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An Approach to Develop a System Dynamics Model for Education Effectiveness Evaluation

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Abstract- This study investigates method of system dynamics and applied the Vensim software to develop an education effectiveness evaluation model. This study propose four cause-and-effect chains affecting education effectiveness, including Professors' teaching method, home environment, study habits and Institute's execution of scientific activities, as well as the system dynamics model based on the four cause-and-effect chains. Based on the developed system dynamic model, this study performed simulation to explore the association among Professors' teaching method, home environment ,study habits and Institute's execution of scientific activities,. The results of this study verified that there are positive correlations between home environment and students' education effectiveness.

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An Approach to Develop a System Dynamics Model for Education Effectiveness Evaluation

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Abstract- This study investigates method of system dynamics and applied the Vensim software to develop an education effectiveness evaluation model. This study propose four cause-and-effect chains affecting education effectiveness, including Professors' teaching method, home environment, study habits and Institute's execution of scientific activities, as well as the system dynamics model based on the four cause-and-effect chains. Based on the developed system dynamic model, this study performed simulation to explore the association among Professors' teaching method, home environment ,study habits and Institute's execution of scientific activities,. The results of this study verified that there are positive correlations between home environment and students' education effectiveness.

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I. Introduction

Student's educational performance and graduation rates have been the area of attention for higher education institutions. Exploration of factors related to the educational performance of Technological Institute students become a topic of growing interest in higher educational circle. Many current studies were carried out to discover factors that affecting Technological student's educational performance and education effectiveness. Hanson (2000) reported that Student performance is affected by different factors such as learning abilities, gender and race. Simmons, et al. (2005) concluded that family income level, attending full time, receiving grant aid and completing advanced level classes in high school having statistically major effects on college persistence among Technical college students. When entering the graduate level in Technological Institute, students are facing the new challenge in the education of "technical and practical" subject. Because the knowledge inspiration and knowledge method of "technical and practical" are significantly different from those of other fields and also different from school level, it is essential to examine the education effectiveness of the of "technical and practical" subject. Many variables may affect students' education effectiveness of science and technology. The research design of this study incorporated four parts that affect education effectiveness, which are Professors' teaching method, Institute's execution of scientific activities, home environment and study habits.

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Each of the above subsystems is jointly connected with one another to develop cause-and-effect associations .Most of the past studies on the issues regarding the learning of science and technology of technological institute are static studies, which cannot assess the post execution policies. This study used Vensim software to develop the framework of a systemic model from the perception of system dynamics and performed dynamic simulation for investigation and explanation. This study investigated the education effectiveness of science and technology based on system dynamic model. This study eminent the earlier static studies to a dynamic level. The suggestions anticipated based on the simulation results can provide as suggestion for educators and policymakers in the educational community. It is hoped that this study can help in getting better the education motivation and education effectiveness of science and technology of students and apply the model-based concepts to different learning fields to further extend such concepts to other related studies.

II. Research Method

This work implement the investigate methods of system dynamics and the specific package software vensim software for system dynamics to develop the model and executed system dynamics equations to make analysis and discussions.

System dynamics is a methodology based on feedback systems borrowed from control theory, and it can handle easily the non-linearity and time-delay and the multi-loop structures of the complex and dynamic systems. Forrester's methodology provides a foundation for constructing computer models to do what the human mind cannot do—rationally analyse the structure, interactions and modes of behaviour of complex social systems, thus providing a framework whereby strategies can be tested and trade-offs can be performed, while options are still open. Much software such as STELLA, VENSIM, and POWERSIM are these days accessible which have revolutionized the system dynamics modelling. Moreover, this software's are icon operated and permit us to represent virtually any procedure or system. System dynamics excels in the handing out of high-level, nonlinear, and time-varying issues, and it can still be used for exploration under the circumstance of lack of data.

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III. Cause and Chain Effects

The system developed four cause-and-effect chains affecting education effectiveness, including, Professors' teaching method, home environment, study habits and Institute's execution of scientific activities. During the teaching process, the better the teacher-student interaction is, the better the behavioural performance of students is. As long as teachers give proper expectation to students according to their abilities, their high learning motivation can be triggered, their learning effectiveness will become better, and teachers-students relationship will be improved to inspire teachers' teaching enthusiasm. Based on the above, the cause-and-effect chain diagram of relevant factors affecting teachers' teaching enthusiasm and students' learning effectiveness is drawn, as shown in Figure.

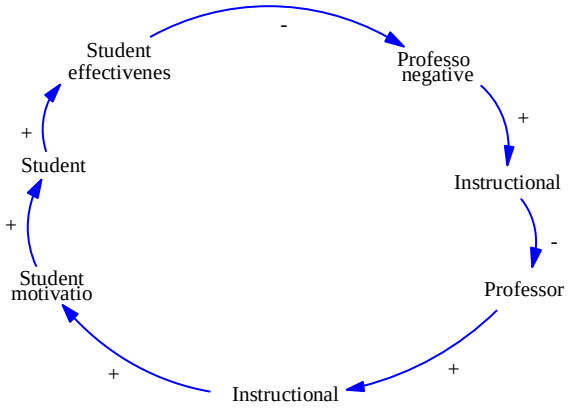

Figure 1: Cause-and-effect chain diagram of Professors' teaching method and students' education effectiveness

Reviewed literature indicated that there is an awareness of the importance of the home environment or family on pupil's/students academic performance. The home has a great influence on the students' psychological, emotional, social and economic state. In the view of Ajila and Olutola (2007), the state of the home affects the individual since the parents are the first socializing agents in an individual's life. This is because the family background and context of a student affect his/her reaction to life situations and his/her level of performance. If parents are willing to spend more time accompanying children to learn, the learning obstacles of science and technology encountered by student will be reduced. Once learning obstacles are reduced, students' learning motivation will be enhanced to further affect their academic performance, learning achievement, and education effectiveness. This study develops the cause-and-effect chain diagram of relevant factors affecting home environment and student's education effectiveness, as shown in Figure 2.

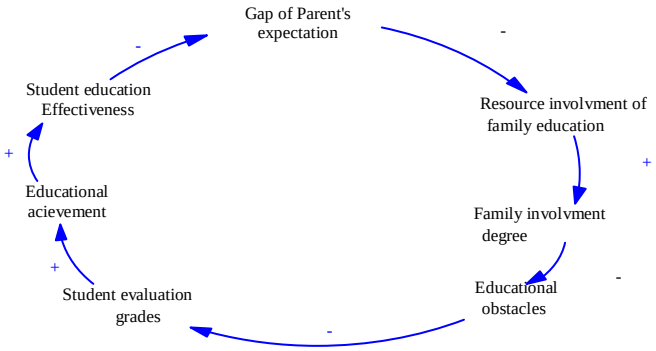

Figure 2: Cause-and-effect chain diagram of relevant factors affecting home environment and student's education effectiveness

Study habits of students may be relevant to the prediction of grades because it is possible that student's education effectiveness may be related to their study habits. That is, students with poor study habits may have difficulty in learning than those students with better study habits. The importance of the relationship between education effectiveness, instructor ratings and study habits has not been determined [Middleton (1979)]. Study skills and learning approaches include, for example, time management, using information resources, taking class notes, communicating with teachers, preparing for and taking examination, and several other learning strategies. The research shows a significant correlation between such learning behaviour and approaches and education effectiveness. This study develops the cause-and-effect chain diagram of relevant factors affecting Study habits and education effectiveness, as shown in Figure 3

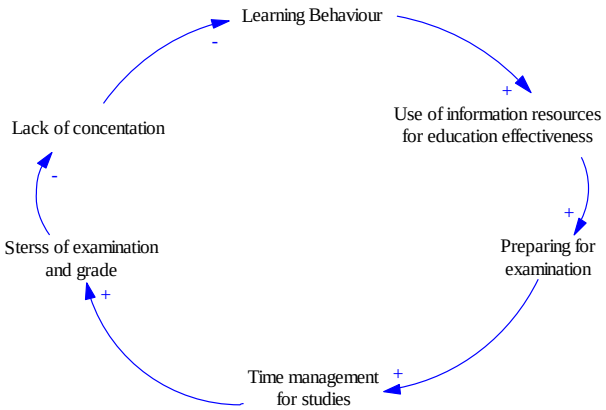

Figure 3: Cause-and-effect chain diagram of relevant factors affecting Study habits and education effectiveness

The scientific activities implemented by Institutions' are mainly instructed by science and technology subject teachers. The success of such activities and the performance of students are subject to the intention and involvement of instructors. The higher the Professor's intention to hold activities is, the better the students' performance we receive.

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In this way, students' learning motivation can be triggered and enhanced, and their education effectiveness can also be improved. Another very important factor in establishing high Education effectiveness at a college is the degree to which students establish close and supportive personal and professional relationships with faculty and other significant people on campus which can be easily developed during implementation of scientific activities.

This study develops the cause-and-effect chain diagram of relevant factors affecting Institutions' implementation of scientific activities and learning effectiveness, as shown in Figure 4.

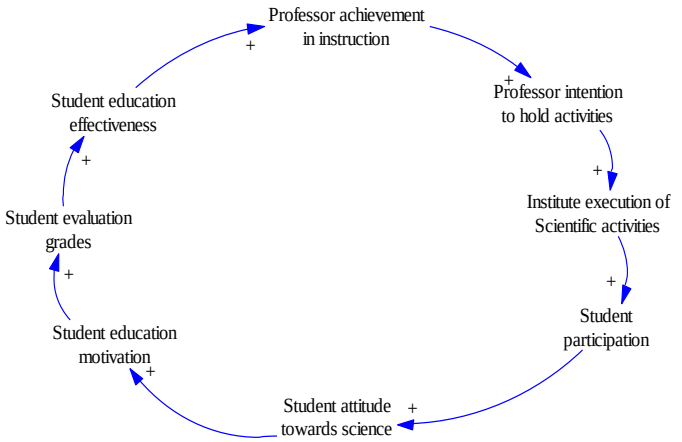

Figure 4: Cause-and-effect chain diagram of relevant factors affecting Institutions' execution of scientific activities and learning effectiveness

Based on the four cause-and-effect chain diagrams above, this study develops the cause-and-effect chain diagram of relevant factors affecting the education effectiveness of science and technology, as shown in Figure 5

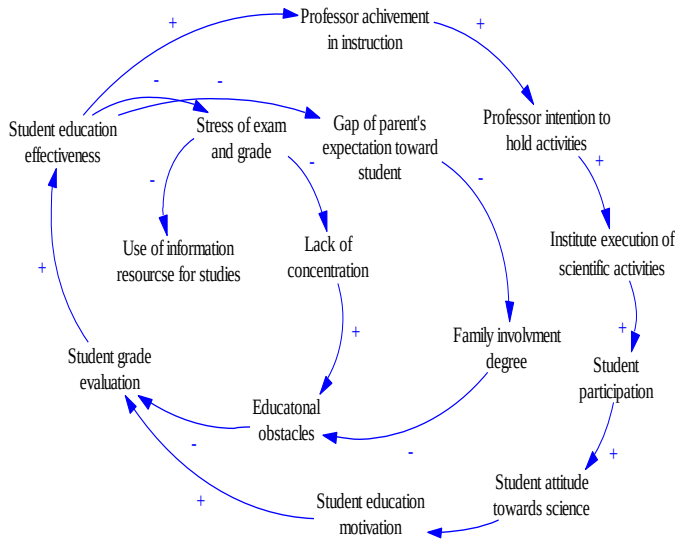

Figure 5

IV. System Dynamics and Models

This study developed the system dynamics model based on the cause-and-effect chain diagrams, which are discussed as follows. In the learning field of science and technology, professor need sufficient teaching enthusiasm to encourage themselves to change teaching method and strategies and further trigger students' education motivation and improve their learning intention. This study develops the system dynamics model of the relationship between Professor teaching method and educational effectiveness, as shown in Figure 6.

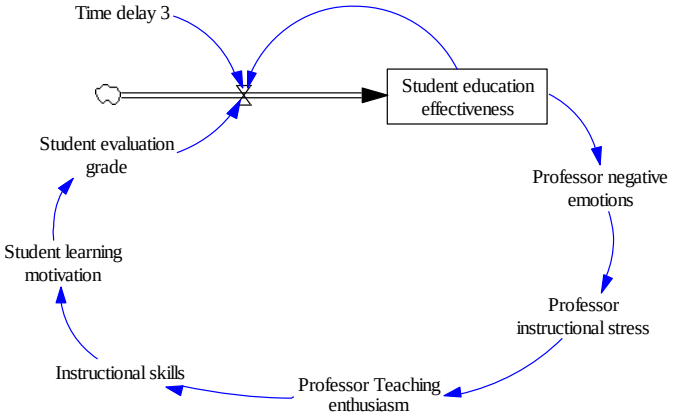

Figure 6: System dynamics model of Professor teaching enthusiasm and students' education effectiveness

Parents' educational attitude toward the learning of various subjects will affect students' education condition. During family involvement in student's education, other factors will intervene with the education of science and technology. This study develops the system dynamics model of the relationship between family involvement and education effectiveness, as shown in Figure 7.

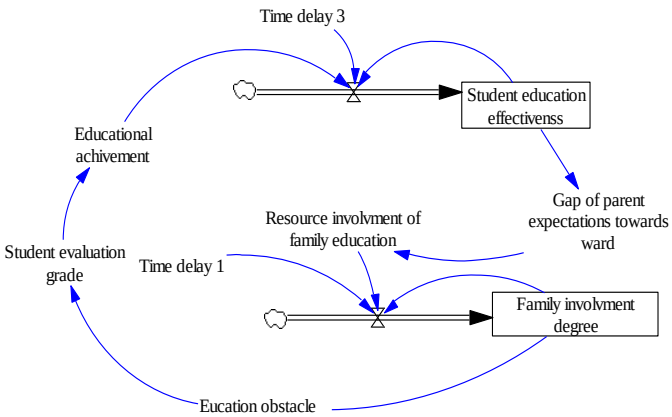

Figure 7: System dynamics model of Home environment and students' education effectiveness.

According to Fagbemi (2001), the degree of education depends on the amount of time the student is actively engaged in learning. The time spent on studying helps students to retain the materials learnt, which will

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eventually boost the students‟ performance outcome during tests or examinations. This study develops the system dynamics model of the relationship between Study habits and education effectiveness, as shown in

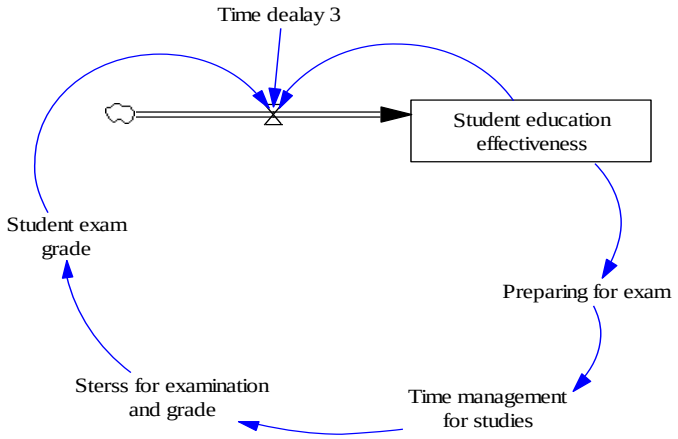

Figure 8: System dynamics model of Study habits and students' education effectiveness.

Institute execution or participation in scientific activities has a significant effect on students' education motivation and education effectiveness. Therefore, Professor intention to hold or cooperate with activities affects students' scientific attitude and education effectiveness. This study develops the system dynamic model of the relationship between Institute execution of scientific activities and education effectiveness, as shown in Figure 9.

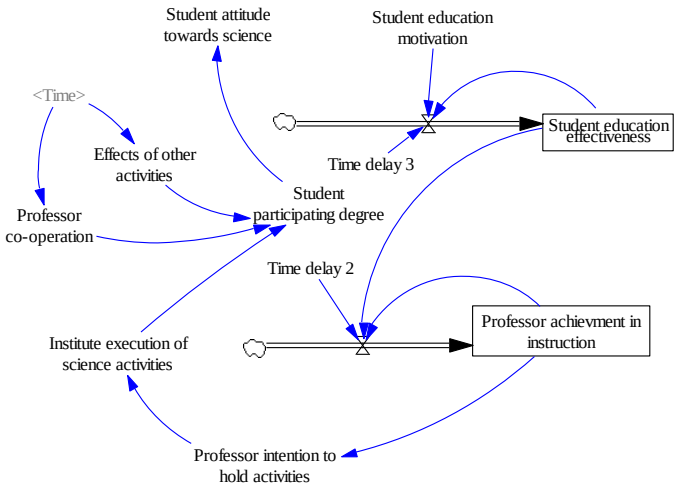

Figure 9: System dynamics model of Institute execution of scientific activities and students' education effectiveness

Based on the four system dynamics models above, this study integrated the four sub-models to develop the system dynamics model of science and technology, as shown in Figure 10.

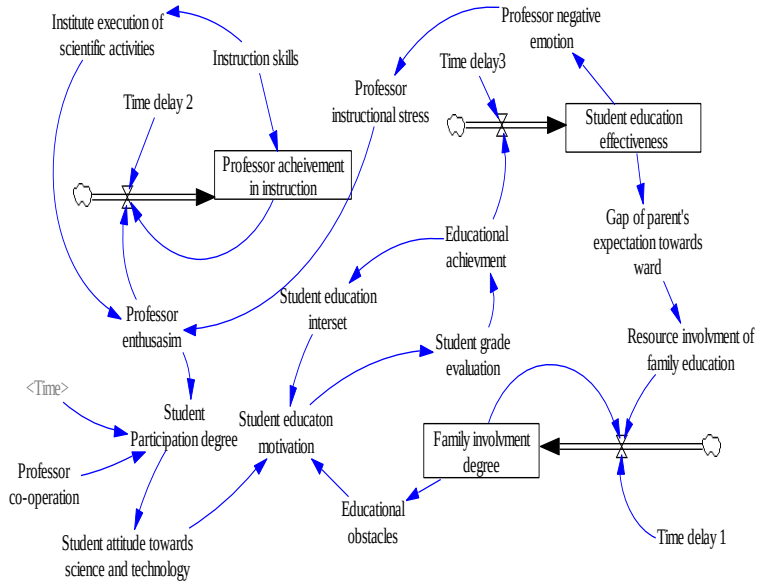

Figure 10: System dynamics model of education science and technology.

V. Results

Based on the developed system dynamic model, this study performed simulation to investigate the relationship among Professors' teaching enthusiasm, home environment ,study habits and Institute's execution of scientific activities and student education effectiveness. (1) Home environment and students' education effectiveness: the simulation of this system mainly investigated the relationship between home environment and education effectiveness. According to the simulation results, in the short term, there is a steady increase, as well as ups and downs, in, home environment and so is education effectiveness. In the long term, there is a highly positive correlation between them. In other words, the Positive the home environment is, the higher the students' education effectiveness is, as shown in Figure 11

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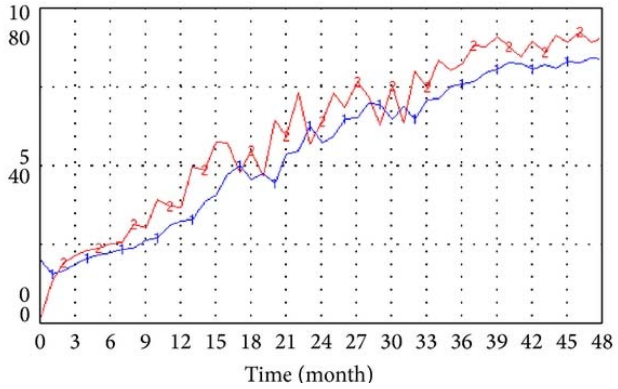

Figure 11: Graph of Home environment (1) and students' education effectiveness (3).

(2)Students' education effectiveness and Professors' teaching enthusiasm: the simulation of this system mainly investigates the relationship between students' education effectiveness and Professors' teaching enthusiasm. The results showed that there is a positive correlation between students' education effectiveness and Professor' teaching enthusiasm. The higher the teaching enthusiasm is, the higher the students' learning effectiveness is, as shown in Figure 12.

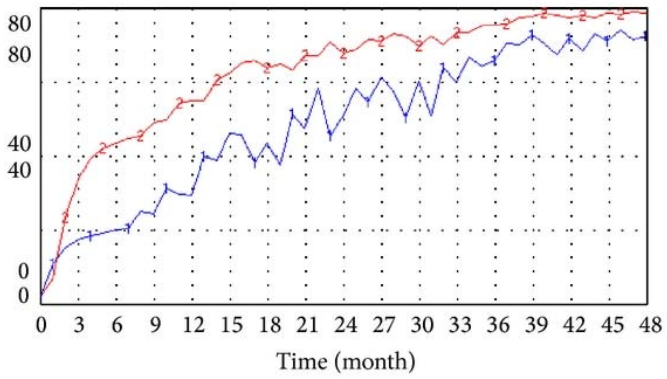

Figure 12: Graph of Professors' teaching enthusiasm (1)and students' education effectiveness(2).

(3)Effect of Study habits on students' education interest: the simulation of this system mainly investigates the relationship between Study habits and students' learning interest.Good study habits like taking proper lecture notes, revision, concentration can arouse student education effectiveness in science and technology subjects. The use of different study habits can immediately arouse students' interest, as shown in Figure 13.

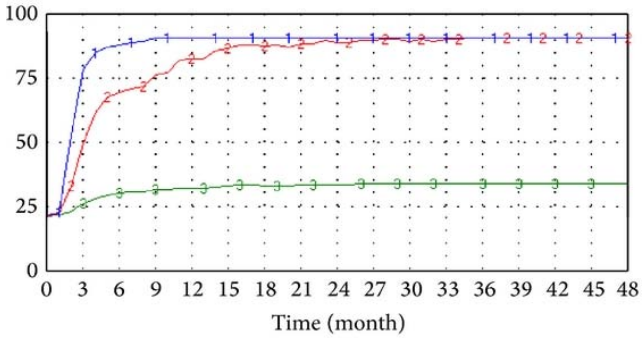

Figure 13: Graph and students' education effectiveness with of bad study habits (3), average study habits (2) and good study habits (1).

VI. Conclusions

This study verified that there is a highly positive correlation between Home environment students' education effectiveness. In other words, family plays an important role in students' education, and the role of parents is particularly important. The learning of science and technology in Institute is different from the School level. Instead, it is the integration of learning approaches of various fields. Higher family involvement, lower obstacles encountered in the field of science and technology, and parents willing to help ward can further improve their education effectiveness.

This study also verified that there is a positive correlation between students' education effectiveness and Professor teaching enthusiasm. Professor can handle their teaching content and teaching method to obtain a sense of achievement from the gradual progress in education effectiveness of students. Their sense of achievement is usually higher than students' education effectiveness. Under such an atmosphere, students' education effectiveness will be better as well.

Study habits and education approaches include, for example, time management, using information resources, taking class notes, communicating with teachers, preparing for and taking examination, and several other learning strategies help education effectiveness. Good study habits elevate exam grade as well as students' education effectiveness. Compare to students with poor study habits.

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