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OPTIMIZING CLASSROOM INSTRUCTION THROUGH SELF-PACED LEARNING PROTOTYPE

Romiro G. Bautista

Secondary Education Department, College of Teacher Education

Quirino State University

Philippines

bautista.romer@yahoo.com

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Abstract

This study investigated the learning impact of self-paced learning prototype in optimizing classroom instruction towards students' learning in Chemistry. Two sections of 64 Laboratory High School students in General High School Chemistry were used as subjects of the study. The Quasi-Experimental and Correlation Research Design was used in the study: a pre-test was conducted, scored and analyzed which served as the basis in determining the initial learning schema of the respondents. A questionnaire was adopted to find the learning motivation of the students in science. Using Pearson-r correlation, it was found out that there is a highly significant relationship between their internal drive and their academic performance. Moreover, a post-test was conducted after self-paced learning prototype was used in the development of select topics in their curriculum plot. It was found out that the students who experienced the self-paced learning prototype performed better in their academic performance as evidenced by the difference of their mean post-test results. ANCOVA results on the post-test mean scores of the respondents were utilized in establishing the causal-effect of the learning prototype to the academic performance of the students in Chemistry. A highly significant effect on their academic performance (R-square value of 70.7%) and significant interaction of the models to the experimental grouping and mental abilities of the respondents are concluded in the study.

Keywords – Self-paced Learning Prototype, Self-Regulated Learning, Modular Instruction.

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1 INTRODUCTION

The current curricular paradigm for teaching recognizes that knowledge is constructed, discovered, and extended by student-learners as they interact their pace and mood in a constructive learning environment. It recuperates learning by putting the student-learners at the center of the educative processes. The teacher, who serves as the facilitator of learning, plays an important role in the learning process as he creates relevant conditions necessary to the development of this cognitive and metacognitive knowledge that support and encourage student-learners to construct meaning (Lee, 2003; Kumar et al., 2005; Bautista, 2005).

Cognition in any classroom instruction is anchored on the nature of the student-learners as strokes of the classroom instruction are made to be responsive. Offered in a constructive learning environment, student-learners are allowed to proceed at their own pace and mood. Educationists assume that student-learners do not learn at the same rate and are not ready to learn at the same time. Hence, the student-learners regulate their own pace and task towards learning (Butler, 2002; Dick, Carey & Carey, 2014; Anderson, 2006).

Self-paced learning, banked on the development of cognitive and metacognitive knowledge, is imperative to optimizing the classroom efficacy as it offers an array of benefits to the student-learners. Students' real achievement are measured and optimized as it deviates from the artificial assumptions of teaching and learning based on a normal curve. If it is designed and implemented well, self-paced learning is highly beneficial to students' learning as it allows flexibility, cooperation, feedback, mastery, motivation, objectives and recycling. These make them realize their satisfaction to activities by making them part of the learning process (Dick et al, 2014; Lee, 2003; Fine, Jaeger, Farmer & Qian, 2013).

Astutely, learning is said to be efficient if student-learners can build cognitive and metacognitive knowledge from their past experience, relate what they are learning to things that are relevant to them, have direct "hands-on" experience, construct their own knowledge in collaboration with other students and teacher, and communicate their results effectively through personalized learning prototypes (Bautista, 2005; Bautista, 2012).

Optimized classroom efficacy is achieved as the teacher and student-learners work enthusiastically in the transformation of the traditional learning condition into a rich and active learning condition. Conducted in a constructive learning environment, self-paced learning is developed on the prototype of mastery learning and self-regulated learning. Thus, self-regulated learning strategies help prepare learners for lifelong learning and the important capacity to transfer skills, knowledge, and abilities from one domain or setting to another (Butler, 2002).

1.1 Self-paced Instruction

Self-paced instruction is a kind of instruction that proceeds based on the learners' ability and responses to instructional and pedagogical interventions. It is constructed in such a way that a learner proceeds from a topic or a segment to the next academic activity and learning material at his own speed (Dick et al, 2014). Furthermore, it enables the learner to control his rate of exposure to learning activities that contains a non-adjacent dependency from the teacher (Fine et al, 2013). Aptly, self-paced learning is in concordance to the pursuit of life-long learning. Hence, it comes into a play which can be defined as structured learning. Participants access the learning material and content, selecting when, where and how to study. This pursuit supplements and complements the traditional educational system and satisfies the demand of life-long learners. When properly implemented through an enforced vigilance from the academic mentor, this instruction ensures quality learning (Anderson, Upton, Dron & Malone, 2015). Apropos of, self-paced learning strategies direct a better academic achievement among student-learners. It is further concluded that it develops a better internal drive among the student-learners as it harnesses overt perceptual processes as they interact with their colleagues and teachers in their learning tasks. Butler (2002) elucidated that the motivation component used in this learning prototype includes both self-efficacy (degree to which one is confident that one can perform a task or accomplish a goal) and epistemological beliefs (beliefs about the origin and nature of knowledge).

Self-paced instruction, as used in this study, made use of learning module as a supplementary and complementary material in leveraging the academic learning activities offered among Laboratory High School students in Chemistry. Learning modules were given to the participants prior to the development of the learning outcome. Classroom interventions were provided vis-à-vis with the lecture and laboratory activities, e.g., focus group discussion, peer-tutoring, etc. Enrichment activities, like homework activities, practice tests, guided laboratory experiments, were also provided in the module. Check-point by the teacher and other evaluative techniques were slated to check the progress of the students. New module is to be given when the student is ready.

1.2 Model for Self-Regulated Learning Strategy

Figure 1 presents the Zimmerman's Model of Self-Regulated Learning Strategy (Zimmerman, 1999). The model is observed in a cyclical nature that involves planning, practice and evaluation. Multiple opportunities abound the student-learners to gather and effectively use learning feedbacks to improve his performance. During the planning phase, students learn to accurately assess their academic situation and choose strategies that best address a specific learning challenge. They also set achievable short-and-long-term goals by recalling and analyzing his previous learning schema and performances. This develops an inner drive that motivates him to do his learning tasks better. During the practice phase, learners implement select strategies and make on-going adjustments to their plan as they self-monitor their progress. Lastly, during the evaluation phase, student-learners assess the applicability and correctness of each strategy in helping him achieve his goals. Constructive feedback is drawn in the evaluation phase. Coupled with flexibility, cooperation, feedback, mastery, motivation, objectives and recycling, student-learners generate a better plan in the next SRL cycle.

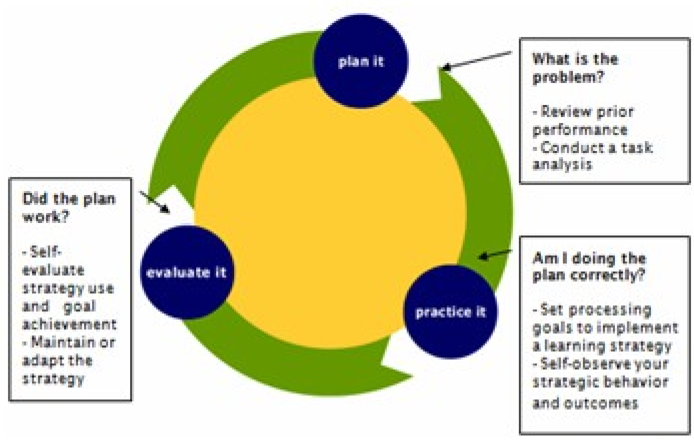

Figure 1. Zimmerman's Model of Self-Regulated Learning (Zimmerman, 1999)

Self-regulated learning helps the student-learners focus their attention in discriminating between the most effective and the least effective performances that can reveal their inadequacy. Feedback plays overt perceptual processes in their interaction with their colleagues and teachers through self-instruction and self-reinforcement responses.

This prototype helps the student-learners to become achievers as they develop better time management, specific and proximal goals, accurate monitoring, higher standard for satisfaction, and self-efficacy. Hence, student-learners become more persistent to learning despite learning obstacles (Zimmerman, 1999; Wolters et al., 2003).

1.3 The Social Learning Theory

Bandura's Social Learning Theory (SLT) presents the interrelationship of observation and modeling of behaviors, attitudes, and emotional reactions of others in the learning process of an individual learner. The theory posits that human behavior is learned observationally through modeling: from observing others one forms an idea of how new behaviors are performed and on later occasions, this coded information serves as a guide for action (Bandura, 1986).

Social Learning Theory (SLT) is also influenced by reciprocal causation: the person, behavior and environment are influencing each other through self-efficacy and self-regulation. Learning employs self-confidence towards learning (self-efficacy) under circumstances of an individual's personal ideas on the appropriateness and inappropriateness of actions in improving his own behaviors (self-regulation). Self-regulation involves modeling (doing what others do both live model and symbolic models) and imitation (using another learner's behavior as a discriminating stimulus both vicarious reinforcement and vicarious punishment). Therefore, SLT spans to both cognitive and behavioral frameworks by encompassing attention, memory and motivation. Hence, the central role of social learning is on behavioral interpretation of modeling. These leaps are link to the Social Development (Vygotsky, 1978) and Situated Learning (Lave, 1988) Theories.

Social Development Theory posits that the social interactions made by a student-learner precede development, consciousness and cognition. Hypothesizing that cognition and development is the end product of socialization and social behaviors, the theory posits the following tenets:

- Social interaction plays a fundamental role in the process of cognitive development. Vygotsky felt social learning precedes development. He states: "Every function in the child's cultural development appears twice: first, on the social level, and later, on the individual level; first, between people (interpsychological) and then inside the child (intrapsychological)";

- The More Knowledgeable Other (MKO). The MKO refers to anyone who has a better understanding or a higher ability level than the learner, with respect to a particular task, process, or concept. The MKO is normally thought of as being a teacher, coach, or older adult, but the MKO could also be peers, a younger person, or even computers.
- The Zone of Proximal Development (ZPD). The ZPD is the distance between a student's ability to perform a task under adult guidance and/or with peer collaboration and the student's ability on solving the problem independently. According to Vygotsky, learning occurred in this zone. (Vygotsky, 1978 as cited in http://www.learning-theories.com/vygotskys-social-learning-theory.html).

Situated Learning Theory argues that learning is a function of various activities, contexts and culture of inquiry under social interactions in a process of "legitimate peripheral participation. Social interaction is a critical component of situated learning. Student-learners are invited to come across learning in a "community of practice" which embodies certain beliefs and behaviors to be observed and practiced. As student-learners involve themselves in the process of cognitive inquiry, they become more active and engaged within each interaction. Hence, the student-learners assume roles in the learning environment which is usually unintentional rather than deliberate. (Lave, 1988 as cited in http://www.learning-theories.com/situatedlearning-theory-lave.html).

1.4 Objectives of the Study

This study was designed to determine the learning impact of self-paced learning prototype in optimizing classroom chemistry instruction.

Specifically, it sought to find explanations of the following:

- What are the mean pre-test and post-test scores of students exposed in the self-paced learning prototype and the traditional classroom routine?
- Are there significant differences between the pre-test and post-test scores of student-learners in the self-paced learning prototype and the traditional classroom routine?
- How do the respondents assess their motivation in learning Chemistry?
- Is there a significant relationship between the students' motivation in learning science and their academic achievement in Chemistry?

2 METHODOLOGY

The Quasi-Experimental Design (pretest-posttest control group design) was used in this study. This provided bases for the causal effect of the independent variable to the dependent variable involving experimental and control groups. Treatment, integration of self-paced learning prototype, was introduced in the experimental group. The discourse treatment, which includes a self-paced instructional modules and guided experiment and laboratory activities, was limited only in the development of Stoichiometry. Modeling of the eclectic methods and approaches in a personalized learning condition was integrated in the discourse treatment as well as reinforcement strategies based on Zimmerman's Model of Self-Regulated Learning. The use of groupings and motivation was introduced in the process. Analysis of the scores was done to conclude on the causal effect of the independent variables.

On the other hand, the customary instruction was made to the control group with the usual class session, ordinary assignment, individual seatwork and exercises.

This study was conducted at the Quirino State College – Laboratory High School, Philippines, during the last quarter of School Year 2006-2007. Two sections of sixty-four General High School Chemistry students handled by the researcher were utilized in the study. Lottery was done in determining the experimental grouping of the study.

This study made use of an adopted questionnaire on students' Motivation towards Science Learning (Tuana, Chin & Shieh, 2005) in determining the motivation level of the respondents in learning Chemistry and a Teacher Made Test developed by the researcher to determine their academic achievement in Stoichiometry. The instrument was refined through expert pooling with his colleagues in the Natural Sciences Department during his Master's Thesis study on Modular Instruction. Learning objectives were mapped in a two-way Table of Specification in ascertaining the content/face validity of the instrument. The average grade of the student-learners in Chemistry (First, Second and Third Grading) was used as the basis in determining their learning ability in Chemistry.

The mean, percentage, independent t-test, ANCOVA, and Pearson-r correlation were used in the treatment of the data gathered to conclude on the stated research problems.

3 RESULTS AND DISCUSSION

	Respondents	N	Mean	Std. Deviation	t	df	Sig. (2-tailed)	Mean Difference	Result/ Decision
Pre-test	*Experimental*	*31*	*16.32*	*4.578*	*-0.923*	*60.436*	*0.359*	*-1.011*	*Insignificant / Accept Ho*
	Control	*33*	*17.33*	*4.151*					
Post-test	*Experimental*	*31*	*23.52*	*4.373*	*4.688*	*62*	*0.000**	*4.789*	*Significant/ Reject Ho*
	Control	*33*	*18.73*	*3.794*					

Table 1. Test of Difference on the Pre-test and Post-test Mean Scores of the Respondents

Presented in the foregoing table are the pre-test and post-test results of the 2 groups of respondents. Using independent t-test, it was found out that there is a comparable academic readiness of the learner-respondents at the start of the experimentation: t-value of -0.923, and p-value of 0.359, at 0.05 level of significance. It can be noted that the experimental group even scored lower than their counterparts: mean difference of -1.011. This means that the control group manifested greater knowledge and understanding on the concepts to be mastered in the modular coverage. However, post-test results show a significant difference on their performance after the treatment procedures as indicated by their incomparable group mean scores: t-value of 4.688 and a p-value of <0.001 at 0.05 level of significance. It can be construed then that the experimental group performed better than their counterparts in the control group as shown by their group mean scores: 23.52 versus 18.73. These results lead to the rejection of the null hypothesis of no significant difference on the academic performance of the students after the treatment procedures were incorporated in the classroom processes.

The foregoing results could be attributed to the tenets of Social Development Theory (Vygotsky, 1978). It was posited that the social interactions made by a student-learner precede development, consciousness and cognition. Hypothesizing that cognition and development is the end product of socialization and social behaviors, the theory posits the following tenets:

- Social interaction plays a fundamental role in the process of cognitive development. Vygotsky felt social learning precedes development. He states: "Every function in the child's cultural development appears twice: first, on the social level, and later, on the individual level; first, between people (interpsychological) and then inside the child (intrapsychological)";
- The More Knowledgeable Other (MKO). The MKO refers to anyone who has a better understanding or a higher ability level than the learner, with respect to a particular task, process, or concept. The MKO is normally thought of as being a teacher, coach, or older adult, but the MKO could also be peers, a younger person, or even computers.
- The Zone of Proximal Development (ZPD). The ZPD is the distance between a student's ability to perform a task under adult guidance and/or with peer collaboration and the student's ability on solving the problem independently. According to Vygotsky, learning occurred in this zone. (Vygotsky, 1978 as cited in http://www.learning-theories.com/vygotskys-social-learning-theory.html).

The results of the study indicate that students who were exposed to the treatment mechanism obtained a significantly higher mean post-test score on their academic achievement than the students who were exposed to the customary teaching models and techniques. This result is supported by the theoretical explanations of Kumar et al. (2005), Montague (2008) and Newman (2002) in elucidating that the students in the collaborative learning group posted better scores on the critical thinking test than students who studied individually.

Apropos of, cognition is believed to reshape the learning environment of the student-learner by transforming the individual's learning schema through imitation, modeling and feedback consists of environmental, individual and other social stimulus. Learning in this condition is based on collaborative social interaction and social construction of knowledge by enabling the students to acquire and develop cognition as they get involved in a community of practice in a "legitimate peripheral participation" (Anderson, 2006).

Hence, the teacher plays an important role as the teacher's feedback and interaction is still essential to facilitate learning since students are vulnerable to generate significant ideas. Thus, teachers must be flexible enough in the switch response categories in the analysis of problem, proposition, statement, among others (Anderson, 2006; Dick et al, 2014; Anderson et al., 2015).

Source	*Type III Sum of Squares*	*df*	*Mean Square*	*F*	*Sig.*	*Result/ Decision*
Corrected Model	*1016.235[a]*	*4*	*254.059*	*38.972*	*0.000**	*Significant/ Reject Ho*
Experimental Grouping	*360.474*	*1*	*360.474*	*55.295*	*0.000**	*Significant/ Reject Ho*
Learning Ability	*32.712*	*1*	*32.712*	*5.018*	*0.029**	*Significant/ Reject Ho*

a. R Squared = 0.725 (Adjusted R Squared = 0.707)

Table 2. The Two-way Analysis of Covariance on the Tests Conducted

Presented in Table 2 is the two-way analysis of covariance of the tests conducted between the two groups of the study. It presents the causal effect of the teaching model to the academic performance of the students when grouped according to their experimental grouping and the interaction of the experimental grouping with the respondents learning abilities.

It was found out that the impact of the model of optimizing the instruction is moderately average considering that the coefficient of determination indicated by the adjusted R-squared is 0.725: F-value of 38.972 and a p-value of <0.001 at 0.05 level of significance. This means that the model of teaching account for 70.7 % of the variability in the academic achievement of the students. It is construed then that there are other important variables or factors such as student ability and other classroom techniques which may explain better the difference in the academic achievement of the groups of students in both the experimental and control groups.

It also presents the effect of the reconstructed classroom instruction when the respondents are grouped according to their experimental grouping and learning abilities: F-values of 55.295 and 5.018, and p-values of <0.001 and 0.029 at 0.05 level of significance. These results lead to the rejection of the null hypothesis of no significant effect of the self-paced learning prototype when used as an underpinning instructional design on the academic performance of the student-learners in Stoichiometry. This means that the students under the experimental group who experienced the self-learning prototype performed better in the subject after the method was introduced in their learning experiences and became a potent mechanism in their learning-routine.

Table 2 likewise presents the interaction between the students' motivation in learning science and the method (self-paced learning prototype). It further presents the impact of the treatment conditions to the academic performance of the students across the learning abilities of the students in the two groups as shown in Figure 2.

Figure 2 presents the relationship of the estimated marginal means of the post-test result and the learning abilities of the students, categorized as low and high. The result of the post-test mean score is evaluated with the pre-test covariate value of 16.84. It presents that the high ability groups of the experimental and control groups had incomparable results while a comparable result is observed on the academic performance of the student-learners in the low ability group. This result confirms the perception of the student-respondents towards their motivations on self-efficacy, performance goal, achievement goal and learning environment stimulation as the experimental group had a better motivation and self-esteem towards learning. Motivation takes the exploration drive among the students to be successful as they can in any classroom routine.

These results confirm the findings of Chen (2002), Lee (2003) and Bautista (2005) when they concluded that self-paced learning strategies direct a better academic achievement among student-learners. They further concluded that it develops a better internal drive among the student-learners as it harnesses over perceptual processes as they interact with their colleagues and teachers in their learning tasks. Butler (2002) elucidated that the motivation component used in this learning prototype includes both self-efficacy (degree to which one is confident that one can perform a task or accomplish a goal) and epistemological beliefs (beliefs about the origin and nature of knowledge).

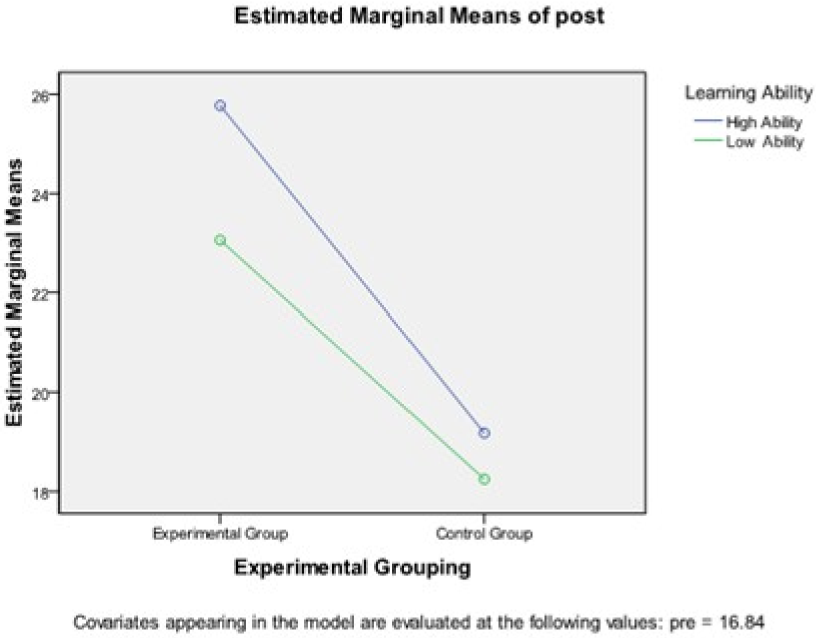

Figure 2. Estimated marginal mean of the post-test scores

Various proponents of collaborative instruction and constructivism claim that the active exchange of ideas within small groups not only increases interest among the members of the group but also promotes critical thinking and academic achievement. As cited by Petilos (2003), there is a convincing evidence that cooperative teams achieve higher levels of thought and retain information longer than students who work only as individuals. The shared learning during small-group discussion gives students an opportunity to engage in discussion, take responsibility for their own learning, and thus become critical thinkers (Newman, 2002; Bautista, 2005). Small-group discussion also engenders further thinking since students are engaged in activity, reflection, and conversation where the learners become responsible for defending, proving, justifying, and communicating their ideas to the other members of the group (Bautista, 2012).

Indicators		***Respondents***		***Composite***	
		Experimental	***Control***	***Mean***	***Descriptive Interpretation***
1	***Self-efficacy***	*4.40*	*3.30*	*3.85*	*True of Me*
2	***Active learning Strategy***	*4.50*	*4.20*	*4.35*	*True of Me*
3	***Science Learning Value***	*4.30*	*4.90*	*4.60*	*Very True of Me*
4	***Performance Goal***	*5.00*	*4.30*	*4.65*	*Very True of Me*
5	***Achievement Goal***	*4.90*	*4.20*	*4.55*	*Very True of Me*
6	***Learning Environment Stimulation***	*5.00*	*4.10*	*4.55*	*Very True of Me*
Average		*4.68*	*4.17*	*4.43*	*True of Me*

Table 3. The Students' Motivation in Learning Science (Chemistry)

Table 3 presents the students' motivation in learning science particularly in Chemistry. It presents that the respondents totally agree that they manifest a positive motivation in learning the subject as indicated by their composite mean score to the indicators set forth in this study: 3.85, 4.35, 4.60, 4.65, 4.55 and 4.55 for self-efficacy, active learning strategy, science learning value, performance goal, achievement goal and learning environment stimulation, respectively. This gives a general mean of 4.43 and interpreted as true of me. It could be inferred that the students have a high sense of motivation in learning science particularly Chemistry. Great attention must be given to their perception on their self-efficacy and strategies for an active learning as it is observed that they behold less self-esteem as compared to the rest of the indicators. The morale of the student-learners must be boosted in order for them to recuperate learning challenges towards better cognition in Chemistry.

It can be construed that a constructive learning environment is a potent factor in any educative process. Learners tend to be active and responsive to the dynamism of the classroom routine if they take part in the process. This confirms the conclusions of the studies of Chen (2002), Lee (2003) and Bautista (2005). These cognitions make them realize their satisfaction to activities by making them part of the learning process in personalizing the classroom routines through self-paced instructions. They concluded that students learn best when students are involved in the discussion and other challenging classroom cognition (Petilos, 2003; Anderson, 2006).

		Students' Motivation in Learning Science					
		SE	***ALS***	***SLV***	***PG***	***AG***	***LES***
Post-Test Results	***Pearson Correlation***	*0.601***	*0.426***	*-0.102*	*0.412***	*0.518***	*0.442***
	Sig. (2-tailed)	*0.000*	*0.000*	*0.425*	*0.001*	*0.000*	*0.000*
	N	*64*	*64*	*64*	*64*	*64*	*64*

***Correlation is significant at the 0.01 level (2-tailed)*
Legend: SE – Self-efficacy; ALS – Active learning Strategy; SLV – Science learning value; PG – Performance goal; AG – Achievement goal, and LES – Learning environment stimulation

Table 4. The Relationship of the Students' Motivation in Learning Science to their Academic Performance

Table 4 presents the relationship of the students' motivation in learning Science and their academic performance in the subject. As can be gleaned in the table, a significant result is observed on self-efficacy, active learning strategy, performance goal, achievement goal and learning environment stimulation: r-values of 0.601, 0.426, 0.412, 0.518 and 0.442, and p-values of <.001, at 0.01 level of significance. This means that the greater the drive and control that the students carry in their learning tasks, the greater is their leap towards their academic performances. Hence, the null hypothesis of no significant relationship between the students' motivation in learning science and their academic performance in the subject is hereby rejected.

However, careful attention must be given to the realization of a sound science learning values as it posts an insignificant result: r-value of -0.102 and p-value of 0.425. Remediation, together with classroom interactions, must promote the development of science values needed to do tasks in the development of the cognitive and metacognitive knowledge in science particularly in Chemistry. The attainment of cognitive and metacognitive knowledge must be developed and harmonized with the necessary science values for them to appreciate science concepts and explorations. This appreciation will eventually reshape their drive to do higher learning tasks in the subject.

4 CONCLUSION

Based on the findings of the study, the following are concluded:

- students exposed to the self-paced learning prototype performed better in the subject as indicated by their post-test results;
- great impact of the self-paced learning prototype was observed among high ability students; however, marginal impact was observed among low ability students;
- the learner–respondents manifest a positive motivation in learning the subject;
- students' motivation in learning science like self-efficacy, active learning strategy, science learning value, performance goal, achievement goal, and learning environment stimulation are highly related to their post-test performances.

In general, it is concluded that self-pace learning prototype optimizes students' performances and a potent tool in optimizing classroom instruction.

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AUTHOR BIOGRAPHY

Romiro G. Bautista

Dr. Romiro G. Bautista holds a straight degree programs in science education and an academic excellence awardee when he finished his bachelor's degree in education. Having been in the research and college instruction for more than a decade now, he has presented and published research articles across the US and the Europe and became a guest scientific paper reviewer and evaluator in international journals and international organization for research presentation. Hailed from the ranks as a faculty at the College of Education, and Director for Research and Planning in the Philippines, Dr. Bautista had been a professor of Natural Sciences and Mathematics in an international university in the Kingdom of Bahrain. At present, he is a Professor of Research and Thesis Writing, a Research Conference Coordinator and a Research, Planning and Publication Director in the Philippines.

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