IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 1 Issue 10, December 2014.
www.ijiset.com
ISSN 2348 – 7968

Promoting the Ability of Innovative Technology Using Q-technique

Wen-Chen Huang[1], Chi-Cheng Chang[2] and Yu-Hsuan Chang[3]

[1] Taipei Jingwen High School, Taiwan

[2] Department of Information Management, Lunghwa University of Science and Technology, Taiwan

[3] National Tainan Junior College of Nursing, Taiwan

Abstract

This study confirms the instructional effect of the Q-technique in enhancing the innovation ability of students, with research applying focus group and quasi-experimental methods. First, innovation ability was confirmed by experts to be a professional competency required by enterprises. Next, Q-technique instruction in the form of an experiment designed to increase students' innovativeness was performed. In the course of the experiment, it was determined that innovation ability is composed of eight components, and the Q-technique upgrades students' innovativeness. In application in practice, the Q-technique can result in integral learning in a systematic manner from the first creative stages till the realization of an innovative product in technology; and with this, a deficiency in the "process perspective" innovation instruction literature is supplemented. Its contribution is it demonstrates the Q-technique can be applied in innovative instruction and learning, valuable to the reform of innovation teaching.

Keywords: IT enterprise, professional competency, curriculum, Q-technique.

1. Introduction

How to reduce the difference between the innovation ability requirements of enterprises and the focus of innovation curricula is an important issue in employability (Støren&Aamodt, 2012). Through higher education, the difference between work requirements and the competencies of employees can be alleviated, reducing the frequency of a mismatch between job requirements and education results (Green et al, 2002). However, industry demand-oriented professional competencies must be an important basis for curriculum innovation. Therefore, through a continued innovation in curriculum, and successive focusing on professional competency requirements, the employability of students can be upgraded, and the education and service compliance of graduated students can be promoted (Li, Yen, & Cheng, 2008；Chang & Chang, 2011).

It has been pointed out in previous studies that innovation ability is one of the important indices of information employability (Chang, 2014). It already forms one of the important competencies required by contemporary IT enterprises (Ehrenmann&Warschat, 2013). By so-called innovation, we mean creativity plus market application (Ettlie, 2000). In other words, to upgrade innovation, although it is still required to trace the source of the inspiration in creativity, the creative result must be further marketised, to facilitate ideas that generate market value.Concerning the integration of the results of studies in the creativity literature, the approaches of several such studies can be summarised as oriented variously toward the influence perspective, the structure perspective, the process perspective and consequentialism (Chang, 2013).The influence perspective, as for example, in Piffer (2012) defines the relationship of creativity and products to be greater than the relationship of creativity to human beings. The structure perspective, for example, Gruys, Munshi, &Dewett (2011) think only with the novel and value generation can ideas or actions be considered to be provided with creativity. Studies following the process perspective concentrate on the application of brainstorming to generate ideas, procedures, actions or behaviourswith creativity (Drazin, et al., 1999). Consequentialism points out that the result of creativity is closely related to marketability (Duke & Mount, 1996). As the outcome of creativity is highly related to market demand, this conforms to the true implications of creativity as far as the requirements of industry and education are concerned. At the same time it points out two major problems which are encountered in the creativity study approach of the process perspective. The first problem is that in the past, the "process perspective" has concerned itself with the production process of creativity (Drazin, et al., 1999; Gomes, Kruglianskas, & Scherer，2011), but without any special attention to the systematic learning generated in the process from creation to marketization. The second problem is that the transition in technology is rapid, yet the cultivation of innovation ability is in lack of a learning method

ISSN 2348 – 7968

with high operability that fits the learner's technical life experience, and further inspires high performance increases in creativity by means of recognition, identification and change of creative thinking. In order to solve the aforementioned problems, it is necessary to find an effective learning method to aid the learner to attain a comprehensive learning ability that sustains him/her from the generation of ideas, through the results of innovation, to the end in the marketization process.

In order to attain the cultivation of this "innovation ability", the Q-technique is introduced in this study as the instruction method. The purpose of this study was to confirm the Q-technique's instructional effect in enhancing the students' innovation ability. The major difference between this and other studies is that it particularly emphasises recognition, identification and changes in creative thinking as key factors in technology product innovation. The contribution of the study is that the learning of the Q-technique method can improve the performance of students in the IT field in innovation. It verifies the Q-technique can be applied in innovative instruction, contributing reference value to the reform of innovation teaching.

2. Index in Innovation Ability

The requirement that the IT industry has of innovation ability, from the viewpoint of competency-based theory, is that its possessors be able to engage in innovative IT work that creates high added value (Chang & Chang, 2014). Under the guidance of this theory, creativity and expressed innovation have already become mandatory professional competencies of IT personnel (Baytiyeh, 2012). Concerning "innovation ability", this study follows the approach of the process perspective, applying the definitions provided by Amabile (1983). That is: creativity is considered to be an interaction of an individual within an internal system, or the performance of an individual in interaction with the external environment.

In order to explore innovation ability increases, confirmation of the priority of various factors in its composition shall be necessary (Chang, 2013). Ehrenmann and Warschat (2013) indicate that uncertainty, flexibility and adaptability are essential properties of innovation ability. Besemer&Treffinger (1981) conclude there are 14 indices on the basis of which to judge innovation, each separately classifiable into three categories: (1) novelty (originality, ingenuity, convertibility); (2) problem solving (adequacy, relevance, logicality, utility, and value); (3) elaboration and comprehensiveness (attractiveness, complexity, excellence, manifesting, system organization, tact). Chang (2014) points out the essential properties of innovation ability can be regarded to include eight items: (1) sensitivity to a problem, (2) organizational integration, (3) complexity, (4) originality, (5) flexibility (6) novelty (7) fluency and (8) creative impulse, among others. Piffer (2012) thinks creativity includes three dimensions, i.e., novelty, appropriateness and impact. Integrating the indices, definitions and topic distribution of innovation ability obtained from these studies, we arrive at the indices shown in the following Table 1.

Table 1. Operational definitions for the indices with innovation ability

Topic Distribution	Indices	Operational Definitions
A1-A5	(1) Market sensitivity	The sensitivity, while exploring an idea or object for fun, to its potential value in production.
B6-B9	(2)Organization integration	The organization's integration ability while performing comparisons, analysis, synthesization, and deductions and reaching conclusions on a product's content.
C10-C14	(3)Complexity	The ability to convert complex knowledge or technology and make it simple, logical and available for diversified applications.
D15-D19	(4)Originality	The ability to bring a product or service into being from nothing; or to transfer existing knowledge or technology into a new application field.
E20-E24	(5)Flexibility	The ability to possess an ingenious concept, to self-evolve learnt knowledge or technology, and apply it to a product or service.
F25-F29	(6)Novelty	A product or service's going beyond existing knowledge or technology application, and attracting the attention of a client.
G30-G34	(7)Fluency	The ability to rework existing knowledge or technology into a new concept, practice, or new product or service in a fluent manner.
H35-H37	(8)Creative impulse	The possession of a creative impulse and courage in innovating new things, with a sustaining creativity.

Resource: revised from Chang (2014).

ISSN 2348 – 7968

3. Q-technique

The Q-technique is a research method developed to study the subjectivity of human beings, often referred to as Q-method, Q-technique, or Q-sort (Barbosa et al., 1998). It can be characterised as a method by which a subject can, by means of his own pointed statements of opinion, define for himself his attitudes, and can be regarded to be a combination of qualitative and quantitative research methods (Dennis & Goldberg, 1996). The goal of applying Q-technique, after completing the construction of a Q population through brainstorming, is to select a Q sample through group discussions, and then order the statement sentences of the Q sample, to decide on the priority of the innovation content items.

4. Methodology

4.1 Focus Group method

Three separate focus group sessions were conducted. A total 24 experts in the industrial and academic fields were invited to participate in joint discussion and study; among them 18 came from ICT as junior and senior managers, and 6 were scholars. The objective of the meetings mainly was to confirm that "innovation ability" is one of the professional competencies required by IT enterprises, and the rationality of each index. Next, the aim was to revise the pre-test and post-test scales; review the rationality of the design of the instructional activities; and check the feasibility of an instruction/learning mode, etc.

4.2 Quasi-experimental

□*Design of an experiment*: Taking the senior students of the IT Management Department of a University of Science and Technology in Taiwan as the target, purposive sampling was used to assign 44 students each to the experimental group and to the baseline group. The experimental group received the "Q-technique instruction mode" (i.e., X1), and the baseline group received the "general instruction mode" (i.e., C), in the traditional lecture manner as the main instruction type as shown in Table 2. The same teaching material was used, to engage in instruction for a total 8 weeks, with 2 hours each week. Each class was divided into 9 teams, with 4-5 people in each team. An assignment was done in a group manner, and was handed in in fulfilment of class requirements.

Table 2. Design chart of the Quasi-experiment Research

Group attribute	Pre-test	Experiment treatment	Post-test
Experimental group	Y1	X1	Y2
Baseline group	Y1	C	Y2

Remarks: X1 refers to involvement in the experiment; C refers to the control treatment; Y1 refers to the pre-test scale; Y2 refers to the post-test scale.

□*Development of the Pre-test Scale and Post-test Scale:*Taking the content perspective of eight "innovation abilities" as its basis, a pre-test scale and post-test scale were prepared in accordance with the behavioural events method of Dessler (2007), to serve as evaluation tools in the instruction experiment. For each topic, the Likert Scale 5-point design (1=not important, 5=very important) was applied. The topic distribution of each index is shown in Table 3.

□*Data Analysis:*In the first stage, a covariance analysis was applied to assist in verification of the effect of experimental instruction. An attempt was made to check if the difference between the experimental group and baseline group reached a significant level. In the analysis, the pre-test scores before learning were taken as the covariate, with different instruction modes being the independent variable; while the post-test scores after learning were the dependent variable, determining the instruction effect of the Q-technique unit instruction. In the second stage, a factor analysis was conducted on the post-test results; the obtained Q factors represented a hypothesis attitude type (Lo, 1985). The objective was to use the characteristic value as a criterion measuring the strength/weakness of the attitude loaded on each topic factor, in order to understand to what extent the Q-technique innovation ability instruction promoted the level of each index of innovation ability, and to interpret how much the innovative ability of the learners changed.

□***Design of instruction activity***

Taking the "Application of the Q-technique in Innovation Ability Instruction" to be the instructional method or policy, the instruction was carried out in accordance with three principles, These principles were, (1) the cultivation of "innovation ability" shall serve as the instructional objective, (2) a group assignment topic shall be designed and implemented, and (3) appropriate instruction (including a pre-test and a post-test) shall be delivered. The instruction/learning objectives are shown in the following Table 3.

ISSN 2348 – 7968

Table 3. Instruction/Learning objectives of enhancing the innovation ability

Instruction Objectives	Learning Objectives
Students can demonstrate the innovation ability conforming to IT job site requirements, and are:	□Able to understand the theory, ingenuity technique and procedure of the Q-technique. □Able to seek for answers in accordance with the technique and procedure of the Q-technique, and demonstrate and report the results. □In a supportive environment, able to show more market sensitivity and fluency, and flexible thinking ability.

□***Instruction Design***

The design of the teacher/student activity is shown in Table 4.

Table 4. Design of Teacher/Student activity

Process	Teacher's actions	Students' actions
Instruction/ learning activity	(1).Explain the indices of innovation ability, and interpret the definition of each index (2).Describe the theory and procedure of the Q-technique	(1).Recognition activity (2).Understand the theory and procedure of the Q-technique
	(3).Prompt a problem-based assignment – the topic of the Q-technique group assignment (for example: 'Please refer to each brand of Smartphone, and App software in this list. In accordance with the Q-technique, specify the items with innovation content, and arrange them in order in accordance with their level of innovation.'	(3).Understand the problem and the quality requirements of the assignment
Development activity -- practice of the Q-technique	(4). Guide the writing of the statement sentences of each innovation item, and construct a Q population.	(4).(Individual students) Initiate concept development, writing one sentence for each card, to form the Q population.
	(5). Guide the ordering of Q-sort priority (6).Interpret Q sorting table, and conform to the principle of close to normal distribution.	(5). (Group discussion) Select the most representative 44 statement sentences, to form the Q population.
		(6). (Group discussion) Engage in flat ordering. Make the statement sentences follow the flat ordering of the balance principle with 17 positive, 17 negative, and 10 neutral comments, after weighing the statement sentence attribution positions of the Q sample, insert them in the 3-6-8-10-8-6-3 developed Q sorting table.
Synthetic activity	(7). In the workshop process, provide guidance, support and encouragement necessary in response to each group	(7). Display results and share
	(8). Evaluate and guide thinking	(8). Respond to teacher guidance and revision

5. Results & Discussion

5.1 The application of Q-technique with adequacy

The use of the Q-technique in the instruction of innovation ability is a full application of that method. Implementing the Q-technique, brainstorming is integrated in a similar manner to the way the KJ method for generating innovation uses brainstorming (Kunifuji& Kato, 2007), sharing the same principle as that method, though its expression is different.

During the instruction process, it is required, through participation in the activity practice, that active learning and conscious recognition of the "doing" process (Burton, Schlemer, &Vanasupa, 2012) take place. Substantially speaking, the difference of the Q-technique from traditional

ISSN 2348 – 7968

instruction mainly lies in its catalysing effect on identification by students of their ideas, and hence on promoting the generation of innovation. Through the recognition of innovation and the upgrading of the thinking ability of individuals, it incurs a change in creative thinking.The application of Q-technique to the instruction of innovation conforms to the perspective of Drazin, et al., (1999); Gomes, Kruglianskas, and Scherer (2011) concerning the role of process in creativity.

In addition, the application of Q-technique to the instruction of innovation conforms to the instructional concept of teaching scientific creation thinking (Burton, Schlemer, &Vanasupa, 2012), and the group dynamics principles addressed by Cole and Faota (2005). . In other words, it emphasises mutual knowledge sharing in a group discussion; it helps to break through personal thinking frameworks, change thinking habits, and further promote the generation of creativity.

5.2 Instruction effect of the Q-technique

Concerning the reliability and validity test of the test scale, itsContent Validity was investigated by submission in its draft form to experts, who checked if the scale content sufficiently reflected the substantial essence of innovation. Concerning the reliability of the scale, the overall Cronbach α was 0.958, while the Cronbach α of each topic ranged between 0.956~0.960, all indicating a high reliability. This shows there is a high accordance inside the topic respondents. Concerning the examination of homogeneity for the regression coefficients in each group, the result wasF=.307, p=.581>.05, failing to be significant, indicating the slopes of the regression lines of both groups to be the same, and conforming to the assumption of homogeneity of the regression coefficients in the covariate group. The covariance analysis was conducted continuously. Concerning the results of the Tests of Between-Subjects Effects, F value was 13.724; p <0.001.. This shows after eliminating the influence of the pre-test performance record, the treatment effect of the experiment is significant. That is, the learning performance record of the experimental group after applying the Q-technique instruction is significantly better than that of the baseline group. The result presented Q-technique can be applied in domain of innovation teaching.

Table 5. Tests of Between-Subjects Effects Dependent variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2.131[a]	2	1.066	8.381	.000
Intercept	16.307	1	16.307	128.255	.000
X	.605	1	.605	4.757	.032
A	1.745	1	1.745	13.724	.000
Error	10.808	85	.127		
Total	1127.717	88			
Corrected Total	12.939	87			

a. R Squared = .165 (Adjusted R Squared = .145)

5.3 Instruction is provided with a commendable result

Distribution of innovation indices

The distribution of the statement sentences conforms to the principle of a balance among the positive, negative and neutral opinions, following Brooks (1970). The result shows (Table 6): the statement sentences concerning complexity and fluency with three items on the positive side account for the maximum; next to it are two items each about market sensitivity, organizational integration, flexibility and novelty.

Table 6. Distribution of the statement sentences for the Q sample

Perspective	Topic Distribution			Topic Quantity (Topic No.)
	Positive	Neutral	Negative	
(1)Market sensibility	2	3	0	5(a1~a5)
(2)Organizational integration	2	1	3	6(b6~b11)
(3)Complexity	3	1	2	6(c12~c17)
(4)Originality	2	1	4	6(d18~d23
(5)Flexibility	2	0	4	6(e24~e29)
(6)Novelty	2	3	0	5(f30~f34)
(7)Fluency	3	0	2	5(g35~g39)
(8)Creative impulse	1	1	2	4(h40~h44)
	17	10	17	

ISSN 2348 – 7968

5.4 Priority ordering of indices of innovation ability

The 17 items distributed on the positive side are highly regarded, as shown in Fig. 1. These 17 items, with their associated innovation ability content, that is, the instructional units of innovation ability, and arranged in order from high to low, are: in the +3 group, (d19、c14、f30), in the +2 group, (f31、c13、g36、d22、g35、b10), and in the +1 group, (e29, h42, b11, e24, g39, a1, a5, c12). After a further analysis was conducted of the attribute indices of innovation ability, three items each, representing complexity and fluency respectively, acquired first place, with next to them two items each representing originality, novelty, market sensitivity, organizational integration, and flexibility. This result showed that the learner attained a comprehensive learning process from the generation of creative thinking to marketization, which in general confirms to the originally determined experimental instruction objective.

			b6.FB mashups a3.EasyCard combinations			
		e25. ConvenientBluetooth watch	a4. Electronic purse combinations	e29. GPS global positioning system combinations		
		d22. Remote control, allowing round-the-clock monitoring	cc15. Automatic photograph beautification	h42. QR-code function provision		
	d18. Key press digitalization	b7.Synchronization with network information	f32. High-resolution picture pixel upgrades	b11. Mobile phone doubling as remote control device	f31. Map inquiry app	
	h41. Convenient video telephone	g38 Waterproof function	h43. NFC wireless induction	e24. Wi-Fi sharing	c13. Encoded graphicalization	
	e26. Keyboard touch-orientation	g37. Child-friendly modes	f33. Electric torch	g39. Intelligence tag, upgrading services	g36. 3D control screen	
d20. Bluetooth MP3 watch	b8. News headline interceptionapp	c16 .Weather forecast function	f34. Projection keyboard	a1. Extremely convenient mobile phone online shopping	d22. Convenient monitor scale resizing checking	d19. Mobile name card
b9. Personalised magazine app	c17. High dynamic photographic range	h40. Eye scrolling performance upgrade	a2. Calorie calculating app	a5. Sound quality upgrade to improve audio enjoyment	g35. Webpage games popular in cell phones	c14. Music ringtone editing
d21. Wireless charging	e27. Projector functions on other devices	e28. Satellite navigation	d23. Horoscope fortune telling	c12. Finger print identification, for theft-proof functions	b10. Office file integration system	f30. Voice secretary SIRI
-3	-2	-1	0	+1	+2	+3

Fig. 1. Q-technique in enhancing the students' innovation ability

5.5 Q-technique in promoting innovation ability

The scales did not serve for the analysis of the covariance of learning effect only; the data obtained from the post-test scale also allowed interpretation of the factors obtained through the factor analysis (Barbosa et al., 1998). Bartlett's Test of Sphericity (Approx. Chi-Square) = 1118.992, df =435, p<.01, confirmed each perspective to be close to the normal multivariate; and the Kaiser-Meyer-Olkin Measure of Sampling Adequacy, KMO=.801 supported this result. Therefore, performing the factor analysis was justified.

So, the Principal Components Analysis was conducted, adopting the Varimax with Kaiser Normalization method. Six factors accumulated a total interpretation quantity of 76.047% as shown in Table 7. The six factors were renamed as: (1) Apply a method to generate ideas; (2) Analyse requirements to solve the problem; (3) Apply knowledge to create a new product; (4) Satisfy the demand and be active in innovation; (5) Be topic-oriented and propose innovation; (6) Be client-oriented and courageous in innovation. The result presented that Q-technique with high operability and linked to the learner's technological life experience can enhance creativity.

ISSN 2348 – 7968

Table 7. Relationship of the factors after rotation with each item

Items	Component					
	1	2	3	4	5	6
D17	.886	.171	.061	-.055	.234	.058
F25	.765	.062	.155	.364	.242	.044
D19	.740	-.059	.255	.201	.019	.218
E24	.719	.118	.382	.133	.107	-.007
D18	.662	.090	.376	.232	.276	.064
E22	.660	.107	.234	.277	-.059	.451
E21	.644	.071	-.003	.556	.086	.210
F27	.600	.268	.312	.421	.164	.084
B8	.096	.841	.120	.105	.271	-.011
C11	-.140	.754	.063	-.079	.041	.129
A2	.176	.747	.213	.094	.231	.088
B6	.365	.713	.028	.341	.110	.212
C10	.057	.697	.358	.121	-.074	.012
B7	.355	.621	.188	.180	.156	.218
G33	.205	.197	.840	.102	.170	-.042
F29	.234	.371	.633	.086	.059	.440
G32	.301	.323	.597	.233	.208	.206
G31	.387	.248	.595	.300	.174	.246
G34	.438	.204	.559	.503	.006	.154
G30	.290	.243	.513	.438	.385	.162
D15	.339	.370	.241	.689	.059	-.077
H35	.204	-.064	.379	.669	.223	.343
B9	.469	.315	.029	.526	.353	-.111
H37	.220	.177	.326	.486	.267	.482
A5	.191	.109	.014	.110	.878	.147
A4	.134	.362	.351	.147	.745	.039
C13	.432	.237	.358	.175	.552	.013
A1	-.053	.495	.054	.051	.010	.685
E20	.515	.079	.089	.049	.162	.682
H36	.143	-.014	.269	.503	.472	.509
Eigenvalue	14.152	3.048	1.605	1.580	1.369	1.061
Explained Variance	47.174	10.161	5.349	5.265	4.562	3.536
Cumulative Explained Variance	47.174	57.335	62.684	67.949	72.511	76.047

Rotation converged in 15 iterations.

5.6 Factor attitude

A further Factor Array with Z score was generated, to understand the factor attitudes of each respondent on each item (Barbosa, et al., 1997). The strength/weakness of the factor attitude of each item is judged taking the characteristic values as the basis, to understand the level to which each index of innovation ability has been promoted, by the instruction in innovation ability through the Q-technique. Among these figures, +3 indicates the highest promotion, as seen in Table 8.

ISSN 2348 – 7968

Table 8. Factor Attitude of each item of innovation ability

Item	Factor					
	1	2	3	4	5	6
D17	+3	+1	0	0	+1	0
F25	+3	0	+1	+2	+1	0
D19	+3	-1	+1	+1	0	+1
E24	+3	+1	+2	+1	0	0
D18	+2	0	+2	+1	+1	0
E22	+2	+1	+1	+1	0	+2
E21	+2	-1	0	+2	0	+1
F27	+2	+1	+2	+2	+1	0
B8	0	+3	+1	+1	+1	0
C11	-1	+3	0	0	0	+1
A2	+1	+3	+1	0	+1	0
B6	+2	+3	+1	0	0	0
C10	0	+2	+1	+1	+1	+1
B7	+2	+2	+1	+1	+1	+1
G33	+1	+1	+3	0	0	-1
F29	+1	+1	+2	0	0	+1
G32	+1	+1	+2	+1	+1	+1
G31	+1	+1	+2	+1	0	+1
G34	+1	+1	+2	+2	0	+1
G30	+1	+1	+2	+1	+1	0
D15	+1	+1	+1	+2	0	-1
H35	+1	0	+1	+2	+1	+1
B9	+1	+1	0	+2	+1	-1
H37	+1	0	+1	+2	+1	+2
A5	0	0	0	0	+3	0
A4	0	+1	+1	0	+3	0
C13	+1	+1	+1	+1	+2	0
A1	0	+1	0	0	0	+2
E20	+2	0	0	0	+1	+2
H36	0	0	+1	+2	+2	+2

6. Conclusions

“Innovation ability” is one of the most important professional competencies required in the IT industry. Therefore, this study sought to determine how it could be better taught, adopting the “process perspective” as its approach. In the first stage, through literature review and focus group expert consultations, eight indices, namely, market sensitivity, organizational integration, complexity, originality, flexibility, novelty, fluency, and creative impulse, which together allowed a precise determination of innovation ability, were obtained. By means of the pre-test and post-test scales as they stood at the completion of development, the instruction and learning effect could be effectively verified for each index.

In the second stage, the quasi-experimental research method was selected in an instruction experiment to see to what extent the Q-technique could enhance creativity instruction in the area of “innovation ability”. Systematic learning over the range of the creative process from the generation of innovative ideas to marketization is of particular concern to the IT industry. The experiment showed the instruction effect to be significant, verifying that the Q-technique is applicable to innovative instruction in the field. The Q-technique can cultivate capability most successfully in the complexity and fluency indices, followed by market sensitivity, organizational integration, flexibility, and novelty. As for originality and the creative impulse, it failed to attain the level of significance in these indices.

Concerning the factor attitude results of the third stage, the post-test scale analysis revealed six factors: the application of methods to generate ideas, the analysis of requirements in problem solving, theapplication of knowledge in developing an innovative product, the satisfaction of the requirements of active innovation, a topic orientation in proposing ideas, and a customer orientation in innovation risk. The ideas represented by each factor may serve as the reference basis for

ISSN 2348 – 7968

a further reform of innovative teaching.

In the aspect of practical application of the research result, the indices of innovation ability can be applicable to design the creation curriculum. The pre-test and post-test scales can serve as the tools of measuring the expression of innovation ability. The Q-technique fit the learner's technological life, promotes their output in innovation. It can solve the complete learning problem dealing with the systematic process from creative thinking to innovative products, and compensate the deficiency of creativity literature of the "process perspective".

In the area of study limitations, the period of the unit instruction experiment was merely 8 weeks, and confirmation of the clear and longer term contribution of the Q-technique to a "process perspective" can only await further experimental verification. In respect of future work, verification studies of changes in the mental models of students by means of the Q-technique could be extended to include instruction in other professional fields than information technology.

References

Amabile, T.M. (1983). *The social psychology of creativity*. New York: Springer-Verlag Inc.

Barbosa, J.C., Willoughby, P., Rosenberg, C.A., & Mrtek, R.G. (1998). Statistical methodology: VII. Q-Methodology, a structural analytic approach to medical subjectivity. *Academic Emergency Medicine*, *5*(10), pp. 1032-1040.

Besemer, S.P., & Treffinger, D.J. (1981). Analysis of Creativity. In C.W. Taylor (ed.). *Creativity: Progress and potential*. New York: McGraw-Hill.

Brooks, W.D. (1970). Q-sort technique. In P. Emmert and W. D. Brooks (eds.), *Methods of research in communication*, Boston: Houghton Mifflin Co.

Burton, R., Schlemer, L., & Vanasupa, L. (2012). Transformational innovation: Reflections on how to foster it in engineering education systems. *International Journal of Engineering Education*, *28*(2), pp. 275-285.

Chang, C.C. (2013). Improving employment services management using IPA technique. *Expert Systems with Applications*, *40*, pp. 6948–6954.

Chang, C.C. (2014). An IPA-embedded model for evaluating creativity curricula. *Innovations in Education and Teaching International*, *51*(1), pp. 59-71.

Chang, M.H., & Chang, C.C. (2011). Developmental model of strategic alliance for technological education. *International Journal of Engineering Education*, *27*(1), pp. 91-100.

Cole, M.B., & Faota, M.O. (2005). *Group dynamics-in occupational therapy(3rd Edi.)*. NJ: SLACK Incorporated, U.S.A.

Drazin, R., Glynn, M.A., & Kazanjian, R.K. (1999). Multilevel theorizing about creativity in organizations: A sensemaking perspectives. *Academy of Management Review*, *24*, pp. 286–307.

Duke, C.R., & Mount, A.S. (1996). Rediscovering performance-importance analysis of products. *Journal of Product & Brand Management*, *5*(2), pp. 43-54.

Ehrenmann, S., & Warschat, J. (2013). Diversity in the early phases of product development. *International Journal of Industrial Engineering and Management*, *4*(1), pp. 19-26

Ettlie, J.E. (2000). *Managing technological innovation*. John Wiley & Sons, Inc., U.S.A.

Green, F., McIntosh, S., & Vignoles, A. (2002). The utilization of education & skills: Evidence from Britain. *The Manchester School*, *70*(6), pp. 792-811.

Gruys, M.L., Munshi, N.V., & Dewett, T.C. (2011). When antecedents diverge: Exploring novelty and value as dimensions of creativity. *Thinking Skills and Creativity*, *6*, pp. 132-137.

Kunifuji, S., & Kato, N. (2007). Consensus-making support systems dedicated to creative problem solving. *International Journal of Information Technology and Decision Making*, *6*(3), pp. 459-474.

Li, E.Y., Yen, H.J.R., & Cheng, C.Y.J. (2008). A fit-gap analysis of e-business curricula and job demand in Taiwan and the US. *Computers & Education*, *51*, pp. 969-987.

Lo, V.H. (1985). *Scientific method as a journalistic tool: A Q methodological study*. Unpublished Ph.D. dissertation, University of Missouri-Columbia.

Piffer, D. (2012). Can creativity be measured? An attempt to clarify the notion of creativity and general directions for future research. *Thinking Skills and Creativity*, *7*, pp. 258-264.

Støren, L.A., & Aamodt, P.O. (2012). The quality of higher education and employability of graduates. *Quality in Higher Education*, *16*(3), pp. 297-313.

Treffinger, D.J. (1980). *Encouraging creative learning for the gifted and talented*. Ventura, CA: Ventura County School/LTI.