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Perceptions and Predictors of Science Motivation Under the Realm of Self-Determination Theory Among Grade 10 Public School Students

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ABSTRACT

This research was aimed at finding out the perceptions and predictors that motivate students to study science under the realm of Self-Determination Theory (SDT). Results revealed that students have average perception of satisfaction in terms of personal-related factors such as autonomy, competence and relatedness and high level of intrinsic motivation in terms of science motivation. Multiple linear regression analysis showed that teacher's competence, parental support, teacher's classroom management and autonomy have been found to significantly predict science motivation. Intrinsic motivation emerged as best predictor of student's intention to take Science, Technology, Engineering and Mathematics (STEM) course.

Keywords: *science motivation, intrinsic motivation, self-determination theory, autonomy, competence, relatedness*

INTRODUCTION

One of the most potent factors that educators can consider in improving student's learning is motivation. Understanding the determinants that affect student's motivation to study science is crucial for reforming school program, improving learning, and boosting career choice. Factors such as autonomy, competence, and relatedness which according to some psychologists, are all personal-related universal necessities needed by an individual to be motivated and eventually succeed in life (Deci et al., 2001). The widely researched Theory of Self-Determination proposed by Deci and Ryan supports this notion. Glynn et al., (2009) also points that intrinsic motivation, self-efficacy, self-determination, grade motivation and career motivation are all theoretical constructs that relate to student's science motivation. Social-related factors such as teacher's influence (Furrer et al., 2014), attitude, and classroom management can be strong motivators. School's facilities like library (Gbemi-Ogunleye, 2016) and laboratory (Akande, 2017), parents' involvement and support (Katz, 2011) and internet, gadgets (Silius, 2010; Boyer, 2009) and student's exposure to science inventions can be potent social-related motivators.

This study was conducted to find out the perceptions of the respondents towards personal-related factors of science motivation in terms of autonomy, competence, and relatedness and determine the level of science motivation in terms of intrinsic motivation, self-efficacy, self-determination, grade motivation, and career motivation. It also aimed to discover whether the social-related factors such as the teacher, school, parent, media, and the personal-related factors such as autonomy, competence, and relatedness significantly predict science motivation. This study also sought to shed light which among the components of students' science motivation significantly predict students' intention to take STEM.

METHODOLOGY

Locale, Population and Time of Study

This study was conducted in Tablas Island, Province of Romblon. The respondents were grade 10 students randomly selected from 9 municipalities where the 23 public secondary schools were located namely Odiongan, San Andres, Calatrava, San Agustin, Sta. Maria, Alcantara, Santa Fe, Looc, and Ferrol from October 2017 to December 2017 (Table 1).

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Instruments Used

Basic Psychological Need Satisfaction Scale (PNS). It is a 21-item instrument developed by (Deci & Ryan, 2000). It was used to assess the autonomy, perceived competence and relatedness of student. The questionnaire addresses need satisfaction. It is calculated by computing three subscale scores, one for the degree to which person experiences satisfaction of each of the three needs. This is done first by reversing scores of all items that are worded in a negative way (i.e., the items below with (R) following the items number). To reverse score an item was simply subtracted from 8. Thus, for example, a 2 would be converted to a 6. Once the scored items have been reversed, simply average the items on the relevant subscale were averaged. They are:

Autonomy: 1, 4(R), 8, 11(R), 14, 17, 20(R)
Perceived Competence: 3(R), 5, 10, 13, 15(R), 19(R)
Relatedness: 2, 6, 7(R), 9, 12, 16(R), 18(R), 21
The scale is:

1	2	3	4	5	6	7
Not at all true		Somewhat true			Very True	

Table 1. Population and Respondents of the study by school.

Name of School	Population	Number of Respondents
Alcantara National High School	208	26
Buenavista National High School	65	8
Cabolutan National High School	44	6
Calatrava National High School	160	20
Carmen National High School	51	6
Eduardo Moreno National High School	56	7
Esteban Madrona National High School	99	13
Ferrol National High School	85	11
Guinbirayan National High School	99	13
Libertad National High School	130	16
Looc National High School	425	54
Mayha National High School	71	9
Melodias Imperial National High School	30	4
Odiongan National High School	303	38
Pascual Catajay National High School	37	5
San Agustin National High School	96	12
San Andres National High School	201	26
Sta Maria National High School	101	13
Sta Fe National High School	232	29
Sto Niño National High School	46	6
Tanagan National High School	101	13
Tranquilino Cawaling National High School	49	6
Tugdan National High School	60	8
Total	**2,749**	**349**

Science Motivation Questionnaire (SMQ). It is a 25-item instrument developed by Glynn (2011), which will better understand about what and how students feel about science courses or subjects. It contains statements or items about intrinsic motivation, self-efficacy, self-determination, grade motivation and career motivation. The scales were 4-Always; 3-Often; 2-Sometimes; 1-Rarely; and 0-Never.

Social Factor Questionnaire. It is a self-made instrument used to measure the perceptions of students towards the social factors of science motivation. The indicators were taken from other materials relevant to the study. The rating scales are 4-Strongly Agree, 3-Agree, 2-Disagree, and 1-Strongly Disagree. The questionnaire was subjected to validation by experts and reliability test using Cronbach's Coefficient Alpha.

Data Analysis

The descriptive quantitative method of research was used. Mean was used to determine the perceptions of the respondents towards personal-related factors and their level of science motivation. Since the two main constructs include perceptions-BPNSS tool and predictions, multiple linear regression analysis (MLRA) and logistic regression were used. The MLRA was used to determine which social and personal-related determinants such as teacher, school, parent, media, autonomy, competence, and relatedness best predicts the science motivation of students while logistic regression was used to assess which among components of science motivation significantly predict student's intention to take Science, Technology, Engineering, and Mathematics (STEM) course/track.

RESULTS AND DISCUSSION

Perceived Satisfaction of the Respondents in Terms of Autonomy, Competence and Relatedness

In general, grade 10 students were satisfied with the personal-related factors such as autonomy, competence, and relatedness (M = 4.35, SD = 1.69). Most of the students are generally open in expressing their ideas and opinion while some felt the need of following what others have told them to do. In addition, students feel satisfied with their competence in learning science through developing interesting new skills. However, it should also be noted that there are some students who felt that they were not able to showcase their full capabilities. Lastly, most of the students believed that people in their lives are concerned about their well-being while there are some who expressed negative relatedness towards other people.

Table 2. Level of satisfaction of the respondents on basic psychological needs in terms of autonomy, competence, and relatedness.

Personal-Related Factors		Mean	DI	SD
A. Autonomy				
1.	I feel like I am free to decide for myself how to live my life.	3.83	S	1.82
2.	I feel pressured in my life	4.41	S	1.80
3.	I generally feel free to express my ideas and opinions.	4.60	S	1.80
*4.	In my daily life, I frequently have to do what I am told.	3.76	S	1.62
5.	People I interact with on a daily basis tend to take my feelings into consideration.	4.28	S	1.47
6.	I feel like I can pretty much be myself in my daily situations.	4.17	S	1.72
*7.	There is not much opportunity for me to decide for myself how to do things in my daily life.	3.91	S	1.80
	Overall	**4.14**	S	1.72
B. Competence				
*1.	Often, I do not feel very competent.	4.61	S	1.49
2.	People I know tell me I am good at what I do.	4.19	S	1.72
3.	I have been able to learn interesting new skills recently.	5.18	MS	1.67
4.	Most days I feel a sense of accomplishment from what I do.	4.43	S	1.54
*5.	In my life I do not get much of a chance to show how capable I am.	4.13	S	1.62
*6.	I often do not feel very capable.	4.52	S	1.49
	Overall	**4.51**	S	1.59
C. Relatedness				
1.	I really like the people I interact with.	4.33	S	1.80
2.	I get along with people I come into contact with.	3.91	S	1.69
*3.	I pretty much keep to myself and don't have a lot of social contact.	4.37	S	1.80
4.	I consider the people I regularly interact with to be my friends.	5.04	S	1.72
5.	People in my life care about me.	5.26	MS	1.86
*6.	There are not many people that I am close to.	4.25	S	1.88
*7.	The people I interact with regularly do not seem to like me much.	4.45	S	1.56
8.	People are generally pretty friendly towards me.	4.86	S	1.76
	Overall	**4.56**	S	1.76
	General Overall Level of Satisfaction	**4.35**	S	1.69

Negative statement. Scored in reverse.

Legend:

Mean	Descriptive Interpretation (DI)
5.81 – 7.00	Very Satisfied (VS)
4.61 – 5.80	More Than Satisfied (MS)
3.41 – 4.60	Satisfied (S)
2.21 – 3.40	Partially Satisfied (PS)
1.00 – 2.20	Not At All Satisfied (NS)

Table 3. Level of science motivation of the respondents in terms of intrinsic motivation, self-efficacy, self-determination, grade motivation and career motivation.

Level of science motivation of respondents.		Mean	DI	SD
A. Intrinsic motivation				
1.	The science I learn is relevant to my life.	2.61	A	.92
2.	Learning science is interesting.	2.92	H	1.00
3.	Learning science makes my life more meaningful.	2.66	A	.96
4.	I am curious about discoveries in science.	2.84	H	1.03
5.	I enjoy learning science.	2.89	H	.98
	Over all	**2.78**	**H**	**.98**
B. Self-efficacy				
1.	I am confident I will do well on science tests.	2.58	A	1.02
2.	I am confident I will do well on science labs and projects.	2.51	A	.99
3.	I believe I can master science knowledge and skills.	2.28	A	.94
4.	I believe I can earn a grade of "100" in science.	2.15	A	1.08
5.	I am sure I can understand science.	2.62	A	.95
	Overall	**2.43**	**A**	**1.00**
C. Self-determination				
1.	I put enough effort into learning science.	2.63	A	.99
2.	I use strategies to learn science well.	2.50	A	1.00
3.	I spend a lot of time learning science.	2.35	A	.91
4.	I prepare well for science tests and labs.	2.36	A	.99
5.	I study hard to learn science.	2.72	H	.91
	Overall	**2.51**	**A**	**.97**
D. Grade Motivation				
1.	I like to do better than other students on science tests.	2.30	A	.96
2.	Getting a good science grade is important to me.	3.32	H	.94
3.	It is important that I get "100" in science.	2.54	A	1.22
4.	I think about the grade I will get in science.	2.85	H	1.00
5.	Scoring high on science tests and labs matters to me.	2.54	A	.98
	Overall	**2.71**	**H**	**1.02**
E. Career Motivation				
1.	Learning science will help me get a good job.	2.80	H	1.07
2.	Knowing science will give me a career advantage.	2.71	H	1.03
3.	Understanding science will benefit me in my career.	2.68	H	1.03
4.	My career will involve science.	2.38	A	1.10
5.	I will use science problem-solving skills in my career.	2.37	A	1.00
	Overall	**2.59**	**A**	**1.05**
	General Overall Level of Motivation	**2.60**	**A**	**1.00**

Legend:
Mean Descriptive Interpretation (DI):

2.68 – 4.00	High (H)
1.34 – 2.67	Average (A)
0.00 – 1.33	Low (L)

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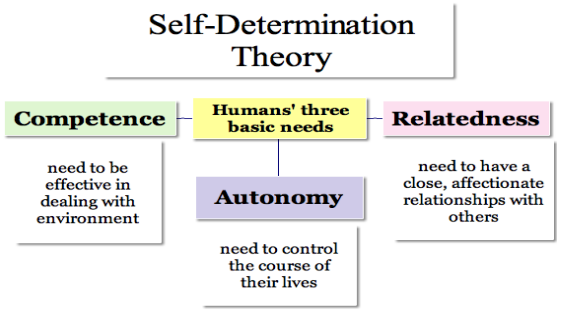

Figure 1. Deci and Ryan's Model of Self-Determination Theory (Deci & Ryan, 2000).

Overall, the results above implied that the grade 10 students are satisfied with what they feel about autonomy (*M* = 4.14, *SD* = 1.72), competence (*M* = 4.51, *SD* = 1.59) and relatedness (*M* = 4.56, *SD* = 1.76). This supports the Deci and Ryan's Self-Determination Theory (SDT), which explains that people have three basic innate psychological needs that are considered universal: autonomy, competence, and relatedness (Niemic & Ryan, 2009). Without satisfying these basic needs of students as what Abraham Maslow has also theorized in his Hierarchy of Needs, success in life cannot be possibly achieved. In Figure 1, the theory specifies that motivation can be achieved when autonomy, competence and relatedness are satisfied. (Lavigne, 2007). It is thru satisfying student's needs that will trigger self-determined behavior (Deci & Ryan, 2000).

Level of science motivation of the respondents in terms of intrinsic motivation, self-efficacy, self-determination, grade motivation and career motivation

Results in Table 3 indicate that the level of science motivation of grade 10 students is high in public secondary schools (*M* = 2.60, *SD* = 1.00). Based on the results, all the intrinsic factors given (Table 3) contributed to the motivation of students in learning science. Learners are more motivated especially if they find the subject interesting (*M* = 2.92, *SD* = 1.00) and relevant in their lives (*M* = 2.61, *SD* = 0.92). Moreover, self-determination (*M* = 2.51, *SD* = 0.97) helped a lot in increasing the motivation of learners. By giving more time in studying and learning science, it increased the confidence and competitiveness of students (*M* = 2.43, *SD* = 1.00). They tend to be more conscious with their grades as well as the grades of their classmates (*M* = 2.71, *SD* = 1.02). Lastly, the students believe that their knowledge in science will helped them in securing a job and advancing in their careers (*M* = 2.59, *SD* = 1.05).

It is interesting to note that intrinsic motivation (*M* = 2.78, *SD* = 0.98) was found to be the highest motivational variable. It is also the best predictor in grade 10 student's intention to take STEM course after graduation in high school which can be gleaned in Table 7. Highly controversial intrinsic motivation studies supported this finding. The study of Deci et al., (2001) emphasized that extrinsic rewards such as gold stars, best-student awards, honor roles, pizzas for reading, and other reward-focused incentive systems that have long been part of the currency of schools have demonstrated negative effects on students' intrinsic motivation to learn. Some studies have suggested that, rather than always being positive motivators, rewards can at tines undermine rather than enhance self-motivation. The studies of intrinsic motivation under SDT, strongly suggests that intrinsic motivation is a factor to develop self-determined behavior (Lavigne, 2007). Trenshaw (2016) pointed out that being intrinsically motivated means that a student has a sense of own free will to act out of own values (Deci & Ryan, 2000; Niemic & Ryan, 2009).

Multiple Linear Regression Analysis of the Social-Related Factors and the Personal-Related Factors

Table 4. Regression analysis of the social-related factors and the personal-related factors.

Model	Coefficients				
	B	Std. Error	Beta	t	Sig.
Constant	-.738	.246		-2.99	.003
Teacher's Competence	.434	.070	.342	6.236	.000
Parental Support	.270	.058	.216	4.647	.000
Teacher's Classroom Management	.251	.069	.199	3.643	.000
Autonomy	.090	.043	.089	2.099	.037

Legend:
Dependent Variable: Motivation, R = 0.642, R^2 = 0.413

To find out which factors significantly predict science motivation of grade 10 students, all the personal-related and social-related factors were regressed using the multiple linear regression analysis (MLRA). In Table 4, regression model shows that among the predictors of student's science motivation, only four factors significantly entered the regression equation. These are teacher's competence, teacher's classroom management, parental support, and autonomy. Teacher's competence, B = 0.434, *t* = 6.236, *p* = < *0.05*, parental support, B = 0.270, *t* = 4.647, *p* = < 0.05, teacher's classroom management, B = 0.251, *t*=3.643; *p* = < 0.05 and autonomy, B = 0.090, *t* = 2.099, *p* = 0.037<0.05.

The direction of relationship is positive thus, the predicted science motivation can be estimated using the following regression equation:

$$Predicted\ ScienceMotivation\ Score = -0.738 + 0.434 + 0.270 + 0.251 + 0.90.$$

Table 5. Analysis of Variance (ANOVA)

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	55.118	4	13.780	60.393	0.000[d]
Residual	78.489	344	0.228		
Total	133.607	348			

Results showed that for every unit increase in teacher's competence, parental support, teacher's classroom management and autonomy there is a corresponding increase of 0.434, 0.270, 0.250, and 0.090 in their science motivation score, respectively. Other social and personal factors which were reported to be also playing significant roles were not found to be significant predictors. The Analysis of variance (Table 5) and multiple regression analysis (Table 6) showed that the equation is highly significant, and that science motivation may be predicted or regressed from the four variables that entered the equation (R^2 = 0.413, F = 60.393, $p < 0.01$). This means that 41.3% of the variability in science motivation could be explained by the variables included in the above equation.

Several studies supported these findings. Brophy (2004) revealed that teacher's competence are significant predictors of science motivation. The core of professional science education is competence. In science education, teacher's competence is a key component of teacher's professionalism and competence, which lead to highly motivated students. The study of Zahedani et al., (2016) also supported that parental support is one factor that influence children's motivation to study. Students whose parents are interested in science perform better than students whose parents do not show interest (Tubingen, 2017). Teacher's classroom management has greater influences on student's science achievement (Cockman, 2002). Students are eager to learn, willing to undertake activities and attend classroom punctually and regularly if teacher's management style is effective.

Table 6. Multiple Linear Regression Model Summary

Model	R	R^2	Adjusted R^2	Std Error of the Estimate
1	0.572	0.327	0.325	0.50904
2	0.619	0.383	0.379	0.48828
3	0.636	0.405	0.400	0.48002
4	0.642	0.413	0.406	0.47767

Table 7. Logistic Regression predicting intention of students to take STEM course/track in Senior High School.

	B	**S.E.**	**Wald**	***df***	***p***	**Odds Ratio**	**95.0% C.I for Odds Ratio**	
							Lower	**Upper**
Intrinsic Motivation	.629	.269	5.458	1	.019	1.876	1.107	3.180
Self-Efficacy	.093	.293	.101	1	.750	1.098	.618	1.949
Self-Determination	.282	.325	.757	1	.384	1.326	.702	2.505
Grade Motivation	.072	.289	.063	1	.802	1.075	.610	1.894
Career Motivation	.529	.286	3.420	1	.064	1.698	.969	2.976
Constant	-4.972	.662	56.362	1	.000	.007	-	-

Effective teacher should plan adequate science activities to maintain the zeal or motivation of the class. It is recommended that teacher should endeavor to introduce motivation ideas related to science concepts like frequent debates and quiz competitions. In autonomy, the more teachers support students to participate in science activities, the more autonomously motivated they will be (Reeve, 2009). Several researchers concluded that autonomously motivated students has higher academic achievement (Black, 2000). Interestingly, students who has higher sense of autonomy were more likely to have higher motivation to learn science.

Predicting Intention of Students to Take STEM Course/Track in Senior High School (SHS)

Direct logistic regression assessed the impact of number of factors on the likelihood about student's intention to take STEM in Senior High School (SHS). The model contained five independent variables (intrinsic motivation, self-efficacy, self-determination, grade motivation and career motivation). The full model containing all predictors was statistically significant, X^2 (5, 349) = 64.971, $p < 0.001$, indicating that the model was able to distinguish between

respondents who intended and did not intend to take STEM in SHS.

It can be gleaned in Table 7 that only one of the independent variables made a unique statistically significant contribution to the model (intrinsic motivation), which reported and odds ratio of 1.876. This indicated that respondents' high intrinsic motivation were over 1.876 times more likely to take STEM course/track. In Tables 8, 9, and 10 the model explained between 17% (Cox and Snell R^2) and 23.3% (Nagelkerke R^2) of the variance in intention to take STEM, and correctly classified 72.2% of cases.

Table 8. Omnibus Tests of Model Coefficients

		Chi-Square	df	Sig.
Step 1	Step	64.971	5	0.000
	Block	64.971	5	0.000
	Model	64.971	5	0.000

Table 9. Model Summary

	-2 Log likelihood	Cox & Snell R^2	Nagelkerke R^2
Step 1	390.373[a]	0.170	0.233

Table 10. Classification Table

	Observed		Predicted		
			Intention to take STEM		Percentage Correct
			No	Yes	
Step 1	Intention to take STEM	No	193	31	86.2
		Yes	66	59	47.2
		Overall Percentage			72.2

Discussing further, these findings may be brought about by grade 10 student's exposure in numerous computer-related and advanced science activities which are interesting, enjoyable, and challenging in public secondary schools in Tablas Island. Intrinsic motivation has something to do with individual's satisfaction and enjoyment in doing an activity (Deci et al., 2001). Most grade 10 students are enjoying and highly engaged in science–related computer technologies today (Hassan, 2012). Intrinsically motivated people intend to take science-related courses out of interest and innate satisfaction. In fact, tangible rewards like grades and money do indeed have a substantial undermining effect (Deci et al., 2001). Intention of students to take STEM course is significantly related to intrinsic motivation as described by Deci and Ryan where autonomy, competence and relatedness are considered as fuel for action to satisfy one's innate needs (Deci & Ryan, 2000).

Niemic and Ryan (2009) and Deci et al., (2001) described intrinsic motivation as the desire of every man to enjoy while working. Glynn (2011) explained that intrinsic motivation is student's inherent satisfaction to learn science by his own. In other words, individual or student's intention to take STEM course as in the case of grade 10 students to enter the Senior High School in Tablas Island are decisions or forces not externally dictated by others but by their own choice.

Finally, Hassan (2012) and Pascual (2014) concluded that students with high levels of interest in science thru teacher's support will most likely pursue their study on science and mathematics careers. Students who have high motivation in learning science will most likely pursue science career or intend to take STEM course/track.

CONCLUSION

Based on the results of the study, grade 10 students in Tablas Island have an average perception of satisfaction in terms of their personal-related factors such as autonomy, competence, and relatedness. The level of science motivation is high in intrinsic motivation and grade motivation. Teacher's competence, parental support, teacher's classroom management and autonomy have been found to significantly predict science motivation of students.

Among the components of students' science motivation, intrinsic motivation best predicts students' intention to take STEM-related courses in college. To improve students' intrinsic motivation, concerned authorities and professionals in the field of education should conduct forum and seminars on Self-Determination Theory which will empower students how to satisfy basic psychological needs such as autonomy, competence, and relatedness. On the other hand, intrinsic motivation, and grade motivation, should be maintained. Regarding the findings that teacher's competence, parental support, teacher's classroom management, and autonomy significantly predict science motivation, school officials should recruit competent teachers to handle and manage STEM courses/strands thereby improving science motivation of students.

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CONFLICT OF INTEREST

The Author declare that there is no conflict of interest.

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