

STUDENTS' AFFORDANCE OF TELEOLOGIC EXPLANATIONS AND ANTHROPOMORPHIC LANGUAGE IN ELICITING CONCEPTS IN PHYSICS**Romiro G. Bautista**

Cagayan Valley Computer and Information Technology College, Inc.
Philippines
bautista.romer@yahoo.com

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Abstract

This study ascertains that the students' affordance of teleologic explanations and anthropomorphic language in eliciting concepts in Physics is influenced by their age and learning exposure and experience. Using Explicative-Reductive Method of Descriptive Research, this study focused on the determinants of students' affordance of teleologic-anthropomorphic reasoning to select concepts in Physics: Kinematics, Dynamics, Statics and Introduction to Thermodynamics. It was found out that the respondents had intermittently committed teleologic-anthropomorphic languages across age and nature of their secondary education. Furthermore, teleologic-anthropomorphic languages were found correctible by classroom interventions as indicated by the test results on age and curricular exposure.

Keywords – Teleologic Explanation, Anthropomorphic Language, Pedagogical Intervention, Physics Concepts.

1 INTRODUCTION

Learning, which takes place in a non-interventionists environment, is an active process which is dynamically preceded by understanding and further analysis and investigation. Knowledge and understanding taken from an array of sources, e.g. teachers, reading materials, educational films, learning peers, cultural and traditional beliefs and daily experiences, are re-processed into new forms of information that refocuses the belief and understanding of a learner.

Understood in a new sense of cognitive structures, these a-priori knowledge and understanding are taken as imperative information from a merely teleologic-anthropomorphic reasoning to a conceptual meaning. Descriptive analogies were less prone to elicit tenacious misconceptions than teleological analogies (Taber & Watts, 1996).

Teleologic explanations and anthropomorphic languages among learners had been regarded as a conceptual structure which in turn plays an active role in the process of constructing personal knowledge in learning concepts of science. These meaningful and scientific explanations lead them in eliciting concepts in Physics in a more coherent and logical perspective.

The students' teleologic explanation, which is believed to be based on age, learning exposure and experience, is interpreted in a framework that converts personal beliefs and practices into contextual frameworks affected by their learning exposures through classroom discussions and cognition between teacher and students, student and students, students and select learning modules and other academic infrastructures.

Learning exposure plays a vital role in the re-formation of their teleologic explanation capabilities and anthropomorphic reasoning. If not intervened properly by academic learning and cognition, this forms an impetus-type of conception which eventually forms mounting-roadblocks that hinder their scientific understanding and explanations to the abstraction process of new concepts.

1.1 Theories of Anthropomorphism

Anthropomorphism, or the tendency to attribute human motivation, characteristics, or behavior to nonhuman entities, reflects and shapes perception and beliefs to the nonhuman world (Pickett et al., 2000; Chartrand et al., 2008). Believed to be attributed to age, it diminishes as one gets full cognition to a phenomenon through conceptual and scientific explanation through learning experience.

1.1.1 Familiarity Thesis

The familiarity thesis affirms that we anthropomorphize phenomenon because it allows us to explicate things we do not comprehend in a manner that we understand; hence, what we understand best is ourselves. The familiarity thesis is a primarily cognitive motivation for anthropomorphism: it attempts to understand the world based on a mental model of the world that we are most familiar with. (Guthrie, 1997) in DiSalvo and Gemperle (2003).

1.1.2 Comfort Thesis

The comfort thesis is the prime emotional motivation for anthropomorphism. People anthropomorphize because they are not comfortable with things that are not like us; hence, “making” things be like us reduces discomfort. According to the comfort thesis, anthropomorphism is “an attempt to feel like we can delineate and persuade the world if it is more like us than not” (Guthrie, 1997) in DiSalvo and Gemperle (2003).

1.1.3 Best-Bet Thesis

The best-bet thesis is a cognitive and game-theoretic approach to anthropomorphism. The best-bet thesis states that “in a world of chronic uncertainty about the nature of the world, guessing constitutes a good bet on something or to an event that has a human cause: we gain much if we are right and we usually lose little if we are wrong” (Guthrie, 1997) in DiSalvo and Gemperle (2003).

1.1.4 Social Thesis

Caporaël and Heyes (1997) put forth a theory of anthropomorphism in a term Species-Specific Group-Level Coordination System, which was then translated to social thesis. This thesis claims the psychological discussion of anthropomorphism is not neutral but is in fact value laden and defines our interaction with the environment. “From this perspective, attributing human characteristics to animals is a way of changing the values we place on them and how we can behave towards them”. In the social thesis, the act of anthropomorphizing reflects values and possesses the potential for social consequence (DiSalvo & Gemperle, 2003).

1.1.5 Object-Subject Interchangeability

The concept of object-subject interchangeability proposes that people attribute meaning to other people and objects in the construction, adaptation and maintenance of the self. The distinction between the influence of other people and objects is not always firm. Anthropomorphism may be used to attribute a human-like quality to an object that has particular salience in defining who we are individually or culturally (Jackson, 2002) in DiSalvo and Gemperle (2003).

1.1.6 Phenomenological Intersubjectivity

The concept of phenomenological intersubjectivity proposes that anthropomorphism is a reflection of how we experience and order the world. This concept argues that the objects that we experience seem to be animated by human consciousness and will. This causes the distinction between self and other to be blurred. Hence,

anthropomorphism is a pragmatic response to such objects in order to make sense of them (Jackson, 2002) in DiSalvo and Gemperle (2003).

1.2 Van Fraassen (VF) Pragmatic Theory of Explanation

VF theory of explanation is essentially a theory of why-questions. According to Van Fraassen, formulating a theory of explanation poses two main problems:

- the provision of an account of justifiable rejection of explanation-request, and
- the accounting for the asymmetries of explanation.

To this end, he takes explanation as a ternary relationship that holds between theories, facts and contexts.

Why-questions and their answers are individuated relative to a context. The point of construing a contextual analysis of explanation is to put the concept of explanation on grounds that are respectable from an empiricist standpoint. VF takes the “received view” as characterizing explanation as a relationship between theory and fact. This cognition ends up to the existence of causal relationships beyond the observable phenomena.

1.3 Objectives of the Study

This study attempted to analyze the students’ affordance of teleological explanations and anthropomorphic language in eliciting select concepts in Physics.

Specifically, it sought to find explanations of the following:

- What is the extent of the students’ preconceptions on select concepts in Physics as a result of their affordance of teleologic-anthropomorphic reasoning?
- Do classroom pedagogical interventions correct the students’ affordance of teleologic-anthropomorphic reasoning on select concepts in Physics?
- Which learning factor is associated with the students’ affordance of teleologic-anthropomorphic reasoning on select concepts in Physics?

2 METHODOLOGY

The Descriptive Research design was used in this study as it tried to gather data on the prevalence of teleologic-anthropomorphic languages of the respondents to select concept of Physics. This research design fits best in studies which aim is to describe the nature of situations as it exists at the time of the study and to explore the cause of a particular phenomenon. The Explicative-Reductive Method was employed in this study focused on the students’ affordance of teleologic-anthropomorphic reasoning to select concepts of Physics: Kinematics, Dynamics, Statics and Introduction to Thermodynamics. The Explicative Method was used to account a context encompassing variables and qualities attributed to the problem. This paved for the determinant of the students’ affordance on teleologic explanations and anthropomorphic language of the respondents. On the other hand, the Reductive Method was used to elicit potential variables of the identified context for enrichment and further analysis.

It involved a systematic investigation using pre-assessment results, formative evaluations, interview and questionnaire as predominant methods of data collection. Corroboration of findings, vis-à-vis with the identified norms of the context of the study, was used to conclude on the students’ affordance of teleologic explanation and anthropomorphic language on select concepts of Physics.

The respondents of the study were the 48 students of the author in Physics 1 at AMA International University in the Kingdom of Bahrain, second trimester, AY 2013. There were 23 students in the age group 16 – 17, 18 for the age group 18 – 19, and 7 for the age group 20 and above.

T-test was used to differentiate the occurrence of teleologic understanding and anthropomorphic language to select principles in Physics before and after classroom pedagogical interventions. Pearson-r correlation and Pearson chi-square were used in determining the relationship of select variables to their affordance of teleologic explanations and anthropomorphic language. Analysis of Covariance (ANCOVA) results were utilized to determine which of the variables in the grouping variables used is cogently discriminated in the process.

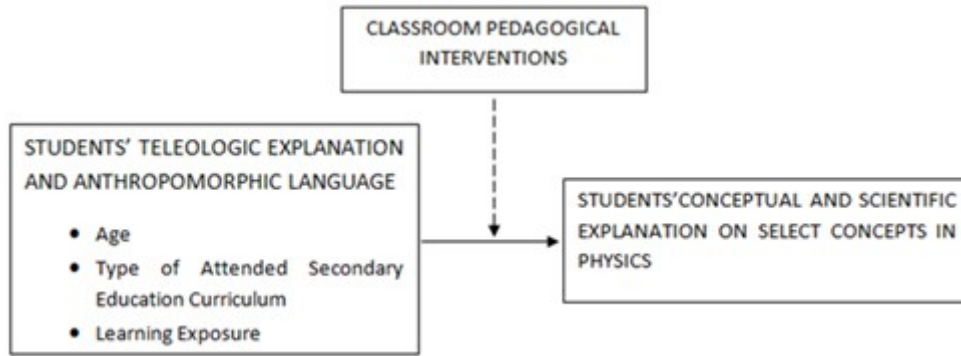


Figure 1. Research Paradigm

Presented in Figure 1 is the paradigm of the study. It made use of the assumptions that teleologic explanation and anthropomorphic language of the students are influenced by their age and learning exposure. Moreover, it also assumes that their learning exposure is dependent on the type of their attended secondary education curriculum. In this set up, there were 2 curricular orientations which the respondents were grouped of: English and Arabic. The English curriculum was used by the International and Private Schools, and the Philippine School-Bahrain while the Arabic Curriculum was the public Science Curriculum. The science program of the English curriculum differs significantly from the Arabic curriculum in the following aspects:

- all students are required to take science subjects in the English curriculum: Earth Science, Environmental Science, Biology, Chemistry and Physics. On the other hand, not everybody in the Arabic curriculum were required to take science as the content of their curriculum depends on their assessed inclination: Technical, Language and Arts, and Science. Only the qualified students in Science were required to do science courses in their secondary education like Earth Science, Environmental Science, Biology, Chemistry and Physics;
- English is the medium of Instruction in the English Curriculum while plain Arabic is the medium of instruction in the Arabic Curriculum.

These variables were believed to be the respondents' input on their affordance of teleologic explanation and anthropomorphic language on select concepts in Physics.

On the other hand, the teleologic explanation and anthropomorphic language of the respondents were expected to be corrected by classroom pedagogical interventions. The interventions made were multimedia presentations, classroom interactions and online discussions in the university online portal (both synchronous and asynchronous) to complement the designed laboratory experiments in honing their competencies in the subject. These cognitions helped them formulate new concepts and scientific explanations on select concepts in Physics: Kinematics, Dynamics, Statics and Thermodynamics.

3 RESULTS AND DISCUSSION

Age	Frequency	D.I.	Topics	D.I.	Frequency	Curriculum
16-17	1.65	M	Kinematics	L	1.19	English
18-19	1.67	M		H	2.96	Arabic
20 and above	2.96	H				
16-17	1.03	L	Dynamics	L	1.21	English
18-19	2.56	M		H	2.93	Arabic
20 and above	2.98	H				
16-17	1.37	L	Statics	L	1.33	English
18-19	1.05	L		H	2.64	Arabic
20 and above	2.64	H				
16-17	0.96	L	Thermo-dynamics	L	1.43	English
18-19	1.25	L		M	2.36	Arabic
20 and above	2.45	M				

L – Low; M – Moderate; H – High

Table 1. The General Preconceptions of the Students on Select Concepts in Physics as a Result of their Affordance on Teleologic-Anthropomorphic Reasoning

Presented in Table 1 are the general preconceptions of the student-respondents as a result of their affordance on teleologic-anthropomorphic reasoning abilities in eliciting concepts in Physics.

Using questions forming generalizations on select topics of Kinematics, Dynamics, Statics and Thermodynamics, students' teleologic-anthropomorphic reasoning was determined. It can be said that the students' who had just completed their secondary education had the least affordance of teleologic-anthropomorphic reasoning when compared to their counterparts.

Concomitantly, the students who completed English curriculum in their Secondary Science Program had the least affordance of teleologic-anthropomorphic reasoning when compared to their counterparts who had the Arabic curriculum. This phenomenon can be attributed to the fact that the medium of instruction used in the present study is English. This attribution is believed to be useful as students who have both the linguistic and semantic competences in English can easily infer on phenomenon and validate generalizations based on facts. Astutely, Piaget's Cognitive Development posits that language is contingent to the cognitive development of a learner.

Concept	Before-After	Mean	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)
1	10-4	.125	.334	.048	2.591	47	.013*
2	15-5	.208	.410	.059	3.517	47	.001*
3	28-20	-.167	.377	.054	3.066	47	.004*
4	12-4	.167	.377	.054	3.066	47	.004*
5	34-21	-.271	.449	.065	4.178	47	.000*
6	20-6	.292	.459	.066	4.399	47	.000*
7	48-40	-.167	.377	.054	3.066	47	.004*
8	40-10	.625	.489	.071	8.851	47	.000*
9	35-20	-.312	.468	.068	4.622	47	.000*
10	12-8	.083	.279	.040	2.067	47	.044*
11	35-10	.521	.505	.073	7.148	47	.000*
12	38-6	.667	.476	.069	9.695	47	.000*
13	25-5	.417	.498	.072	5.794	47	.000*
14	19-7	.250	.438	.063	3.958	47	.000*
15	37-0	.771	.425	.061	12.573	47	.000*

* significant at .05 level of significance

Table 2. Comparison of the Students' Anthropomorphic Explanations in Physics

Presented in Table 2 is the comparison of the students' anthropomorphic explanation to select concepts in Physics. Using the assumption that anthropomorphic explanations are correctible, students' were asked to explain the 15 abstract concepts in Physics before and after classroom pedagogical interventions. The concepts used in this study were the following: 1 – Position and Speed, 2 – 4 Velocity and Acceleration, 5 – 9 Forces and Motion, 10 – 12 Momentum and 13 – 15 Thermodynamics. Among the concepts used in eliciting their anthropomorphic explanations were the following: 1 – Position vs Speed. When objects are in the same position, they got the same speed; 2 – 4. Velocity vs acceleration. The same velocity means the same acceleration; Constant velocity is zero acceleration; and Velocity is absolute and not dependent on the frame of reference. 5 – 9. Forces vs motion: Zero acceleration is a zero net force; The greater the angle of an applied force to a body, the greater is its resolved magnitude in the x-axis; Taken at x-axis, the resolved magnitude of a given force is inversely proportion to its angle of application; direct proportion is observed in the y-axis; Inert forces do not make sense on the body's motion; and For a net force to point upward, the upward force must exceed the downward force, i.e. the normal force has to be greater than the weight (mg) of the ball. 10 – 11. Momentum: Moving masses in the absence of gravity do not have momentum; Conservation of momentum applies only to collisions; and The center of mass of an object must be inside the object. 13 – 15. Thermodynamics. A cold body contains no heat; An object has no mass at absolute zero; and Heat and temperature are the same thing. All these had formed part in the students' teleologic explanation and anthropomorphic language of the students in the subject. These explanations and language when not corrected would eventually hamper their knowledge and understanding on select content and concepts of the subject.

Using dependent t-test, it shows that anthropomorphic explanations of students to abstract concepts differ significantly before and after the classroom treatment. It shows that the t-values of the 15-stems made a significant difference at .05 level of significance. Concept 10 on Momentum (Moving masses in the absence of gravity do not have momentum) was found in lesser significance when compared to the concepts contained in the study as it earned a p-value of .044. Concomitantly, the rest of the concepts yielded highly to very highly significant difference. It can be said, therefore, that there is a significant difference on the anthropomorphic explanations of the students before and after classroom pedagogical interventions. Hence, the null hypothesis, which states that there is no significant difference on the anthropomorphic explanations of the students before and after classroom pedagogical interventions, is hereby rejected.

This phenomenon is likened to the explanation on the effects of pedagogical advancements in stimulating students' cognition in redirecting their teleologic reasoning and understanding to learning abstract principles in science (Taber, 2008). Central assumptions in learning science were encapsulated through the following tenets

- Learning science is an active process of constructing personal knowledge;
- Learners come to science learning with existing ideas about many natural phenomenon attributed to their mental readiness and cognition;
- The learner's existing ideas have consequences for the learning of science;
- It is possible to teach science more effectively if account is taken of the learner's existing ideas;
- Knowledge is represented in the brain as a conceptual structure;
- Learner's conceptual structures exhibit both commonalities and idiosyncratic features; and
- It is possible to meaningfully model learners' conceptual structures. Hence, teleologic and anthropomorphic languages are really correctible.

<i>Source</i>	<i>Type III Sum of Squares</i>	<i>df</i>	<i>Mean Square</i>	<i>F</i>	<i>Sig.</i>
Corrected Model	468.323 ^a	6	78.054	17.305	.000*
Intercept	2.365	1	2.365	.524	.473
Teleologic and Anthropomorphic Affordance	42.432	1	42.432	9.407	.004*
Age	3.562	2	1.781	.395	.676
Curriculum	22.946	1	22.946	5.087	.030*
age * curriculum	22.432	2	11.216	2.487	.096

a. R Squared = .717 (Adjusted R Squared = .675)

Table 3. Tests of Between-Subjects Effects of Classroom Pedagogical Interventions on the Students' Affordance of Teleologic and Anthropomorphic Language in relation to their Age bracket and Curricular Exposure

Presented in the foregoing table are the tests of between-subjects effects of classroom pedagogical interventions on the students' affordance of teleologic and anthropomorphic languages in eliciting concepts of Physics.

It was found out that there is a significant difference on the students' affordance of teleologic and anthropomorphic languages after various classroom pedagogical interventions had been introduced: F-value of 9.407 and a p-value of .004, at .05 level of significance. Hence, it can be said that teleologic and anthropomorphic languages can be corrected as student-learners are confronted with various classroom pedagogical interventions.

The interactions of the classroom pedagogical interventions to the respondents' affordance of teleologic and anthropomorphic languages were also analyzed when the respondents were grouped according to their age and curricular undertakings: F-values of .395 and 5.087, and p-values of .676 and 0.030, at .05 level of significance, respectively. Hence, it can be said that in this study, anthropomorphism is not reduced as one ages but it is depended on the nature of the curriculum attended. Hence, it can be said that teleologic and anthropomorphic language is dependent on the nature of the educational training and academic exposure. This phenomenon could be attributed to the fact that the students who were exposed to the English language could elicit better ideas over their counterparts who were exposed to Arabic instruction.

It may be noted, however, that the impact of the classroom pedagogical interventions is moderately high considering that the coefficient of determination indicated by the adjusted R-squared is 67.5 %. This means that the pedagogical interventions done in the subject account for 67.5 % of the variability in the teleologic and anthropomorphic reasoning of the students. It is construed then that there are other important variables or factors that affect the students' teleologic and anthropomorphic reasoning, e.g., cognitive and metacognitive abilities, attitude and motivation in learning Physics.

Table 2 likewise presents the interaction between classroom pedagogical interventions and the age and curricular undertakings of student-respondents. It presents the impact of the interventions done in the study: F-value of 2.487 and p-value of .098 at .10 level of significance. These results were analyzed using the estimated marginal means with a covariate value of 7.92 as shown in Figure 2.

Figure 2 presents the relationship of the estimated marginal means of the post-affordance results and the age of the respondents' concomitant to their curricular undertakings. The result of the post-test mean score is evaluated with the pre-affordance covariate value of 7.92. It presents that the students who were exposed to the English curriculum had the least affordance when compared to their Arabic counterparts across age brackets. Concomitantly, the interaction is highly evident to the affordance of the respondents at the age bracket of 20 and above.

These findings support the claim of Kelemen and Rosset (2009) when they said that educational procedures and learning exposures alleviate the learner's tendency to anthropomorphize. On the other hand, Dorion (2011) concluded that anthropomorphic utterances are formed subsets of students' alternative responses brought about by their intuitions and metacognitions. He further concluded that students use their prior knowledge in a

range of self-reflexivity in their abilities to anthropomorphize. Hence, the typology and heuristics of conceptual thinking among students must also be considered. Leboe and Whittlesea (2002) concluded that the human mind has evolved heuristics by using its prior experiences in bridging the missing, lost and damaged in a framework of conceptual thinking and understanding. It is in this context that the human mind conceptualizes and re-conceptualizes concepts based on his experiences and available explanations within his schema.

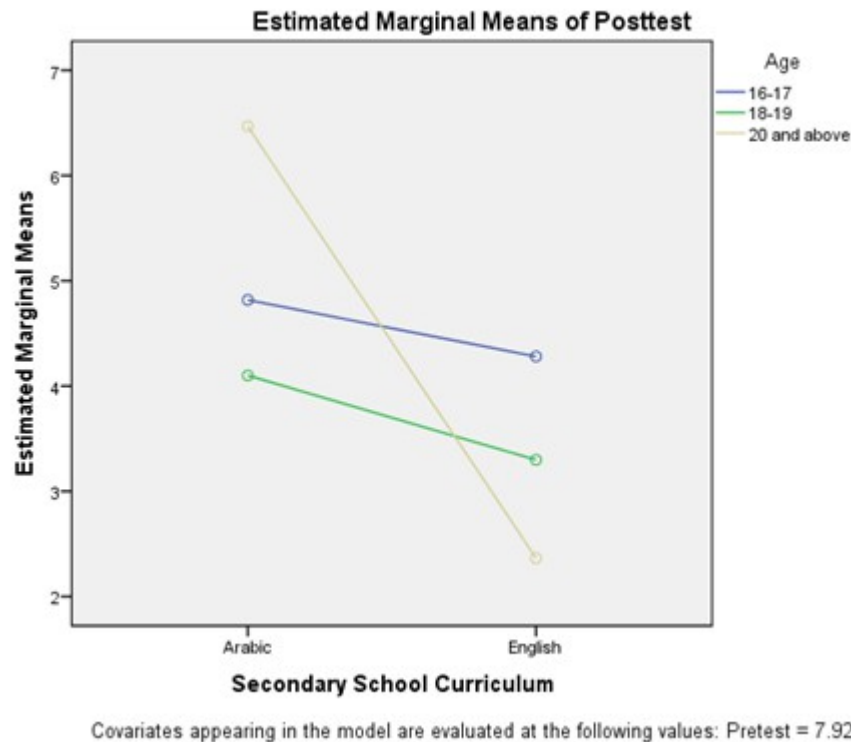


Figure 2. Estimated Marginal Means of Between-Subjects Effects of Classroom Pedagogical Interventions on the Students' Affordance of Teleologic and Anthropomorphic Language in relation to their Age and Curricular Exposure

On the other hand, the theories of anthropomorphism explicate well the transition of the different levels of understanding that leads a person formulate his central schema of thinking and reasoning. Corollary to Piaget's Cognitive Development Theory, these beliefs, which are innate to the person, become his central schema in formulating a pragmatic explanation to a certain phenomenon. The theory explicates further the nature of a person's conceptual knowledge and understanding and how he comes to gain, create and apply it to various mental exercise and activities. Cognitive development, in this sense, is a progressive restructuring of intellectual progressions as a result of the learner's biological maturation and environmental experiences. Learners construct a conceptual understanding on phenomena that takes place around him through his experiences and to what he already knows. They also tend to discover understanding through his environment. Hence, the theory conjectures the idea that cognitive development happens at the center of human organism and language is dependent to cognitive development.

Therefore, it can be said that teleologic-and-anthropomorphic affordance to elicit concepts in Physics forms a dichotomy of understanding: a springboard to develop a scientific explanation as one is exposed to further studies and explanation. Taber and Watt (1996) hypothesized that anthropomorphism is just a stage in the development of an understanding. This affordance is expected to diminish as other levels of explanation become available (cognitive and metacognitive understanding).

Age		Teleologic Explanations and Anthropomorphic Languages of the Respondents	Curriculum	
.731**	Pearson Correlation		Pearson Chi Square	-.308*
.000	Sig. (2-tailed)	Sig. (2-tailed)	.033	

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Table 4. The Attribution of the Students' Teleologic Explanations and Anthropomorphic Languages to their Age and Curricular Undertakings

Presented in Table 4 is the attribution of the students' teleologic and anthropomorphic languages to their age bracket and curricular undertakings.

As can be gleaned on the table, the teleologic explanations and anthropomorphic languages of the student-respondents are attributed to their age and curricular undertakings: r-value of .731 and X^2 of -.308, and p-values of <.001 and .033, at .01 and .05 levels of significance, respectively. This means that their teleologic explanations and anthropomorphic languages are dependent to their age and educational undertakings. It can be construed further that students hold their teleologic and anthropomorphic beliefs as they ages but is correctible once exposed to constructive learning environment which reshapes their learning and understanding. These results confirm the assumption of the study which says that teleologic explanations and anthropomorphic languages of students are related to their age and educational training and exposure.

4 CONCLUSIONS

Based on the foregoing results, the following are concluded:

- Newly graduates of high school and the English curriculum had the least affordance of teleologic explanations and anthropomorphic languages;
- teleologic explanations and anthropomorphic languages are correctible through constructive training and exposure to academic learning environment;
- teleologic explanations and anthropomorphic languages of students are related to their age and educational training and exposure.

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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 at AMA International University - 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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