IMPACT OF SIMULATOR TRAINING ON COGNITION AMONG MARINE ENGINE STUDENTS

Brenda B. TUMALA ¹, Grace P. TROMPETA ², Luis G. EVIDENTE ³, Ronnie C. MONTAÑO ⁴

¹ Dr., Research Coordinator, bb_tumala@yahoo.com
² Dr., JBLFMU Graduate School Professor
³ Capt., Administrator/DQMR, JBLCF-Bacolod
⁴ Marine Engineering Instructor, JBLCF-Bacolod

ABSTRACT

People do things which are based on varied mental operations. Either they operate abstractly or concretely. These mental operations are used to identify analytically the fundamental components of mental life, like attention, developing paradigms to make sense of collected observations. There are general principles which have been uncovered over the years of laboratory research on cognition and some of those principles seem to promise fruitful application to natural situations, especially in education and training.

Simulation activity offers numerous maritime education providers a significant educational tools that meet the needs of today’s maritime learners by providing them with interactive, practice-based, instructional technologies.

This research takes up how simulation activity affects the nature of learning suitable to individual differences among marine engine students in terms of their cognitive ability. Chen, Czerwinski, and Macredie (2000) report an overview of some approaches and major findings of various research studies concerning the effects of individual differences on the use of new technology. It is along these concepts that this study is anchored upon.

This research study is about the impact of simulation training on the cognitive styles among the marine engineering students of John B. Lacson Colleges Foundation-Bacolod, Philippines. Specifically, it sought to answer the following queries:

1. What is the impact of simulation training among the marine engineering students who are classified as abstract learners?
2. What is the impact of simulation training among the marine engineering students who are classified as concrete learners?
3. Is there a significant difference in the impact of simulation training when learners are grouped according to their cognitive styles?
4. Does the students’ spatial orientation play important role in their simulation training performance?

This study used a one-group pretest posttest design where 14 marine engine 2nd year students were subjected to a simulator training after having been given a pretest. An adopted instrument was used to determine the cognitive style of the student participants. Student participants were given a spatial orientation test to determine their spatial ability. Variables taken up in the study were the cognitive styles as independent variable, spatial orientation as moderator variable and simulator training performance as the dependent variable.

Findings show that the participants were 29 % concrete learners and 71% abstract learners. The impact of simulation training to abstract learners is high (88) while that of the concrete learners is also high (90). The study found no significant difference on the impact of simulation training performance between the abstract and concrete learners. On the other hand both the concrete and abstract learners were high in their spatial orientation and no significant difference was found in the spatial orientation when the participants were grouped as concrete and abstract learners.

This study concludes that the learning experiences facilitated by simulators are indeed enhancing so much so that abstracts and concrete learners performed similarly high. Simulation instruction is suitable to any type of cognition style. Therefore this seems to create a laudable call for simulator program developers to better design their programs to ensure better and clearer information, fidelity, complexity to test crucial skills, cues as well as debriefing procedures.
1. INTRODUCTION

People do things which are based on varied mental operations. Either they operate abstractly or concretely. These mental operations are used to identify analytically the fundamental components of mental life, like attention, developing paradigms to make sense of collected observations. There are general principles which have been uncovered over the years of laboratory research on cognition and some of those principles seem to promise fruitful application to natural situations, especially in education and training.

Simulation activity offers numerous maritime education providers significant educational tool that meet the needs of today’s maritime learners by providing them with interactive, practice-based, instructional technologies.

Discoveries and development in educational technology make a wide array of options, such as sophisticated simulators, available to faculty to facilitate knowledge acquisition and cognitive growth. Such developments also create an environment that is ripe for systematic and substantial change. To create the most effective and efficient ways of teaching maritime education, faculty members need to develop a wide range of methods of engaging students in learning activities, including simulation. By incorporating simulation technology into maritime courses, faculty can begin to explore the impact of such strategies on learning even on their critical-thinking and problem-solving skills. Some consideration related to cognition and the use of simulation in the marine engineering education program will be explored in this study.

2. LITERATURE SURVEY

Vygotsky's sociocultural theory of learning emphasizes that human intelligence originates in our society or culture, and individual cognitive gain occurs first through interpersonal (interaction with social environment) than intrapersonal based on social environment can influence students' learning and thinking. Another aspect of Vygotsky's theory is the idea that the potential for cognitive development is limited to a certain time span which he calls the "Zone of Proximal Development" (ZPD). Vygotsky defined ZPD as a region of activities that individuals can navigate with the help of artifacts. In Vygotsky' view, artifacts are one of the important ways to facilitate individual cognitive growth and knowledge acquisition. ZPD among others include artifacts such as books, computer tools, and scientific equipments. The purpose of ZPD is to support intentional learning.

In the socio-cultural theory of learning developed by Vygotsky and his co-workers and students (e.g. Cole, 1996; Kozulin, 1998; Kozulin, Gindis, Ageyev, & Miller, 2003; Leont'ev, 1978; Leontyev, 1981; Vygotsky, 1978; Wertsch, 1991, 1998, 1979, 1985) the concepts of “tool” and “mediation” are key. The central thesis is that the structure and development of human psychological processes are co-constituted by the interaction with tools. These are historically developed and could be of different types such as “psychological tools”, “material tools”. Using tools makes it possible to act in more powerful and functional ways and enhances and alter human development.

According to the philosopher of technology Don Ihde perception is co-determined by technology. In science instruments do not merely “mirror reality” but mutually constitute the reality investigated. The technology actively shapes the relationship between humans and their world by placing certain aspects in the foreground (and others in the background) and also by making certain aspects of reality visible that otherwise would be invisible. According to Ihde (e.g. 1991) neglecting the role of instruments (i.e. technological artefacts) in science leads to naïve realism. However in the philosophy of science the emphasis is often placed only on concepts and ideas.

Ekstrom, French, Harman, and Dermen (1976) defines spatial orientation as a measure of the ability to remain unconfused by changes in the orientation of visual stimuli, and therefore it involves only a mental rotation of configuration, and McGee (1979) defines spatial visualization as a measure of the ability to mentally restructure or manipulate the components of the visual stimulus and involves recognizing, retaining, and recalling configurations when the figure or parts of the figure are moved.

Aptitude-by-treatment interaction (ATTI) research investigates the effects of learner aptitudes and traits on learning outcomes from different forms of instruction (Cronbach & Snow, 1969; Berliner & Cahan, 1973). The major assumption of this kind of research is that it is possible and desirable to adapt the nature of instruction to accommodate individual differences in terms of ability, style or preference to improve learning outcomes. Indeed, research concerning individual differences in the context of VR is still at its infancy. Chen, Czerwinski, and Macredie (2000) reports an overview of some approaches and major findings of various research studies concerning the effects of individual differences on the use of this new technology. However, most of these studies focus particularly on the human-computer interaction aspect. Salzman, Dede, Loftin, and Chen (1999)
also points out the need for more study on the interaction of individual characteristics with the characteristics of VR.

According to Sternberg the two levels of mental self-government are local and global. The local style focuses on more specific and concrete problems. The global style, in comparison, focuses on more abstract and global problems. A concrete learner is someone who learns most easily from empirical happenings, and has difficulty grasping information in the abstract (unlike abstract learners), such as being told one thing is a consequence of another. A concrete learner usually has to observe something happening to truly integrate the concept to their mind and be able to respond to it from memory and react to it. While abstract thinker are people who prefer to learn deductively, with the big picture, concepts, and theory first, followed by examples.

2.1. Target Area

New Methodologies and Technologies in MET

2.1.1. Target (Simulation as a New Methodology and Technology in MET)
Simulation activity offers education providers a significant educational tool that meets the needs of today’s learners by providing them with interactive, practice-based, instructional technologies.

Testing and implementing teaching strategies that use simulations has the potential to enhance the following:
1. More effectively utilize faculty in the teaching of basic engineering skills.
2. Allow learner to revisit his skill in the simulator a number of times in an environment that is safe, non-threatening and conducive to learning.
3. Actively engage students in their learning process where they display higher-order of learning rather than simply mimicking the teacher role model.
4. Contribute to the refinement of the body of knowledge related to the use of simulation in maritime education by providing insights in order to formulate best practices related to design and use of simulation technology.

2.1.2. Area (Cognition and Simulation)

The purpose of this paper is to study a parameter in cognition related to the use of simulation in the marine engineering education program and modified by spatial visualization. Specifically, it is designed to:
1. Explore the relationships between the use of simulation technologies and student cognition (student’s inherent ability to see and understand either concretely or abstractly) and modified by students spatial visualization.
2. Contribute to the refinement of the body of knowledge related to the use of simulation in maritime education.

2.1.2.1. Method
2.1.2.1.1. Design
The cognition based pretest and posttest which was employed in this study was composed of 10 questions and was aimed at assessing the learners’ cognitive style (abstract or concrete learners). The pretest and posttest were similar in content but the posttest takes the form of test where a scenario of a 3D distiller program was used to arrive at the status of the participants’ cognition style after having been exposed to simulator training.

2.1.2.1.2. Scoring
The total score for the pretest was 50. For each question, participants received a score of 1 if the answer is rarely, 3 if sometimes and 5 if often. There were 10 items. Their total score was converted using the conversion table to convert it to percentage.

The total score of the posttest was 30. For each question, participants received a score of either 1 for disagree, 2 for agree and 3 for strongly agree. Their total score was converted using the conversion table to convert it to percentage.

Vandenberg Mental Rotation Test
This instrument was chosen to test the spatial visualization ability of the participants. It consists of 2 patterns that could be folded into figures. A feature inherent in these items is that they required mental manipulation of objects in three-dimensional space. It tests the ability to visualize a constructed object from a picture of pattern, which is illustrated in two-dimensional.

The test is to be completed in 10 minutes. In this project, participants who scored above 50% were classified as having high spatial visualization ability and participants who scored 50% or below were classified as having low spatial visualization ability.

2.1.2.1.3. Validity
Content validity of the pretest and posttest was determined by the expert judgment (Gay & Airasian, 2003). Subject matter expert from the cognitive psychology was requested to review the process that was used to develop the test as well as the test itself, and then made a judgment about how well these items represent the intended content area.

2.1.2.1.4 Reliability
A pilot study was carried out after the test items were designed and validated. A test –retest was conducted to assure the reliability of the test.

Research Questions:
1. What is the participants’ profile in terms of their cognition and spatial visualization?
2. What is the level of cognition of abstract and concrete learners?
3. How do abstract learners perform with the simulator?
4. How do concrete learners perform with the simulator?
5. Is there a significant difference in the level of cognition among the marine engineering students when they are grouped as concrete and abstract learners before and after the simulator activity?
6. Does using the simulation activities increase the student cognition?
7. Are students’ spatial visualizations significantly related to their cognition using the simulator?

2.2. Database
Profile of the Participants
Profile of the Participants is shown in table 1
Table 1: Profile of the Participants

<table>
<thead>
<tr>
<th>Cognition</th>
<th>n (in %)</th>
<th>Spatial Visualization</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>29</td>
<td>1.7</td>
<td>High</td>
</tr>
<tr>
<td>Concrete</td>
<td>71</td>
<td>1.5</td>
<td>High</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-.67</td>
<td>low</td>
</tr>
<tr>
<td>.68-1.34</td>
<td>fair</td>
</tr>
<tr>
<td>1.34-2</td>
<td>high</td>
</tr>
</tbody>
</table>

Level of Cognition
The next problem dealt with the level of cognition among the participants. Table 2 shows the data.

Table 2 : Level of Cognition

<table>
<thead>
<tr>
<th>Cognition</th>
<th>Level of Cognition</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>84</td>
<td>Fair</td>
</tr>
<tr>
<td>Concrete</td>
<td>86</td>
<td>High</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>93-100</td>
<td>Very High</td>
</tr>
<tr>
<td>77-84</td>
<td>Fair</td>
</tr>
<tr>
<td>69-77</td>
<td>Low</td>
</tr>
</tbody>
</table>
The abstract learners had a fair level of cognition while the concrete learners had a high level of cognition.

**Performance in the Simulator.**
Next question dealt with the performance of the learners in the simulator. Table 3 shows the data.

Table 3: Performance in the Simulator

<table>
<thead>
<tr>
<th>Cognition</th>
<th>Mean</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>91</td>
<td>High</td>
</tr>
<tr>
<td>Concrete</td>
<td>88</td>
<td>High</td>
</tr>
<tr>
<td>Mean Total</td>
<td>90</td>
<td>High</td>
</tr>
</tbody>
</table>

**Difference in the level of cognition among the marine engineering students when they are grouped as concrete and abstract learners**
The difference in the level of cognition among the marine engineering students when they are grouped as concrete and abstract learners is shown in table 4.

Table 4: Difference in the level of cognition among the marine engineering students when they are grouped as concrete and abstract learners before and after the simulator activity.

<table>
<thead>
<tr>
<th>Variable</th>
<th>df</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before (Pretest)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concrete</td>
<td>12</td>
<td>.292</td>
<td>.775</td>
</tr>
<tr>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>p &gt; .05 (Difference is not significant)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

After (Posttest)

<table>
<thead>
<tr>
<th>Variable</th>
<th>df</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete</td>
<td>12</td>
<td>1.187</td>
<td>.258</td>
</tr>
<tr>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>p &gt; .05 (Difference not significant)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Simulation Activities and the Students’ Cognition**
The next problem dealt with the Simulation Activities and the Students’ Cognition. Table 5 shows the data.

Table 5: Group Statistics

<table>
<thead>
<tr>
<th>Cognition</th>
<th>N (%)</th>
<th>Mean Gain (Posttest - Pretest)</th>
<th>Total Mean Gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete</td>
<td>71</td>
<td>7.75</td>
<td></td>
</tr>
<tr>
<td>Abstract</td>
<td>29</td>
<td>6.2</td>
<td></td>
</tr>
<tr>
<td>Total Mean Gain</td>
<td>6.975</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Students' Visualization and their Cognition
The last problem dealt with the relationship between the level of students' visualization and their level of cognition. Table 6 shows the data.

Table 6
<table>
<thead>
<tr>
<th>Correlated Variable</th>
<th>r-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level of Students' Visualization</td>
<td>.099</td>
<td>.737</td>
</tr>
<tr>
<td>Level of Students' Cognition</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ \text{p}>.05 \ \text{(relationship not significant)} \]

3. RESULTS
3.1 Results for Participants Profile
3.1.1. The participants were 29% abstract learners and 71% concrete learners.

3.2 Performance in the Simulator among the Learners
3.2.1. The abstract learners perform higher than the concrete learners by point 2(.2).

3.3 Difference in the Level of Cognition among the Participants
3.3.1. No significant difference was noted in the level of cognition among the participants. During the pretest the level of cognition among concrete learners themselves were the same that of the abstract learners. The same thing happened during the posttest where the \[ p \ \text{value} \ \text{(}.775 \ \text{and} \ \text{.258 for the pretest and the posttest respectively)} \] of the test conducted being higher than the alpha value (.05). This was computed using the Statistical Software for Social Sciences (SPSS). This could mean that no specific type of cognition is better favored by simulator instruction.

3.4 Simulator Activity and the Level of Cognition among the Learners
3.4.1. On the average simulator activity has increased the level of cognition of both the concrete and abstract learners by 6.975 or by 7 points.

3.5 Student's Visualization and Student Cognition
3.5.1. No significant relationship (\[ \text{p}>.05 \]) was noted between level of students' visualization and their level of cognition.

4. ANALYSES AND DISCUSSION
The finding that the level of cognition in both the concrete and abstract learners remained the same in the simulator seems to validate the claim of Chen (2000) that simulation learning decreases extraneous cognitive load and this has enabled the learners to align and focus the cognitive resources for understanding the content of the learning environment. Indeed, the three dimensional representations and the dynamics of the 3D distiller get the learners to stay oriented in the guided virtual reality presentation. Vygotsky's theory on "Zone of Proximal Development" (ZPD) contended that an individual learner can easily reached its ZPD through the aid of an artifact which of course in this study is taken to mean the simulator. To Vygotsky, an artifact is one of important ways to facilitate individual cognitive growth and knowledge acquisition whether in concrete or in abstract cognition. Also Vygotsky believed that the structure and development of human psychological processes are co-constituted by the interaction with tools such as the simulator in this study.

To Cronbach & Snow, 1969; Berliner & Cahen, (1973) the nature of instruction can accommodate individual differences in terms of ability, style or preference to improve learning outcomes. Finding from this study showed that the nature of learning and instruction through the simulator has significantly increased the level of cognition both in the concrete and in the abstract learners. This research went out further to show that levels of spatial visualization did not affect the level of cognition among the participants. Since the 3D simulator used in this study had a well constructed interface design it seems to coincide with the findings of Stanney and Salvendy (1995) that the use of interface design can avoid the need of structuring embedded information. Consequently this is believed to have bridged the gap between the learners with low and high spatial visualization. This has
further believed to contribute to the absence of relationship between the levels of spatial visualization and the level of cognition among the participants.

5. CONCLUSION
This study has been among the very few that took into account the use of virtual environment for instructional use in relation with the learner’s characteristics. This study has shown how the learners benefited from the use of simulator as a learning tool irrespective of the type of cognition. This study has farther shown the weight of the type of learning programs as an indicator of successful learning through the simulator since the effectiveness of simulator learning has become dependent now on the simulator itself. Installation of proper instructional design seems has become a mandate among the simulator program developers. There is indeed a great task ahead not only among the simulator manufacturers but also among instructors in the field of Maritime education to join hands in coming up with a program and a program design that will best cater to the desired learning outcomes of the learners.

6. REFERENCES