AMELIORATING PERFORMANCE OF GRADE 12 STUDENTS IN SOLVING PROBLEMS IN DIRECT CURRENT CIRCUIT THROUGH 4MAT TEACHING MODEL

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Abstract: This study aimed to look into the effectiveness of 4MAT Teaching Model in solving problems on direct current circuits of Grade 12 students. Using True-Experimental Research Design, there were two groups having 38 students respectively. The said groups were given a pre-test about solving problems on direct current circuits. One group which was the Experimental, was exposed to the 4MAT Teaching Model technique while the other group which was the Control, was exposed with the traditional way of teaching particularly the lecture method. The administration of post-test happened after six (6) class sessions. Using Paired Sample T-test via SPSS, the results showed a computed probability of 0.000. This implies that there is a significant difference between the post test score results of the control versus experimental group. The mean of 13.82 for experimental group indicated that the section have higher performance in the competency of solving problems involving direct current circuits using the 4MAT Teaching Model compared to the controlled group with a mean score of 11.45, wherein lecture method was administered as its mode of teaching. Using the Cohen's d analysis for t-test, the computed value is 1.3989 which means that 4MAT Teaching Model has a large effect on the performance of students in solving direct current circuits. This also indicates that approximately 92% of the students scored higher in experimental group than those who were on the control set.

***Keywords**: 4MAT Teaching Model, Direct Current circuits*

I. INTRODUCTION

Studies conducted across the globe have identified innovation and education in the fields of Science, Technology, Education and Mathematics (STEM) as critical determinants in economic prosperity. Indeed, STEM educated and trained individuals have been identified as major determinants of innovation, thus, contributors to significant economic productivity.

In the Philippines, one of the aims of the K to 12 program is to increase the numbers of STEM oriented professionals. The K to 12 program introduced a new science curriculum to enhance the teaching and learning of science and science related subjects such as Physics. There is a clear commitment to STEM education in the region and the reported Philippine initiative is well placed to provide the necessary STEM education experiences for students that will lead to an increase in participation in STEM study and careers (Bevins & Prinec, 2015).

However, in the advent of this educational reform program of the government, there is still worldwide difficulty in understanding one of the branches of science, which is Physics. One of the branches of Physics that is highly difficult to comprehend for learners is Electricity. Unfortunately gaining understanding on electricity seems to be very challenging and difficult for students in various school levels. These difficulties and misconceptions seem to be very resistant to change (Shipstone, 1988). As Psillos (1998) argues, the emerging picture worldwide is not promising given that an adequate knowledge of electricity has rarely been acquired by students by the end of secondary education.

Electricity is regarded as an essential topic in the school science curricula worldwide. However, many learners experience difficulty understanding it. In fact, problems with regard to teaching and learning electric circuits have been common amongst learners all over the world (Kucukozer & Kocakulah, 2007; Chang, Lui & Chen, 1998).

In Tuguegarao City Science High School which offers STEM Strand for Senior High School, the percentage of correct responses based on their Third quarter summative test for the topic electricity is one of the least mastered among grade 12 students for the past two years, SY 2016-2017 and SY 2017-2018. In the year 2016-2017, the electricity part particularly the Direct Current topic scored an average of 35.00% only. Although there was an improvement in the performance of the students in the year 2017-2018 with an average of 51.09%, it still falls under the Least Mastered skills and capabilities. The competency enclosed under the Direct Current Content based on the curriculum guide issued by the Department of Education is to solve problems involving the calculation of currents and potential differences in circuits consisting of batteries, resistors, and capacitors. While various modes or strategies of lesson delivery such as lecture, experiments and cooperative learning were already utilized in class, they still seem to be ineffective to increase the academic mastery of students.

Aside from the traditional mode of teaching, there are different teaching and learning approaches that can be used to enhance learners' achievement such as Problem-based learning, Brain-based learning, 5E learning and CIPPA learning.

Equally important as those approaches mentioned is the 4MAT learning model, which especially caters to 4 types of learners: Active Experimenter, Reflective Observator, Abstract Conceptualizer, and Concrete Experiencer. Besides, the learning activities described in the model, it can also respond to both the left-side and the right-side of the brain (Sasithon, 2013). This new method or style of teaching is the primary reason that the teacher-researcher will be using a 4MAT teaching method to teach Direct Current Circuits in the Physics 2 subject.

In this regard, the researcher believes that 4MAT Teaching method would raise the problem solving skills of students especially in computing for direct current questions. This aims to improve the performance of students on simple direct current circuits of Grade 12 students of Tuguegarao City Science High School and hence increase the students' mastery level. This study aims to improve the performance of grade 12 students on the concept of Electricity particularly the Direct Current Content through 4MAT teaching Method.

Specifically, this research study aims to answer the following:

1. What are the pre-test mean scores of the control and experimental groups?
2. What are the post-test mean scores of the control and experimental groups?
3. Is there a difference on the pre-test mean scores of the control and experimental groups?
4. Is there a difference on the post-test mean scores of the control and experimental groups?
5. What is the effect size of the 4MAT Teaching Method to the performance of the students in solving problems in direct current circuits?

As a teacher, it is very tough and problematic to see students struggling in a given school work particularly on problem solving of a certain topic. It is a very challenging job to look for ways of delivering the content to the learners in a very understandable and simple manner because the delivery greatly affects how students could easily grasp the subject matter. Hence, a large effect on the performance of the students is on how the teacher delivers the content/subject matter to them. Choosing the right strategy would make the complicated and hard subjects easier to understand. Moreover, a large factor of how the teacher manages the class would affect greatly on their performance on a certain subject.

Learning management is an important tool to encourage learners to love learning. Teachers play an important role in learners' academic achievement. If teachers can create various types of activities to accommodate different abilities in learners, the learners can definitely benefit from those activities. First, learners will gain knowledge and will have positive attitude towards what they learn; second, learners can

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apply the knowledge in their daily life and acquire further knowledge in the future (Valaya Alongkorn Rajabhat University under the Royal Patronage, 2010: 3).

As different learning activities are believed to bring benefits, proper lesson planning is vital in increasing the learners' achievement and the learners' connection skills. There are different teaching and learning approaches that can be used to enhance learners' achievement such as Problem-based learning, Brain-based learning, 5E learning and CIPPA learning.

Equally important as those approaches mentioned, the 4MAT model is another effective learning model because its lesson planning caters for 4 types of learners: Active Experimenter, Reflective Observator, Abstract Conceptualizer, and Concrete Experiencer. Besides, the learning activities described in the model can respond to both the left-side and the right-side of the brain (Sasithon, 2013). In other words, the 4MATS activities facilitate different types of learners, making them happy with learning and activities that they feel comfortable to do. At the same time, the 4MAT provides a challenge and a satisfying response to the needs of the learner (Sukchai, 1999).

One of the advantages of the 4MAT model is that it can be applied to all subjects and its activities are easy to perform in the classroom (Monthana, 2005). Unlike the traditional method, the 4MAT model emphasizes evident development of the learners' connection skills for the learners to learn from understanding instead of memorization. Therefore, the tendency is high that the 4MAT model may increase learning achievement better than the traditional counterpart.

The 4MAT lesson planning comprises 8 steps: (1) Creating experience (2) Analyzing experience (3) Concept visualization (4) Concept development (5) Practicing by concepts (6) Extension (7) Analyzing and application and (8) Exchanging experience (Kittichai, 2001: 32-41).

The 4MAT learning method is visualized in Figure 1.

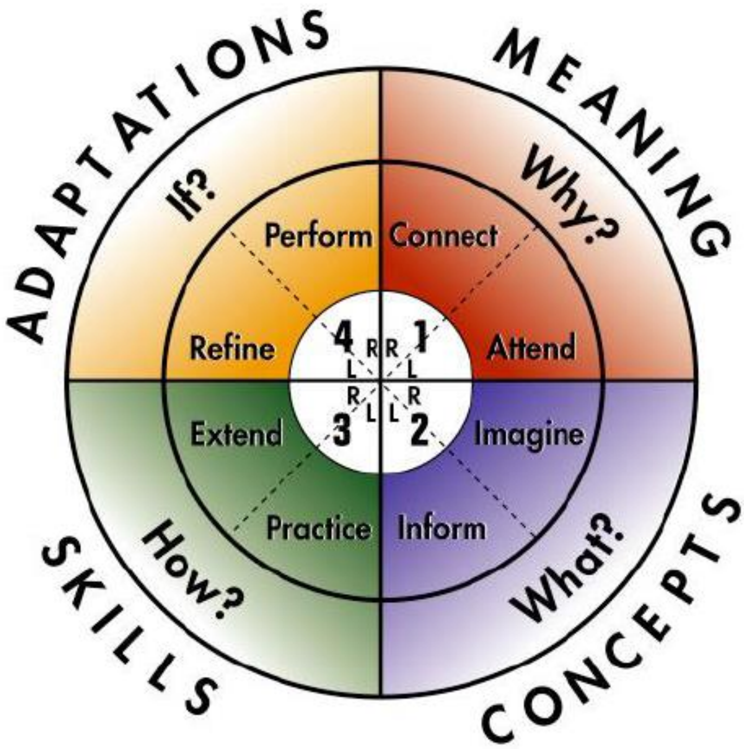

Figure 1. 4MAT system (www.4mationweb.com, 2003).

A brief information on the steps to be followed for successful implementation of the 4MAT is given below: The 4MAT instructional activities included 8 steps on "Direct Current".

Step 1: Creating experience (Right-side brain): the teacher prompts the learners to think about their experiences by giving questions relevant to daily life. This step is optimal for Reflective Observer type of learners.): Relationships are established between the content and daily life experiences of the students. Thus, the students get an idea whether the subject will be of use to them in their real life. When students see that the information will be of use in everyday life, they will be more motivated to the class (McCarthy and McCarthy, 2006).

Step 2: Analyzing experience (Left-side brain): the learners are made more curious by questions relevant to those in step 1, in order for them to consolidate their experience or knowledge. This step is optimal for Reflective Observer type of learners. The objective in this step is to carry our classroom resolutions of the activities performed in the previous step and to enable the students to develop empathy (Ergin and Sarı, 2015). When the students discuss the experiences by observing them, they will better understand the relationships and differences between events. In this step, teachers refrain from influencing students by not declaring their own ideas. Events are resolved by students. Teachers encourage the students by leading them to resolve the experience given in the first step (Ergin and Sarı, 2015).

Step 3: Concept visualization (Right-side brain): lessons are taught and ideas are summarized by the teacher and learners. This step is optimal for Abstract Conceptualizer type of learners. In this step, teachers should carefully select the information relating to the real life of the students, before giving them content information and should help them learn the content through visualization, visual comparison, and analogy. In this way, it will be easier for the students to learn the things taught by teachers, as they will feel that they already know the topic (Demirkaya et al., 2003).

Step 4: Concept development (Left-side brain): the learners integrate the concept with their daily life. This step is optimal for Abstract Conceptualizer type of learners. The students are familiar with the content owing to the practices of the first three steps (McCarthy, 2000). In this step, teachers lecture the students. The teacher is the lecturer in the class and the students are the listeners. While teachers lecture on a topic covering the finest details, students take notes and ask the teacher to repeat the things they have not understood. The questions in the minds of the students are tried to be solved in this way (Demirkaya et al., 2003).

Step 5: Practicing by concepts (Left-side brain): the teacher leads the learners to the experiments or activities. This step is optimal for Active Experimenter type of learners. In this step, the students apply the information they have acquired and turn that into reality. The goal in this step is to enable students to acquire skills in parallel with the information they have acquired and to help them transfer their knowledge to their real life (Demirkaya et al., 2003, Ergin and Sarı, 2015).

Step 6: Extension (Right-side brain): learners are offered the opportunity to create their own work freely. This stage will expose learners' different personalities. Their work can come in the form of a video presentation, a booklet, a pop-up and a slide presentation. This step is optimal for Active Experiment type of learners. In this step, students transfer their knowledge to new situations in a

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concrete manner. They have now acquired a sufficient amount of content. They wonder about the application of their theoretical knowledge and learn through trial-and error. In this step where manual skills are heavily used, all of the students are engaged in different subjects and will reach actual satisfaction at the end of the process (Demirkaya et al., 2003; McCarthy, 2000; McCarthy and McCarthy, 2006)

Step 7: Analyzing and application (Left-side brain): the teacher offers the opportunity for learners to analyze their work before they modify the work again. This step is optimal for Concrete Experiencer type of learners. In this step, the students step back and study their output. They assess their own products like a person observing the situation as an outsider. Besides self-assessment, they assess each other's product as the whole class in order to reach perfection. In this step, the teacher makes various suggestions to help the students (Demirkaya et al., 2003; McCarthy, 2000; McCarthy and McCarthy, 2006).

Step 8: Exchanging experience (Right-side brain): the learners analyze their peers' work and rate each. This step is optimal for Concrete Experiencer type of learners. In this step, students exhibit their products and present them to friends and school. In this step, the students show everybody, including particularly their teachers and classmates, what they have comprehended, to what extent they are related with the content they have learned, their relationship with more holistic views and how much they fit their life. Their communication skills are developed by enabling them to share their outputs and answer the questions (Demirkaya et al., 2003).

According to McCarthy (2000), the 4MAT learning cycle and its application steps show that 4MAT learning style establishes a bond between content and real life, and thus, is important in creating new ideas and turning knowledge into experience. From this point of view, the 4MAT learning method can be used as an effective method to improve the academic achievement of students, as it is able to meet different learning styles and respond to the question why the students should learn the topics (Cengizhan and Özer, 2016).

II. METHODOLOGY

a. Research Design

The researcher used the descriptive- comparative research design to determine the mean scores of the students before and after the employment of the 4MAT teaching method. Moreover, the researcher utilized the true-experimental design because the study required two groups, the control and the experimental.

b. Sources of Data

The researcher used the purposive sampling technique to identify the participants. Two classes consisting of 38 each which were assigned as the control group and experimental group served as the participants of the study. Each class was grouped heterogeneously.

Data were gathered through primary source where in scores from the pre-test and post-test of the participants and were directly collected by the researcher.

c. Data Collection

Experiment method was utilized in the study since 4MAT teaching method was integrated in teaching and learning on direct current circuits. Also, questionnaire method was used since there were pre-test and post-test forms that were distributed to the participants after the integration of 4MAT teaching method. The participants in each section were given a pre-test questionnaire consisting of 20 multiple choice questions to check their prior knowledge on the subject matter. One class was the control group, which was the Grade 12 Vesalius, while the other was the experimental group which was the class of Grade 12 Da Vinci. These classes were utilized since it is where the researcher teaches the subject General Physics 2 of the STEM Strand in school. After the conduct of the pre-test, two different teaching strategies were employed. For the control group which was the Grade 12 Vesalius, traditional way of teaching by lecture was utilized to explain the concept and problem solving of direct current circuits. For the experimental group, which was the Grade 12 Da Vinci, 4MAT Teaching Strategy was used to impart concepts and problem solving strategies on direct current circuits. This 4MAT teaching method is the intervention under study. After the conduct of the teaching strategy, post-test questionnaires were administered to the student-participants. These post-test questionnaires are in multiple choice format, wherein the questions are similar/parallel to the pre-test one with complete table of specifications for its guided construction.

d. Ethical Issues

The researcher observed protocol. The researcher asked permission to the school principal to conduct the study. Since the participants were minors, parent's consent was secured before the conduct of the research. Only those with parent's consent were included in the study. Also, the researcher acknowledged the sources to avoid plagiarism.

e. Data Analysis

The following were used to analyze the data in the study:

- **Mean.** This was used to determine the mean scores before and after the integration of 4MAT teaching method of the control and experimental groups using SPSS (Statistical Pack for Social Science) Software.

- **Standard Deviation.** This was computed to determine the measure of the amount of variation or dispersion of the pretest and the post test scores respectively using SPSS (Statistical Pack for Social Science) Software.

- **Paired Sample T-test**. The purpose of the test is to determine whether there is statistical evidence that the mean difference between paired observations on a particular outcome is significantly different from zero. This was used to determine the significant increase in the mean scores before and after the integration of 4MAT teaching method of the control and experimental groups using SPSS (Statistical Pack for Social Science) Software.

- **Cohen's D** . This was used to determine the effect size of the intervention used using Online RStat Effect Size Calculator for t-test which could be accessible at https://www.socscistatistics.com/effectsize/default3.aspx

III. RESULTS AND DISCUSSIONS

This study used the pre-test post-test research design. This research employed the utilized mean and standard deviation for the analysis of pre-test and post-test scores, paired sample t-test for the determination of the significant difference between the mean scores. The 5% Level of Significance was used as reference level in all analyses. Eta-squared interpreted by Cohen's d value for the analysis of the intervention's effect size or effectiveness in improving the problem solving performance of the students in direct current circuit is under study.

Table 1: Mean Pretest Scores of the Control and Experimental Groups

Group	Mean	Standard Deviation	Verbal Interpretation
Control	6.18	1.98	Fairly Satisfactory
Experimental	7.03	2.02	Fairly Satisfactory

Table 1 shows the Mean Pretest Scores of both the Control and Experimental Groups. It could be seen from the table that Control Group scored a little lower than the Experimental Group. Moreover, the Control Group's Scores are considered to be more clustered than the scores of the Experimental Group because they obtained a lesser standard deviation. The Mean Scores of the Control Group and the Experimental group are verbally interpreted as Fairly Satisfactory.

Table 2: Mean Post test Scores of the Control and Experimental Groups

Group	Mean	Standard Deviation	Verbal Interpretation
Control	11.45	2.04	Satisfactory
Experimental	13.82	1.44	Very Satisfactory

Table 2 shows the Mean Posttest Scores of both the Control and Experimental Groups. It could be seen from the table that Experimental Group scored higher than the Control Group. Moreover, the Experimental Group's Scores are considered to be more clustered than the scores of the Control Group because they obtained a lesser standard deviation. The Mean Score of the Control Group is verbally interpreted as Satisfactory whereas the mean score of the Experimental Group is verbally interpreted as Very Satisfactory.

Table 3: T- test Comparison of the Mean Pretest Scores of the Control and Experimental Groups

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Paired Samples Test

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Control Pre Test vs Experimental Pre Test	-0.84211	2.71658	0.44069	-1.73502	0.05081	-1.911	37	0.064

Table 3 shows the T-test comparison of the Mean Pretest Scores of the Control and Experimental Groups. From the table, it could be seen that the probability is 0.064 which is more than 0.05 hence leads to the acceptance of the null hypothesis at 5% Level of Significance. This further means that there is no significant difference in the performance of the two groups of students before any intervention was made. The result ascertains that the two groups are of equal footing in so far as solving problems on Direct Current Circuits.

Table 4: T-test Comparison of the Mean Posttest Scores of the Control and Experimental Groups

Paired Samples Test

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Control Post Test vs. Experimental Post Test	-2.36842	2.46512	0.39990	-3.17869	-1.55816	-5.923	37	0.000

Table 4 shows the T-test comparison of the Mean Posttest Scores of the Control and Experimental Groups. From the table, it could be seen that the value of the probability is 0.000 which is lesser than 0.05 hence leads to the rejection of the null hypothesis at 5% Level of Significance. This means that there is a significant difference in the scores registered by the two groups of respondents after Traditional Method of Teaching and the 4MAT Teaching method were implemented in the Control and Experimental Groups, respectively. This further implies that there is a significant difference in the two methods of instruction employed, with students exposed to the 4MAT Teaching Method performing significantly better than those exposed to the conventional method.

Table 5: Magnitude of the Effect of 4MAT Teaching Method

Group	Mean	Standard Deviation	Cohen's D Value	Verbal Interpretation
Control	11.45	2.04	1.3989	Large Effect
Experimental	13.82	1.44		

Table 5 shows the magnitude of the effect of 4MAT Teaching Method used as an intervention in teaching the concept of Direct Current Circuits. The intervention registered a large effect on the performance of the students with a cohen's d value of 1.3989. The value also implies that there is a large mean difference between the control and the experimental group. The basis of this verbal interpretation could be seen on table 6. This would indicate that approximately 92% of the student-respondents in the experimental group have higher performance in problem solving direct current circuits than those student-respondents on the controlled group. The large effect size means that the use of 4MAT Teaching Model in solving problems in direct current circuits yielded greater performance for students than students exposed to just the lecture method.

IV. CONCLUSION AND RECOMMENDATIONS

4MAT Teaching Model has a large effect on the performance of students in solving direct current circuits. This also indicates that approximately 92% of the students scored higher in experimental group than those who were on the control set.

It is recommended that this research will be disseminated through the implementation of activities such as In-Service Trainings, LAC Sessions and other trainings and seminars that will be conducted in the future. The use of the 4MAT teaching Model is an effective cognitive approach for the students to learn Direct Curren t Circuits.

LITERATURE CITED

Agustin, C.P. & Lagundi R.F. N. (2019) Classroom teaching Management and Evaluative techniques of the Instructional Staff of business, entrepreneurship and accountancy. *International Journal of Advance Research in Management and Social Sciences*.8 (3), 171-196.

Aliustaoğlu, F. & Tuna, A. (2018). The Influence of 4MAT Model on Academic Achievement and Retention of Learning Transformation Geometry. *International Journal on New Trends in Education and Their Implications.* 9(2). 16-32.

Bangayan-Manera, A. (2019). Textual Analysis of School Graffiti. *The Asian EFL Journal*. 21 (2.3), 273-285.

Bangayan-Manera, A. (2019). Doodle: Towards A Hermeneutical Appreciation in Jacques Derrida's Deconstruction. *The Asian EFL Journal*. 24 (4.2), 291-204.

Bangayan- Manera, A. (2020). Writing Without Permission: A Case study on Skinner's Analogy through Vandalism. *International Journal of Psychosocial Rehabilitation*. 24 (08), 571-578

Butac, S. (2021). A Comparative Study of Faculty Communication Satisfaction, Job Satisfaction and Productivity of Sectarian and Nonsectarian Private HEI's in Manila. *International Journal of Arts, Sciences and Education*, *1*(1), 29–41. Retrieved from https://ijase.org/index.php/ijase/article/view/4

Bevins, S. & Price, G. (2015). The Introduction of the New Curriculum and Senior High School System in the Philippines : report of the consultation exercise undertaken in November 2015. Available from Sheffield Hallam University Research Archive (SHURA) at http://shura.shu.ac.uk/14890/

Chittiwattanakorn, R. & Sookkheo, B. (2017). Using the 4MAT Model to Promote Learning Achievement and Connection Skills on Chemical Reaction of the 10th Grade Students. *RJES* 4(2). 25-31.

Domingo- Tuliao, J. (2020). Instructional Materials Used in Teaching Mathematics: Basis for Enhancing Mathematics Program. International Journal of Psychosocial Rehabilitation. 24 (8), 796-808

Ergin S, Sari M (2012). Effects of the 4MAT Instruction Method on the Achievement of High School Students with Different Learning Styles on the Subjects of Work, Power and Energy in Physics. Energy Educ. Sci. Technol. Part B-Soc. Educ. Stud. 4(2):807-820

Gokhan, U., et.al (2012). The Effects of Analogy on Students' Understanding of Direct Current Circuits and Attitudes towards Physics Lessons. *European Journal of Education Research 1(3)*, 211-223.

İnel, Y. (2018). The Effect of 4mat Method on The Academic Achievement of Students in Social Studies Education. *Review of International Geographical Education Online (RIGEO)*, *8*(3), 440-458. Retrieved fromhttp://www.rigeo.org/vol8no3/Number3winter/RIGEO-V8-N3-2.pdf

Irfan, O. et.al. (2016). Effect of using 4mat method on academic achievement and attitudes toward engineering economy for undergraduate students. *International Journal of Vocational and Technical Education.* 8(1). 1-11. http://www.academicjournals.org/IJVTE

Jaakkola, T. et.al (2004). Academic impact of learning objects: the case of electric circuits. Paper presented at the British Educational Research Association Annual Conference, University of Manchester, 16-18 September 2004 (In the symposium, "Learning objects in the classroom: a European perspective". http://www.leeds.ac.uk/educol/documents/00003702.htm

Malana, M.L. (2020) Comparative Analysis in the Performance of Students in Chemistry. International Journal of Psychosocial Rehabilitation. 24 (6)

Malana, M.L. (2020). Attitude and Level of Performance of Students in Chemistry. International Journal of Psychosocial Rehabilitation. 24 (8)10148-10154

McCarthy (1990). Using the 4MAT System to Bring Learning Styles to Schools. Educational Leadership Journal.pp. 31-37.

McCarthy B (1997). A tale of four learners: 4MAT‟s learning styles, Educ. Leadersh. 54:46-51.