How to combine math, physics and real world in education: The case of SOGOSURI project in Uganda

Tatsuhiro Uchida[1], **William Mugisa Kihire[2]**

[1] Comprehensive Scientific Education Center, Meijo University, 1-501 Shiogamakuchi, Tempaku-ku, Nagoya 468-8502 Japan.
[2] East African dairy Development, TechnoServe/Uganda, 1st Floor IDC Building, 12 Teman Avenue Nakasero, Kampala, Uganda.

E-mail: uchi@meijo-u.ac.jp

Abstract

Mathematics and Physics education are only book learning that loses touch with real world. In 2001, SOGOSURI program was provided for resolving this problem in Meijo University. We have attempted SOGOSURI program in Uganda. Uganda has three educational problems, 1) missing textbook, 2) learning only memory, 3) not consistent curriculum with Uganda. We started SOGOSURI project in Uganda and established a referable model apprenticeship school that enrolls graduates of upper secondary school from April 2007. Students are re-constructed their isolated knowledge in this school, experimental and practical based education such that making transmitter, making electronic motor, are implemented in this school. This education consists 1) practical work, 2) lecture, and 3) SOGOSURI volunteer salon. Especially the volunteer salon is a core curriculum that combines Physics and Real world using Mathematics. The school educational stuff consists of technicians, instructors and super teachers who are called "sogosurist". The "sogosurist" is a manager of the volunteer salon, and leads students to combine organically their knowledge *e.g.*, mathematics and physics on textbook, experience of practical work. This education model was evaluated on following results: Some graduates who had two years education in this school are working as promoter of entrepreneur for local communities, two local governments have requested to establish similar school, Makerere University tries to implement similar curriculum. Practical works that connected or related to the real world, and existence of "sogosurist" are important factors for success. But it is difficult to produce sogosurist because sogosurist is required abilities not only to teach physics, but also structurally and organically to combine student's knowledge.

Keywords: SOGOSURI, Practical Education, Education for Physics, Education for Mathematics, Experimental Education.

Resumen

Las matemáticas y la educación física son sólo aprendizaje de los libros que pierden el contacto con el mundo real. En 2001, el programa SOGOSURI fue proporcionado para resolver este problema en la Universidad Meijo. Hemos tratado el programa SOGOSURI en Uganda. Uganda tiene tres problemas educativos, 1) libros de texto perdidos, 2) aprendizaje de memoria solamente, 3) currículo no coherente con Uganda. Empezamos el proyecto SOGOSURI en Uganda y se estableció una escuela modelo de aprendizaje referible que inscribe a los graduados de la escuela secundaria superior a partir de Abril de 2007. Los estudiantes son re-construidos en sus conocimientos aislados en esta escuela, la educación basada en lo experimental y práctica de manera que se hace la transmisor, elaborando el motor electrónico, se lleva a cabo en esta escuela. Esta educación consiste en 1) trabajo práctico, 2) lectura, y 3) salón de voluntarios SOGOSURI. Especialmente el salón de voluntarios es un plan de estudios que combina la Física y el mundo real usando las matemáticas. El material educativo escolar se compone de técnicas, instructores y super profesores quienes son llamados "sogosurist". El "sogosurist" es un director del salón de voluntarios, y conduce a los estudiantes a combinar orgánicamente sus conocimientos por ejemplo, matemáticas y física en libro de texto, la experiencia de trabajo práctico. Este modelo educativo se evaluó en los siguientes resultados: Algunos graduados que tenían dos años de educación en esta escuela están trabajando como promotores de empresarios para las comunidades locales, dos gobiernos locales han solicitado establecer una escuela similar, la Universidad de Makerere trata de implementar un plan de estudios similar. Trabajos prácticos que estén conectados o relacionados con el mundo real, y la existencia de "sogosurist" son factores importantes para el éxito. Pero esto es difícil de producir porque sogosurist requiere habilidades no sólo para enseñar física, sino también estructural y orgánicamente para combinar el conocimiento de los estudiantes.

Palabras clave: SOGOSURI, Educación práctica, Física para la educación, Matemáticas para la educación, Educación experimental.

I. INTRODUCTION

It is important to produce good scientists who lead science and technology in Japan. Japanese high quality and homogeneous education is producing many good engineers by sacrifice of producing above leaders. Another problem is that only reading text-book lacks a reality of science. Meijo University started SOGOSURI program to solve this problem at April 2001 [1].

A. SOGOSURI

SOGOSURI is Japanese new word that is created by Meijo University. SOGOSURI means "comprehensive science which is based on mathematics". SOGOSURI program is an educational curriculum to realize comprehensive science [2].

Several African country's ambassadors and scientists have a great interested in SOGOSURI because of its educational ideology "cultivating capable persons with originality and creativity to lead in scientific development". They required to introduce SOGOSURI into their countries. We demonstrated SOGOSURI Volunteer Salon, core part of SOGOSURI program, in Nigeria and Tanzania [3].

B. Ugandan science education

Uganda is a leading country of education in East Africa because of free education system, Universal Primary Education and Universal Secondary Education programs. In spite of this education system, big costs and teacher absenteeism and insufficient schoolhouse cause deterioration of the educational quality. Teacher only writes contents of text-book on the blackboard then students copy them on their notebook. Some of schools have science lab. and library. The other side, there are progressive educational projects. For example, Great Lakes regional college trains primary school teachers move on start primary school also engineers and managers move on promote agriculture market of this area (see Fig. 1). Dr. Hamlet Mbabazi, the chancellor of Great Lakes Regional College, organized this system that include rural area and its community toward self-dependency of this region. He also have interest in SOGOSURI and offered to introduce the SOGOSURI Program.

FIGURE 1. Great Lakes Regional College and its staffs.

C. SOGOSURI Project in Uganda

Tatsuhiro Uchida, an author of this paper, was invited from Ugandan nonprofit organization BSTEP and started "SOGOSURI Project in Uganda" at April 2007. The project consisted of authors and Ugandan scientist and educator and politician [Table I], researched the best way of implementation method during April 2007 – March 2008.

TABLE I. Major member of SOGOSURI Project in Uganda.

Name	Affiliation
Tatsuhiro Uchida	Assistant professor of Meijo University
Arnold Bakenzana	Founder of BSTEP
William Mugisa Kihire	Senior business advisor of TechnoServe, Inc., co-worker of PAD[*]
Joan Kakwenzire	Senior presidential advisor of Uganda statehouse and director of PAD[*]
Hamlet Mbabazi,	Chancellor of Great Lakes Regional College, former member of parliament

[*]PAD: The State House Poverty Alleviation Department of Uganda.

The project made an executable plan, making "Implementation outline of SOGOSURI Education", establish new school that was implemented SOGOSURI. H. Mbabazi and his colleagues had a plan to establish a new university, East African University that was implemented extended idea of Great Lakes regional college, before started the project, November 2006. The plan has been shifted to more realistic way of establishing a graduate school, "East African Science, Technology and Business Institute (EASTBI)" that enrolled graduated people who

had much knowledge but didn't know how to use them. The other hand, the project has establish an apprenticeship academy, Mukono District Apprenticeship Academy (MDAA) that was established by BSTEP and PAD and Mukono district council at September 2007 [4]. The schoolhouse was placed at social centre of Mukono District (see Fig. 2) and its workshop was placed at the work shop of the district. First students were enrolled from graduated of upper secondary school who lived on Mukono District by paper examination of English and science.

This paper explains the curriculum and results of MDAA.

FIGURE 2. The fast schoolhouse of MDAA.

II. CURRICULUM OF MDAA

MDAA is similar to vocational school because of which training technology and filed work occupied lots of study. But the curriculum is different from vocational school. The significant difference is the special education program (SOGOSURI Program) which is modified the Meijo University's SOGOSURI Program for MDAA.

A. The special education program (SOGOSURI PROGRAM)

This education program is designed by the SOGOSURI Project in Uganda. This education program consists next 5 parts and applies to all students of two schools.
(1) SOGOSURI Volunteer Salon - The aim of the Salon is to give an opportunity to naturally acquire courtesy and social grace.
(2) Group project - Students learn membership and leadership. (Collaborative project with two schools).
(3) Science Exhibition - Students demonstrate their achievement and attend innovation contest. (Collaborative exhibition with two schools).
(4) Demand lecture of students - Students have lectures as an instructor in village community and/or school.

(5) SOGOSURI fundamental seminars-Compulsory subject for students in the SOGOSURI Program, Mathematical thinking ability is cultivated through actively introducing experiments.

B. Details

(1) SOGOSURI Volunteer Salon - The aim of the Salon is to give an opportunity to naturally acquire courtesy and social grace.
Acquiring knowledge and learning problem solving are not the only requirements for becoming capable individuals who will be champions in the future. In order to properly demonstrate one's knowledge and problem solving to the community one must learn courtesy and social grace.

Apprenticeship Academy places importance on this point, and therefore has set up the SOGOSURI Volunteer Salon to give students opportunities to naturally acquire courtesy and social grace. The Salon consists of Apprenticeship Academy department members and their families, instructors, other fully-fledged members of society, people similarly involved at other universities, and so on.

Similar to a club-house, it can be likened to a club activity, and students in the SOGOSURI Program venture in and out of the salon on a daily basis. The SOGOSURI Volunteer Salon is available for mingling with a variety of people and will be a place of importance and meaning, especially in contributing to broadening the student's viewpoint.
(2) Group project - Students earn membership and leadership, (Collaborative project with two schools).
We make some groups that consists at least one student of every department. We study membership and leadership during the process of project in each group. Each group has a subject of production and distribution, and makes a plan and executes it in school and/or filed.
(3) Science Exhibition - Students demonstrate their achievement and attend innovation contest, (Collaborative exhibition with two schools).
All students make a presentation of individual or group study. Especially, students who produce good result that has ability of enterprise get award from the Sci-Fair Committee.
(4) Demand lecture of students - Students have lectures as an instructor in village community and/or school.
(5) SOGOSURI fundamental seminars - Compulsory subject for students in the SOGOSURI Program, Mathematical thinking ability is cultivated through actively introducing experiments.
- Mathematical philosophy and its practice
  We learn that mathematics is not independent from age or culture, and have a view of the future of Ugandan mathematics and science.
- Linguistic information technology
  We try to develop Linguistic technology as a new category of Mathematical. The main objects are a decoding and an analysis of information that is translated by language, and its methods of expression.

- Mathematical information technology
  We learn Mathematics as technology that simulates reality and predicts it exactly. And learn Physics, Electronics, Mechanics, Chemistry, Structure of DNA, Economy as its applications.
- Technical philosophy
  Science and Technology shows invisibles such that radiation and risk of flaking concrete. Technical philosophy is that we determine how we should act after we look above things.

We learn that Mathematics has a key to this determine. We also learn Design Methodology based on above thought and make artifact.

TABLE II. School schedule (weekly).

		MON	TUE	WED	THU	FRI	SAT
1	9:00-10:30	Material	Mechanical	Biochemical	Electrical/Electronics	SOGOSURI Seminar	Arts
2	10:40-12:10	Business enterprise	Social organization	Marketing	Computer	SOGOSURI Seminar	Physical exercise
3	13:00-14:30	Practice	Practice	Practice	Practice	SOGOSURI Volunteer Salon	
4	14:40-16:10	Practice	Practice	Practice	Practice	SOGOSURI Volunteer Salon	
5	16:20-17:50	Presentation	Presentation	Presentation	Presentation	SOGOSURI Volunteer Salon	

III. ACTUAL CONDITION

Educational staffs consists of technicians, instructors, super teachers who are called sogosurist. Sogosurist manages the SOGOSURI Volunteer Salon and the SOGOSURI fundamental seminar.

A. SOGOSURI Volunteer Salon

The SOGOSURI Volunteer Salon was opened on every Friday. Following subjects were discussed.
- Why did Japan grow up technology and economy?
- Relation between language and culture
- Importance of moral and manner
- Problems their study life
- Physics that is hidden their practical work.

B. SOGOSURI fundamental seminar

The SOGOSURI fundamental seminar was opened on every Friday. Following subjects were discussed as study of physics.
- What is the unit and measure?; make a measuring stick then measure the height of tree. Learn how to apply trigonometrical ratio to real world.
- Where is physics in the modern technology?; explain material research needs atom and molecule theory.
- What is a quality?; gaps between theory and real world.
- How to develop physics, relation between Mathematics and Physics, modern technology and its physics, structure of language.

Teacher gathers subjects from students and discuss about the subject of salon.

C. SOGOSURI daily salon (not official curriculum)

When student have question or mistake of he/her practical work, give suggestion to lead solution.

D. Science Exhibition

Students learn how to explain he/her work by own word (see Fig. 3).

FIGURE 3. Sci-Fair 2007.

IV. RESULTS AND ANALYSIS

Students learn how to combine physics and real world through mathematical thinking during daily work.

A. Achievements

After 6 months education, MDAA have opened a science fair and students explained their products and work by their

own word to guests. Some graduated students started entrepreneurs with local communities of Mukono district. Two districts governments offered to introduce same type school. Makerere University will start new collaborative curriculum in 2011.

B. Problems

Poverty is not a big problem. There are problems in their life style and educational conditions. Education schedule was changed frequently because of electric power down, lack of working on-time include stuffs. It is impossible to find super teacher "sogosurist". We have to produce sogosurist by ourselves. This problem is same as Japan.

V. CONCLUSIONS

Students have enough knowledge to learn how to connect them to real world but some of their knowledge are in fragment and includes some errors. We try to combine these fragmented knowledge and connect to real world. The project successfully applied the SOGOSURI Program to MDAA. But the project has to solve the problem "how to produce sogosurist".

We established a non profit organization, SOGOSURI INNOVATIONS, that works on Internet at January 2011 [5]. SOGOSURI INNOVATIONS are going to support to produce super teachers.

REFERENCES

[1] Uchida, T., *History of SOGOSURI Education Center*, Comprehensive Scientific Education Center of Meijo University Annual report 2010, 10-15 (2011).
[2] Leaflet of "Meijo University SOGOSURI Education Center", (2001).
[3] Uchida, T., *Africa Visitation*, Comprehensive Scientific Education Center of Meijo University Annual report 2002, 2-64 (2003).
[4] Uchida, T., *What is a required in Uganda? – The 2007 report of the Japan sci-edu. Support project*, AIP Conf. Proc. **1263**, 75-78 (2010).
[5] Uchida, T. and Mugisa, W., SOGOSURI, <http://www.sogosuri.org> (2011).