual development by involving trainees in designed activities that are challenging, adventurous, and include novel experiences, from which the trainees acquire interpersonal and intrapersonal skills. Through learning-by-doing activities and self-reflection, individuals achieve lifelong learning and development on the basis of experience transfer and attitude cultivation (Lee, 2003). In addition, adventure education offers educational training methods that provide trainees and groups with adequate medium for developing behavioral norms and values (J.-T. Wu, 2006).

Experiential Learning Cycle (ELC)

ELC is a key theoretical framework and learning model of adventure education, integrating behavioral, cognitive, cerebral and neurological, experiential, conscious, and other learning-related theories (Kolb, 1984). The philosophical basis of ELC was derived from the educational ideas of Dewey in 1930, who claimed that education should be conducted on the basis of current experiences, so that the next-generation individuals could develop knowledge and abilities required for solving present or future problems. Previous knowledge and skills serve merely as medium or tools in a process (J.-T. Wu, 2006). According to Dewey's view, the ELC emphasizes the essence of experience as its fundamental concept, positing that all experiences are consecutive and that any experiences influence future ones (Dewey, 1983).

Referencing Dewey's experiential education, Kolb (1984) developed the ELC model, which comprises two dimensions (i.e., apprehension and comprehension, and transformation) and four stages (i.e., concrete experience, reflective observation, abstract conceptualization, and active experimentation), to describe the learning process.

Two Dimensions:

In Kolb's experiential learning model, experience processing in the learning cycle can be divided into two dimensions, namely apprehension and comprehension, and transformation. Interactions between these two dimensions form various learning styles.

Apprehension and Comprehension (Grasping and Prehension):

This dimension can be further divided into concrete experience and abstract conceptualization. Concrete experience refers to personal experiences or concrete feelings an individual obtains through apprehension, enabling the individual to understand the world and share their knowledge and interact with others. Abstract conceptualization involves understanding the world through comprehension, and forming abstract concepts and contemplating specific knowledge or feelings that are difficult to explain in words.

Application of Concept Advanced Interpretive Structural Modeling to Evaluating Learning Effectiveness in Adventure Education

Transformation:

Although knowledge of the world can be obtained through apprehension and comprehension, a learning process cannot be complete unless explicit knowledge obtained through apprehension and comprehension is internalized into the individual. Kolb considered transformation occurs in two levels, namely reflective observation and active experimentation. Reflective observation is defined as transforming individual understanding of the world through intention, which facilitates internalizing reflection through purposeful observation. By comparison, active experimentation achieves external transformation through extension, which involves having individual apprehension and thoughts implemented in practical operations.

Four Stages

In addition to the aforementioned two dimensions, Kolb's ELC model posits that individuals undergo a four-stage cycle of learning, in addition to the two aforementioned dimensions: concrete experiences provide a basis for reflective observations, which are then assimilated into abstract concepts that can be actively applied and tested.

Concrete Experience

By taking part in planned guided activities, participants gain new experiences and develop specific affection, cognition, and behaviors, which serve to replace their original cognition and behaviors. Consequently, the participants improve in their abilities to perceive problems and comprehend the external environment.

Reflective Observation

Practical demonstrations in an activity comprise only a part of the learning process. Reflection must be assimilated into the process to yield satisfactory outcomes. By intentionally internalizing observations into reflections during an activity, the participants can reflect on and examine the core problems, thereby linking their present experiences with previous ones to identify solutions to the problems.

Abstract Conceptualization

The objective of this stage is to link the observations and perceptions acquired

in the second stage of the learning cycle into real-life situations or concerns, thus leading to generalizations. Through continual discussion and reflection, abstract concepts are formed for facilitating in-depth inductions and integration.

Active Experimentation

After being guided in the previous three stages, the participants can summarize concepts and apply their activity experiences and comprehended concepts or ideas to real-life situations and work sites, thereby implementing changes.

Effectiveness Evaluation

Adventure education creates simulation of real situations, enabling participants to learn through experiences. Specifically, during the individual–team interactive learning process, personal growth and abilities necessary for organizational operation are enhanced (Chang & Pan, 2008; Tsai & Liao, 2001). However, an adequate evaluation instrument is needed to determine the effectiveness of adventure education. Previous evaluation instruments are typically oriented toward psychological dimensions, neglecting the effects of personal changes. However, since the 1980s, researchers began developing more multidimensional evaluation instruments. Marsh, Richards, and Barnes (1986) developed the Life Effectiveness Questionnaire (LEQ), comprising seven dimensions and 38 items. In 2000, LEQ-C and LEQ-I were subsequently adapted from the original version (Luo, 2004).

Currently, adventure education institutions in Taiwan generally adopt LEQ-H, which was revised by James Neill and subsequently translated by Luo (2004), in evaluating the effectiveness of their adventure education courses. Although Neill's version exhibits satisfactory reliability and validity, those of the Chinese version must be tested because of cultural and custom differences (C.-C. Wu & Hsieh, 2008). Consequently, C.-C. Wu and Hsieh (2008) performed factor analysis and reliability and validity tests on the Chinese version of Neill's LEQ-H comprising eight dimensions (i.e., time management, emotional control, achievement motivation, social competence, task leadership, self-confidence, intellectual flexibility, and active initiative), and 24 items. After the analysis, the LEQ consisted of 21 items under seven dimension, namely time management, emotional control, achievement motivation, social leadership, self-confidence, active initiative, and value contract, which are explained as follows:

Application of Concept Advanced Interpretive Structural Modeling to Evaluating Learning Effectiveness in Adventure Education

Time Management

Neill claimed that satisfactory life effectiveness includes effective time management. This dimension measures the extent to which an individual perceives that he or she makes optimum use of time.

Emotional Control

This dimension measures the extent to which an individual perceives that he or she maintains emotional calmness when facing stressful situations. In adventure education activities, participants face conflicts with other individuals and teams, at which point self-perception, including perception of the thinking process and emotions, serves as a key element of emotional control. Through guidance, participants understand that each person has different needs and cognitive and behavioral models. Eventually, the participants adopt a positive attitude in interacting with others.

Achievement Motivation

This dimension measures the extent to which an individual is motivated to pursue excellence and devote the required effort in attaining it. When participants are driven to achieve their desired goals, to surpass others, and to pursue success, they are more likely to demonstrate favorable academic or work performance.

Social Leadership

After factor analysis, Neill's original dimensions, task leadership and social competence, were combined into the dimension of social leadership, which measures the degree of personal confidence an individual has in his or her abilities to succeed in social and interpersonal interactions. Because people are social animals, communication and interaction with others are unavoidable. Adventure education creates an environment in which participants are willing and required to cooperate with others, prompting them to learn interaction skills for team building and interpersonal communication. Moreover, social leadership measures the extent to which an individual perceives he or she can effectively lead others.

Self-confidence

Self-confidence is a psychological feeling and perception and is defined as the

degree of confidence an individual has in himself or herself. Self-confident individuals are confident in what they know and what they are capable of, showing no doubt in their actions or judgments. Self-confidence is related to concepts such as self-perception, self-esteem, and self-efficacy. Through adventure education activities, participants can establish self-worth and enhance their self-concept.

Active Initiative

This dimension measures the extent to which an individual is willing to initiate actions in new situations. This concept is crucial in the operation of organizational human resources. When recruiting new employees or evaluating employee performance, firms often incorporate active initiative in addition to work skills and competency into consideration.

Value Contract

Ellmo and Graser (1995) considered value contract as one of the fundamental principals in adventure activities. A team and its members hold distinct values, which are integrated, forming the behavioral guidelines with which the team can follow.

Empirical studies

Adventure education is a type of growth activity focusing on experiential learning, providing trainees with learning experiences in real situations. Under the assistance of professional guides, trainees are encouraged to learn, eliciting their potential and willingness to learn. Through gaming or sports activities, trainees are guided to face their self and assimilate their experiences with those of others, and further apply these experiences to the real world. Currently in Taiwan, experiential learning is widely applied in schools, targeting mostly students. However, in recent years, adventure education has gradually been applied to medical treatment, consulting, psychological therapy, corporate training, and various other fields.

Hsieh, Wu, and Hsieh (2007) observed that adventure courses improved the performance of undergraduates in interpersonal communication, life effectiveness, and subjective well-being. In addition, the research results of Shang and Chou (2012) indicated that the team-building project in adventure courses was effective in enhancing the sense of belonging to the team, perceived capabilities, and

Application of Concept Advanced Interpretive Structural Modeling to Evaluating Learning Effectiveness in Adventure Education

self-confidence of junior high school students, aiding them in identifying their self-worth and uniqueness. Moreover, strength-based adventure education encourages participants to use their talents actively to achieve success (Passarelli, Hall, & Anderson, 2010).

Scholars have developed various components and concepts of adventure education curriculum. Shooter and Furman (2014) proposed both adventure education and socioecological models with positive behavior change as a desired outcome. Adventure education can be an effective way to teach systems thinking and the socioecological model provides a useful framework. In addition, Miller et al. (2015) developed a new curriculum model called Content, Transition, Inquiry, and Synthesis for education and outreach research projects to explore the capacity of hands-on and web-based climate science education experiences. Williams and Wainwright (2016) outlined four non-negotiable features of a pedagogical model for outdoor adventure education (OAE) in the UK: mainly outdoors, experiential learning, and challenge by choice, and managed risk. These features encourage pupils to take more responsibility for their own learning, develop closer links between school OAE and local opportunities, support teachers in making judgments about pupils managing their own risk, and develop teachers' expertise in reviewing and developing assessment tools that measure pupils' affective learning. In addition, Sutherland, Stuhr, and Ayvazo (2016) explored content knowledge (CK) and pedagogical CK (PCK) as curricular models to teach adventure-based learning. In these models, four themes represented the demonstration of PCK when learning to teach adventure-based learning. The themes were (a) trusting the sequence, (b) knowing your students, (c) facilitating mutual decision-making, and (d) processing the experience.

Regarding evaluation of adventure education, Stuhr, Sutherland, Ressler, and Ortiz-Stuhr (2015) illustrated four stages: connecting, valuing, developing, and transferring. The stage of connecting includes warming-up, enjoyment and fun, and personal meaning. The stage of valuing includes acknowledging the general importance and benefits of learning. The stage of developing includes evaluating the uses of respect, communication, and leadership. The stage of transferring includes applied in area.

Concept Advanced Interpretive Structural Modeling

Warfield (1976) proposed the interpretive structural modeling (ISM), in which the inter-element relationships are defined as binary. This model is inapplicable to conceptual studies in the educational field, because from the perspective of cognitive psychology, links between concepts do not comprise absolute dichotomy. In other words, exhibiting no link does not mean that the two concepts have absolute no association, and when there is a link, it does not mean that they are absolutely related.

Lin (2005) proposed the fuzzy approach of ISM, using the alpha cut in the fuzzy theory and the fuzzy logic model of perception (FLMP) to improve the limitation that ISM is applicable to only binary data. The fuzzy ISM involves calculating the probability to which a matched stimulus belongs to a category according to the FLMP. Subsequently, the alpha cut in the fuzzy theory is applied to evaluate the subordination level among the concepts.

Lin (2006) extended ISM according to the FLMP and concept vector matching. The ISM algorithm based on fuzzy alpha cut presents individualized CHS in both numerical value and graphic structures; moreover, the test questions are not limited to a binary scoring system.

CAISM provides individualized CHS information according to test data. This model presents individualized CHS, expressing it as numerical values and graphic structures (Lin, Hung, & Huang, 2006).

Research Methods

Research Participants

This study recruited students who had enrolled in the Adventure Education Learning course offered by the researchers of the present study in the spring of 2013. None of the recruited participants had experiences in participating in adventure education programs. Overall, 45 participants were recruited (average aged = 20.3; men = 20; women = 25), of which 15 were first-year undergraduate students, 10 were in their second year, 12 were third-year students, and 8 were in their fourth year. These students were from the Departments of Education, Psychology and Counseling, Physical Education, Childhood Education, and Special Education.

Application of Concept Advanced Interpretive Structural Modeling to Evaluating Learning Effectiveness in Adventure Education

The participating students completed the LEQ during Weeks 1, 9, and 18. The researchers summed the pretest, midtest, and posttest scores of each student and ranked the 45 students from high to low by individual scores. Then, a quartile deviation approach was used to select the 9th (Q1), 24th (Q2), and 45th (Q3) students as examples for presenting the data analysis.

Research Instruments

This study adopted the LEQ proposed by C.-C. Wu and Hsieh (2008); its scale consisted of seven dimensions: time management, emotional control, achievement motivation, social leadership, self-confidence, active initiative, and value contract. The Cronbach's α values of these dimensions are respectively .81, .71, .72, .64, .72, .62, and .79, satisfying the criteria of internal consistency proposed by Cronbach (1951). This scale adopted a five-point Likert scale, which scores 1 to 5 respectively representing "strongly disagree," "disagree," "neutral", "agree," and "strongly agree."

Activity Planning and Execution

Previously, Ringer and Gillis (1995) classified adventure education into the following four major types: recreation, education and training, development, and psychotherapy. Tsai (2004) further classified Rohnke's adventure education activities into nine categories: ice breaker, warm-up exercises, games, problem-solving activities, trust activities, stunts, low ropes courses, high ropes courses, and finishing activities. The present study incorporated the adventure education course design of Tsai (2004) into the series of adventure-based activities for the research participants. The levels, types, objectives, names, and tasks of these adventure education activities are shown in Table 1.

In this study, the course involved a two-credit course, requiring the participants to attend classes for a total of at least 32 hours according to the regulations of the school where the researcher teaches. Hence, the researcher planned that the low-and-medium-level activities respectively accounted for 16 hours, whereas the high-level activities accounted for 8 hours. Upon the completion of activities in each stage, the participants filled the LEQ (C.-C. Wu & Hsieh, 2008) for evaluating the learning effectiveness of that stage.

The effectiveness of low-level activities was measured using the dimensions of

time management, emotional control, self-confidence, and active initiative. By comparison, the effectiveness of medium-and-high-level activities was measured on the basis of time management, emotional control, achievement motivation, social leadership, self-confidence, active initiative, and contract value.

Data Analysis

Pretest CHS of Participants in the Top, Middle, and Bottom Sets

The CHS of three participants were obtained by calculating their test answers through the CAISM program, as shown in Figs. 1, 2, and 3. Using Fig. 1 as an example, the principles for interpreting the structures are explained as follows:

Level of concept mastery:

On the CHS diagram, the numbers in the circles represent the concept codes, where 1–7 respectively represent Concepts 1–7, specifically, time management; emotional control; achievement motivation; social leadership; self-confidence; active initiative; and value contract. In addition, the numbers below the codes represent the degree to which the participant has mastered this concept. For example, Student 9 exhibited a mastery level of .55 in Concept 1.

Hierarchy:

The hierarchy on the CHS diagrams indicates the sequence in which the concepts developed in the participants. The concepts in the upper level are those that the participants are unfamiliar with, whereas the concepts in the lower level are concepts that the participants have mastered. In Fig. 2, the CHS for Student 9 reveals that the student did not master Concepts 1, 2, 4, and 5 but the student was familiar with Concepts 3, 6, and 7.

Concept Link Relationships:

The arrows in the CHS diagrams indicate the sequential relationship between pairs of concepts. In Fig.2, the CHS for Student 9 shows “Concept 3→Concept 1,” meaning that this participant has to learn Concept 3 before learning Concept 1. Similarly, Concepts 3, 6, and 7 all point to Concept 5, suggesting that if the participant wishes to master Concept 5, then he or she has to master Concepts 3, 6, and 7 first.

Application of Concept Advanced Interpretive Structural Modeling to Evaluating Learning Effectiveness in Adventure Education

Fig. 1 shows that the concept hierarchy of Student 9 comprises two levels: the students has to learn Concepts 3, 6, and 7 before learning Concepts 1, 2, 4, and 5. The concept hierarchy of Student 24 has four levels: the students has to learn Concept 7 before learning Concepts 3 and 4, and then he or she needs to learn Concepts 1, 2, and 6 before learning Concept 5. The concept hierarchy of Student 45 consisted of two levels: he or she has to learn Concepts 2 and 3 before learning Concepts 1, 4, 5, 6, and 7.

Fig. 1 reveals that the pretest CHS diagrams of the three students shared the following characteristics:

Among all conceptual elements in the hierarchical structures, Concept 5 (self-confidence) is a common element found in the top layer of the three participants' hierarchy diagram.

The link relationships shown on all of the participants' CHS diagram reveal that Concept 3 (achievement motivation) was linked to Concept 1 (time management) and Concept 5 (self-confidence).

In summary, the three participants did not master Concept 5 in their pretest. In terms of concept links, the participants have to learn the concept "achievement motivation" before learning "time management" and "self-confidence." The structure diagram shows that "achievement motivation" is a precondition for "time management" and "self-confidence."

Midtest CHS of Participants in the Top, Middle, and Bottom Sets

The CHS of three participants in the midtest were obtained by calculating their test answers through the CAISM program, as shown in Fig. 2.

Figure 2 reveals that the CHS diagrams of the three students comprised three layers. Student 9 in the top set must learn Concepts 2, 3, and 7 before learning Concepts 1 and 4, and then learn Concepts 5 and 6. Student 24 in the middle set must learn Concepts 1, 3, and 7 before learning Concepts 2, 4, and 6, and eventually Concept 5. Student 45 in the bottom set must learn Concept 3 before learning Concepts 2, 4, an 6, and then learning Concepts 1, 5, and 7.

Fig. 2 LEQ-Midtest CHS of the participants in the top, middle, and bottom sets

Figure 2 reveals that the midtest CHS diagrams of the three students shared the following characteristics:

Each of the concept hierarchy of three tested students comprised three layers.

In terms of shared elements among the three students, Concept 3 (achievement motivation) was located in the bottom layer of all concept hierarchies, whereas Concept 5 (self-confidence) was located in the top layer of all concept hierarchies.

The between-concept link relationships shown on the participants' CHS diagrams indicate that Concepts 4 (social leadership), 2 (emotional control), and 3 (achievement motivation) were linked to Concept 5 (self-confidence). Moreover, Concept 3 (achievement motivation) was linked to Concept 6 (active initiative).

In summary, the participants mastered Concept 3 (achievement motivation). They should learn the concept of self-confidence only after developing emotional control, achievement motivation, and social leadership. Furthermore, developing achievement motivation is a prerequisite for the participants to learn active initiative.

Posttest CHS Diagrams of the Participants in the Top, Middle, and Bottom Set

The CHS of three participants in the midtest were obtained by calculating their test answers through the CAISM program, as shown in Fig. 3.

Fig. 3 LEQ-Posttest CHS diagram of the participants in the top, middle, and bottom sets

Fig. 3 reveals that the CHS diagram of Student 9 comprises two layers: the student must learn Concepts 4 and 7 before learning Concepts 1, 2, 3, 5, and 6. The CHS diagram of Student 24 contained three layers: the student must learn Concepts 1, 3, 4, 6, and 7 before learning Concept 2, and then, learning Concept 5, whereas Student 45 must learn Concepts 1, 6, and 7 before learning Concepts 2, 3, 4, and 5.

The characteristics shared by these three students in their posttest CHS diagram are summarized and explained as follows:

The posttest hierarchies of students in the top and bottom sets have two layers, whereas that of the student in the middle set comprises three layers.

Application of Concept Advanced Interpretive Structural Modeling to Evaluating Learning Effectiveness in Adventure Education

In terms of shared elements, Concept 7 (contract value) was located in the bottom layer of all hierarchies, whereas Concept 7 (self-confidence) was located in the top layer.

The between-concept link relationships shown on the participants' CHS diagrams indicate that Concept 7 (contract value) was linked to Concepts 2 (emotional control) and 5 (self-confidence).

In summary, the three students mastered the concept of contract value in their posttest, suggesting that contract value is a prerequisite for developing other concepts.

Conclusion

A comprehensive data analysis shows that the participants exhibited the highest level of mastery in the concept "contract value". After completing the adventure course, the students mastered more concepts in the posttest than they did in the pretest and midtest, whereas most students demonstrated a low level of mastery in the concept "self-confidence" in their pretest, midtest, and posttest. The differences in the CHS diagrams of LEQ for various test stages are summarized as follow:

In terms of concept hierarchies, the CHS of the top- and bottom-set students comprised two layers in the pretest, whereas the CHS of the student in the middle set had four layers. In the midtest, the CHS of the three students presented two-layer hierarchies. Finally, in the posttest, the CHS of the top- and bottom-set students comprised two layers, whereas the CHS of the student in the middle set had three layers.

According to the CHS diagrams for the three test stages, although the concepts in the top layer differed, Concept 5 was located in the top layer in all three test stages, indicating that Concept 5 (self-confidence) was the most difficult concept to be mastered in all three test stages.

According to the CHS diagrams for the three test stages, the concepts in the bottom layer differed considerably. However, Concepts 3 and 7 were located in the bottom layer of the structure, indicating that the participants displayed the highest level of mastery in these two concepts.

Suggestions

Immediate Evaluation of Training Effectiveness

In this study, the effectiveness of the adventure training was evaluated at the end of the low-, medium-, and high-level activities. However, each level of activity was distinct in that the low-level activities comprised three types and six names, the medium-level activities comprised three types and six names, and the high-level activities comprised two types and four names. Therefore, the present study suggests that when a course is designed according to a series of adventure activities, the effectiveness of such course should be evaluated on the basis of either activity types or names to ensure accurate evaluation of training effectiveness.

In addition, to achieve efficient evaluations of training programs, the researcher of the present study will introduce the CAISM program as the core design into mobile devices for designing an application software. Thus, after completing an activity, the trainers and trainees could immediately access the numerical values and graphics of the generated CHS by the type or name of the activity. Trainers could then revise the course design, teaching model and grouping arrangements, and the trainees could examine their concept structure and distribution and know their ranking in terms of learning effectiveness.

Developing Indices and Question Items for Training Effectiveness Evaluation

Adventure education has been widely applied to various institutions, including elementary and secondary schools, universities, companies, the public sector, and non-profit organizations, as well as foundations and management consulting firms. However, when evaluating the effectiveness of adventure education, most institutions in Taiwan still adopt existing evaluation indices and question items, overlooking the need to adjust these indices according to participant characteristics. Therefore, the researchers of this study will develop multiple training effectiveness indices and items according to the type and name of adventure education courses as well as participant attributes, in order to appropriately evaluate the training effectiveness of these courses.

Combining Instructional System Design, Course Design, and Evaluation Model

The adventure education course used in this study was designed according to the study conducted by Tsai (2004). However, in response to a changing socio-economic environment and advancements in information technology, subsequent adventure education courses should be based on the Instructional System Design (analyze, design, develop, implement, and evaluate). Furthermore, course design (the objective and process models) and evaluation model (formative and summative evaluation) should be introduced at different stages to serve as the basis for improving adventure education courses.

Analyze:

This phase involves assessing participant needs, to identify the gap between the ideal and the reality, which is then used as the basis for setting the course content (the knowledge, skills, and attitude).

Design:

Specific learning objectives and content frameworks are developed on the basis of learners' needs and course content features, serving as the criteria for designing teaching materials, selecting teaching methods, and evaluating teaching effectiveness. When this stage is completed, a blueprint illustrating the entire process of course development is created.

Develop:

Teaching materials typically include teacher handbook, student handbook, teaching media, and instruments for evaluating learning effectiveness. Producing these materials often requires the assistance of external and media experts. Before the official launch of these materials, formative evaluation should be conducted to revise the inadequate areas.

Implement:

This phase refers to verifying and realizing the outcomes of the preceding three stages. Adequate teaching support is required to ensure successful implementation of teaching activities. In addition, teachers should be able to flexibly revise teaching

materials when unexpected events occur during the teaching process, thereby conforming to the concept of the process model.

Evaluate:

Summative evaluation of the teaching activity is performed at the end of the teaching process, thus providing a basis for improving future teaching activities.

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Application of Concept Advanced Interpretive Structural Modeling to Evaluating
Learning Effectiveness in Adventure Education

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Application of Concept Advanced Interpretive Structural Modeling to Evaluating
Learning Effectiveness in Adventure Education

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Table 1 Levels, types, objectives, names, and tasks of adventure activities and their corresponding effectiveness

Level	Type	Objective	Name	Task
Low-level	Introduction	Helping team members to get to know one another and build basic understanding of each other through simple and interesting activities and games.	Guess who I am?	Becoming acquainted with other members whom they met for the first time.
			Birds of a feather flock together	Encouraging active engagement of team members to acquaint other teammates.
Low-level	Ice-breaking	Helping team members to break the unfamiliarity and boundary with other members and create a positive atmosphere beneficial for the subsequent formation of cohesion among team members.	Small circles in large circles	Helping members to get to know other members and establish a cooperative partnership with them.
			Quick rabbit	Using exaggerated fun gestures to assist members in maintaining their concentration and actively interacting with others.
Low-level	Communication	Using activities or games to examine how trainees communicate with others, enabling them to reflect on their communication skills.	Rescuing Godzilla	This task requires communication among members, during which they observe what other members have said and their responses.
			Snowflakes	Practicing accurate communication skills to deliver the exact information they hear from others.
Medium-level	Cooperation	Using activities or games to examine the overall status of the trainees in the team, further determining whether a consensus can be reached through effective leadership and communication in the team, thereby enabling goals to be achieved.	Group rope jumping	Members are encouraged to help and cooperate with one another to complete the task.
			Cobweb	Members are encouraged to help and cooperate with one another to reach consensus and thereby complete the task.

Application of Concept Advanced Interpretive Structural Modeling to Evaluating
Learning Effectiveness in Adventure Education

Medium-level	Problem-solving	These activities are designed to examine whether trainees can solve problems and overcome difficulties by leveraging team spirit. Instead of individualism, these activities emphasize teamwork.	Incantation Seven	Members are required to communicate in developing strategies for completing the assigned task.
			Adventure Factory	Developing problem-solving abilities.
Medium-level	Trust	Activities and games are designed to examine the trust among team members. Through these activities, members can get to know each other and establish trust, thereby developing team solidarity.	Trusty Falls	Trainees are trained to trust their teammates.
			Communication Landmines	Members are encouraged to communicate and establish trust in other members.
High-level	Low ropes	Using low ropes to examine how members take responsibility for one another. Members are also taught to reflect on the activity process and create new values with which they can apply to future works and life.	Island-hopping Leaps	Developing a sense of responsibility in members during the activity, thereby encouraging them to protect their teammates.
			High walls	Building a sense of responsibility and trust among members.
High-level	High ropes	High ropes activities are designed to motivate trainees to willingly face challenges with a positive attitude, thus they can assimilate such attitude into their workplace and activities of daily living.	Vine Road	Challenging their courage and risk-bearing capability.
			High Single-Plank Bridge	Overcoming fear of height and developing trust in teammates.

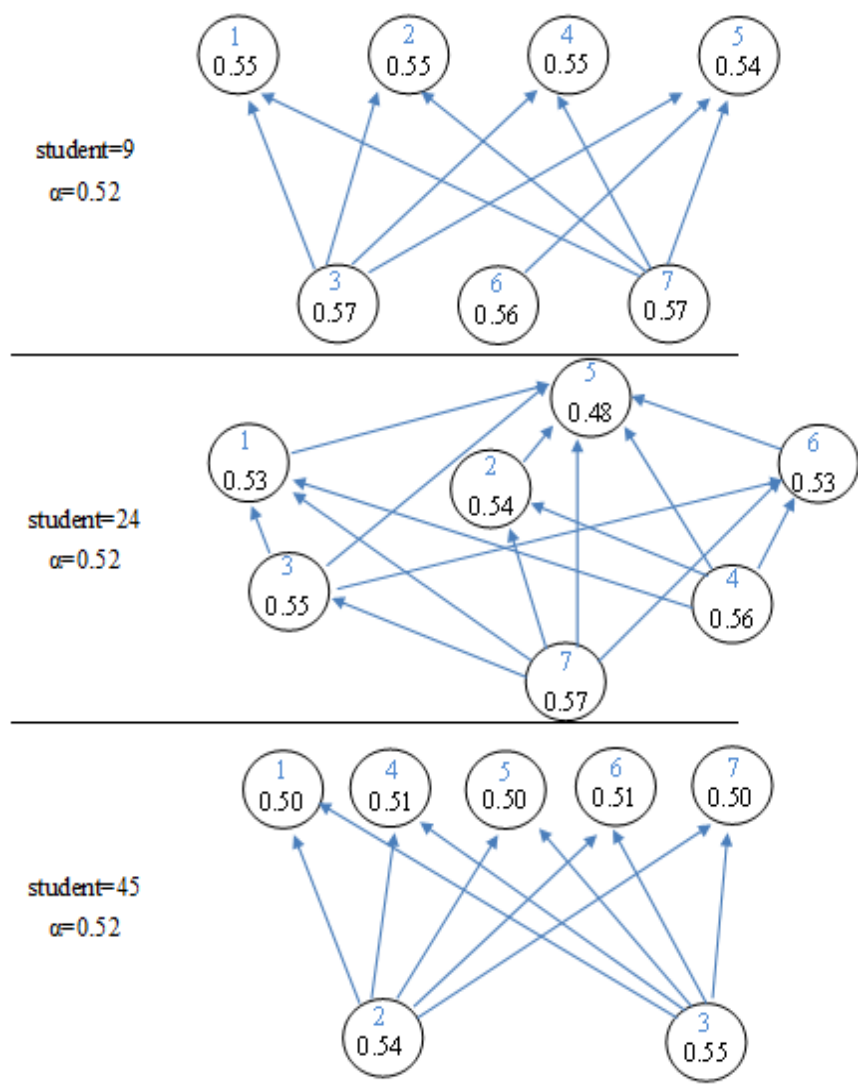


Fig. 1 LEQ-Pretest CHS of the participants

Application of Concept Advanced Interpretive Structural Modeling to Evaluating Learning Effectiveness in Adventure Education

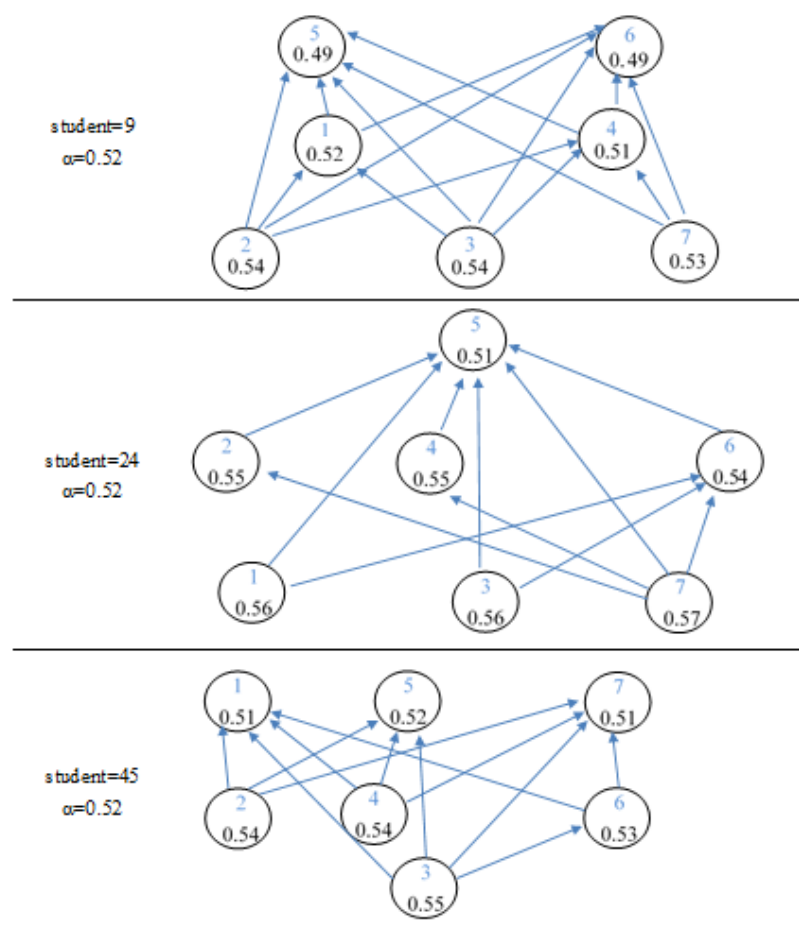


Fig. 2 LEQ-Midtest CHS of the participants in the top, middle, and bottom sets

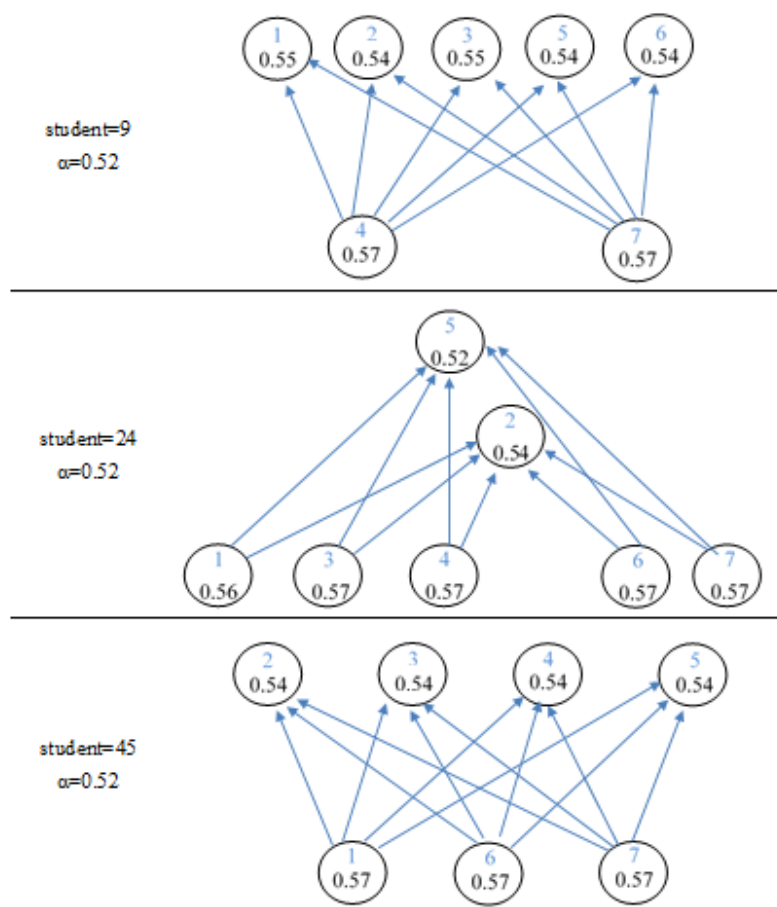


Fig. 3 LEQ-Posttest CHS diagram of the participants in the top, middle, and bottom sets

探索教育課程學習成效評估： 概念詮釋結構模式

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探索教育是在經驗學習圈的理論基礎下，透過一系列各種不同層次室內或戶外團體活動，發展各項團隊建立所需的技能。本研究旨在運用概念詮釋結構模式分析辨別探索教育參與者之學習概念階層及其遷移變化，以達到教育訓練成效衡量之個別化與建立教育訓練評鑑的新取向。依研究者整體資料分析顯示「契約價值」概念最為精熟，經探索教育後學生精熟概念數多於前測及中測，而不論在前、中或後測「自信心」概念普遍為不精熟。最後，研究者提出探索教育課程設計與教育訓練成效評估之實務建議。

關鍵詞：探索教育、學習成效、概念詮釋結構模式

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