Effect of Innovative Instructional Approaches and Self Efficacy on Achievement of Chemistry among Secondary School Students in Kenya

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***Abstract*— The delivery of science education seems to be rapidly shifting toward pedagogy rich in experiential learning and strongly embedded in educational technology. This study investigates and extends previous research efforts on the effects of Innovative instructional approaches (5E Model, Group Discussion, Small Group Class Experiments, Teacher demonstration) and self efficacy on learning outcomes (Academic Achievement, Science Process Skills, Scientific Literacy and Science Motivation) in chemistry among high school students in Kenya. A quasi-experimental non-equivalent control group research design was adopted and this paper presents findings of a study conducted in Vihiga county in Kenya where 11 schools were selected through stratified random sampling and a sample of 550 form four students randomly selected. Quantitative data were collected using six research instruments (1) Achievement test (a pre-test (PrT), and a post-test (PoT)), (2) a 22-item self-report science self-efficacy scale (SSES), 3) a10-item scientific literacy assessment test (SLAT), (4) a 20-minute practical science process skills Achievement test (SPSAT), (5) a science Motivation Questionnaire (SMQ). Data were analyzed using Factorial MANOVA at α = .05. Results suggest that the use of innovative instructional approaches leads to favourable learning outcomes with 5E learning cycle yielding highest scores on the learning outcomes. These findings have implications for science educators, specifically teachers of chemistry and for policy.**

***Index Terms*— Motivation, Innovative Teaching Approaches, Science Process Skills, Scientific Literacy, Self efficacy.**

I. INTRODUCTION

The use of innovative teaching strategies has been a hot topic for the last decade. Creative and skilled teachers use different innovative teaching methods whose application is critical if we are to motivate and engender a spirit of learning as well as enthusiasm on the part of students, for learning while at school and indeed for lifelong learning. Stensaker (2008) argues that in order to achieve quality teaching and learning, greater attention must be paid to teaching and learning practice.

Traditional methodologies of ‘talk and chalk’ which are teacher centred are not adequate for current students and that effective teaching and learning is not taking place at the desired level (Race, 2003). Research is focused on advancing and improving the existing learning methods, as well as introducing and experimenting with innovative teaching which involves using innovative methods and teaching learning materials for the benefit of students (Mandula, Meda, & Jain, 2012). According to Anderson and Neri (2012), innovative teaching can involve virtual labs: learning activities based on real-life problems; learning environments with equipment, furnishings, materials, and audiovisual resources; and learning guides for students and the teacher. All of these are combined with methodologies that promote the use of active teaching techniques that help teachers develop their students’ learning abilities.

In Kenya, science is taught at all levels of schooling from early childhood education (ECD) through primary and secondary to tertiary institutions, including universities. Chemistry is one of the key science subjects taught in secondary schools in Kenya and it has a major influence on students’ career prospects and choices. It is a critical Science Technology, Engineering and Mathematics (STEM) subject with wide application in industry and in daily life (Gili, 2010; Twoli, 2006, Zengele & Alemayehu, 2016). In Kenya, chemistry is taught as a stand-alone science subject from secondary school up to university level. Students’ learning outcomes (SLOs) in science have attracted considerable attention, debate and research interest in the last decade (Adesoji & Ibraheem, 2009; Astra, Wahyuni & Nasbey, 2015; Bybee & Fuchs, 2006; Harrison, 2014; Klette, 2007; Mitee & Obaitan, 2015; Omwirhiren & Ibrahim, 2016; Panasan & Nuangchalerm, 2010; Puncochar & Klent, 2013; Suskie, 2009; Yager & Akcay, 2008). Classroom instructional approaches have a strong bearing on whether or not the desired SLOs in science are achieved. The current study was designed to investigate four innovative instructional approaches against the traditional approach and their effects on learning outcomes. The innovative instructional strategies were 5-E learning cycle, group discussion, small scale experiments, and teacher demonstration. These are some of the inquiry-based pedagogical approaches that have been shown to encourage active, deeper and authentic learning of science (Dudu & Vhurumuku, 2012; Gormally, Brickman, Hallar & Armstrong, 2009 ;Krajcik, Blumenfeld, Marx ,Bass & Fredricks, 1998; \Roth, 1995). Indeed, inquiry-based instruction and laboratory investigation have become the hallmarks of science education around the world particularly in North America, the UK and Australia (Duschl & Grandy, 2013; Hofstein & Lunetta, 2004, Ituma, Twoli & Khatete, 2015).

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5-E is an instructional model for the implementation of Inquiry-Based Learning (IBL). The model, proposed by Bybee (1997) and which has since undergone many modifications provides a systematic approach involving a sequence of well thought-out and structured stages that a teacher can use to help learners have a clear understanding of a lesson concept (CEMASTEA, 2018). The 5-E instructional model sets out to promote interactive and authentic learning. Learning activities under this model enable learners to Engage, Explore, Elaborate/Extend and Evaluate their progress. The Engage stage is used to arouse learners' curiosity and to generate interest in the concept under study. At the Explore stage, the teacher facilitates the learner to conduct activities that enable an experience with the key concepts, discovery of new skills, probe, and establish conceptual relationships and understanding. This stage is very interactive providing opportunity for cooperative learning particularly on the part of the learner. At the Explain stage, connections are made between prior knowledge and new discoveries, if any. Students are encouraged to communicate their observations and findings in their own words. During the Elaborate/Extend stage students are expected to apply what they will have learnt to new or familiar situations and make conceptual connections. The Elaborate/Extend stage is critical to promoting additional learning. The last stage, Evaluate, enables students to assess their understanding by applying the knowledge acquired within a problem situation or be able to demonstrate evidence of accomplishment. Open-ended questions are often used at this stage. Pulat (2009) studied the impact of 5E learning cycle on sixth grade students' mathematics achievement and attitude toward mathematics. The results showed that the students' mathematics achievement improved after the instruction of 5E learning cycle. Hiccan (2008) in Pulat (2009) reported that the use of 5E learning cycle had statistically significant effect on conceptual and procedural knowledge. Studies by (Baser, 2008; Lee, 2003; Lord, 1999; Whilder & Shuttleworth, 2004) made similar findings. The study by Lee (2003) found that the students acquired knowledge about plants in daily life easier and understood the concepts better – when taught with learning cycle. As a curriculum framework, the learning cycle provides experiences from which learners construct meaning, assert Huhoglu & Yalcin, 2006, who studied the effectiveness of learning cycle model to increase students' achievement in the physics laboratory. The results of this study showed that learning cycle facilitated students to learn effectively and organize the knowledge in a meaningful way. It was also found to make the knowledge long lasting. Students became more capable to apply their knowledge in other areas outside the original context. 5-E learning cycle is best achieved when learners work in groups and engage in discussions.

According to Killen (1998) a discussion is an orderly process of face-to-face interaction in which people exchange ideas about an issue for the purpose of solving a problem, answering a question, enhancing their learning, or deciding. Collaborative or cooperative learning is widely applied in educational settings, and it is often seen as a valuable learning condition by educators. An often encountered argument is that a group can achieve more than individuals working on their own (Kirschner, Paas, & Kirschner, 2009b; Slavin, Hurley, & Chamberlain, 2003; Van Blankenstein, Dolmans, Van der Vleuten, & Schmidt, 2013; Vojdanoska, Cranney, & Newell, 2010). A significant part of both collaborative and cooperative learning is learning by participating in group discussions. For both teachers and students, it is important to know which learning strategies are most effective, as well as how individual differences may affect learning. Hence, in the present study, we investigated the learning effects of group discussions with and without feedback on individual performances and assessed how the effects of learning are related to individual differences with respect to the need for cognition (NFC). NFC is a personality characteristic defined as 'an individual's tendency to engage in and enjoy thinking' (Cacioppo & Petty, 1982, p. 116). Moreover, in both cases, the effects of group discussions on learning are compared with those of test-enhanced learning, an effective learning technique with much scientific support, Group discussions are, as previously indicated, a significant part of group learning and they have been defined as a group of individuals that come together for verbal communication to make decisions or simply share knowledge (Morgan et al., 2000). In an educational context, the teacher often introduces concepts or questions to discuss, or the group analyses a problem or carries out an assigned task. Hence, group discussions are viewed within the context that the learning takes place when completing a well-defined task. This task could as well be an experiment where a small group designs their own experiment.

Practical work is necessary for school science education. In Science, learners do practical work to expand their knowledge to understand the world around them (Kolucki & Lemish, 2011). It develops learners' understanding of ideas, theories, and models (Millar & Abrahams, 2008). Thus, teaching science involves learners experiencing the basic and integrated processes of science (NARST, 1990; Millar et al. 1999). Research has established that achievement and skills improved when students are taught science using practical work (Kerr, 1963; Turpin & Cage, 2004; Aladejana & Aderibigbe, 2007; Watts, 2013). However, as observed, practical work is not done in some schools in the country due to inadequate resources, lack of practical science skills and large classes in science (pers. Obs) and (Onwu & Stoffel, 2005; Ramnarain, 2014). Sometimes, when resources are limited and an experiment cannot be conducted in groups, teacher demonstration becomes critical

Demonstration strategy is a method of teaching concepts, principles of real things by combining explanation with handling or manipulation of real things, materials, or equipment (Akinbobola and Ikitde 2011). "In the matter of physics, the first lessons should contain nothing but what is experimental and interesting to see. A pretty experiment is in itself often more valuable than twenty formulae extracted from our minds." A famous quote by Albert Einstein (Moszkowski1970).The novelty, spectacle and inherent drama of an in-class demonstration can provoke significant interest from students. Psychologists termed this kind of interest, situational interest which spontaneously creates interest among all students (Schraw et al. 2001). The demonstration strategy is effective for long-term memory retention and appropriate to college students' study skills (McCabe 2014). The act of demonstrating readily helps to kindle more natural interactions between the students and the teacher. In-class demonstrations, a standard constituent of science courses in schools and universities, are generally believed to help students understand science and to stimulate student interest (Crouch et al. 2004). Demonstrations provide a multi-sensory means to describe a concept, idea, or product that may otherwise be difficult to grasp by verbal description alone (Cabibihan 2013). Demonstration strategy has emerged to become an instructional approach that is gaining rising interest within the engineering education community (Hadim and Esche 2002). Research has found that diverse students benefit vastly when they can participate in activities, interact with materials and manipulate objects and equipment (Carrier 2005; Prpicand Hadgraft 2009).

There are studies that have investigated the effects of inquiry-based learning environments almost all grades students' understanding (Leonard, 1984; Rissing., & Cogan, 2009; Marx, Honeycutt, Clayton & Moreno, 2006; Ulu, 2011), scientific process skills (Leonard, 1984; Laipply, 2004; Chu, Chow, Tse & Kuhlthau, 2008; Kramer, Guillory,, & Hancock, 2014; Lord, & Orkwiszewski, 2006), and provides motivation and positive attitude owards science (Chu, Chow, Tse, & Kuhlthau, 2008; McNicholl, 2013; Hadjichambis, Georgiou, Paraskeva Hadjichambi, Kyza & Mappouras, 2015; Philip & Taber,, 2015; Ekici, .2009). However, there is limited research on how students learn. This gap was the driving force behind this empirical study. On the other hand self-efficacy beliefs of students are among the most important factors in an innovative teaching environment due to the fact that students ask questions, make observations, conduct experiments, work in groups and hypothesize during the inquiry process (Wallace & Kang.,2004; Martin, 2009). In this study, the effect of self-efficacy beliefs on students' learning outcomes was investigated.

Self-efficacy generally refers to the trust an individual has towards himself to produce certain tasks or responsibilities properly and effectively (Bandura, 1977; Lee & Mendlinger, 2011). Self-efficacy is an evaluation of the ability to perform a certain behavior in certain circumstances (Pajares, 1996). Academic self-efficacy refers to students' assessment towards their own ability to organize and implement learning behavior to achieve the chosen level of academic achievement; for example, to pass the exam (Bandura,1997). Yusuf (2011), on the other hand, argues that academic self-efficacy makes students to always think about the most effective ways to accomplish each task. It refers to the level of confidence and self-belief of a student to complete a task and to produce something at its best according to their respective capabilities. Many studies have proved that self-efficacy or optimism (self-confidence) can give a positive impact in many aspects including students' academic achievement (Bresslere, Bressler, & Bressler, 2010; Kluemper, Little, & DeGroot, 2009; Mahyuddin, Elias, Loh, Muhamad, Nordin, & Abdullah, 2006; Siddique, LaSalle-Ricci, Arnkoff, & Diaz, 2006). Self efficacy is widely associated with improved students' performance on learning tasks and a number of studies have shown that students science self-efficacy not only influences but is also a predictor of academic achievement (Ahmed & Khalib, 2010; Aurah, 2013a; Baanu, Oyelekan & Olorundane, 2016; Britner & Pajares, 2006; Chen et al., 2012; Pajare & Schunk, 2001; Kiran & Usher,2016; Multon & Leni (1991) as cited in Motlagh et al., 2011; Usher & Pajares, 2006; Valentine, DuBois & Cooper, 2004). In this study, interactive effects of innovative instructional approaches and self-efficacy beliefs were also investigated

The purpose of this study was to investigate the effect of integrating innovative instructional approaches in teaching of secondary school chemistry in Kenya. The main objective was to determine the effects of innovative instructional approaches and self-efficacy on students' learning outcomes (academic achievement and science process skills) in chemistry in secondary schools in Kenya

The study was guided by three objectives:

1. To determine the effect of Innovative Instructional approaches on students' Learning outcomes
2. To determine the effect of self-efficacy on students' Learning outcomes
3. To find out the interactive effects of Innovative Instructional approaches and self-efficacy on students' Learning outcomes

The following null hypotheses were tested

H_{o1}: There is no difference in mean score of students' learning outcomes by method of instruction

H_{o2}: There is no difference in mean score of students' learning outcomes by level of self efficacy

H_{o3}: There is no interactive effects of instructional approach and self-efficacy on learning outcomes

II. METHODOLOGY

A. Research Design

This study employed a quasi-experimental research design where intact classes were assigned to treatment groups. Each of the selected school provided either an experimental or a control group and where a school had innovative streams, only one stream was randomly selected. A pre-test was administered to all the control and experimental groups followed by treatment only for the experimental groups as the control group was taught using traditional instruction. Finally, a post-test was administered to all groups. The intervention/treatment involved teaching chemistry using innovative instructional approaches (small-scale class experiments, class demonstrations and small group discussions and 5-E cycle model) alongside the traditional instruction.

B. Study Sample and Sampling Techniques

Proportionate stratified random sampling by sub-county was used to select 11 schools. Simple random sampling was used to select the schools that formed the experimental and control groups. Form four students were purposively sampled because they happen to be in the class where the topic under investigation is usually taught, as prescribed in the syllabus. Each of the five sub-counties contributed several participants to the total sample equivalent to a proportional fraction of the student population in the sub-county. Yamane (1967: p.886) formula for calculating sample sizes was adopted. A 95% confidence and p = .5 are assumed in the Yamane equation given below.

$n = N/ 1+ N (e)^2$.

In this equation, n = sample size

N = population size = 14630

e = precision level = ± 5% (or .05)

In this study, $n = 14630/ 1 + 14630(.05)^2$

= 389.35 ≈ 390.

Therefore 390 respondents form an adequately representative sample of the population but according to Israel (1992) researchers typically add 10% to the sample size to compesate for respondents whom the researcher may not be able to reach and a further 30% to compensate for non-response. Determining the sample size in this way reduces the probability of committing Type I error to 0.05, achieving a desired power of 0.90 and to be able to detect variances greater than 0.10 in the dependent variable and the independent variable. The compensated sample size (n) 546 rounded to n=550

C. Data Collection

Quantitative data were collected using six research instruments (1) a pre-test (PrT), which consisted of 25 matching-pair and innovative-choice questions testing understanding of basic chemistry concepts (2) a post-test (PoT), which consisted of 26 question items testing students' content knowledge and understanding of a range of topics taught in the first three years of secondary chemistry (3) a science self-efficacy scale (SSES), a 22-item self-report questionnaire on a 5-point Likert-type scale which was used to assess students' science self-efficacy beliefs on four sub-scales. The science self-efficacy questionnaire was modified version of the Self-Efficacy Questionnaire developed by Webb-Williams (2006) (4) a scientific literacy assessment test (SLAT), which was based on a theoretical framework proposed by Shwartz, Ben-Zvi & Hofstein (2006) and consisted of 10 questions testing four main areas of scientific literacy namely (1) recall of chemistry content knowledge (2) ability to apply scientific principles in non-scientific contexts (3) ability to read, write, reason and ask for further information and (4) understanding of the Nature of Science (NOS) and an understanding of science plus attitude toward Science-Technology-Society (STC) topics. (5) a science process skills Achievement test (SPSAT), which was a 20-minute practical investigation which will test both basic and integrated science process skills and lead to answering of 18-item innovative choice questions. This activity required students to apply their chemistry content knowledge on properties of acids, bases and salts. They also required knowledge on separation of mixtures, and (6) a science Motivation Questionnaire (SMQ), was a self-report questionnaire adopted from the guidelines of the ARCS model developed by Keller & Suzuki (2004) used to determine students' motivation to learn science (chemistry). It had four motivational sub-scales: Intrinsic motivation and personal relevance (IMPR) Self-efficacy and assessment anxiety, and Career motivation (CM), Grade motivation (GM). Positive statements were scored incrementally from 1 to 5 while negative statements were scored in reverse order from 5 to 1. From the scores, an overall score was computed for each respondent.

D. Piloting

A pilot study was conducted in two public secondary schools in Vihiga County to assess the validity and reliability of the research instruments. The experts were used to assess how well the items in the instruments represent the intended constructs. A rating scale was provided and feedback from the experts was used to determine the validity of the instruments.

For reliability of instruments the split-half method was used. The reliability ranged from 0.8 to 0.9 which was deemed acceptable

E. Data Analysis

Data were analyzed both descriptively (means and standard deviations) and inferentially using Factorial MANOVA) at $\alpha = .05$ using spss.

III. RESULTS

Quantitative data were coded in spss, screened to identify outliers, missing cases, and erroneous entries before being subjected to descriptive and inferential analyses. Underlying assumptions of MANOVA were assessed.

A. Preliminary Results

Data were screened to identify missing values, outliers, and erroneous entries.

B. Statistical Assumptions

Statistical assumptions were tested, and results showed that data for dependent variables and covariate were all measured on interval scale. Multivariate normality in which the dependent variables collectively have multivariate Normality within the groups. This was checked through Box's test which was significant. This meant that the assumption was violated. However, since the sample sizes were almost equal across the treatment groups and MANOVA test statistics are robust to the violation. Homogeneity of covariance matrices was assessed through univariate normality of the dependent variables, and both were normally distributed.

C. Descriptive Statistics

Descriptive statistics presented in Table 1 as means and standard deviations for the dependent variable namely: academic achievement and Independent Variables: instructional Approach and Self Efficacy

Table 1: Means (M) and Standard Deviations (SD) of Learning Outcomes and Independent Variables (instructional Approach and Self Efficacy)

Descriptive Statistics

	Instructional Approach	Mean	Std. Deviation	N
Post-Test	Teacher Demonstration	19.45	1.312	122
	Class Experiment	19.42	1.135	95
	5-E	20.27	.591	95
	Group Discussion	18.15	1.087	94
	Traditional Method (CONTROL)	17.47	1.030	144
	Total	18.85	1.487	550
Science Self-Efficacy	Teacher Demonstration	72.80	12.411	122
	Class Experiment	75.71	10.360	95
	5-E	75.44	14.647	95
	Group Discussion	65.27	9.383	94
	Traditional Method	64.20	9.542	144
	Total	70.22	12.362	550
Scientific Literacy	Teacher Demonstration	20.41	2.411	122
	Class Experiment	20.34	2.071	95
	5-E	20.62	3.288	95
	Group Discussion	18.37	2.463	94
	Traditional Method	18.15	2.910	144
	Total	19.49	2.884	550
Science Process Skills	Teacher Demonstration	14.56	.872	122
	Class Experiment	14.69	.864	95
	5-E	14.00	1.031	95
	Group Discussion	13.99	.967	94
	Traditional Method	13.89	.983	144
	Total	14.21	.999	550
Science Motivation	Teacher Demonstration	88.98	7.046	122
	Class Experiment	85.49	7.497	95
	5-E	94.28	7.791	95
	Group Discussion	87.52	8.075	94
	Traditional Method	68.22	11.421	144
	Total	83.61	12.942	550

The descriptive statistics in Table 1 indicate that, on average, the experimental group attained superior scores across the three levels of self-efficacy. This can be taken to mean that use of innovative instructional approaches resulted in better learning outcomes. The 5-E model was superior to the other innovative strategies in science motivation, scientific literacy and academic achievement, whereas lass experiments was superior in science self efficacy and class experiment in science process skills.

Table 2: Results of MANOVA on Student Learning Outcomes with Instructional Approach and Self-Efficacy as Independent Variables

Multivariate			T/App	SE	T/App*SE
		F	41.864	58.710	2.911
		Wilks Lambda	0.349	0.418	0.843
		p-value	<0.001	<0.001	<0.001
		n^2	0.232	0.306	0.042
Univariate	AcademAchievement	F	86.83	1.672	0.644
		p-value	<0.001	0.189	0.741
		n^2	0.394	0060	0.394
	ScieLiteracy	F	15.394	220.97	1.785
		p-value	<0.001	<0.001	0.077
		n^2	0.103	0.452	0.004
	SPS	F	18.476	25.987	4.318
		p-value	<0.001	<0.001	<0.001
		n^2	0.121	0.089	0.061
	SciMotivation	F	107.82	56.027	4.713
		p-value	<0.001	<0.001	<0001
		n^2	0.980	0.173	0.066

There is a statistically significant 2-way interaction between teaching instruction and self-efficacy (F(8, 542) = 2.991 p -.001; Wilks' Λ = .843). The null hypothesis was rejected in favour of the alternative, meaning that the effect of the intervention (instructional strategy) on the linear combination of the dependent variables (academic achievement, scientific literacy, science process skills and science motivation) is not the same for the different levels of the independent variables. Main effects of Teaching instruction (F(4, 546) = 41.86, p <.001; Wilks' Λ = .349) and Self efficacy (F(2, 548) = 58.71 p <.001; Wilks' Λ = .306) were also statistically significant for linear combination of the dependent variables. This means the two independent variables uniquely influence the linear combination of the DVs

As a follow up on significant MANOVA, univariate tests revealed a statistically significant 2 way interaction between instruction and self-efficacy for science process skills F(8,542)=4.318, p<0.001, n^2=0.061) and science motivation F(8,542)=4.713, p<0.001, n^2=0.066). Main effects of Teaching instruction had statistically significant effects on all learning outcomes: Academic achievement (F(4, 546) = 86.83, p <.001, n^2=0.394), Scientific literacy (F(2, 548) = 15.39 p <.001; n^2=0.103), science process skills (F(2, 548) = 18.48 p <.001; n^2=0.121) and science motivation (F(2, 548) = 107.82, p <.001; n^2=0.980). It indicates that Innovative teaching that actively engages students has gains on learning. In addition Self efficacy had statistically significant main effects on all DVs except academic achievement Scientific literacy (F(2, 548) = 220.9 p <.001; n^2=0.452), science process skills (F(2, 548) = 25.99 p <.001; n^2=0.089) and science motivation (F(2, 548) = 56.03, p <.001; n^2=0.173).

The two independent variables uniquely influence learning across all the investigated learning outcomes but interact to influence only science process skills and science motivation. Again, partial eta squared values are reported showing the amount of variance in the dependent variables. For all DVs, magnitude of the difference ranged from small to high based on Cohen (1988) guidelines. Teaching approach accounts for approximately 98% of the variance in science motivation, a very high effect and 10.3 % of variance in scientific literacy. Self-efficacy accounted for 0.4% of variance in scientific literacy and 39.4% of variance in academic achievement.

IV. CONCLUSIONS AND DISCUSSIONS

In this study innovative instructional approaches 5-E learning cycle model, small group class experiments, Group discussion and teacher demonstration. They were tested against the traditional way of teaching that is basically lecture and large class experiments. The results indicated that innovative strategies that involve students in an active learning environment were superior to the traditional method. Linear combination of the four innovative instructional approaches resulted in statistically significant gains in academic achievement but not science process skills. These results are consistent with prior studies that indicated that use of 5E learning cycle had statistically significant effect on conceptual and procedural knowledge (Baser, 2008; Lee, 2003; Lord, 1999; Whilder & Shuttleworth, 2004; Hiccan, 2008; Pulat, 2009). Self efficacy was found to have statistically significant effects on other learning outcomes except the ability test in chemistry (academic achiement). This was an interesting finding which was inconsistent with a host of research has been done and consistent results have indicated a statistically effect of self-efficacy on academic achievement (Britner, 2002, 2008; Britner & Pajares, 2001, 2006; Pajares et al., 2000; Zeldin & Pajares, 2000).

With a statistically significant 2-way interaction between teaching instruction and self-efficacy, it is concluded that use of innovative teaching strategies influences science process skills and science motivation differently across different levels of self-efficacy. Students with low self-efficacy benefit less from innovative teaching strategies. It may be necessary for teachers to identify strategies that would boost the self-efficacy of such students so that they benefit from the superior innovative teaching strategies. Perception of self-efficacy can affect whether students are willing to try courses or programs that require problem-solving skills. Moreover, this perception, or lack thereof, affects the future use of such skills (Schneider and Pressley, 1989). As Zimmerman and Capillo (2003) argue, "teaching students to use problem solving strategies does not guarantee their continued use or generalization to similar tasks unless other self regulation processes and a wide array of motivation beliefs are involved" (p. 252).

The findings of this study have implications for secondary school science instructional practice. Instructional approaches that actively engage learners and which are interactive appear to lead to superior effects on student learning outcomes.

V. RECOMMENDATIONS

Science classroom instruction ought to be improved to make it more effective through teacher professional development programs that emphasize inquiry-based learning. Both pre-service and in-service teacher training programs should have components that encourage teachers to employ more student-centered teaching/learning strategies and a component of self-efficacy.

VI. FUNDING

The research was partially funded by University Research Fund (URF) with an amount of USD 1715 and partially by the authors.

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