Calculation of Special Angles in Trigonometry via Visual Mathematical Hand Mnemonic Tactic (VMHMT)

Romnick M. Ureta
MIMAROPA Regional Science High School, Pag-as, Bansud, Oriental Mindoro, Philippines
romnickm.ureta@gmail.com

Abstract. In 2016, the Mathematical Society of the Philippines (MSP) testified that among Filipino learners of ages 14-18, 85% experienced the dilemma on dealing with the evaluation of special angles in Trigonometry wherein 45% was from public high schools. This study aimed to determine the potential of a visual mathematical hand mnemonic tactic (VMHMT) as fast and accurate classroom mathematical mnemonic strategy in evaluating special angles in Trigonometry. A 20-item multiple choice type test with 50-minute time allotment. Reliability of the test items was also measured via Pearson’s. The test was administered three times with 7-day interval for each strategy with uniform starting time. ANOVA results showed no significant difference among the three manual strategies in terms of accuracy of answers (p=0.373) which means that the accuracy of the VMHMT is comparable with that of the other existing manual strategies. Meanwhile, significant difference was obtained in terms of speed of calculations (p=0.000) wherein the use of unit circle rendered longest time for calculations (M=21.234) while the VMHMT (M=14.70) and table of trigonometric ratios (M=14.23) appeared to be very fast. Learners find the strategy more relevant and experiential which could make a more lifelong learning.

1. Introduction
Many students have difficulty in learning Trigonometry. The reason generally is that it primarily involves not just application of logical procedures but also remembering facts and relationships. Blackett and Tall
[1] explain that despite of the good impact of learning the subject, learners are discouraged in performing when they encounter functions in Trigonometry. In fact, research says that students often “feel disconnected from their math instruction and perceive it as irrelevant to their lives” [2]. This feeling may impact their level of interest and achievement in math. Therefore, it is imperative that teachers use the instructional strategies that will motivate the students and increase their understanding in math.

There are different manual strategies that can be applied in evaluating special angles in Trigonometry like the use of the unit circle and the table of trigonometric ratios. These are both visual strategies for numbers wherein learners can readily find ratios of functions in the material. On the other hand, mnemonic strategy application can also be utilized in simplifying the approach in learning the mind boggling subject. According to Paris [3], the introduction of the visual hand mnemonic strategy is considered as manual technique to easily learn the evaluation of special angles in Trigonometry.

In this study, the potential of visual mathematical hand mnemonic tactic (VMHMT) was evaluated as an effective Mathematical mnemonic strategy which could help students in learning the concepts of evaluating special angles in Trigonometry more accessible and easier to follow. Specifically, the study analyzed the level of speed of calculations and accuracy of answers in evaluating special angles in Trigonometry of the Grade 11 learners of the MIMAROPA Regional Science High School using the VMHMT and was compared on the use of unit circle and table of trigonometric ratios through test results.

2. Methodology

The respondents of this study were from the total population of Grade 11 learners in MIMAROPA Regional Science High School for the school year 2017-2018. The student-respondents were selected using random sampling. The study utilized the Raosoft sample size calculator. There were 76 11th graders in MIMAROPA Regional Science High School and 64 students were used as samples. This was computed at 95% confidence level with 5% margin of error.

The study utilized a 20-item multiple choice type tests with allotment of 50 minutes to accomplish. Basic operations like addition and subtraction, multiplication and division were presented in the given questions of the test.

Score and time limits and intervals were used as bases in describing the obtained mean scores and time of the respondents under study. The verbal descriptions of the obtained times and scores are presented in Table 1.

Table 1. Scaling for the Level Speed of Calculations and Accuracy of Answers Level of Speed of Calculations

| Time                 | Level   |
|----------------------|---------|
| 1 min – 20mins       | Very Fast |
| 21 mins – 30mins    | Fast    |
| 31 mins – 40mins    | Slow    |
To ensure the content validity of the research instrument, three (3) Master Teachers in Mathematics who are experts in Trigonometry evaluated and validated the test that was administered for the gathering of data. On the other hand, a trial was made for the reliability of the research instrument. After the test-retest, the results were analyzed through the use of Pearson Product Moment Coefficient of Correlation or the Pearson’s r.

2.1 Data Gathering Procedure

A week before the actual administration of the test, the researcher taught first the application of the VMHMT in evaluating special angles in Trigonometry and had reviews and drills on the use of unit circle and table of trigonometric ratios. The class sessions for the three manual strategies covered one (1) whole week. In the administration of the test questionnaire, the 69 respondents took a 20-item multiple choice type tests.

![Figure 1. The VMHMT application](image)

The same set of test was utilized for all the manual strategies in evaluating special angles to ensure the consistency on the level of difficulty of the test. Interval of seven (7) days was observed for the test administrations of each manual strategy. Each set of questions had a maximum time of 50 minutes to
finish. Uniform starting time of each respondent was noted in the top of the answer sheet so as after answering the test. The scores were identified after checking.

**Examples:**

\[
\cos \alpha = \frac{\sqrt{2} \text{ above}}{2}
\]

\[
\sin \alpha = \frac{\sqrt{2} \text{ below}}{2}
\]

1. Lower pointer finger.
2. Count fingers above: 1
3. Count fingers below: 3

**Figure 2.** The VMHMT application

2.2 Data Analysis

The study applied the descriptive and Inferential Statistics in analyzing the results. All the gathered data were analyzed properly via One-Factor ANOVA using the QI Macros. On the other hand, interview sessions were also executed after the application of all the manual strategies.

3. Results and Discussion

a) The VMHMT exhibits high accuracy when used as mathematical mnemonic strategy in evaluating special angles in Trigonometry as shown in figure 3.
Figure 3. Level of accuracy of answers of the Grade 11 learners in evaluating special angles using VMHMT, table of trigonometric ratios and unit circle.

The learners obtained high accuracy for both the VMHMT and the table of trigonometric ratios with mean values of 15.13 and 15.22 respectively. This is of the same observation with that of Paris [3] wherein he argued that the utilization of the mnemonic strategies is sufficient to help children to have a worthwhile and effective way of solving special angles and almost comparable to the utilization of a desk-glance material such as tabular values. On the other hand, the learners obtained 14.36 as mean score for unit circle. Although it also has a high accuracy, compared to the VMHMT and table of trigonometric ratios the unit circle still has the lowest value. This simple means that the students find it more difficult to use the unit circle in evaluating special angles. According to Sorensen [4] some of the visual materials that served as guide in learning do not give exact values and require long evaluative process before coming up with the desired result.

On the other hand, there is no significant difference among the three manual strategies in terms of accuracy of answers (F=0.991; p=0.373). This means that the accuracy of VMHMT do not really differ to the existing manual strategies like table of trigonometric ratios and unit circle.

According to Scruggs and Mastropieri [5] the keyword strategy works best when the information to be learned is new to students. This is also parallel to that of Williams [11] as he explained that when cooperation is done simultaneously with the aid of some simple hand techniques like maximizing visual mnemonics, learning would be more effective and easy to transfer which could lead in obtaining high scores in a given evaluative test and exercises.

The presented result is also supported by the study ‘Learning the Functional Significance of Mnemonic Actions and Desk-Glance Utilization’, wherein parallel results revealed that better learning and high performance in evaluative tests resulted when children understood the utilization and significance of using simple mnemonic strategies [3].

b) The VMHMT has a very fast speed when it comes to the calculations of special angles in Trigonometry so as with the use of table of trigonometric ratios while the unit circle exhibits the longest time as shown in Figure 4.
Figure 4. Level of speed of calculations of the Grade 11 learners in evaluating special angles using VMHMT, table of trigonometric ratios and unit circle.

Based on figure 2, the utilization of the VMHMT and table of trigonometric ratios in evaluating special angles appeared to be very fast with means of 14.70 and 14.23 respectively. It means that learners find it easy evaluating special angles at less time when they actually see the actual ratios listed on a table and by means of mnemonic strategy. These results are supported by De Torres [9] as he enumerated classifications of learners according to their preferred ways of understanding lessons in her article Learning Styles and Strategies. One of these classifications is categorize whether learners are visual or verbal learners who learn best through visual or written presentations. Students easily answer questions particularly written exercises when they see patterns or cues to follow and it results to a less time consumed in understanding the concept. However, the use of unit circle in the evaluation of special angles in Trigonometry took the longest time with a mean speed of 21.23 minutes. This is parallel to that of Bohan and Shawaker [6] wherein they explained that picture associations in Mathematics like the unit circle are not just mere pictures sometimes these are figures of patterns, table of numbers, and formula guide that may help bridging the gap between the concrete states and symbols which also took more time when used or applied.

In addition, using One-Factor ANOVA, it was found that there is significant difference among the three manual strategies in terms of the speed of calculations ($F=55.121; p=0.000$). According to Salonga [7] mnemonic strategy applications when employed inside the classroom can also really help in a fast transfer of knowledge like generation of ideas, formulation of questions and solving problems in different disciplines in education. The results also imply that the constructivist approach anchored to the employment of mnemonics and visual strategies held at hand helped learners in obtaining high performance in less time [8].

The promising speed recorded for both the VMHMT and table of trigonometric ratios may be attributed to the fact that majority of the learners learned through visuals. Students who are visual type learners most
likely performed faster in using the table of trigonometric ratios. Visual learners are those who learn best through visual or written presentations. Students easily answer questions particularly written exercises when they see patterns or cues to follow and it results to a less time consumed in understanding the concept [9].

c) The VMHMT has a positive feedback based on the actual interview results as shown in Table 2.

Table 2. Sample responses/feedbacks of the students in utilizing the VMHMT.

| Student | Actual Response | English Translated Response | Remarks |
|---------|-----------------|-----------------------------|---------|
| A       | “Naging madali na ang pag sosolve ko ng special angles dahil sa tulong lang ng aking mga daliri sa VMHMT. Mas mabilis ang pag kompyut namin ngayon.” | Solving special angles became a lot more easier just because of my fingers in applying the VMHMT. Computation became faster now for us. | Positive |
| B       | “Pagkatapos ko ma-evaluate yung given sa trigonometry na isip ko na madali lang pala ang pag solve nung mga special angles kasi pwede pala na gamitin lang ang sarili naming kamay.” | After I evaluated the given in Trigonometry I realized that solving special angles is not that hard because we can just use our hands to evaluate them. | Positive |
| C       | “Mas nauwaan ko na kung paano mas mabilis na ma eevaluate yung mga special angles sa subject naming Trigonometry. Dati kasi sobrang sakit sa ulo ang pag solve nung mga functions sa Trigonometry, pero ngayon masaya pala ang topic nay un dahil sa pag gamit ng VMHMT.” | I had a greater understanding now on how to evaluate special angles faster in Trigonometry. Before, my head really ached once I started solving functions in Trigonometry, but now I realized that the topic is really fun because of the use of VMHMT. | Positive |

Based on the presented student-feedbacks above, the VMHMT affirmed its potentiality as an effective mathematical mnemonic strategy in evaluating special angles in Trigonometry. According to one of the responses, the VMHMT helped the students understand the evaluation of special angles easily and more accessible. The students also find evaluation of special angles really fun and enjoyable through the application of VMHMT.

In addition, learners find the strategy more relevant and experiential which could make a more lifelong learning. According to Bauno [10] most students in high school appreciate interactive type of strategies like the mnemonics particularly when dealing complex subjects areas like Mathematics. The application of the VMHMT is aligned with experiential learning wherein the concept of discovery is employed. VMHMT being an application of Bruner’s discovery learning makes learning more experiential and perennial addressing short term memory issues for mathematical concepts. In this sense, better learning is transferred.
4. Conclusion

Based on the results, the current study has met its objectives. The VMHMT has high accuracy and very fast speed in the calculation of special angles in Trigonometry. No significant difference was obtained among the three manual strategies in terms of accuracy of answers which testifies that the VMHMT exhibits the same accuracy with that of the existing manual strategies. However, a significant difference was obtained for the three manual strategies in terms of speed wherein both the VMHMT and table of trigonometric ratios exhibit comparable speeds while the unit circle appears to consume more time in evaluating special angles. This means that VMHMT aside from high accuracy could also evaluate special angles at less time. On the other hand, interview results revealed positive feedback for the utilization of VMHMT. Learners find the strategy more relevant and experiential which could make a more lifelong learning. Therefore, VMHMT can be utilized as a convenient and easy-to-follow mathematical mnemonic strategy in evaluating special angles since it has promising accuracy and speed just like the existing manual strategies which could lead to a more relevant learning process in learning Trigonometry.

5. References

[1] Blacket, J., & Tall, F. (2008). Effective Math Teaching Today. Educator: Magazine for Teachers, 24, 10-13.
[2] Glickman, H.T. (2011). Simple Yet Effective Teaching Strategies. 21st Century Learning Journal, 10(2), 25-27.
[3] Paris, S. (2005). Learning the Functional Significance of Mnemonic Actions: A Microgenetic Study of Strategy Acquisition. Retrieved September 29, 2014, from http://deepblue.lib.umich.edu/handle/2027.42/23793.
[4] Sorensen, V. (2008). Motivating Middle School Mathematics Students. Retrieved September 25, 2014, from http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=065&context=mathmidactionresearch.
[5] Scugge,T.E., & Mastropieri, M.A. (2009). The Case for Mnemonic Instruction: From Laboratory Research to Classroom Applications. The Journal of Special Education, 24, 7-32.
[6] Bohan, H., & Shawaker, D. (2004). Standardized Test Outcomes for Students Engaged in Inquiry-Based Science Curricula in the Context of Urban Reform. Journal of Research in Science Teaching, 45(8), 23-28.
[7] Salonga, I. (2008). Soak Up the Fun: Tips on Changing the Way You Handle Your Class. Educator: Magazine for Teachers, 30, 12-13.
[8] Kim, A. (2007). Direct Instruction and a Plea for Action – The Behavior Analyst Today. Retrieved on October 11, 2014 from https://itunes.apple.com/us/book/direct-instruction-educators/id510104393?mt=11.
[9] De Torres, P. (2005). Learning Styles and Strategies. Educator: Magazine for Teachers, 30, 12-13.
[10] Bauno, L. (2012). Rote Technique Vs Mnemonic Devices: Learning Tools in Enhancing the Memory Retention among Grade 6 Pupils of Arellano University. Retrieved September 12, 2014, from http://www.studymode.com/essays/Rote-Technique-And-Mnemonic-Device-1313152.html.
[11] Williams, D. (2005). The Impact of Cooperative Learning in Comparison to Traditional Instruction on the Understanding of Multiplication in Third Grade Students. Unpublished Master’s Thesis, Capella University, Minneapolis US.