A Study of Increase the Critical Thinking and Problem Solving Abilities by Web-based Instruction

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Abstract: - The purpose of this study is to understand the experimental effects of web-based critical thinking instruction program for promoting students’ abilities. The methodology is experiment instruction with two tools: “The test of critical thinking skills for k-9 students” and “The test of problem-solving abilities for primary school students”. It found that students’ critical thinking and problem-solving abilities has been promoted after performing web-based critical thinking instruction. The results can be given reference for teachers to innovative instruction and performance in web-based instruction.

Key-Words: - Web-based Instruction, Critical Thinking Instruction, Problem-solving Abilities

1 Foreword

It’s an important development trend of today’s educational technology to integrate information into instruction. Owing to the fast improvement of www, communication technology, computer technology and software and technology, it can be foreseen that information technology must be the initial element of present education and instruction [21]. There are also various studies on the possibilities of web-based instruction. Jian-Sheng Ro [10] indicated that there are four features of web-based instruction including sharing, interaction, advancement and globalization.

However, according to the quantitative analysis on 436 worldwide instruction websites by Mioduser, Machmias, Lahav and Oren [14], there are 52.5% of websites inspiring the learners’ cognition processes by information acquisition, 42% by mechanical learning, 32.6% by analyzing and reasoning, and only 5% involving the problem-solving and project decision.

Among the thinking abilities, critical thinking and creative one are most popular [22]. The two abilities always complement each other in our daily life. Besides, criticizing and creative thinking are necessary prior abilities for problem-solving [12] [24]. From Hambermas’s theory of democracy, there are two priorities reaching a consensus by debate. First, those who attend the debate must be reasonable enough to communicate and judge the reality, legitimacy, and sincerity. Second, 「an ideal talking situation」 [23]. This mold of discovery and participation allows students to be the master of learning, encourages them to develop the thinking ability, creativity, and builds up their values and worldview [7] [27].

2 Literature Review

2.1 Meaning and Features of Critical Thinking Instruction

Critical thinking is a high level of cognitive ability. According to Ennis [17], critical thinking is to 「decide what to be believed or to be the focused
reflective and reasonable thinking. In view of problem-solving, critical thinking is an intellectual activity of choosing proper hypotheses or answers[12][2]. Norris and Ennis [17] argued that critical thinking can be regarded as a part of problem-solving process generally. In the intension of critical thinking argued by Norris & Ennis (Fig.1), critical thinking background, knowledge, ability and tendency are initial conditions to critical thinking. The establishment of democratic and legal society relies on citizens’ judging ability. If they are asked for objective and correct judgement, there must be a critical thinking instruction since they were little.[25].

The 「 Provisional Schema of Grade 1-9 Integrated Curriculum (first step)」 by the Ministry of Education stresses the cultivation of ten basic abilities from seven fields for students to apply in their future life. Among them, 「 independent thinking and problem-solving ability 」 are to cultivate students with independent thinking ability and reflection habits, and hope that they can judge and solve problems as well as conflicts systematically. Which means that students have to be equipped with abilities of problem-solving, critical thinking and make reasonable decision?

A. Classroom situation and class atmosphere.
   1. Be safe and warm, encouraged expression.
   2. Debate on dialogue, multiple interaction.
   3. Mistake allowance, respect to others.
   4. Detect prejudice, avoid arbitrary conclusion.
B. Peers’ interaction
   1. Cooperative learning and social construction.
   2. Brave query and interactive debates.
C. Roles of teacher-student
   A proper instruction and training to students in active and safe situation will promote students’ critical thinking ability. Therefore, while there is critical thinking instruction, teachers have to play the role of guide for learning and offering students learning scaffolding properly for their active self-organizing and learning[11][7].
D. Instruction contents
   It’s an important feature to link the context of instruction contents among critical thinking instruction. Besides the proper situation context, students have to be taught to develop the thinking process from being contextualized to de-contextualized.

2.2 Critical Thinking Instruction and Problem-solving

A. Encountering problems: confusion or difficulty created on emotional cognizing of things.
B. Defining problems: distinguishing the problems from confused situation.
C. Developing assumptions: advancing possible proposals of solving problems according to the situation of problems.
D. Verifying assumptions: verifying the possible proposals step by step is to see if they are available.
E. Application: Applying the proposals to real situation for solving problems.

Regarding to the problem-solving instruction, Kuo, Yo-Yu [28] argued that its design of problem situation is based on teaching materials to make students have queries and discover answers to develop ability of problem-solving. Fang, Chong-Xiong [1] assumed that problem-solving instruction is to use problem-solving mold to develop a learning report and integrate the problem-solving steps into teaching activities.

2.3 Features of World Wide Web

World Wide Web originated from U.S.A. in 1980. It connects different websites to form a global channel for information conveying and offer information service. The services are e-mail, file request, remote access and e-bulletin board [29]. Hypermedia is one of the features of www. It derived from Hypertext and is a non-sequential data management. It saves the data in the nodes of web and connects them by linking. The different types of nodes and links can form diversiform information construction, and display the intended subjects [16].

Another feature of www is the connection of network. The development of net construction is
from a data communication of peer-to-peer to a computer local area networks (LAN), and then becomes a connection of metropolitan area networks (MAN) and wide area networks (WAN) [9]. WWW adopts Client-Server Architecture and the browser of application end, such as Nescape that can be executed on different terminals, and the server is operated on remote machine.

3 Methodology

3.1 Study Tools
A. Teaching website of critical thinking mold.

PHP-Nuke [19] is a free software. It can be used to set up an instructional website and manage easily. Hopefully, the limit of time and classroom can be disappeared with the assistance of educational technology, and students can have adequate thinking, criticizing, and reflecting, and reach the effect of learning.

B. Test of Critical Thinking Skills for Primary and Secondary School Students

This study adopts 「Test of Critical Thinking Skills for Primary and Secondary School Students」[30]to test students’ ability of critical thinking through web-based instruction. There are five sub-skills in the test: 1. verifying assumption (hypothesis), 2. inference, 3. deduction, 4. illustration and 5. evaluation. That means there are five sub-scales with 24 questions. Five questions are from part one to part four (Q.1-20), and have three options for each question. Question 21-24 of part five have two options. There are 25 minutes limitation for secondary school students and 30 minutes for primary ones. When index of difficulty is .37~.87, the average is .66; when index of discrimination is .25~.71, the average is .46. This test is edited with appropriate questions and discrimination. Its Alpha coefficient is .80, which is higher than pilot-test scale. The Alpha coefficients of the five sub-scales 「verifying hypothesis」, 「inference」, 「deduction」, 「illustration」 and 「evaluation」 are .27, .46, .60, .43, and .54 (N=277). The five coefficients are higher than those on pilot-test scales except the one for 「deduction」. There is a high correlation between the general scale and sub-scales, its correlation coefficient is .630~.790, reaching a remarkable level of .001. There is a moderate correlation between the five scales and its coefficient is .313~.540, which also reaches a remarkable level of .001 (N=277).

C. Test of Problem Solving Ability for Primary School Students.

There are four main questions in the questionnaire [20], and five sub-questions with each main question. Pretest and posttest are held for this test. The first and second main questions belong to pretest, the third and fourth ones belong to posttest. The two tests are replicated and the correlation of their reliability tests reaches a remarkable level of .01. The correlation for general test is .482, and .473, .479, .501, .486 and .481 for sub-tests. Besides, the Cronbach value of internal consistency for pretest is .706, .676 for posttest, and .784 for the whole test. Regarding to the construct validity, the correlation of internal consistency is .531~.876 which reaches the remarkable level of .01.

3.2 Objectives for the Study

The objectives of this study are the fifth grade students of Zhen-Bei Primary School in Kaohsiung County, and examples of two classes are chosen randomly. One class is assigned as the experimental group for web-based instruction on critical thinking, another one is the controlled group for traditional instruction on critical thinking. There are 20 students for each group and the total number is 40.

3.3 Experiment Design

Quasi-experimental design is adopted in this study and shown as table 1.

<table>
<thead>
<tr>
<th>Group</th>
<th>Pretest</th>
<th>Experimental treatment</th>
<th>Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tested</td>
<td>O₁</td>
<td>X₁</td>
<td>O₂</td>
</tr>
<tr>
<td>Controlled</td>
<td>O₂</td>
<td>X₂</td>
<td>O₄</td>
</tr>
</tbody>
</table>

O₁, O₂: Experimental and Controlled groups take tests of 「Scale on Critical Thinking」 and 「Test of Problem Solving Ability for Primary School Students」 (pretest).

X₁: Experimental group takes the test of web-based instruction on critical thinking for five weeks.
X2: Controlled group takes the traditional instruction on critical thinking for five weeks.
O2, O4: Two groups take tests of 「Scale on Critical Thinking」 and 「Test of Problem Solving Ability for Primary School Students」 ( posttest )

4 Results and Discussion
4.1 About 「Critical Thinking Ability」
It can be found from the F value on table 2 about the 「Test of Critical Thinking Skills for Primary and Secondary School Students」 showing that the difference of the two groups is remarkable (F=4.939, p<.05). From the adjusting mean of table 3, the total scores (12.24) of students of experimental group on test of critical thinking skills is better than students of controlled one (10.36). Thus, it can be argued that the critical thinking ability of students of experimental group gets great promotion after the teaching test.

Table 2. Analysis of covariance for 「Test of Critical Thinking Skills for Primary and Secondary School Students」

<table>
<thead>
<tr>
<th>Variance origin</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between groups</td>
<td>35.133</td>
<td>1</td>
<td>35.133</td>
<td>4.939</td>
<td>.032*</td>
</tr>
<tr>
<td>(teaching Project)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>in the groups (deviation)</td>
<td>263.183</td>
<td>37</td>
<td>7.113</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3. The mean and standard deviation for 「Test of Critical Thinking Skills for Primary and Secondary School Students」

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tested</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pretest</td>
<td>20</td>
<td>11.95</td>
<td>2.33</td>
</tr>
<tr>
<td>posttest</td>
<td>20</td>
<td>12.15</td>
<td>3.67</td>
</tr>
<tr>
<td>adjusting mean</td>
<td>12.24</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Controlled</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pretest</td>
<td>20</td>
<td>12.15</td>
<td>3.10</td>
</tr>
<tr>
<td>posttest</td>
<td>20</td>
<td>10.45</td>
<td>3.46</td>
</tr>
<tr>
<td>adjusting mean</td>
<td>10.36</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4.2 About 「Problem-solving Ability」
It found from table 4 that the F value for total scores on the 「Test of Problem Solving Ability for Primary School Students」 showing a remarkable difference between the two groups (F=4.418, p<.05). From the adjusting mean of table 5, the total scores (15.30) of students of experimental group on test of problem-solving ability is better than students of controlled one (12.40). Thus, it can be argued that the problem-solving ability of students of experimental group gets great promotion after the teaching test.

Table 4. Analysis of covariance for 「Test of Problem Solving Ability for Primary School Students」

<table>
<thead>
<tr>
<th>Variance origin</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>between groups</td>
<td>80.242</td>
<td>1</td>
<td>80.242</td>
<td>4.418</td>
<td>.042*</td>
</tr>
<tr>
<td>(teaching project)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>in the groups (deviation)</td>
<td>671.968</td>
<td>37</td>
<td>18.161</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5. The mean and standard deviation for 「Test of Problem Solving Ability for Primary School Students」

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tested</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pretest</td>
<td>20</td>
<td>11.60</td>
<td>4.61</td>
</tr>
<tr>
<td>posttest</td>
<td>20</td>
<td>11.85</td>
<td>5.09</td>
</tr>
<tr>
<td>adjusting mean</td>
<td>12.40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Controlled</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pretest</td>
<td>20</td>
<td>11.85</td>
<td>4.79</td>
</tr>
<tr>
<td>posttest</td>
<td>20</td>
<td>11.85</td>
<td>5.09</td>
</tr>
<tr>
<td>adjusting mean</td>
<td>15.30</td>
<td></td>
<td></td>
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</tbody>
</table>

5 Conclusion
According to above-mentioned experiment, the conclusion is: 「The practice of web-based instruction on critical thinking promotes effectively students’ abilities on critical thinking and problem-solving」. Moreover, it founds that there are features of unlimited time and classroom for web-based instruction. Students can use more time to have interactive discussion on line under the
limited time, and make the activity more smoothly. Because people can be anonymous on line, some introverted students can express their ideas and thoughts with fearless on line and practice their critical thinking.

Therefore, we have some suggestions for educational purpose and later studies according to the literature review. [a] To develop multiple teaching programs on critical thinking,[b] There are differences from web-based instruction on critical thinking because of the courses, study time and objectives.[c] The qualitative study can be tried to discuss on students’ ability development of critical thinking and problem-solving.

References:


[29] Yu-Ching Lee, Research of Instructional Design Model for the Web-based Natural Science Education. Department of Informatics, Yuan Ze University, 2000.