THE EFFECT OF INTERACTIVE MULTIMEDIA FUNCTIONS TO ENHANCE STUDENTS' GENERIC SCIENCE SKILLS

Liliasari
Indonesia University of Education
liliasari@upi.edu

Abstract

Science education has an important role to develop scientific thinking, through generic science skills (GSS) mastery. Interactive multimedia (IMM) softwares can be used to enhance the skills. Four topics have been chosen in developing those multimedia softwares for senior high schools, i.e. Neural System (Biology) and Special Relativity (Physics) have tutorial function; Human Urine Excretion (Biology) has simulation function; Rate of Reaction (Chemistry) as models of teaching; Motion of Earth and Planets (Earth and Space Science) multimedia had been developed for physics education students, as a teaching media for e-learning. The implementation of those softwares used control group pretest-postest design. Involvement of 120 physics education students in Bandung enhanced 6 GSS; 56 high school students in Kota Ternate enhanced 5 GSS; 68 students in Yogyakarta enhanced 4 GSS; 153 students in Garut enhanced 4 GSS; and 52 students in Palembang enhanced 5 GSS. The similar GSS enhanced was indirect observation,except on Physics. Besides Physics and Biology IMM could also enhanced logical inference, but Chemistry and Earth and Space Science enhanced symbolic language. It could be concluded that the number of GSS enhanced depends on the educational level of students, the function of interactive multimedias in learning, and science dicipline.

Key words: interactive multimedia function, generic science skills, science dicipline

Introduction

Global challenges should be faced by Indonesian people that make their life more difficult. Resession at the end of the year 2008 and further in 2009, caused vacancy hardly to be found. Only the smart and competitive people win the competition at work. How to prepare smart and competitive people is a big problem in Indonesia. Therefore earlier development of students' thinking skills is very important. Science (biology, physics, chemistry, earth and space science) education has an important role in the development of students' thinking skills.

Many Indonesian students learn science concepts and principles through recall. Their concepts' mastery usually low, because the concepts are not meaningfull to them. On the other hand there are too many science concepts and principles that make students difficult to learn the subject. Learning science that way made students hardly applied the concepts in their everyday life. They failed get the competency that stated in the content standard (BSNP, 2006). Therefore to reach the competency should be a new

paradigm on learning science, to give students many experiences to master science and guide them applied science knowledge (Gallagher,2007).

In order to overcome the problem, students need to learn scientific thinking skills that described as generic science skills (Brotosiswoyo, 2000). The alternative solution to enhance science education in Indonesia is changing science education paradigm from recall scientific concepts to generic science skills mastery.

Generic science skills consist of soft skills. It is abstract and hard to be learned. ICT has capacities to make the abstract concepts to be concreted. There are many abstract concepts representations made easier by ICT (Heinich, et al 1996). One of them is through interactive multimedia software. Those software operating many function in science learning, such as teaching media, tutorial media, simulation media and as a model of teaching. The research problem is what function of interactive multimedia software in learning science could enhance many students'generic science skills development?

Science as Thinking Vechicle

Rutherford and Ahlgren (1990) stated that science thinking frame consist of principles:: (1) in the universe there are consistency and universal framework; (2) science is a proses to get knowledge that comprehend phenomenon; (3) science always change and not the end of truth: (4) science is only an approach to the "absolute" therefore it is not "values free" dan (5) science is limited, that cannot decided "true" or "false".
Science also has common themes, i.e. system, model, consistency, profile of change, and evolution.

Learning science is full of thinking activities that developed through 8 indicator of generic science skills, e.i. (1) direct and indirect observation; (2) sense of scale; (3) symbolic language; (4) logical self consistency; (5) logical inference; (6) causality; (7) mathematical modeling; (8) concepts formation (Brotosiswoyo, 2000).The ninth indicator of generic science skills, especially in chemistry is spatial (Suyanti, 2008; Sudarmin, 2009).

Science learns nature phenomena through **direct observation** to search causality of things that being observed. The limitation of human sense, make the direct observation should be helped by instruments. As an example in chemistry an indicator is needed to prove acid-base property of poisonous solution, amperemeter to observe electric

current, tensimeter to measure blood pressure. The observation helped by instruments described as **indirect observation**.

There are several scales in nature that different size of many things in daily life. Protein has big molecular size and complex in structure. On the contrary electron has very small size and simple. Half life of radioactice element vary from 1,6 X 10^{-4} seconds of Po to 5 X 10^{9} years half life of U-238. **Sense of scale** is needed to study those things.

Symbolic language is used in science communication all over the world**,** for example: elements' symbols as H, O, Na etc; ampere for electric current scale, arrow as symbol for male and plus for female. Long time observation of nature phenomena discovered many scientific laws, but there will be several logical "anomali". **Logical self consistency** of natural laws answered the "anomali" by defined new theory. Difficult biochemistry reaction as an example exist in vivo at the temperature lower than in-vitro. The answer of the phenomenon is the existence of enzyme as catalyst of couple reactions.

Many facts in science cannot be observed directly but it can be discovered through **logical inference** from logical consecuencies in science thinking, i.e. zero Kelvin degree is really true although it is not be proven in real life, but only proven by graphic. If concentration of the reactant larger, than rate of the reaction larger. If the temperature of the system is reduced, than exoterm reaction conducting in better way. Explanation of those phenomena can be answered by **causality**.

Mathematical modelling can help to explain a lot of phenomena relationship in nature. Through the modeling it is hoped to predict relationship or changes of the series nature phenomena tendency precisely. For example: gas pressure in the contrary of volume according to Boyle that formulated as PV = C. But not all of the nature phenomena could be explained in daily language, therefore it is needed to explain in special terminology, named concept. Concepts formulation is needed to prove their application in further development. The process in science named **concept formation**.

Chemistry as a science discipline needs another generic science skill that is **spatial**. This generic science skill becomes important because chemistry studying structure and changes of the structure of matter. The structural change if there are changes in particles bonding direction in space.

The abstract characteristic of scientific concepts should be learned through several representations. The computer flash program such as interactive multimedia can be used to make verbal, graphical, mathematical and symbolic representation more concrete and easy to be understood (Heinich, et al 1996). In science learning interactive multimedia softwares have many function, i.e.as teaching media, simulation media, tutorial media, and as model of teaching.

Method

Interactive multimedia software has been developed used R & D method. The research aimed to obtain weather different function of interactive multimedia software in learning science made generic science skills development differently, e.i. as teaching media, teaching model, tutorial and simulation. The reseach also conducted on different science disciplines i.e Biology, Chemistry, Physics on senior high school, and Earth and Space Science on in-service teacher training. The topics choosen were Neural System (Biology: Mulyani, A., 2009) and Special Relativity (Physics: Wiyono, K, 2009) used tutorial media; Human Urine Excretion (Biology: Subiantoro, A.W.,2009) used simulation media; Rate of Reaction (Chemistry: Iriany, 2009) used teaching model and Motion of Earth and Planets (Earth and Space Science: Wijaya, A.F.C,2009) used e-learning teaching media. Those topics learned through Interactive multimedia flash to develop students' generic science skills. The relationship of science dicipline, topics and generic science skills indicator developed have listed on table 1.

Tabel 1. The relationship of scince discipline, topics and generic science skills

No	Science dicipline	Topics	Generik science skills
1.	Earth and Space Science	Motion of earth and planets	Sense of scale, logical consistency of natural laws, logical inference, symbolic language, indirect observation, concept formation,
2.	Chemistry	Rate of reaction	Symbolic language, indirect observation, causality, mathematical modeling, concepts formation
3.	Physics	Special relativity	Sense of scale, logical consistency of natural laws, logical inference, causality, mathematical modeling,
4.	Biology	Human urine excretion	Indirect observation, logical inference, causality, concepts formation
5.	Biology	Human neural system	Indirect observation, logical inference, causality, concepts formation

Four of the interactive multimedia implemented to senior high school students, but the fifth implemented on in-service teacher training students. The number of research subjects of experimental class and control class listed on table 2.

Table 2. Relationship of topics and number of research subject on each class

No	Place and educational level	Topics	Number of subject	
			Experimental class	Control class
1	Teacher training program at Bandung	Motion of earth and planets	60	60
2	Senior high school at kota Ternate	Rate of reaction	30	26
3	Senior high school at Palembang	Special relativity	26	26
4	Senior high school at Yogyakarta	Human urine excretion	32	36
5	Senior high school at Garut	Human neural system	77	76

The effectiveness of interative multimedia software on science learning to develop students' generic science skills shown through differences between N-gain score of experimental group and control group using t-test.

Results and discussion

Students' generic science skills mean score of Motion of Earth and Planets topic on experimental and control classes at teacher training program can be seen on the table 3 and figured on diagram 1. Further generic science skill mean score of Rate of Reaction topic on experimental class at senior high school can be seen on the table 4 and the figure on diagram 2. Generic scince skills mean score of Special Relativity at senior high school on experimental and control classes can be seen on table 5 and the figure on diagram 3. Generic scince skills mean score of Human Urine Excretion at senior high school on experimental and control classes can be seen on table 6 and the figure on diagram 4. Generic scince skills mean score of Human Neural System at senior high school on experimental and control classes can be seen on table 7 and the figure on diagram 5.

Table 3. Mean score of generic science skills on pretest, posttest dan N-gain students on Motion of Earth and Planets topic (Wijaya, 2009)

No	Generic Science Skills	Control Class			Experimental Class		
		Mean score			Mean score		
		Pretest	Posttest	N-gain	Pretest	Posttest	N-gain
1	Concepts formation	2,23	2,65	0,04	1,90	3,70	0,31
2	Sense of scale	0,65	0,58	-0,10	0,30	0,82	0,27
3	Logical consistency of natural laws	2,12	1,88	-0,09	1,80	3,68	0,32
4	Logical inference	2,62	2,62	-0,09	2,42	4,32	0,48
5	Symbolic language	1,05	0,98	-0,15	0,93	2,33	0,67
6	Indirect observation	2,62	3,73	0,14	2,30	4,70	0,41
Number of students (N)		60			60		

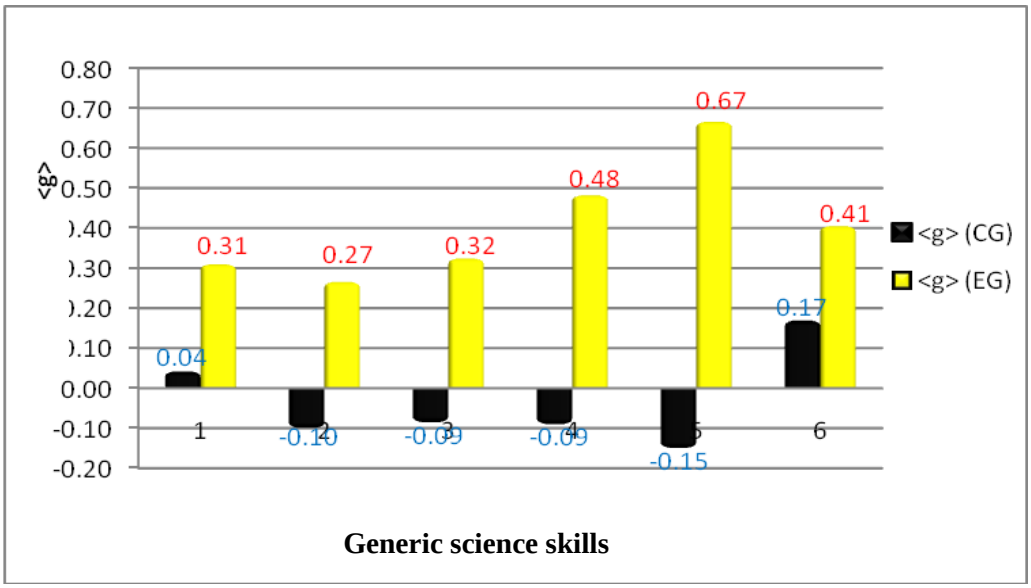

Diagram 1. Mean N-gain <g> diagram of GSS on teacher training program of Earth and Planets Motion Topic

Table 4. Mean score of generic science skills on pretest, posttest dan %N-gain students on Rate of Reaction topic (Iriany, 2009)

No	Generic Science Skills	Mean of Control Group			Mean of Experimental Group		
		Pretest	Posttest	% N-gain	Pretest	Posttest	% N-gain
1	Indirect observation	27,40	64,90	49,74	24,17	87,50	83,72
2	Symbolic language	22,31	53,75	41,39	17,42	62,33	63,94
3	Causality	26,92	64,10	44,87	37,28	88,33	76,67
4	Mathematical modelling	28,85	57,69	40,38	35,00	72,08	58,56
5	Concepts formation	44,23	63,46	28,85	49,25	85,00	76,67
Subjets (N)		26			30		

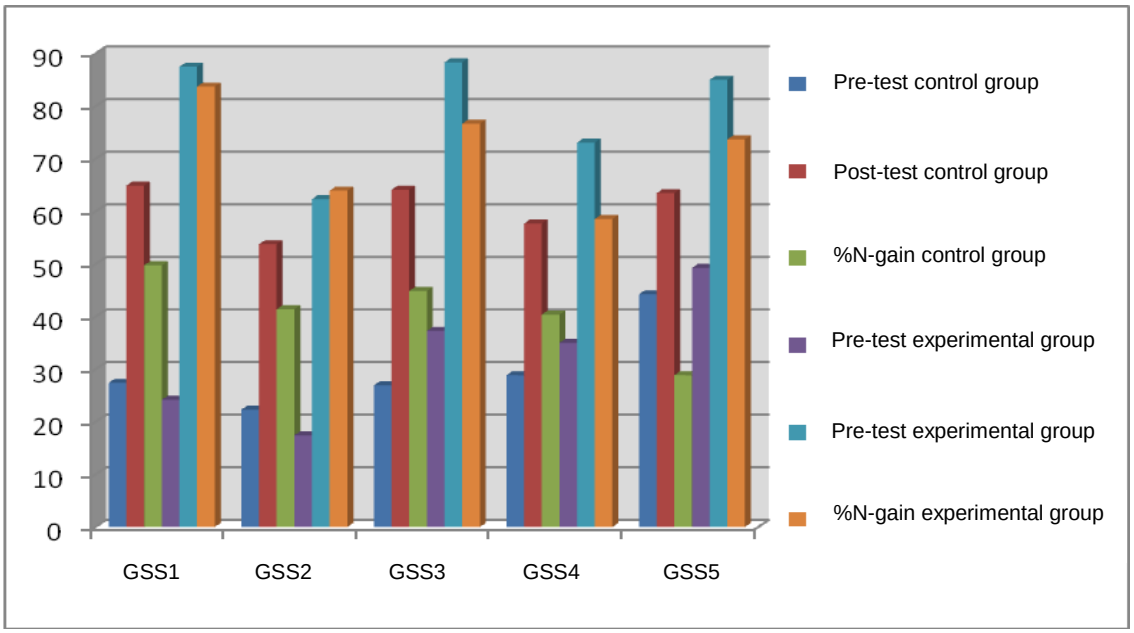

Diagram 2. Mean score of pretest, posttest and N-gain <g> diagram of GSS on senior high school of Rate of Reaction Topic

The result of statistical analysis of students score on generic science skills shows that there were significantly differences between control class and experimental class of Human Neural System topics (Z= 0.000), Human Urine Excretion (Z= -5, 173),Motion of Earth and Planets (t=9.167 > t_{table}) and Special Relativity (p=0.000). The number of generic science skills developed decrease from Earth and Space Science (6) to Chemistry and Physics (5) to Biology (4). These data show that generic science skills developed depend on educational level of students and science dicipline. They also depend on the function of the interactive multimedia software on the teaching-learning

processes. As teaching media on e-learning it developed more generic science skills than as simulation laboratory. This fact was in line with characteristics of ICT-based learning make information access easily (Heinich, et al, 1996).

Tabel 5. Mean score of generic science skills on pretest, posttest dan N-gain students on Special Relativity topic (Wiyono, 2009)

No	Generic science skills	Mean score of control class			Mean score of experimental class		
		Pre-test	Post-test	% N-Gain	Pre-tes	Post-tes	% N-Gain
1.	Sense of scale	13,46	63,46	54	7,69	84,62	85
2.	Logical consistency	51,92	65,38	33	26,92	55,77	35
3.	Logical inference	20,51	56,41	44	12,82	83,33	82
4.	Causality	31,73	50,98	17	20,19	46,15	30
5.	Mathematical modelling	51,92	78,85	44	30,77	86,54	77
Subject (N)		26			26		

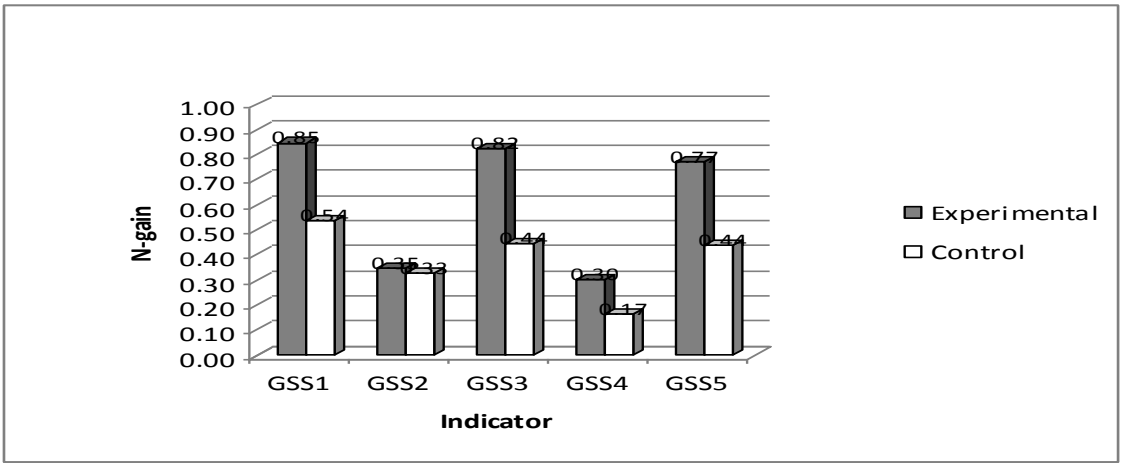

Diagram 3. Mean score of pretest, posttest and N-gain diagram of GSS on senior high school of Special Relativity Topic

Table 6. Mean score of generic science skills on pretest, posttest dan N-gain students on Human Urine Secretion topic (Subiantoro, 2009)

No.	Generic Science Skills	Mean of control class			Mean of experimental class		
		Pre test	Post test	N-Gain	Pre test	Post test	N-Gain
1.	Indirect observation	1,69	2,11	**0,13**	1,94	2,75	**0,31**
2.	Logical inference	3,03	3,81	**0,47**	3,06	4,34	**0,59**
3.	Causality	3,39	3,58	**0,03**	3,13	5,09	**0,51**
4.	Concepts formation	2,25	2,86	**0,10**	2,94	5,09	**0,71**
Subject (N)		**36**			**32**		

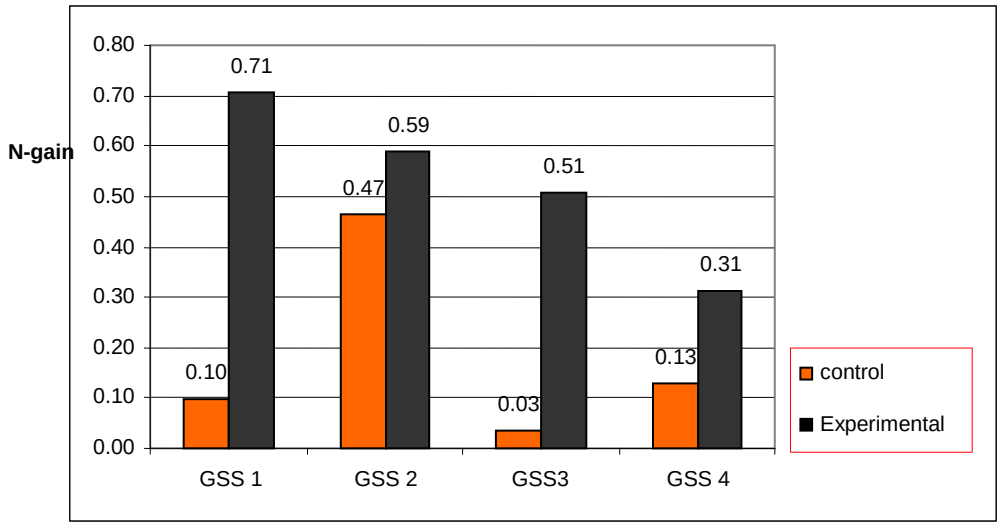

Diagram 4. Mean score of pretest, posttest and N-gain diagram of GSS on senior high school of Human Urine Excretion Topic

Table 7. Mean score of generic science skills on pretest, posttest dan N-gain students on Human Neural System topic (Mulyani, 2009)

No	Generic Science Skills	Mean of experimental class			Mean of control class		
		Pre-test	Post-test	N-Gain	Pre-test	Post-test	N-Gain
1.	Indirect observation	1,61	4,55	0,86	1,92	3,89	0,64
2.	Logical inference	2,23	5,03	0,72	2,62	4,39	0,48
3.	Causality	1,68	3,48	0,38	1,30	2,29	0,16
4.	Concept formation	1,75	5,14	0,63	1,75	4,13	0,42
Subject (N)		77			76		

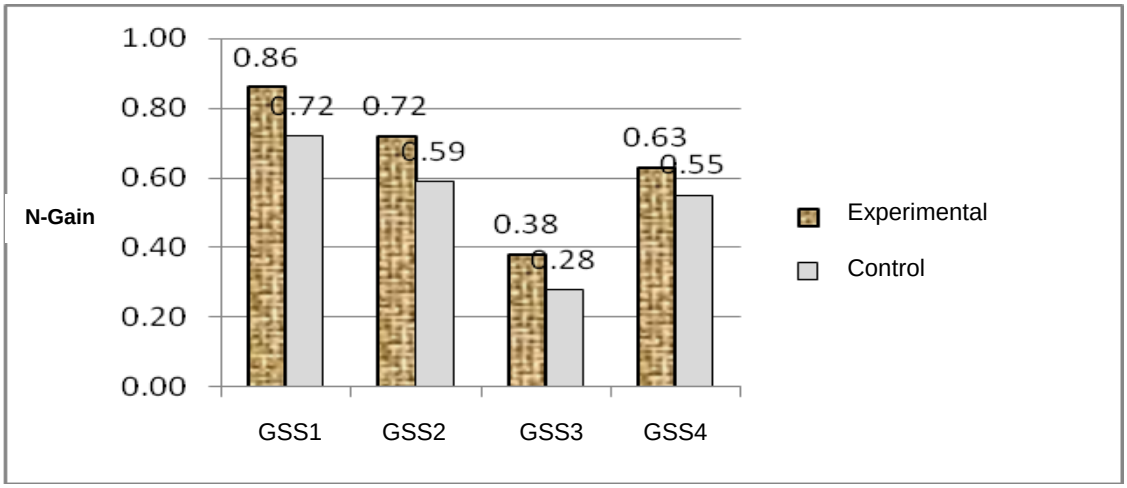

Diagram 5. Mean score of pretest, posttest and N-gain diagram of GSS on senior high school of Human Neural System Topic

Conclusion

Based on research results several points was concluded, those are: (1) learning science in new paradigm through the development of generic science skills; (2) the development of generic science skills made students learn science concepts easier; (3) generic science skills could be developed through interactive multimedia software (4) Generic science skills developed increase parallel with the increasing of educational level; (5) The number of generic science skills developed depend on the function of interactive multimedia in the teaching-learning processes; (6) maximum number of generic science skills can be developed of interactive multimedia as teaching media function through e-learning; (7) generic science skills developed through interactive multimedia also depend on science discipline, that physics and chemistry developed more generic science skills than biology.

It is suggested to applied interactive multimedia software based on relevant function in learning processes to develop as much as students' generic science skills.

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