The Effects of Integrated Information Literacy in Science Curriculum on Students’ Memory and Comprehension

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Abstract: The purpose of this study was to investigate the effects of integrated information literacy in first-grade science curriculum on students’ science learning. In this quasi-experimental study, two first-grade classrooms from a public elementary school were randomly assigned into the experimental group and control group. The former accepted an inquiry-based science curriculum infused information literacy using the Super3 model, while the latter accepted the traditional lecture-typed instruction. Two tests were designed to test student’s memory and comprehension. Results from the analyses of covariance showed that the experimental group significantly outperformed their counterparts on two measures of science learning. It was suggested that information literacy integration could have a positive impact on first-graders’ science learning.

Introduction

Since the concept of information literacy was introduced in 1970s, it has been promoted by numerous countries around the world. United Nations Educational, Scientific and Cultural Organization (UNESCO, 2007) even suggests every nation should develop information literacy initiatives in the four key domains of education, health, business, as well as citizenship, so that their citizens can perform competitively and productively in a 21st century global information society. In other words, information literacy is considered as the important basis for lifelong learning in the age of knowledge-based economy.

Information literacy is the abilities to recognize, locate, evaluate, use and create effectively the need information (AASL & AECT, 1998; Andretta, 2005). There is a large body of studies on information literacy finding that information literacy education should be integrated across the contexts of school curriculum, through inquiry-based or problem solving learning (Chen & Horng, 2004, 2005; Eisenberg, Lower & Spitzer, 2004; Kuhlthau, Maniotes & Caspari, 2007; Rockman, 2004). The Super3 model, designed by Eisenberg and Robinson (2007), is one of the models used by practitioners and researchers for integrating information literacy into curriculum for young learners (Lowery, 2005; Wolf, 2003). This model provides a framework for young children (K-2) to learn how to complete a task or make a decision. The Super3 has three phases: Plan, Do and Review. In the Plan phase, students figure out what they are supposed to do and to develop a plan of how to accomplish that task. In the Do phase, students complete the various activities, including finding the needy sources, reading or viewing the information in the sources, and putting it all together as a finished assignment.
In the final Review phase, students self-assess and reflect on their performance during the whole process in order to improve on future assignment.

According to the National Science Education Standards (NRC, 1996), inquiry was an important teaching method in science. It involves various classroom activities, such as posing questions, making observations, examining books and other sources of information, analyzing data, and communicating the results. Audet & Jordan (2005) stressed that teachers should lead students to ask questions and make discoveries in search for new understanding of science. Cowan and Cipriani (2009) even introduced their first-graders into scientific inquiry through an arts-integrated, pattern-searching approach to build a deeper understanding of science content and processes. In fact, the scientific inquiry is congruent to the concept of information literacy, because they both emphasize the reasoning and critical thinking. Therefore, we may integrate information literacy into science curriculum through inquiry-based strategy to improve students’ learning.

National Research Council (2000) underscored that student understanding of inquiry could not develop in isolation from science subject matter. In other words, scientific knowledge still remained important. Several meta-analyses showed that inquiry-based teaching produced positive results on cognitive achievement, process skills, and attitudes toward science (Bredderman, 1982; Hurd, 1998; Shymansky, Hedges & Woodworth, 1990; Weinstein, Boulanger & Walbergs, 1982). Haury (1993) reviewed many related studies and concluded that inquiry-oriented teaching could result in outcomes that included scientific literacy, familiarity with science processes, vocabulary knowledge, conceptual understanding, critical thinking, and positive attitudes toward science.

However, Chang and Mao (1998) investigated the effects of an inquiry-based teaching in earth science and found that significant higher achievement scores only at the comprehensive test, not at the factual level. National Research Council (2000) also claimed that inquiry-based teaching may not be appropriate for the goal which was for students to memorize information. Furthermore, the roots of both inquiry-based teaching and problem-based learning can be traced to the progressive movement, especially to John Dewey’s belief (Audet & Jordan, 2005; Delisle, 1997). Then, similar research results were also found in the problem-based learning. Reviewing problem-based learning research from the past 30 years, Hung, Jonassen and Liu (2008) concluded that PBL curricula resulted better knowledge application and clinical reasoning skills, but performed less well in basic or factual knowledge acquisition than traditional curriculum.

In summary, for lack of thorough and conclusive empirical evidence concerning effects of inquiry-based integrated information literacy in science curriculum on students’ science learning, teachers usually rely on their intuition in deciding how to teach science. Therefore, it is evident that there is need to further investigate this issue.
Research Questions

The purpose of this study was to investigate the effect of integrated information literacy in first-grade science curriculum on students’ science learning. Specific problems related to the purpose were as follows:

1. Does the integrated information literacy curriculum have an effect on students’ ability to memorize the science content associated with the topic?
2. Does the integrated information literacy curriculum have an effect on students’ ability to comprehend the science content associated with the topic?

Methods

Participants

Participants for the study consisted of two first-grade classes from a public elementary school in an urban area of Taiwan. Each class had 32 students and gender was equally distributed. They all were average students.

Instructional Content

The instructional content for this study was the unit of Exploring Insects in Our School, based on the first-grade science textbook (Kang Hsuan, 2008). An inquiry-based science curriculum infused information literacy was delivered to the experimental group. It was designed according to the Super3 model. First, the science teacher motivated students to inquire various insects found in the school using books and videos, so that they could pose at least three questions relating to the insect selected for inquiring. The teacher clearly stated the criteria for the task and provided examples of different levels. It was the Plan stage based on the Super3 model. Then, in the stage of Do, under the teacher’s guidance, students tried to find the answers to the questions through using books, videos, and observing real insects in the school. Then, they put all of the information from the different sources into a poster and presented to their peers. Finally, they reviewed their own performance during the process and wrote down their reflection in their journals. It was the Review stage. However, if students could not find suitable answers to the questions, or read some information more interesting, they could always go back to the Plan phase to change their questions. In other words, the Super3 process was not linear or in a restrictive order. In the whole learning process, the teacher’s role was as a guide on the side-lines who encouraged students and provided support in poster preparation and oral presentations.

On the other hand, the control group was exposed to the traditional method on the same content used for the experimental group. The traditional method was teacher-centered and lecture oriented. The teacher provided the students with clear and detailed explanation, but did not ask students to raise questions, nor need to find answers through reading, viewing, and observing. The classroom activities mostly focused on memorizing the factual knowledge about insects.
This unit in both experimental and control groups was taught by the same teacher around three weeks, 7 periods of time per week. Each period of time was 40 minutes.

**Research Instruments**

There were two instruments used in this study. They were memory test and comprehension test. The former (Cronbach’s $\alpha = .721$) was designed to test students’ memory of content which was taught in the instruction. There were 20 multiple-choice items in the test. The comprehension test (Cronbach’s $\alpha = .838$) was composed of 14 constructed-response questions which assessed students’ observation ability, in-depth reasoning and application of underlying concept in novel situations. It required students to write their own answers. Some items required short answers while others demanded to circle the differences in two pictures of insects. In scoring the comprehension test, correct answers to the questions were worth one to five points. Thus, the total number of score points available for analyses (23 points) exceeds the number of items in the assessment.

**Procedure**

Two first-grade classrooms from a public elementary school were selected and randomly assigned to the experimental group and control group. Then they received two pretests (memory and comprehension tests) to determine their prior knowledge level in the instructional content. Next, the experimental group accepted an inquiry-based science curriculum infused information literacy using the Super3 model, while the control group accepted the traditional instruction. The instruction lasted for three weeks and was taught by the same teacher. Upon the completion of the instruction, both groups received two posttests (the same memory and comprehension tests).

**Data Analysis**

The data was analyzed using an analysis of covariance (ANCOVA) on posttest scores with the pretest as the covariate to determine any significant differences between the experimental group and the control group.

**Results**

**Analysis of Memory Test Results**

The memory test means, standard deviations and adjusted mean were presented in Table 1. Summary ANCOVA statistics were shown in Table 2. As shown in Table 2, the obtained F ratio was significant ($F= 69.747$, $p< 0.05$). The inquiry-based science curriculum infused information literacy can improve first-grader’s memory achievement than the traditional lecture-led method.
Table 1: Pretest Mean, Posttest Mean, Adjusted Mean in Memory Test

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Pretest</th>
<th></th>
<th></th>
<th>Posttest</th>
<th></th>
<th></th>
<th>Adjusted M</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
<td></td>
<td></td>
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<tr>
<td>Experiment Group</td>
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<td>18.762</td>
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<tr>
<td>Control Group</td>
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<td>2.285</td>
<td>14.675</td>
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Table 2: Summary of Analysis of Covariance in Memory Test

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
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<td>140.868</td>
<td>69.747</td>
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<tr>
<td>Error</td>
<td>123.201</td>
<td>61</td>
<td>2.020</td>
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</tr>
</tbody>
</table>

* $\alpha=0.05$

Analysis of Comprehension Test Results

The comprehension test means, standard deviations and adjusted mean were presented in Table 3. Summary ANCOVA statistics were shown in Table 4. As shown in Table 4, the obtained F ratio was significant (F=49.982, $p<0.05$). The inquiry-based science curriculum infused information literacy can improve first-grader’s comprehension achievement than the traditional lecture-led method.

Table 3: Pretest Mean, Posttest Mean, Adjusted Mean in Comprehension Test

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Pretest</th>
<th></th>
<th></th>
<th>Posttest</th>
<th></th>
<th></th>
<th>Adjusted M</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
<td></td>
<td></td>
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<tr>
<td>Experiment Group</td>
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<td>12.782</td>
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</table>

Table 4: Summary of Analysis of Covariance in Comprehension Test

<table>
<thead>
<tr>
<th>Source</th>
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<th>df</th>
<th>MS</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
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<tr>
<td>Error</td>
<td>190.491</td>
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</table>

$\alpha=0.05$

Discussion

The data analyses of this study showed that the experimental group performed significantly better than their counterparts on memory and comprehension tests. In other words, the integrated information literacy
curriculum using the Super3 model can help first-graders not only memorize factual scientific information, but also gain a deep understanding of science subject matter. These results support previous research, such as Shymansky et al. (1990), Bredderman (1982), Hurd (1988), and Haury (1993).

It is not easy to explain to young students about process, let alone teach them to become better thinkers and problem-solvers. As Eisenberg and Robinson (2007) said, “Learning problem-solving skills does not begin in college. Every day, even very young children tackle tasks, make decisions, and solve problems both on an academic and personal level.” (p. 5) Through Super3 model in this study, students in experimental group selected their favorite insects for inquiry, such as bees, ants, butterflies, and ladybugs. The teacher provided students with related books and videos in the learning environment, and encouraged them to observe the insect. At the same time, the students had to extract the needed information to answer the stated questions. Therefore, they were exposed to an inquiring environment, as NRC (1996, 2000) described, where students posed questions, making observation, examining information from various sources, interpreting data and communicating results. Thus, the finding in comprehension learning of this study verified what many studies have stated that integrating information literacy into curriculum through inquiry-based strategies did help develop higher-order thinking skills (Andrews & Patil, 2007; Khalid, 2010).

In terms of memory learning, the finding of this study was different from Chang and Mao (1998), as well as Hung, Jonassen, and Liu (2008). A possible reason may have been that the Super3 model highlighted both factual knowledge acquisition and knowledge application during the inquiry process. Owing to the first-graders’ reasoning skills was still developing, though they did have a “questioning mind”, most of the questions they posed were memory-based level, such as what did ants eat? Where did bees live? Thus, during the inquiry process, the students gathered and extracted the needed information to solve the problems, what they read repeatedly were all factual knowledge. If the questions they posed were higher-order ones (e.g., cause-and-effect questions, convergent thinking questions, divergent thinking questions, evaluative thinking questions) (Audet & Jordan, 2005; Ciardiello, 1998), students’ memory performance in the experimental group may be not better than in the control group. However, this assumption needs more research to verify it.

In brief, the integrated information literacy in first-grade science curriculum using the Super3 model could improve students’ learning on memory and comprehension level. The inquiry-based learning help students learn both the problem-solving process and subject matter.

Implications & Recommendations

Based on the findings of this study, the following implications and recommendations are made:

1. Integrated information literacy science curriculum can improve students’ factual knowledge and higher-order thinking skills.

2. Science teachers should design more inquiry-based curricula infused information literacy using the Super3
model as early as possible, so that young children is used to this learning strategy, and became life-long learners later.

3. Further empirical studies can be carried out on the relationship among age, types of questions, and inquiry learning.

References


