12

INTERNATIONAL SEMINAR AND WORKSHOP
Mathematics and Science Teaching Innovation
(ISW MSTI-2009)

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Development of Teaching Learning Process by Information Technology System

Seminar Room, Faculty of Mathematics & Natural Science
Yogyakarta State University
December, 12th 2009

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Editors :

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PREFACE

An international seminar and workshop entitled "Development of Teaching Learning Process by Information Technology System" has been held at the Faculty of Mathematic and Natural Science YSU (Yogyakarta State University). It is a seminar designed principally for lecturers in college, offering broad coverage of all the educational methods in mathematics and science applications.

The editors gratefully acknowledge the presenters for their time and efforts in preparing their contributions. Without their contribution, this proceeding would not have been possible. It is our hope that the proceeding will be both useful and interesting to its readers, and encourages further developments of educational methods.

Yogyakarta, December, 12th 2009

SHORT SPEECH

Chairman of the Organizing Committee

At the Opening Ceremony of the International Seminar and Workshop

on Mathematic and Science Teaching Innovation 2009

(ISW MSTI 2009)

Assalamu'alaikum warohmathullohi wabarokatuh.

In Honorable to Rector Yogyakarta State University, Dr. Rochmat Wahab, MA

Dean of Math and Sciense Faculty, Dr. Ariswan

Prof. Dr. Man-Gon Park from PuKyong National University, Korea

Dr. Anna Permanasari, UPI Bandung

Herman Suryono, PhD UNY

And to all participants

On behalf of the organizing committee of the International Seminar and Workshop on Mathematic and Science Teaching Innovation 2009, and all those gathered here today, I humbly express my deepest gratitude to all participant, especially to Bapak Rector Dr. Rochmat Wahab, MA, to major speaker Prof. Dr. Man-Gon Park from PuKyong National University, Korea, Ibu Dr. Anna Permanasari, UPI Bandung and Herman Suryono, PhD UNY for having graciously consented of the International Seminar and Workshop on Mathematic and Science Teaching Innovation 2009. And to all participant that was attendant and participating to the seminar we express thankful for you.

International Seminar and Workshop on Mathematic and Science Teaching Innovation 2009 (ISW MSTI 2009) is seminar and workshop that have a purpose to provide and develop of the teaching learning process by information technology and preparing international teacher on mathematic and science with connections that reach throughout the world. In principle the activity to support UNY to world class university. As we know that Yogyakarta State University is committed to providing an international learning experience through its curriculum, student life, on-campus events, and academic programs abroad. The graduates of Yogyakarta State University are prepared to teach in schools of international level.

Theme of the event is "**Development of Teaching Learning Process by Information Technology and Preparing the Teacher for International School**". The theme is implementation in mathematic and science teaching. The seminar is being attended by over 240 participants. In plenary session there are three paper that divide in two session, Firstly by Prof. Dr. Man-Gon Park and Herman Suryono, PhD with discus about teaching-learning by Information Technology and secondly by Dr. Anna Permanasari with discus about preparation for international teacher. In parallel session, there are 30 paper that be presented in 5 rooms.

Finally, may it please to Rector of Yogyakarta State University give speech and to honor these gathering by declaring open the International Seminar and Workshop on Mathematic and Science Teaching Innovation 2009.

Thanks for attendance all participants.

Wassalamu'alaikum warohmathullohi wabarokatuh.

Chairman of Organizing committee

Dr. Suyanta

CONTENTS

THE INTEGRATION OF INTERACTIVE MULTIMEDIA, COLLABORATIVE WORK AND REFLECTIVE THINKING ON INTRODUCTORY PHYSICS COURSE TO INCREASE PROBLEM SOLVING SKILLS

Wahono Widodo[1] and Suhardi[2]

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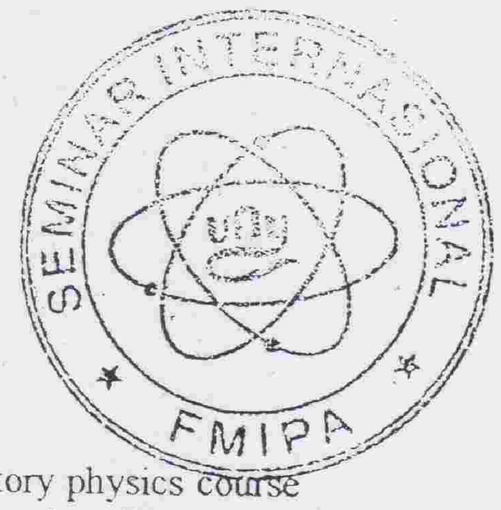

ABSTRACT

Improving problem solving skills on non-physics major students through introductory physics course is one of challenging tasks, but it is less studied. The objective of the research was to know the effectiveness of integration of interactive multimedia, collaborative work, and reflective thinking on introductory physics course to increase problem solving skills on prospective of vocational high school teachers in foods program.

The research used control group pretest-posttest design. The populations were students of prospective of vocational high school teachers in foods program of state university in East Java. The samples were taken by purposive random sampling technique, and then divided into two groups by matching group technique, 35 students on experiment group as well as 33 students on control group. On experiment group, students posed by problems that had to resolved by collaborative works. In order to resolve the problems, student learned concepts underlies of the problem through interactive multimedia. After problems were resolved, students reflected the steps of resolving problems. Problem solving test on elasticity, fluids, as well as temperature and heat was used as instrument. Data was analyzed with Mann-Whitney U Test, to compare normalized gain between experiment group and control group

Result showed that integration of interactive multimedia, collaborative work, and reflective thinking on Introductory Physics course was effective to improve the problem solving skills on prospective of vocational high school teachers in foods program.

Keywords: interactive multimedia, collaborative, reflective, problem solving, prospective of vocational high school teachers in foods program.

INTRODUCTION

Dissatisfaction with the low quality of the process and results of physics courses for non-physics majors has been a long time. The dissatisfaction is partly due to lack of "community" of physics in non-physics majors, large class size, and little interest in studying physics (Tobias in Kirkup et al., 2007). As stated Giancoli (2001), non-physics majors will be asked, "Why do I need to learn physics?" Physics courses for non-physics majors should be able to answer these challenges.

Prospective of Vocational High School (VHS) teachers in Foods Program Department of Home Economics, Engineering Faculty, are also received the physics course (Introductory Physics or applied physics). The importance of Introductory Physics courses for home economics prospective teachers according to the statement Paolucci (in Vaines, 1979), that the focus of the home economics are inter-dependencies and inter-relationships between *physical* phenomena and processes of social and cultural influence human development, as well as Cebotarev (1979) stated that basic knowledge of home economics are *physics*, biology, social science, and art, while McElwe (2004) emphasized the importance of understanding *science* as part of the home economics course. However, the results of preliminary studies conducted on prospective students 40 vocational teachers at one PKTB universities in East Java showed many problems in physics courses. These problems include the educational background of a heterogeneous student, a negative perception of students of physics, and properties of physics are not in accordance with their interests, resulting less optimal in their learning outcomes (Widodo, 2009). The preliminary study results are consistent with Rauma, *et al.* (2006) which showed 40 of 167 home economics teachers in Finland declared that science education at university level are too abstract and too far from everyday life. On the other hand, the results of McElwe's research (2004) in Ireland showed that third level of home economics students have many misconceptions on the scientific principles used in cooking. These results, follow Gallagher thinking (in Rauma et al., 2006), shows that there are many problems in science-physics education for VHS prospective teachers in foods program, concerning the process and results of learning physics courses.

Based on these facts, improving the learning process and outcome on Introductory Physics courses for prospective of VHS teachers in

Foods Program is needed. One of the efforts undertaken in this research is to encourage students to deepen the concepts of physics through problem-solving activities that apply the concepts of physics in foods. Giancoli (2001) stated the importance of the application of physics concepts in various fields (according to area of expertise of non-physics majors) and that is learned within the framework of problem solving so that students will master these concepts.

Problem solving skill is a higher order thinking skill that need to be achieved by a prospective teacher. According to Cohen (1971, in Presseisen, 1985), problem solving using basic thinking processes to solve a problem that is known or defined, assembling the facts about the difficulties and find the necessary additional information, or suggest alternatives and test solutions for compliance, simplify explanations and eliminate mismatches, providing solutions for checking the values that can be generalized. Problem solving skills developed in Introductory Physics in general is to present a situation where certain information is given, more often as the numerical values for the variables in the situation, and the value of one variable can be determined. In this context, a person who solves the problem will find the unknown quantity demanded in the statement of the problem, so the problem tends to *well defined*. However, in the context of prospective of VHS teachers in Foods Program, physics placed as one of the science underlying the applications in the field of foods. In this context, the ability to apply physics concepts in the field of foods problems is more necessary, and the problem tends to *ill defined* in the context of physics applications in food technology. The model of learning that appropriate to the purposes is problem-based learning (PBL).

There are many crucial factors that influence the success of PBL, such as skills of team-working (Yeo, 2007), orienting students to a new instructional strategy, picking the problem, and forming the teams (Peterson, 2004). In the context of the Introductory Physics for non-physics majors, the crucial factors can be elaborated into: 1) the availability of learning resource for students to obtain and study the physics concepts as a basis for problem-solving activities; 2) collaborative setting in order to solve problems; and 3) opportunities for students to reflect on the process and result of problem solving activity.

Information Communication Technology (ICT) can be applied to support in providing learning resources and opportunities for student to reflect his or her problem solving activities. Learning resources to support PBL were selected to provide students the opportunity to study physics at all times necessary, can be repeated by the student until the student understands, can provide quick feedback on student response, and interesting. Interactive multimedia (IM) is an appropriate form for this purpose. Lorenso (2005) indicates that IM can be used to help student to understand the steps of systematic problem solving. On the other hand, Zheng & Zhou (2006) shows that the IM can help working memory, cognitive capacity, as well as providing a source of cognitive in solving the problem.

Activities in PBL can be held by students individually or in groups. However, according to Gick & Holyoak (in Pretz et al., 2003), guidance from the environment can affect the definition or representation that is used for solving the problem. The statement shows that the present social context such as collaborative is useful in increasing of problem solving skills, as shown in the research Nurjanah (2008). Collaboration in the form of coordinated and synchronized activities will generate the building and sharing common conceptualization of the problem and the procedures followed to solve it. The role of social interaction is central to the teaching and learning science and in various studies (Dori and Belcher, 2005), and according to Vygotsky (in Dori and Belcher, 2005) benefit from the interaction to the individual is the integration of knowledge from friends and the environment.

Reflection is a vital component in the process of learning with PBL. Roger (2001) states that reflection is a process that allows student to integrate the understanding gained through experience that allows selecting the option or action better and strengthen the overall effectiveness. Based on the above descriptions, the research focused to know effectiveness of the integration of IM, collaborative work, and providing opportunities for reflection on the Introductory Physics courses in improving problem-solving skills on prospective of VHS teachers in Foods Program.

METHODS

This research used experimental methods, with the *control group pretest-posttest* design. A group of students selected from the population based on problem solving pretest score into two groups, namely an experimental group and a control group. Furthermore, the experimental group was lectured Introductory Physics that integration of IM, collaborative, and reflective thinking as shown in Figure 1. For this purpose, the IM has been developed on the concept of elasticity and fluid (Widodo & Liliasari, 2009) as well as temperature, heat, and heat transfer. For collaborative working purpose, the Students Activity Sheets which contain problems and "hint"

to solve the problem have been developed (Widodo, 2009). The problems were designed to be solved through the application of physics concepts in foods. For example, "Devise ways to determine the crispy of food. Test your design ". To facilitate reflection, students were encouraged to discuss about the process of resolve the problems. Beside that, student was encouraged to upload his/her artifacts on his/her e-portfolio while made comments to the process and result of the resolving problems. In the control group, students learned Introductory Physics conventionally (ordinary Introductory Physics course), i.e.: lecturing activities, recitation sessions, and home working.

The population of the study was students of prospective of VHS teachers in Foods Program on a state university in East Java. Samples were taken with purposive random sampling technique. Only students in Introductory Physics course on semester I 2009/2010 selected as the samples. Based on pretest score, samples were selected randomly and then divided into two equality groups: experimental (35 students) and control (33 students).

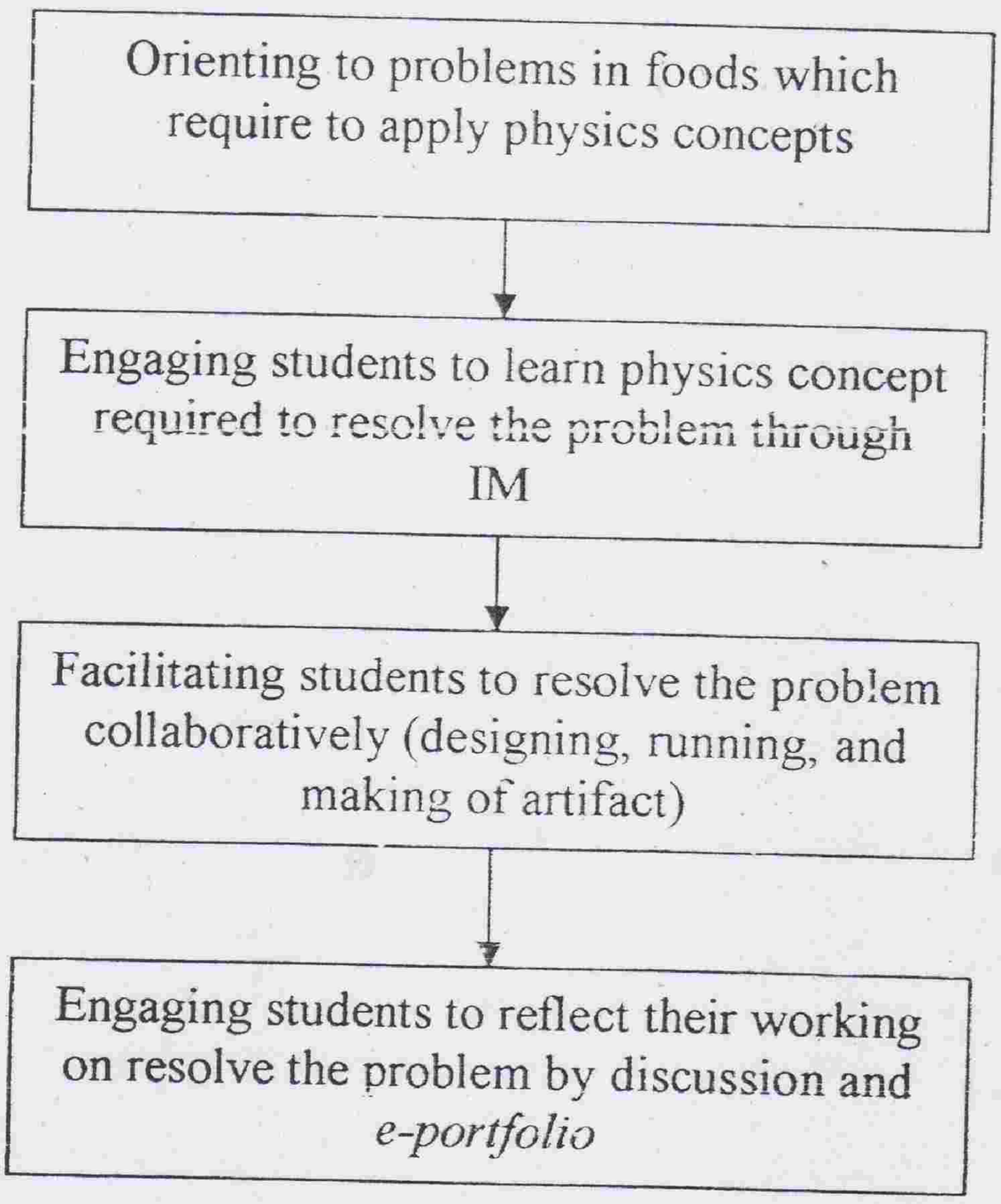

Figure 1: The phases of IM, collaborative, and reflective thinking on experimental group

Instrument of the study was problem solving test on elasticity, fluid, as well as temperature, heat, and heat transfer concepts. Problem solving test was objective test with five options, based on steps of problem solving indicators developed by McGregor (2007). Based on expert judgment, test items can measure indicators of problem-solving. Based on the trial, reability of the instrument (alpha cronbach) is 0.843 for 35 points. Adding with two repaired items, tests composed of 37 items. The effectiveness of the Introductory Physics lecture by implementing IM, collaborative, and reflective thinking were tested with the difference test on normalized gains (N-gain) acording to Hake (1998) between the control group and experimental group using the U Mann-Whitney test.

RESULTS AND DISCUSSION

Figure 2 shows the summary of the average problem-solving test scores for the control group and experimental group, and percentage N-gains for the two groups. The average problem solving pretest at the control group was 25.1% (standard deviation = 5.26%), while the average posttest was 37.0% (standard deviation = 8.81%), with an average N-gain of 15,3%. On the experimental group, average problem solving pretest was 25.0% (standard deviation = 7.01%), average postest was 58.6% (standard deviation = 12.87%) with the average N-gain was 44.1%. Based on Hake's criteria (1998), the control group's average N-gain was "low" category, while "medium" category in the experimental group.

Based on the difference test to N-gain mean between the two groups using the U Mann-Whitney test, it was obtained Z = -6.149, so that Ho was rejected to a significance level of 0.000. As a consequence Ha: there are differences in N-gain mean between the control group and experimental group, accepted. Because of experimental group's N-gain mean was greater than control group's, it can be concluded that the integration of IM, collaborative work, and reflective thinking on the Introductory Physics lecture was effective to improve problem solving skills on prospective of VHS teachers in Foods Program.

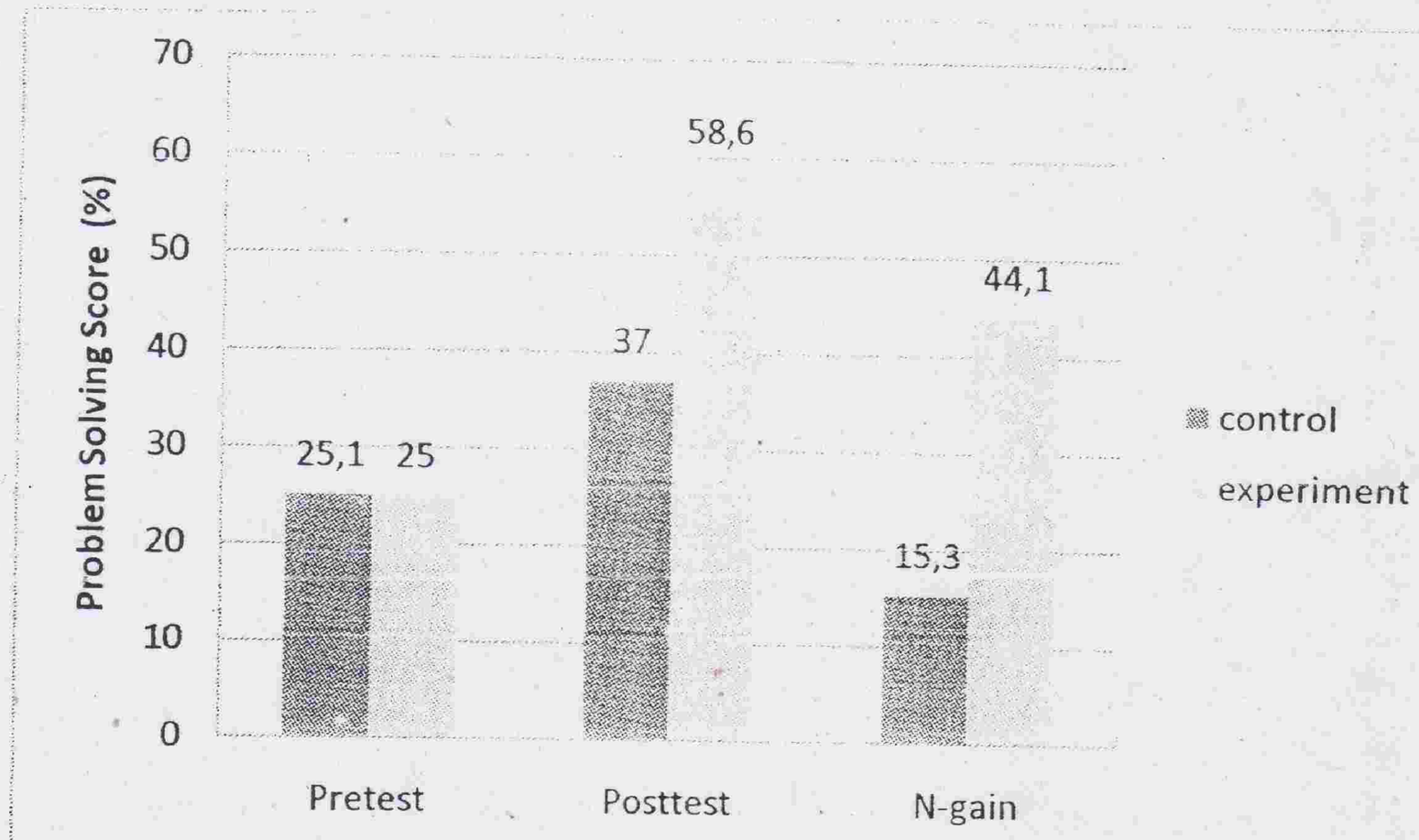

Figure 2. The average score of pretest, posttest, and N-gain of the overall problem-solving aspects of the experimental group and control groups.

Furthermore, the difference of each aspect of problem solving skill is considered. As Figure 3 shows, it appears that all of problem solving skills aspects in both groups were increase after Introductory Physics course. However, the increase in the control group based on Hake's criteria (1998) only into "low" category, except on "Clarifying of the problem" that lied on "medium" category. All of problem solving skills aspects of the experimental group lied on "medium" category.

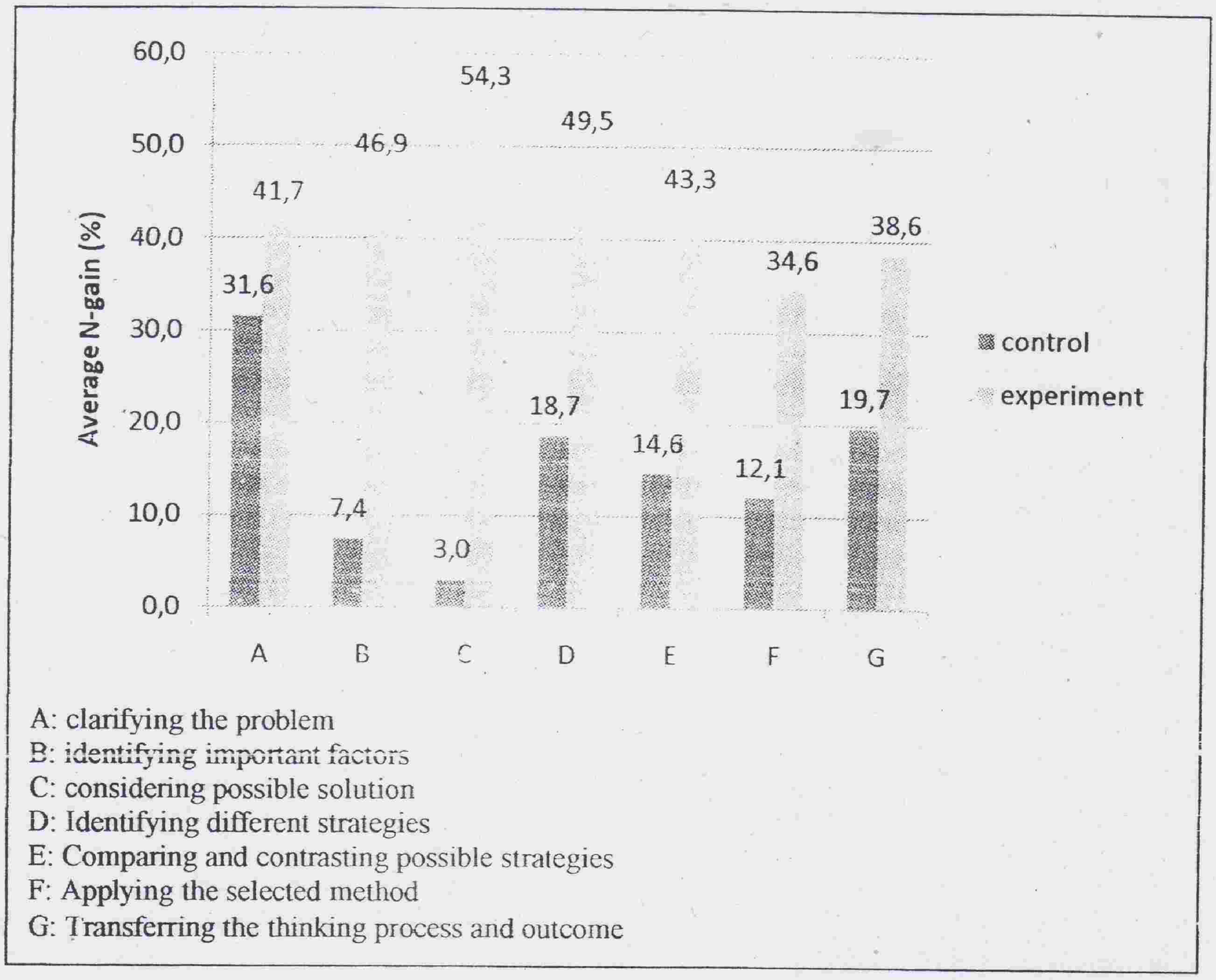

Figure 3. The average N-gain of each aspect of the problem-solving experimental groups and control groups

Table 1 shows the recapitulation of the difference test of N-gain of the seven aspects of these problem solving skills. Based on Table 1, it can be known that on aspect of "Clarifying of the problem", there is no difference between the two groups. The Introductory Physics course on both groups does not make a difference on "Clarifying aspects of the problem". This could be because this aspect according to McGregor (2007) only uses a "simple analysis" of cogniuve skills, which are also achived in conventional lectures.

However, there are differences in N-gain (for alpha = 0.05) between the two groups on the following aspects: 1) identifying important factor; 2) considering possible solutions; 3) identifying different strategies; 4) comparing and contrasting possible strategies; 5) applying the selected method; as well as 6) transferring the thinking process and outcome.

Table 1. The Sumary of Difference Test of the Problem Solving Skills Aspects

	KLARFKS	I_FAKTOR	T_ALT	I_STR	BDG_STR	TRP_MTD	TRANSFR
Mann-Whitney U	519,500	177,500	207,500	314,500	295,000	313,000	402,000
Wilcoxon W	1080,500	738,500	768,500	875,500	856,000	874,000	963,000
Z	-,725	-4,930	-4,634	-3,309	-3,653	-3,260	-2,228
Asymp. Sig. (2-tailed)	,468	,000	,000	,001	,000	,001	,026

The results of data analysis showed that the combination of IM, collaborative work, and reflective thinking in the Introductory Physics lecture effectively to improve problem-solving skills on prospective of VHS teachers in Foods Program. The results enrich Dori and Belcher

(2005) that combines visualization and simulation of physics with group interaction improved students' cognitive abilities. If compared, this study is more specific to the effort to improve problem-solving skills, and provides students the opportunity to reflect on his or her working to resolve the problem. These results also reinforce the findings of Zheng & Zhou (2006), that IM can provide cognitive resources that play a role in solving the problem. This research is also consistent with Nurjanah (2006) that collaborative learning can assist in problem solving skills training. Collaboration that occurs in the course was coordinated and synchronized activities to build and share a common conceptualization of the problem and the procedures followed to solve it. These results also reinforce the opinion of Roger (2001) who states that reflection is a process that allows student to integrate the understanding gained through experience that allows selecting the option or a course of action the better and strengthen the overall effectiveness.

CONCLUSION

Based on the results of data analysis can be concluded that the Introductory Physics courses that integrate IM, collaborative work, and reflective thinking can significantly improve problem-solving skills on prospective of VHS teachers in Foods Program. The future reseach could be held to test this model for another non-physics major students of prospective teachers, including examining the motivation, responses, and student attitudes toward physics courses after the application of this model.

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Certificate

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Wahono Widodo

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Dr. Ariswan

Dean of Faculty of
Mathematics and Natural Sciences
Yogyakarta State University

Dr. Suyanta

Chief Committee of
ISW MSTI