PHY-01242

The Effects of Scaffoldings in Cooperative Learning on Physics Achievement Among Senior High School Students

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Article info

Keywords:
Conceptual scaffolding,
visual scaffolding,
cooperative learning,
prior knowledge,
physics achievement

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Abstract

The purposes of this study were to explore the effects of scaffoldings in cooperative learning on physics achievement among senior high school students and to explore the effects of prior knowledge on their physics achievement. This study implemented the 3 x 2 factorial design. Participants included 412 eleventh-grade students from 12 classes in four senior high schools in Malang. Data were collected from two data sources: (a) **Prior Knowledge Test to identify students' prior knowledge in physics, and (b) Physics Achievement Test to assess students' physics** achievement. Findings revealed that there were significant differences among the three strategies of teaching with regard to physics achievement but no significant difference between high and low prior knowledge with regard to physics achievement. The conceptual **scaffolding in cooperative learning generated highest students' physics** achievement. Even though students of both high and low prior knowledge tended to have similar physics achievement, there was the effect of interaction between strategies of teaching and prior knowledge **on students' physics achievement**.

INTRODUCTION

Many students got difficulties in solving physics problems. Saul and coworkers reported that many students who took fundamental physics which was taugh by lecturing and traditional laboratory activities, experienced several difficulties [1]. Two major difficulties were weak understanding of concepts in fundamental physics and inability to apply what they knew in a new situation.

The problem solving skills in physics needed critical and logical thinking skills. Learning critical and logical thinking skills were tough, so that many students tried to memorize concepts and formulas of physics. Hammer reported that many students learned physics by memorizing because they had naive physics concepts. Formulas and equations were important in physics because physical quantities had to be solved by applying them. However, if students can not understand physical meaning behind the formulas, they will not be able to solve physics problems [2].

Physics achievement is reflecting the learner's comprehension in implementing physics concepts. Physics achievement of senior high school students in Malang was low. Result of national examination in physics of senior high school students was the lowest in East Java, i.e. rank 36 of 38 districts in East Java [3].

Students who got low physics achievement occurred because there was a discrepancy **between student's prior knowledge and level of complexity the learning materials. This showed that it was important to teacher to understand student's prior knowledge. Teacher** needed to know stu**dent's prior knowledge and experiences and their response to learning** materials [4].

In order to reduce student's difficulty in physics, it is clear that students who learn physics need help to bridge the difficulties by scaffolding. Scaffolding will help students to

use many scaffolds for ascertaining that learning has occurred. Scaffolding will help **students to prevent them from failure by various scaffolds that focus on student's successes[5]. Scaffolding will bridge between student's prior knowledge an**d physics achievement, reduce task difficulties by gradual supports.

Scaffoldingwill improve the quality of physics learning processes and in the long run it will improve physics achievement. Result of the study showed that the quality of learning processe**s significantly affected students' physics achievement [6]. Furthermore, other research found that the growth of physics achievement was caused by student's active involvement, not by increasing of time period of learning [7]. Student's active involvement** can be appeared by implementing cooperative learning.

Study on scaffolding has been done in several ways. Conceptual scaffolding was implemented to solve synthesis problem [8] and visual scaffolding inserted in tutorial to improve retention [9]. Therefore, it was needed to study empirically whether conceptual **scaffolding or visual scaffolding in cooperative learning can improve students' physics** achievement.

RESEARCH METHOD

Design and procedure

Design of this quasi experiment was the 3x2 factorial design. Three different treatments were implemented into three different groups, i.e. conceptual scaffolding in cooperative learning, visual scaffolding in cooperative learning, and cooperative learning. Each group was categorized into two subgroups based on their prior knowledge, i.e. high and low prior knowledge. The effects of the treatments were measured by the test of physics achievement.

Student sample

Subjects of this research were 412 eleventh-grade students in 12 classrooms of 4 senior high schools in Malang.Experimental groups consisted of 135 students in four classrooms who learned via conceptual scaffolding in cooperative learning and 137 students in four classrooms who learned via visual scaffolding in cooperative learning, while control group consisted of 140 students in four classrooms learned via cooperative learning.

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Data of prior knowledge and physics achievement were collected by tests. Data of prior knowledge were collected before treatments. On the other hand, data of physics achievement were collected after treatments. The test of prior knowledge was a multiple choice test consisted of 25 items and had reliability coefficient 0.75. The test of physics achievement was an essay test consisted of 10 items and had reliability coefficient 0.80.

Data were analyzed by two-way anova. This technique was used to analyze the difference of physics achievement among three groups.

RESULTS AND DISCUSSION

Table 1 describes means and standard deviations of physics achievement for three groups in two levels of prior knowledge. The group of students who learns by conceptual scaffolding in cooperative learning acquires highest physics achievement score 70.2 and students with high prior knowledge get higher physics achievement than students with low prior knowledge. However, groups of students who learns by visual scaffolding or without scaffolding show tendency that students with low prior knowledge acquire higher physics

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	Total	70.2	16.8	135
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	Total	56.0	18.2	140
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Result of two-way anova on physics achievement among three groups based on high and low prior knowledge is shown in Table 2. There is difference on physics achievement among three groups of students that learn physics in different ways ($p < 0.05$). However, there is no difference on physics achievement between high and low prior knowledge ($p > 0.05$). Furthermore, there is interaction between the strategies of teaching and prior knowledge on physics achievement ($p < 0.05$).

TABLE 2. Summary of two-way anova on physics achievement

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	24112.568[a]	5	4822.514	17.034	.000
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a. R Squared = .173 (Adjusted R Squared = .163)

Table 3 shows the post hoc test among three groups of students. The test shows that three strategies of teaching affect signifi**cantly on student's physics achievement. The** strategy of conceptual scaffolding in cooperative learning generates the highest physics achievement and the strategy of cooperative learning without scaffolding results the lowest physics achievement.

TABLE 3. Summary of post hoc test on physics achievement

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.[a]
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[9]. C. Lindstrøm & M. D. Sharma. *Teaching Physics Novices at University: A Case For Stronger Scaffolding*. Physical Review Special Topics - Physics Education Research, 7, 2011, pp. 1 -14.

[10]. L.A. Liang. *Scaffolding Middle School Students' Comprehension and Response to Short Stories.*RMLE Online. (Online),2011 inHighBeam Research (http://www.highbeam.com/doc/1P3-2338166961.html), accessed 17 April 2012.

[11]. P.H. Wu, G.J. Hwang, L.H. Su & Y.M. Huang. *A Context-Aware Mobile Learning System for Supporting Cognitive Apprenticeships in Nursing Skills Training.*Educational Technology & Society. (Online),2012 inHighBeam Research (http://www.highbeam.com/doc/1G1-284221942.html), accessed 18 April 2012.

[12]. L.S.Vygotsky. *Mind in Society: The Development of Higher Psychological Processes.* Cambridge, MA: Harvard University Press, 1978.

[13]. M.G. Arreguin-Anderson & J.J.Esquierdo. *Overcoming difficulties: bilingual second-grade students do scientific inquiry in pairs during a lesson on leaves.*Science and Children, (Online),2011.in HighBeam Research (http://www.highbeam.com/doc/1G1-252562911.html), accessed 16 April 2012.

msceis 2015

October 17, 2015

Proceedings

International Seminar on
Mathematics, Science, and Computer Science Education

"Improving Quality of Mathematics, Science and Computer Science Education Through Research"

Published by:
Faculty of Mathematics and Science Education
Universitas Pendidikan Indonesia
Jl. Dr. Setiabudhi No. 226 Bandung, 40154, West Java, Indonesia
Official website: http://fpmipa.upi.edu

ISBN 987-602-95549-2-2

Proceeding

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Layout and Design by:
Ika Mustika Sari

Published by:
Faculty of Mathematics and Science
Education Universitas Pendidikan Indonesia
Jl. Dr. Setiabudhi No. 226 Bandung, 40154, West Java,
Indonesia Official website: http://fpmipa.upi.edu

PREFACE

We are pleased to welcome all of the participants to Second International Seminar on Mathematics, Science and Computer Science Education (MSCEIS 2015). MSCEIS 2015 is organized by Fakultas Pendidikan Matematika dan Ilmu Pengetahuan Alam Universitas Pendidikan Indonesia (FPMIPA UPI), in collaboration with:

- Program Studi IPA Sekolah Pascasarjana UPI (Science Education Graduates Program)
- University of Tasmania
- National Taiwan Normal University

MSCEIS has been started since 2013 as an International Seminar of Mathematics, Science and Computer Science Education. This seminar is motivated by improving the quality of mathematics, science and computer science education. The aims of the seminar are: (1) To bring together the scientists, education experts and practitioners, students, and civil society organization representatives in the scientific forum; (2) To share and to discuss theoretical and practical knowledge about innovation in mathematics, science and education.

MSCEIS will be held every year to provide forum for researchers in Mathematics, Science and Computer Science Education to share new ideas or research result in their field. The theme for this seminar is **"**Improving the Quality of Mathematics, Science and Computer Science Education through Research**"**. This seminar is sponsored by FPMIPA UPI.

The scope of research results to be presented and discussed in this seminar covers Pure and Applied Mathematics, Science and Technology, Information and Technology, Mathematics, Science and Computer Science Education.

The MSCEIS 2015 Program features 13 invited speakers and 380 contributed oral presentations, which come from different countries: Taiwan, Australia, USA and Indonesia. All papers reviewed before and after they are presented in this event. Selected papers will be published in the American Institute of Physics (AIP) Conference Proceedings series.

To all participants, we hope that you will learn new subjects, make new contacts, and have fruitful discussions with others. To overseas participants, we wish you a pleasant stay in Bandung.

Finally, we wish to express our sincere appreciation to all of the presenters for their valuable contributions and also to the members of the program committee for their excellent works in selecting abstracts and organizing the program.

October, 2015

MSCEIS 2015 Committee

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SCHEDULE OF PROGRAMME

Time	Event	Venue
07.30-08.00	Registration	Registration Desk (Lobby FPMIPA A)
08.00-09.00	Opening Ceremony Welcoming Address by Rector Universitas Pendidikan Indonesia Doa	Auditorium of FPMIPA A UPI
09.00-10.20	Prof. John Williamson Prof. Hsin Kai Wu	Main Session (Auditorium of FPMIPA A UPI)
10.20-10.30	Group Photo	Auditorium of FPMIPA A UPI
10.30-11.00	Coffee Break	Lobby of Auditorium FPMIPA A UPI
11.00-12.00	**Plenary Session**	
	Physics and Physics Education: Prof. Dr. Eng. Khaerrurijal Dr. John Kenny	Plenary Session (Auditorium of FPMIPA A UPI)
	Mathematics and Mathematics Education: Prof. Dr. H. Tatang Herman, M.Ed Dr. Robyn Raeburn	Plenary Session (E405 of FPMIPA A UPI)
	Biology and Biology Education: Prof. Hj. Rr. Hertien Koosbandiah Surtikanti, M.Sc.ES., Ph.D Prof. Hsin Kai Wu	Plenary Session (E406 of FPMIPA A UPI)
	Chemistry and Chemistry Education: Prof. Bruce Waldrip Dr. Eng. Asep Bayu Nandiyanto, M.Eng	Plenary Session (E210 of FPMIPA A UPI)
	Computer Science and Computer Science Education: Prof. Zaenal A. Hasibuan, Ir., MLS., Ph.D Dr. Adrew Fluck	Plenary Session (Meeting Room (S209) of FPMIPA A UPI)
	Science Education: Prof. Raphael Finkel Dr. Harry Firman, M.Pd	Plenary Session (Auditorium of Sekolah Pascasarjana UPI)
12.00-13.15	Lunch Break	
13.15-15.45	Parallel Session	
15.45-16.00	Coffee Break	
16.00-16.15	Closing Ceremony	

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[7]. E.F. Redish, J.M. Saul & R.N. Steinberg. *On the Effectiveness of Active-Engagement Microcomputer-Based Laboratories.* American Journal of Physics, 65(1), 1997, p 45.

[8]. D. Lin, N. Reay, A. Lee, & L. L. Bao. *Exploring The Role Of Conceptual Scaffolding in Solving Synthesis Problems.* Physical Review Special Topics - Physics Education Research,7 (2), 2011, pp. 1 – 11

[9]. C. Lindstrøm & M. D. Sharma. *Teaching Physics Novices at University: A Case For Stronger Scaffolding*. Physical Review Special Topics - Physics Education Research, 7, 2011, pp. 1 -14.

[10]. L.A. Liang. *Scaffolding Middle School Students' Comprehension and Response to Short Stories.*RMLE Online. (Online),2011 inHighBeam Research (http://www.highbeam.com/doc/1P3-2338166961.html), accessed 17 April 2012.

[11]. P.H. Wu, G.J. Hwang, L.H. Su & Y.M. Huang. *A Context-Aware Mobile Learning System for Supporting Cognitive Apprenticeships in Nursing Skills Training.*Educational Technology & Society. (Online),2012 inHighBeam Research (http://www.highbeam.com/doc/1G1-284221942.html), accessed 18 April 2012.

[12]. L.S.Vygotsky. *Mind in Society: The Development of Higher Psychological Processes.* Cambridge, MA: Harvard University Press, 1978.

[13]. M.G. Arreguin-Anderson & J.J.Esquierdo. *Overcoming difficulties: bilingual second-grade students do scientific inquiry in pairs during a lesson on leaves.*Science and Children, (Online),2011.in HighBeam Research (http://www.highbeam.com/doc/1G1-252562911.html), accessed 16 April 2012.