

Effects of Two Reflective Teaching Strategies on Secondary School Students' Achievement in Biology

Efectos de dos estrategias de enseñanza reflexiva en el rendimiento de los estudiantes de secundaria en biología

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Abstract

The teaching of biology has been beset by routine and poor students' achievement. Most of the instructional methods adopted by teachers failed to improve students' achievement. This is partly because of the inability of biology teachers to carry out reflective teaching in their practices of teaching. Previous studies on biology teaching and learning in Nigeria have concentrated on instructional methods used by teachers as against how teachers actually employ various aspects of the instructional process to impact students' achievement. This study therefore, determined the effects of Reflective Focus Group Discussion (RFGD) and Reflective Peer Observation (RPO) strategies on students' achievement in biology and the moderating effects of teachers' reflective teaching, knowledge and gender.

The study adopted a pretest-posttest, control group, quasi-experimental design. 576 students with eighteen biology teachers were drawn from 9 secondary schools in Ibadan metropolis. The schools were randomly assigned to the two experimental (RFGD and RPO) strategies and the control groups. Instruments used were: Teachers' Instructional Guide for RFGD Strategy, Teachers' Instructional Guide for RPO Strategy, Teachers' Instructional Guide for Traditional Lecture, Instructional Guide for Facilitators, Biology Teachers' Reflective Teaching Knowledge Test, Students' Achievement Test in Ecology. Seven hypotheses were raised and tested at the 0.05 level of significance. Data was analysed using descriptive and inferential statistics.

There were significant differences in students' achievement. Students of teachers in RFGD strategy had the highest achievement mean score=41.8) followed by RPO (12.2) and control (=9.3) groups. Teachers' reflective teaching knowledge and gender had no significant effect on students' achievement. Interaction effect of treatment and teachers' gender was significant on students' achievement ($F_{(2,575)}=5.4, p0.05; =0.12$). The 3-way interaction effect was not significant on students' achievement.

Reflective focus group and reflective peer observation strategies improved students' achievement in biology. Therefore, they should be used by teachers to improve students' achievement.

Key words: biology, teaching, reflective teaching,

Resumen

La enseñanza de la biología ha sido criticada por los logros rutinarios y pobres de los estudiantes. La mayoría de los métodos de instrucción adoptados por los maestros no lograron mejorar el rendimiento de los estudiantes. Esto se debe en parte a la incapacidad de los profesores de biología para llevar a cabo la enseñanza reflexiva en sus prácticas de enseñanza. Por lo tanto, este estudio determinó los efectos de las estrategias Reflective Focus Group Discussion (RFGD) y Reflective Peer Observation (RPO) sobre los logros de los estudiantes en biología y los efectos moderadores de la enseñanza, el conocimiento y el género del profesor. El estudio fue organizado en la metodología de pretest-posttest, grupo de control, diseño cuasi-experimental. 576 estudiantes con 18 profesores de biología fueron entrevistados de 9 escuelas secundarias en la metrópoli de Ibadan.

Hubo diferencias significativas en el rendimiento de los estudiantes. Los estudiantes en la estrategia de la RFGD tuvieron la puntuación media de logro más alta seguido por los grupos RPO y grupo de control. El conocimiento y el género de la enseñanza reflexiva de los maestros no tuvieron un efecto significativo en el logro de los estudiantes. El efecto de la interacción entre el tratamiento y el género de los docentes fue significativo en el rendimiento de los estudiantes. El grupo de reflexión y las estrategias reflexivas de observación por pares mejoraron los logros de los estudiantes en biología. Estos datos pueden ser utilizados por los maestros para mejorar el logro de los estudiantes.

Palabras clave: biología, enseñanza, enseñanza reflexiva,

INTRODUCTION

Biology is a science subject which deals with the study of life. The study of the subject among other things provides students with an understanding of the structure and functions of organisms and the relationship of these organisms with their environment. The National Policy on Education (2004;2013) in the objectives of learning secondary school biology stated that the learning of the subject should help provide solutions to most human activities and problems. It is therefore expected that the subject is to be effectively taught by teachers and learned by students in schools.

However, in spite of the importance of biology, students' performance at the secondary school level has not proved to be encouraging. Several researchers such as Odili, (2006) and Ajayi, (2011) have reported the poor performance of students in biology especially in Senior Secondary School Examination.

The poor performance of students may be as a result of their poor understanding of concepts in ecology (Ige, 1998; Tekkaya, Ozkan & Surkur, 2001; WAEC, 2005; 2010;2011) as well as the routine and monotonous teaching of several biology teachers (Ibe and Meduabum, 2001; Udeani & Adeyemo, 2011; Akinfe, Olofinniyi & Fashiku, 2012). Studies have revealed that several biology teachers have been teaching biology concepts in the same manner and have failed to critically consider, analyse and evaluate the nature of teaching activities such as communication, use of instructional materials, inadequate questioning style and poor time management being carried out in the classroom as to how this affects students' performance in the subject. The choice of language, lack of good verbal expression, poor pronunciation of words (Wabuke, 2013) and inadequate or ineffective utilization of instructional materials (Ehikhamenor, 2003) have been observed among most biology teachers. Inadequate questioning style and poor time management (Olaleye, 2011; Potyrala, Walosik & Rzepka, 2011) have been acknowledged to be regular occurrences among biology teachers who thus failed in moving beyond a routine response to classroom teaching.

In order to move beyond routine responses and approach teaching with dynamism, Ferraro (2000), Ajitoni (2008), Onwuachu and Nwaknobi (2009) suggest that teachers should get involved in reflective teaching. Reflective teaching is a deliberate, continuous, systematic, appraisal and assessment of classroom processes. This involves critical analyses of the practice of teaching by teachers in order to consider alternative ways of achieving their ends to bring about better success. Richards & Lockhart (1994), Ajitoni (2008), Menon and Alamelu (2011) described reflective teaching as a practice in teaching whereby teachers collect data about teaching, examine their attitudes and beliefs, assumptions and teaching practices and use the information obtained as basis for critical assessment of their teaching for the purpose of improvement.

When teachers examine their practices of teaching activities for the purpose of improving students' learning, it is hoped that their teaching would not be monotonous in nature. Therefore, in such instances, the nature of students' achievement would also be considered, examined and evaluated and not routinely found to be poor. Farrell (2010) observed that the practice of reflective teaching is made up of certain integral steps such as collection of data which involves gathering of information about classroom events, analysis of data collected, consideration of how the situation or activity could have been different and creation of a new plan that incorporates the findings.

Reflective teaching could be practiced using different strategies. These include: focus group discussion, critical friend, peer observation, diary keeping/journal writing, story sharing or telling, lesson recording, self reporting, mentoring, students' feedback brainstorming, and action research (Hall, 97; Tice, 2004; Taggart & Wilson, 2005; Pollard, 2005; Larrivee & Cooper, 2006; Minott, 2009; Farrell, 2009; Menon & Alamelu, 2011).

According to Taggart & Wilson (2005) Farrell (2007), reflective focus group discussion strategy involves a group of teachers meeting regularly to reflect in order to complement each other's strength and compensate for each other's limitations. The group convenes to systematically consider, analyse and evaluate their teaching beliefs, attitudes, assumptions and practices with a facilitator as the leader of the group to coordinate the activities. Reflective peer observation strategy was described by Tice (2004) and Taggart & Wilson (2005) as involving two teachers taking turns to observe each other in the classroom for reflective activities.

Important as the practice of reflective teaching is to teaching, Ginemeze (1999), Gugapersad (2008) and Minott (2009) report that it has not received due enthusiastic response from teachers. The implication of this is that teachers especially biology teachers do not practice reflective teaching. This may be due to lack of possession of the knowledge and practice of reflective teaching during training or lack of utilization or use of reflective teaching by teacher educators who are mentors to the pre-service teachers. The teacher preparation program had been confirmed to lack the teaching and learning process of reflective teaching due to its non-inclusion in the teacher education curriculum. Therefore, it becomes almost impossible for teachers to have the knowledge of reflective teaching and the ability to engage in its practice. This knowledge gives a confident understanding of a subject with the ability to use it for a specific purpose. If teachers possess the knowledge and practice of the process of reflective teaching, they could have a better understanding of how their management of instruction could impact students' learning and performance.

However, application of knowledge in any practice has been argued by Drudy & Chathan (2002) to be influenced by gender. But Elstad & Turmon (2005) claim that there is no gender difference in teachers' quality of knowledge acquisition and application in the classroom. However, if teachers irrespective of gender possess the knowledge of reflective teaching, there could be better understanding of how this process may have an impact on students' learning and performance.

Several studies have been carried out using most of the strategies of reflective teaching stated above on pre-service teachers. Few studies on in-service teachers have concentrated mostly on language teachers and rarely on physics and science teachers' classroom practices. However, not many reports have been recorded on the extent to which other strategies such as reflective focus group discussion and reflective peer observation strategies influenced students' achievement in a subject like biology.

Therefore, the study focused on the effect of reflective teaching strategies on students' achievement in biology and the moderating effects of teachers' gender and teachers' reflective teaching knowledge.

Hypotheses

- Ho₁**: There is no significant main effect of treatment on students' achievement in Biology.
- Ho₂**: There is no significant main effect of teachers' reflective teaching knowledge on students' achievement in Biology.
- Ho₃**: There is no significant main effect of teachers' gender on students' achievement in Biology.
- Ho₄**: There is no significant interaction effect of treatment and reflective teaching knowledge on students' achievement in Biology.
- Ho₅**: There is no significant interaction effect of treatment and teachers' gender on students' achievement in Biology.
- Ho₆**: There is no significant interaction effect of reflective teaching knowledge and teachers' gender on students' achievement in Biology.
- Ho₇**: There is no significant interaction effect on treatment, reflective teaching knowledge and teacher's gender on students' achievement.

METHODOLOGY

Research Design

A pretest-posttest, control group quasi experimental design was employed.

Population

The population target of this study consisted of all the senior secondary schools in Ibadan metropolis in Oyo State, Nigeria.

Sampling technique and Sample

A random sampling technique was used to select three local government areas from the eleven local government areas in Ibadan metropolis of Oyo State. All the senior secondary schools within the three local government areas were subjected to scrutiny based on the following criteria:

- (1) presence of laboratory for teaching Biology
- (2) availability of minimum of two qualified teachers teaching Biology in Senior Secondary School II (SS II)
- (3) evidence of completion of SS I biology syllabus.
- (4) a co-educational school.

In all the 25 schools that met the condition, three schools were randomly selected from each local government area and schools were randomly assigned to two experimental groups (RFGD = 174 and RPO = 210 strategies) and control group (n = 192). One intact SS II class was randomly selected per school. In all, a total of 576 biology students made up of male and female students participated in the study.

Instrumentation

The instruments used for the study are:

- Teachers' Instructional Guide for Reflective Focus Group Discussion Strategy (TIGRFD) (Inter-rater reliability index, $r = 0.82$)
- Teachers' Instructional Guide for Reflective Peer Observation Strategy (TIGRPO) (Inter-rater reliability index, $r = 0.80$).
- Teachers' Instructional Guide for Traditional Lecture (TIGTL) (Inter-rater reliability index, $r = 0.85$).
- Instructional Guide for facilitators (IGF) (Inter-rater reliability index, $r = 0.72$).
- Biology Teachers' Reflective Teaching Knowledge Test (BTRTKT) KR 20 = 0.85. Students' Achievement Test in Ecology (SATB) KR 20 = 0.86.

Procedure for Data Collection

Reflective Focus Group Discussion Strategy, Reflective Peer Observation Strategy and Traditional Lecture Strategy constituted the treatment conditions for the study. The pretest which involves administration of Students Achievement Test in Biology (SATB) to the students and Biology Teachers' Reflective Teaching Knowledge Test (BTRTKT) to the teachers in each group commenced the study and lasted for two weeks. This was followed immediately by the training of teachers for the experimental groups – RFGD strategy and RPO strategy groups. During the training, teachers were introduced to the features of each strategy and given practice sessions. This lasted for two weeks. After this period, the teachers were exposed to the treatment using the instructional guides TIGRFD, IGF, TIGRPO, TIGTL, for eight weeks, after which the post-test was administered using BTRTKT for the teachers and SATB for the students for two weeks.

Data Analysis

The data obtained was analysed using mean, Analysis of Covariance (ANCOVA), Multiple Classification Analysis (MCA) and Scheffé Post hoc analysis.

RESULTS

The results of the analysis are presented in accordance with the hypotheses raised for the study.

Hypothesis 1: There is no significant main effect of treatment on students' achievement in biology.

Table 1: Summary of ANCOVA of Post-treatment Students' Achievement Scores by Treatment, Teachers' knowledge and Teachers' Gender.

Source of Variance		Hierarchical Method				
		Sum of squares	df	Mean Square	F	Sig
Covariates	PRE	2487.0	1	2487.0	459.7	.00
Main Effects	(Combined)	2378.4	4	594.6	109.9	.00
	TREATMT	2364.2	2	1182.1	218.5	.00*
2-Way interactions	TRKNOWL	0.061	1	0.061	.0	.92
	TRGENDER	14.2	1	14.2	2.6	.11
	(Combined)	76.4	5	15.3	2.8	.02
	TREATMT	6.1	2	3.1	.6	.57
	TRKNOWL	58.2	2	29.1	5.4	.01*
3-Way Interaction	TR GENDER	16.8	1	16.8	3.1	.08
	TRKNOWL	32.3	2	16.2	2.9	.05
	TR GENDER	4974.2	12	414.5	76.6	.00
Model		4974.2	12	414.5	76.6	.00
Residual		3045.7	563	5.4		
Total		8019.9	575	13.9		

*Significant at P .05

Table 2: Multiple Classification Analysis (MCA) of students' Achievement in Biology by Treatment, Teachers' Knowledge and Teachers Gender

Variable + Category	N	Predicted Mean		Deviation		Eta	Beta
		Unadjusted	Adjusted for factors and covariates	Unadjusted	Adjusted for factors and covariates		
Ref Focus Gp Dissc.	174	15.3	14.8	3.3	2.8	.7	.6
Ref Peer Obs	210	12.4	12.2	.4	.2		
Trad Mtd	192	8.6	9.3	-3.4	-2.7		
TR KNOWL Low	360	11.9	12.0	-.09	.03	.0	.0
High	216	12.2	11.9	.2	-.05		
GENDER Male	240	12.0	12.2	.02	.2	.0	.0
Female	336	12.0	11.9	-.01	-.1		
R = .8							

Table 1: shows that there is a significant main effect of treatment on students' achievement in Biology ($F_{(2,575)}=218.5$; $p<0.05$). This implies that there is a significant difference in the post treatment achievement scores of students exposed to the two strategies (Reflective Focus Group Discussion and Reflective Peer Observation Strategies) than those exposed to the control group. Hence, hypothesis 1 is rejected.

Table 2 is presented to find out the magnitude of the performance of students assigned to the strategies.

From table 2, students exposed to Reflective Focus Group Discussion Strategy obtained the highest adjusted post treatment mean achievement scores (= 14.8; Adj.Dev = .2.8) followed by reflective peer observation strategy (= 12.2; Adj. Dev = .2) and the traditional lecture (= 9.3; Adj. Dev = -2.7) respectively. Thus, reflective focus group discussion strategy was the most effective in improving students' achievement in biology.

Further, the source of the significant difference of treatment on students' achievement was traced using Scheffe Post hoc test.

Table 3: Scheffe Post hoc Tests of Students' Achievement by Treatment

Treatment	N	X	Treatment		
			Focus Gp Diss	Peer Obs	Trad Lect
Focus Gp Dissc	174	14.8		*	*
Peer Obs	210	12.2	*		*
Trad Lec	192	9.3	*	*	

* Pairs of groups significantly different at p .05

Table 3 reveals the significance difference of the strategies. Reflective focus group discussion strategy contributed to the significance difference than others (reflective peer observation and traditional Lecture).

Hypothesis 2: There is no significant main effect of teachers' reflective teaching knowledge on students' achievement in Biology.

From table 1, there is no significant effect of teachers' level of knowledge of reflective teaching on students' achievement in Biology. On this basis, hypothesis 2 is not rejected.

Hypothesis 3: There is no significant main effect of teachers' gender on students' achievement in Biology.

From table 1, teachers' gender has no significant main effect on biology students' achievement ($F_{(1,575)}=2.6$; $P>.05$). Though, table 2 shows that students taught by a male teacher had slightly higher mean biology achievement score (=12.2) than students taught by their female counterparts (=11.9), it was not significant. Hence hypothesis 3 is not rejected.

Hypothesis 4: There is no significant interaction effect of treatment and reflective teaching knowledge on students' achievement in Biology.

Table 1 shows that there is no significant interaction effect of treatment and teachers' knowledge on students' achievement in Biology ($F_{(2,575)}=6$; $p>.05$). On this basis hypothesis 4 is not rejected.

Hypothesis 5: There is no significant interaction effect of treatment and teachers' gender on students' achievement in Biology.

From table 1, there is a significant interaction effect of treatment and teachers' gender on students' achievement in Biology ($F_{(2,575)} = 5.4$; $p < .05$). Hypothesis 5 is therefore rejected.

Hypothesis 6: There is no significant interaction effect of teachers' reflective teaching knowledge and teachers' gender on students' achievement in Biology.

Table 1 shows that there is no significant interaction effect of teachers' reflective teaching knowledge and teachers' gender on students' achievement in Biology ($F_{(2,575)} = 3.1$; $P > .05$). Hypothesis 6 is therefore not rejected.

Hypothesis 7: There is no significant interaction effect of treatment, teachers' reflective teaching knowledge and teachers' gender on students' achievement in Biology.

From table 1, there is no significant 3-way interaction effect of treatment, teachers' reflective teaching knowledge and teachers' gender on students' achievement in Biology ($F_{(2,575)} = 2.9$; $p > .05$). Hypothesis 7 is therefore, not rejected.

DISCUSSIONS

The two strategies of reflective teaching (Reflective Focus group discussion, and reflective peer observation) used in this study proved to be efficacious in improving students' achievement in Biology. The results in tables 1, 2 and 3 showed significant difference between scores of students exposed to the strategies of reflective teaching and traditional lecture (control group). Since the mean scores obtained by students in the treatment groups i.e RFGD strategy with achievement mean score (14.8) followed by RPO (12.2) were higher than the control group mean scores (9.3) then the efficacy of the two strategies were revealed.

The increase in the mean scores of the achievement of students in the treatment groups might be due to the exposure of their teachers to reflective practices such as critical consideration, examination and evaluation on teaching activities which consequently led to better students' performance. This corroborates Lowery's (2003) assertion that reflective teaching practice has the potential to affect students' achievement in mathematics and science classrooms. The reflective activities of biology teachers must have enhanced and enriched their teaching and this consequently, opened the door to more efficient learning of their students and increased their achievement. This is also in agreement with Akbari and Allvar's, (2010) submission that there is a high correlation between teachers' reflectivity and students' achievement. The reason according to the study is that reflective practice is first centered on students' learning.

Students of teachers in the reflective focus group discussion strategy had a higher mean score than students of teachers in the reflective peer observation strategy. The advantage of students of RFGD strategy over students of RPO strategy teachers might be due to the number of teachers who were involved in carrying out reflective activities in the RFGD strategy. The more number of teachers in RFGD strategy must have generated various ideas during reflection activities due to their number in the group which made the teachers to become more effective in improving students' learning and consequently students' achievement. This is in agreement with Roig and Rivera (2013) who submitted that group reflection helps teachers to learn and modify their students' learning.

The improvement of students of biology teachers which might have occurred due to peer reflection of the teachers compared to traditional lecture where an individual biology teacher was responsible for planning of classroom teaching with no reflection, hence such individual teachers are less effective. This is in support of Marzano and Toth (2012) who remarked that even small improvements in teachers' effectiveness can have a possible impact on students' achievement. The little reflective activities by two teachers in RPO strategy must have produced positive influence on students' achievement as compared to the traditional group with only one teacher without systematic reflection.

However, the result obtained indicated a significant interaction effect of treatment and teachers' gender on students' achievement. The interaction effect showed that in RPO strategy students of male teachers performed slightly higher in achievement scores than students of female teachers. This may be due to possession of other characteristics like good problem solving abilities by the male teachers. Possession of such characteristics might have boosted the effect of reflective teaching on the students' learning due to the ability of the males to modify the teaching style thus enhancing students' achievement. Corroborating this assertion, Udeani and Adeyemo

(2011) reported that a biology teacher with good problem solving abilities will be able to modify the teaching style to suit the students' learning thus, enhancing their academic achievement. However, the finding from this study is contrary to that of Akbari and Allvar (2010) and Nevaneedhan (2011) who found that the practice of reflective teaching produces better academic performance of students irrespective of teachers' gender.

CONCLUSIONS

This study showed that reflective teaching had proved to be important in improving students' achievement. However, the study has also revealed that reflective teaching by focus group discussion strategy improved students' achievement more than the reflective peer observation strategy does. This implies that with practice of reflective teaching by biology teachers, especially with the strategies such as reflective focus group discussion and reflective peer observation, students' achievement in biology would be improved. It is believed that the practice of reflective teaching in classroom teaching in biology would greatly improve students' learning and consequently students' achievements.

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Las pizarras digitales interactivas en la enseñanza de ciencias: visión del profesorado de educación secundaria y bachillerato

Interactive whiteboards in the teaching of science: vision of secondary education teachers

PURIFICACIÓN TOLEDO MORALES, JOSÉ MANUEL SÁNCHEZ GARCÍA

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Resumen

En este artículo se explora cómo los profesores de secundaria y bachillerato utilizan las tecnologías y en concreto las pizarras digitales interactivas (PDI) en la enseñanza de ciencias, así como las percepciones que tienen de su uso. Se utilizó un enfoque metodológico cualitativo, realizándose entrevistas semiestructuradas a un total de veintisiete profesores de educación secundaria y bachillerato de Andalucía (España). La codificación y reducción de datos se realizó con el software Atlas.ti, dando lugar a once categorías que facilitaron el análisis. Entre los resultados obtuvimos que los profesores de ciencias utilizan las tecnologías, y en especial la PDI como herramientas habituales en sus clases, que les permite explicar los conocimientos científicos y les facilita a los estudiantes la comprensión de los mismos; perciben la precariedad de recursos tecnológicos y los problemas técnicos como obstáculos para su implantación. Y que los constantes avances tecnológicos hacen necesaria una formación continua del profesorado, con el fin de poder utilizar el potencial pedagógico que ofrece la PDI y las tecnologías que están surgiendo.

Palabras clave: pizarra digital interactiva; nuevas tecnologías; educación secundaria; percepción docente; enseñanza de ciencias.

Abstract

This article explores how teachers of junior high and high school use technologies and specifically interactive whiteboards (IWB) in science education, as well as perceptions of their use. A qualitative methodological approach was used, semi-structured interviews were done with a total of twenty-seven teachers sciences in junior high schools and high schools in Andalusia (Spain). Coding and data reduction was performed with the software Atlas.ti, resulting in eleven categories that facilitated the analysis. Among the results we obtained were that science teachers use technologies, and especially the PDI as usual tools in their classes, allowing them to explain scientific knowledge and provide students with an understanding thereof. Science teachers perceive the precariousness of technological resources and technical problems as obstacles to its implementation. Also, constant technological advance makes necessary a continuous training of teachers in order to fully use the educational potential of the PDI and emerging technologies.

Keywords: interactive whiteboard; new technologies; secondary education; teacher perception; science education.