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Predicting Students' Conception in Physics using the Eccles et al. Expectancy-Value Model

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Abstract: Aspiration in the field of science intrinsically motivates students in their academic study. Students' participation in science activities develops their interest to engage in the field of STEM. Similar to that assumption, this study was designed to analyze the relationship of students' conception in physics to students' expectancy-value of interest. The result of the IRISQ test was correlated to the result of the FCI test to establish connection between students' perception and conception in physics. To identify specific factors that affect students' interest in their study, the expectancy-value of interest clustered into eight indicators were correlated to each other. There are 143 university students who participated in the study. All participants of the study were currently enrolled in Physics 2 and have finished Physics 1A which covered topic in Newton's Law of Motion. The instruments used in the study are the IRIS Q test derived from Eccles et al. Expectancy-Value Model and the FCI test. Both were reliably and validly tested from previous study. The result of the study showed that expectation-value of interest is positively correlated with the students' conception in physics. This shows that expectation-value of interest influence students' development of concept hence motivates them to participate actively in science activity and engage in different learning condition.

Keywords: Eccles et al. Expectancy-Value Theory, intrinsic motivation, and conceptual change

1. INTRODUCTION

Many have given attention on the importance of students' participation in Science, Technology, Engineering and Mathematics (STEM). People are now engaged with activities which have something to do with Science and Technology (S&T). These activities evidently influence people how they do their work, how they make themselves healthy, how they communicate, and how they think effectively. One of the main objectives is how to improve students' participation in the field of STEM. A person who is in the process of choosing career need to consider if the content of the study is interesting, if solving problems is enjoyable, and whether science identity is comfortable (Bøe & Henriksen,2013). Aside from that, students currently under the STEM program have the notion whether this field will lead them to an exciting and high wage career. This assumption in choosing science is one reason why young people move towards or away from science study (Cleaves, 2005). Previous work and study shows that students' participation in the field of STEM is higher for those who established high interest in this field of study. Students' positive perception motivates them intrinsically to engage in learning activities that lead them to acquire new concepts needed to process new knowledge. To analyze the relationship between the student's interests in the field of STEM and to the development of their conceptual understanding in the learning process, the Eccles et al. Expectancy-Value Model of achievement-related choices was used as a framework of the study (Eccles, Vida, Barber, 2004). The analysis of students' educational choice involves measurement of the identity of each student. Individual identity provides relevant information of one's behavior which predicts the interest and motivation of an individual. Although the Eccles et al. Expectancy-Value Model provides valuable insight about people's interest in general, this study will focus mainly on the use of the model in evaluating student's educational choice relative to their conceptual understanding in physics. Decision making process with regards to individual educational choice is broad and complex. In the field of psychology the educational choice of an individual was linked to the personality of the person (Krapp, 2002). Young's people educational choice is also explained by a person's socio-economic status. Study showed that middle class people perform slightly higher than lower class and upper class people. Various initiatives was been developed before just to enhance students' educational motivation in their study. The Eccles et

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al. Expectancy-Value Model imply that self-value also known as subjective task-value is clustered into interest-enjoyment value, attainment value, utility value, and cost relation (Osborne, 2008). This implies that the Eccles et al. Model of Achievement-Related Choices describe individual's assumption of success. This is consistent with the findings that male prefer STEM than female students. The model also shows that individual self identity create young people expectation of success which predict individual choice and decision in STEM.

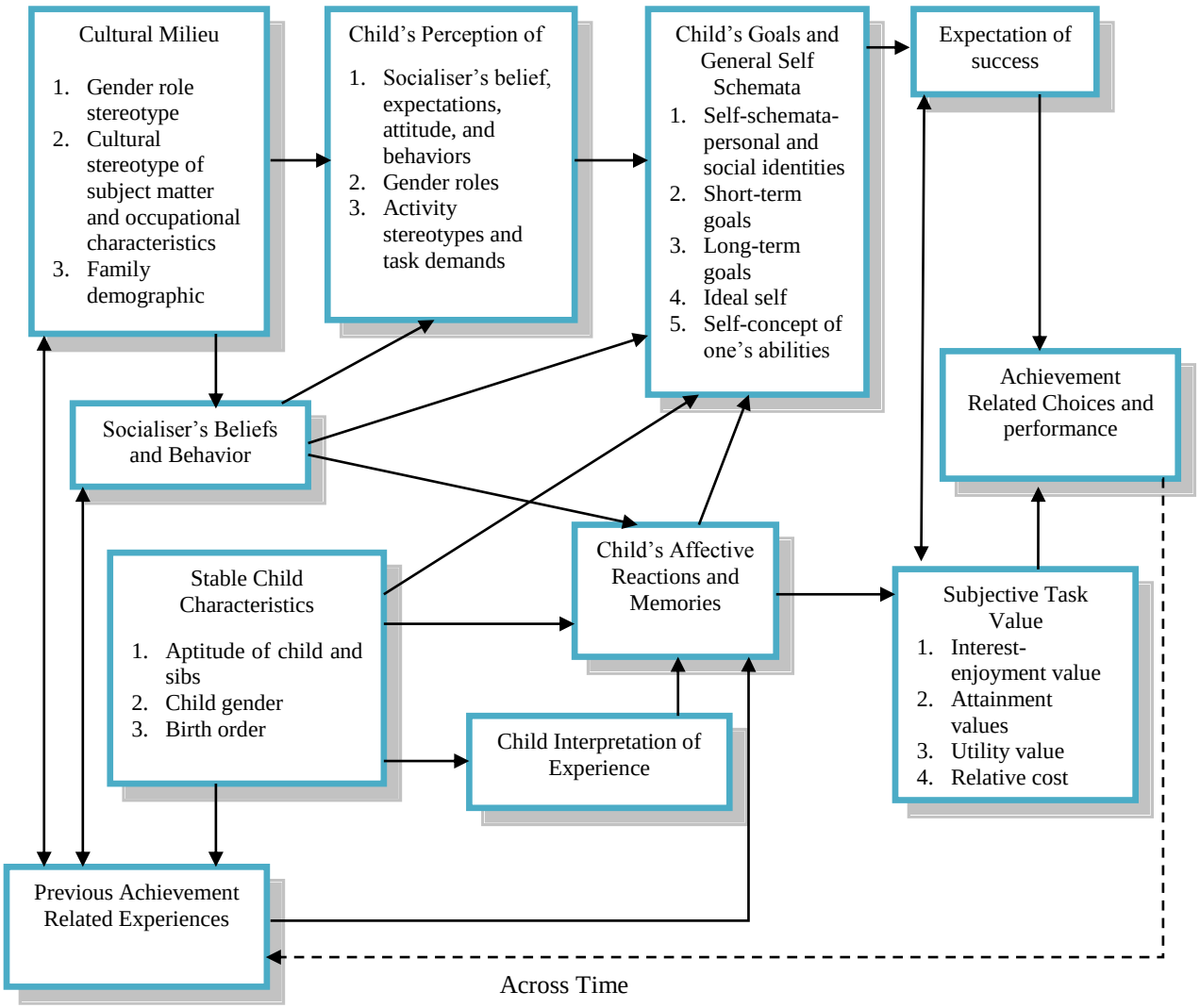

Figure 1. Eccles and Wigfield (2012) Model of Achievement-Related Choices

The association between educational choice and expectation value was been studied before using the Eccles et al. Model of Achievement-Related Choices. Groups of students from fifth grade to ten grades were surveyed using longitudinal study (Archer, DeWitt, Osborne, Dillon, Willis, & Wong, 2010). Similar with other study, findings always shows that expectation-value is related to educational preferences which predicts the choice of an individual to STEM (Simpkins et al.). It shows that those students who participated frequently in science-related activities show positive value-expectation and showed good performance in science. Aside from that, similar

study showed that individual interest, confidence is related to how students perform in class. Findings showed that high academic performance is common to those who established high interest and confidence in their study and tend to precede more in advance studies. Study about individual interest in STEM can be based on the Eccles et al. Model since its construction is based significantly in many observations and academic experiences in the field behavioral psychology (Hazari, Sadler, Tai, 2008). The Eccles et al. model become one of the guide used in the construction of IRISQ (Interest and Recruitment in Science Questions) survey which was developed to study how individual choose STEM as students' preferences in their study (Lloyd, Walsh, Yailagh, 2005). Moreover, the structural component of the Eccles et al. Model can be utilized to analyze the connection of students' interest to science to their conception and learning development. In some other related studies, results shows that expectation of success and subjective goal values are the possible factors that contribute to education choice of an individual. Using the Eccles et al Model as a framework of study is much adequate and suitable to the current problem since the psychological and sociological aspect of the person is considered on its components. Psychosocial is considered in the construction of model because individual identity is related to academic preferences of a person. The model implies that individual decision about education preferences can undergo changes based on the identity of the person developed due to social interventions (Angell, Guttersrud, Henriksen, & Isnes, 2004). This happened when students decide to transfer to other academic work during the time of their course work study.

1.1 Attitude and Interest in Science

It is necessary to consider attitude when studying the behavior of an individual. Individual attitude about a certain things can be due to feelings towards things. Attitudes are form based on judgment and reaction to a certain intervention. Moreover, attitude is parts of behavioral development which is responsible in choice and decision making. This implies that a person reaction and feeling to things can result to change in behavior of the person which also affects the cognitive and affective aspect of the person. Relative to this notion, the study will focus on students' attitude and its strength in science particularly in physics and its connection to students' conception in physics (Meece, Wigfield, Eccles,1990). In a contextual reality, it is quite difficult to evaluate individual attitude without considering the behavioral identity of the person. This means that attitude can be inferred directly through behavioral measure using valid and reliable instruments. However, there are inadequate instrument conventionally implemented which was not been properly evaluated. Furthermore, the study of students' attitude toward science is related to students' enrollment (Bennett, & Hogarth, 2009). Thus, science attitude is related to students' academic choice and decision during the study. Individual interest give instruction to the person to renders selective consideration on things believed to be relevant and important to that person. Student's interest in academic study predicts the probability of ending into science course. Motivational perception and attitude which result to high exposure and participation of students in science related-activities builds interest of the person (Kjærnsli, & Lie, 2011). From the past decade, the study of interest was associated with to object surrounding that person. Another assumption proposed was the association of interest to the affective and cognitive domain of an individual.

1.2 Conceptual Change

Student conception in physics can be associated with interest of students in their study which involves feeling and attitude in their field of specialization. Despite of the significance of affective domain on students' conception, this part of study was still given less attention in the field of research (Barnes, McInerney, & Marsh, 2005). Aside from that, affective domain contributes to the interest of the students to develop conception in their study. This indicates that students' motivation served as one tools in the development of physics concepts. Individual attitude as a result of dissatisfaction to pass experiences which decrease student motivation to develop conception in their study was not given attention in research (Fredricks, & Eccles, 2002). In other word, the connection between conceptual change and affective domain must be considered in concept development. Cognitive psychology becomes one important domain in the study of conception but aside from that there are other domains like self-efficacy, affective domain, expectation, and interest that also contribute to the development of conception. It was emphasized from the study of Vygotsky (1992) the importance social intervention in the development of interest and attitude. Some studies in the field of social science and psychology included the importance of affective domain on the learning activity of the students. The behavior of an individual due to attitude and interest toward

things can be associated to the conceptual development of students in their study.

1.3 Hypothesis

The framework of the study is anchored from previous studies about the significance of students' interest in enhancing and improving the learning activity of the students. The first assumption formulated in this work is the positive relationship between conceptual knowledge and expectation-value of interest. In addition to that, the study also sought to determine the relationship of students' conception to the individual indicators of expectation-value of interest which is clustered into eight: family, science activities, social activities, social relation, self-esteem, economic stability, and cost. In addition to that, it is suggest that expectancy-value of interest is also related to its individual indicators.

2. METHODOLOGY

The method utilized in the study is a cross-sectional correlation which aims to determine if expectation-value of interest clustered into five indicators predicts the result of the concept test. The IRISQ test and the FCI test were administered to 143 university students enrolled in Thermodynamics and Electromagnetism subject. The results of the study were summarized, tabulated and analyzed using descriptive statistics to create link between conceptual knowledge, expectation-value of interest, and its eight indicators.

2.1 Procedure

The instrument of the study IRISQ test and FCI test was requested to the original authors through formal letter. The authors of the said instrument have responded positively in the request together with the confidentiality and proper utilization of the test. The content of the tests was reviewed and revised before it was administered to conform to the present cultural background and norms of the students. Prior to testing, students were informed that their answers are very important and helpful in improving their study. In addition to that, they were also informed that information will be treated confidential. The implementation of IRISQ test takes two weeks similar with the FCI test. To avoid bias in answering the test, all students were not informed about the purpose of the study. Thus, students have no idea about the hypothesis of the study.

2.2 Instruments and administration

Two instruments were exploited in this study, the IRISQ test (Interest and Recruitment in Science Question) and the FCI test (Force Concept Inventory). The IRISQ test is clustered into five indicators that influence students in their study. The reliability and validity of the instrument was established from previous study similar to this work. The FCI test used to evaluate students' conception in physics is the second test utilized in the study. The IRISQ test was framed with the Eccles et al. Model of Expectancy-Value Theory. This initiatives is continuation of previous work of ROSE project (Relevance of Science Education) implemented to study interest of student in the field of science. The IRISQ test is composed of 65 items clustered into five indicators. The response is a four-point likert scales ranging from "Not important" to "Very important". In the other hand, FCI test is a concept test developed by Hestenes, Halloun, Wells, and Swackhamer (1985) aim to measures students' conceptual understanding of Newton's Law of Motion. The instrument becomes one of the forerunners in understanding of students' basic concept in physics. The topic of the FCI test, Newtonian Mechanics was contextualized to adapt to the common real-life experiences of the students.

3. RESULTS AND DISCUSSION

3.1 Result

The normality of the data using Shapiro-Wilk test and Kolmogorov-Smirnov test was screened and established first prior to the analysis of data. Normality test showed that FCI test and IRISQ test are both significant at .01 and .05 level of significance. This indicates that the scores from the two tests are normally distributed. Moreover, the correlation between IRISQ test results and FCI test results, the correlation among IRISQ test indicators were presented in table 1 using descriptive statistics. The result of normality test shows that scores from the FCI test and IRISQ test are normally distributed. To establish the validity of the instruments, the IRIS Q tests which measure the affective domain of the students regarding choices in academic study in STEM was clustered into eight indicators which influence students in choosing science study. These indicators are experience, family, science activities, social activity, social relation, self-esteem, economic stability, and cost of the study. The relationship of indicators to each other showed positive correlation indicating consistency on what the instrument is measuring.

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The descriptive statistics of the results showed that all indicators are significant with each other at p<.01 level of significance. Furthermore, the number of sample size is adequately enough to picture out the correlation between variables. It was advanced earlier the three hypotheses of this study indicating the relationship between the variables. The first hypothesis states that students' expectation-value of interest predicts the concept test scores of the students in physics. The second hypothesis was stated to prove if individual indicators are related to students' physics conception. The correlations of each variable were presented in table 1.

Table 1. Descriptive statistics and correlations

	Mean	S.D.	1	2	3	4	5	6	7	8	9
concept knowledge	14.73	0.73									
affective domain	3.18	0.80	0.34								
experience	3.12	0.71	0.37	0.42							
family	3.31	0.77	0.26	0.37	0.45						
science activities	2.87	0.93	0.61	0.43	0.37	0.32					
social activities	3.24	0.89	0.32	0.57	0.31	0.21	0.47				
social relation	3.04	0.84	0.53	0.32	0.28	0.35	0.56	0.67			
self-esteem	3.45	0.72	0.43	0.27	0.43	0.25	0.64	0.34	0.34		
economic stability	2.97	0.84	0.45	0.38	0.57	0.36	0.31	0.43	0.41	0.23	
cost	3.44	0.72	0.34	0.28	0.34	0.44	0.33	0.54	0.17	0.37	0.04

Note. N=143; Correlation of .30 or greater are significant at p≤.01; p≤.05.

The first hypothesis states that scores of the students in the FCI test is positively correlated with the results of the IRISQ test (r=0.34, p<.01) which proved first hypothesis. In support to the second hypothesis, the results also showed that individual indicators predict the conceptual understanding of students: experience (r=0.37, p<.01), family (r=0.26, p<.05), science-related activity (r=0.61, p<.01), social activity (r=0.32, p<.01), social connection (r=0.53, p<.01), self-esteem (r=0.43, p<.01), economic stability (r=0.45, p<.01), and cost (r=0.34, p<.01) were positively correlated. In support to the third hypothesis the overall expectation-value of interest was correlated to the individual indicators. The first indicator "experience" is positively correlated to IRISQ test scores (r=0.42, p<.01). This implies that students' participation and exposure to science from previous experiences affects students' interest in science. Family is also positively correlated with the IRISQ test scores (r=0.37, p<.01) which indicates that family also affect students' interest in science. Science activity is also positively correlated with the IRISQ test scores (r=0.43, p<.01) which imply that science activity influence students' interest in their study in science. Social activity also influence the interest of the students in their science study showing positive correlation between social activity and IRISQ test scores (r=0.57, p<.01). Similarly, individual indicators such as "social relation" (r=0.32, p<.01), "self-esteem" (r=0.27, p<.01), "economic stability" (r=0.38, p<.01), and "cost of study" (r=0.28, p<.01) are all positively correlated to the IRISQ test scores of the students.

3.2 Discussion

The result of the study suggests that individual interest in science predict students' academic preferences in choosing their study. Students' interest and positive attitude in science improve their motivation to engage in different learning activity which results to better conception in physics. The behavior of students in their study can be trace from their previous real-life experiences. This implies that dissatisfaction of students from their previous experiences can predict their interest and affect their choice and decision in science. One example of this is the use of Context-Based Learning in the physics instruction that allows student to participate more in the learning process. Family is one contributing factor that affects students' interest in science. The positive correlation to students' conceptual understanding and students' expectancy-value of interest tells that parents and other member of the family influence their academic choices and decision. Thus, those students, whose parents are in the field of science exceed those students whose parents are not in the field of science. Another factor that contributes to the interest of student in their study is their pass participation to science activities like science competition, science festivals and science summer class which can be associated with students' conception in physics. Those students who say that they enjoy the company of other students, feel socially comfortable with

others, and enjoy the company friend are indicators of good social acceptance which contribute to the interest of the students in science. Furthermore, those students who believe that they can do better than the average people and believed that they can easily learn the subject course have higher chances of choosing their study in science. In addition to that, those students who believed that science provides secure job, provide opportunity to earn high income and provide noble work that is important to the society have the higher chance of choosing course in science. These factors which influence students' behavior and attitude in science are the structural component of expectancy-value of interest base from Eccles et al Model which motivates students to process conceptual change in physics.

4. CONCLUSIONS

The Eccles et al. Model of Expectancy-Value theorem describe the affective domain of an individual based on psychological aspect and social aspect which can be link to students interest and motivation in the field of science. The construction and the development of IRIS Q questionnaire was based on the model since various studies with similar objectives generated good results. Studies also showed that interest motivate students to engage in their learning activity. Aside from the fact that interest influences the enrollment behavior of students, it was also presented in this study that interest motivates students to enhance their conception in physics.

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