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DIFFERENCES IN TEACHER INTENTIONS TO APPLY SMASSE METHODS IN TEACHING SECONDARY SCHOOL MATHEMATICS AND SCIENCE BASED ON GENDER AND WORKING EXPERIENCE IN KERICHO AND BOMET COUNTIES OF KENYA

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ABSTRACT

The quality of science graduates largely depends on the quality of teachers and their practices. Strengthening mathematics and science education in secondary school education (SMASSE) level is an in-service course for teachers aimed at improving their classroom practices. It encourages teachers to use active learning approaches to enhance quality of learning. This study collected data from mathematics and science teachers who have undergone the SMASSE training. The main purpose of the research was to find out whether teachers intended to use the skills they acquire during the in-service course. A total number of 125 teachers were involved in the study, to establish the differences in teacher intentions to use SMASSE approaches in teaching mathematics and science. The study used an ex-post facto research design to establish this difference. Data was collected using a self-report questionnaire. The data was analysed using t-test and ANOVA to test for differences between groups. The findings indicated that there was no significant difference in teacher intentions to apply SMASSE approaches in teaching secondary school mathematics by gender and working experience. There was however a statistically significant difference in teachers' attitude towards SMASSE methods of teaching mathematics and science by working experience in favour of the most experienced. The findings can guide the ministry of education in improving the SMASSE in-service course and other courses aimed at improving the quality of mathematics and science instruction.

Keywords: Teacher Intentions, SMASSE Methods, Secondary School Mathematics and Science, Gender, Working Experience

INTRODUCTION

The persistently low enrolment in science particularly in secondary schools and tertiary levels of education have aroused concern of science educators, researchers and policy makers the world over (Hardin & Hilderbrand,1988). Most countries at the moment are seeking to improve their education standards by promoting programmes that not only enhance effective acquisition of knowledge in a well-organized framework, but also promote the learners' capability to learn meaningfully (Novak, 1998). The importance of good teaching cannot be overemphasized; however, it is worth noting that good teaching will encourage high quality students learning (Ramsden, 1992). However the constrains of the typical science classroom limits the way the scientific process is taught (Hodson, 1993). Besides the often-heard problems of time and classroom management, there are few curricula materials based on the new understanding about the nature of science, leaving teachers alone in trying to integrate it into their classrooms (Flery & Bentley, 1991). The learning of mathematics and science is very dependent on good teaching therefore a teacher needs to know what classroom strategies will to the learners understanding of concepts. These require that teachers organize the classroom in an inquiry, mode that emphasizes cooperative learning and hands on lessons (Brahier, 2005). According to Harlen (1993) and kolb and kolb, (2008), use of appropriate teaching method by the science teachers should play a key role in helping children develop their ideas and process skills such as observing, hypothesizing, predicting, investigating, drawing conclusions and communicating. This can only be possible if teachers play their role well and select appropriate teaching methods which will facilitate the learning of school science.

Cognitive psychology research has provided considerable insight into the way the learners acquire and organize knowledge. Constructivist theories of learning which had its roots from cognitive psychology place the learner in an active role of knowledge construction. The learner approaches a domain with some prior knowledge about the subject matter constructed from personal experiences, schooling, and social interactions (Okere, 1986). Concepts change as the learner attempts to connect new information with existing conceptual framework (Brahier, 2005; Atherton, 2009). According to constructivist theories of learning conceptual change in learners should be facilitated by activities such as having students actively engaged in processing materials; confronting their conceptual framework; confronting, defending alternatives perspective; linking new concepts to old; and using strategies that encourage both meta-cognition and higher order thinking (Toblin, 1993). Even though the crucial action of constructing meaning is mental, that is, it happens in the mind; physical actions such as hands-on experiences may be necessary for learning, especially for children, but it is not sufficient; there is need to provide activities which will engage the mind as well as the hands (Duckworth et al, 1990).

Research findings on learning and memory show that for learning to be effective, the learner should be actively involved in the learning process (Shuel, 1993; Matlin, 1994). These arguments concur with Newsome, Wardlow and Johnson (2005) who pointed out that experiential learning strategy elevates students' cognition level, increases thinking skills and enhances students' achievement. Similarly Ngesa (2002) reported that experiential learning among agriculture students in Kenya performed better than those who were thought using regular teaching methods. Learning is therefore considered to be an active, constructive, cumulative, self-regulated and goal-oriented process in which the learner plays a critical role. Piaget believed that there is no true learning unless the students mentally act on information and in the process, assimilate or accommodate what they encounter in their environment. Unless this assimilation occurs, teachers and students are involved in pseudo-learning, which is knowledge retained only for short time (Trowbridge, 2004). Efforts made to translate these new conceptions of learning into classroom practices include development of instructional methods that will engage the learner actively in the process of knowledge acquisition. A growing body of research today points to active learning strategies in which the students listen, and talk, write, read and reflect as they become directly involved in the instructional process (Myere & Jones, 1993; Briggs, 2003). Cooper and Robinson (2002) note that constructivist model of learning emphasises student's development of knowledge through active discussion process that link new knowledge to prior knowledge. These strategies are a means to engage students, encourage critical thinking and to improve the general quality of teaching and learning.

Looking at performance of Mathematics and science at secondary school education in Kenya, the vision 2030 is in doubt, because the performance by students in this subject is low. The Kenyan government has made attempts to enhance the subject mastery and pedagogical skills of teachers at all levels under Kenya Education Sector Strategic Plan (KESSP). Under this strategy competitive training programs for in-servicing both primary and secondary school teachers have been put in place to enhance teachers' effectiveness so as to improve quality (Republic of Kenya, 2006). The Strengthening of Science and Mathematics in Secondary Education (SMASSE) project, which is a partnership between the government of Kenya and the government of Japan through Japan International Cooperation Agency (JICA) is part of this effort. SMASSE project was implemented in July 1998 and was to run up to the year 2003. The SMASSE project focuses on improving mathematics and science education by promoting quality classroom practices. The project targeted science teachers, principals, and education officers with the realization that students are the ultimate beneficiaries of the whole process. Ng'eno and Githua (2006) noted that the way teachers make attitudinal statements will be incorporated in the value and belief system of the learners and will influence their attitude towards the subjects.

SMASSE baseline studies indicated that there were numerous problems in Mathematics and science education. This included attitudes towards mathematics and science, inappropriate teaching methods and low content mastery (Njuguna, 1998). During teacher training suitable benchmarks that stipulate both the content and pedagogical developments and growth should be earmarked. SMASSE Project targeted teacher attitudes first because of the time they spent with the students. Teachers' negative attitudes can be impacted on the learners' attitudes towards mathematics and science. SMASSE came up with the Activity, Student, Experiment (ASEI) movement which was geared at making learning student centred as opposed to teacher centred. To achieve the ASEI condition SMASSE came up with the Plan, Do, See and Improve (PDSI) approach to teaching and learning which has to do with planning lessons with hands-on and minds-on activities for the learners which are then assessed to see the successes and failures of the lesson and hence improve on it. Wambui (2005) notes that improving performance in mathematics and science education is a great societal need in Kenya, not only for industrialization but also for producing scientifically empowered citizens. The challenge has been how to make mathematics and science more "alive" more "real" and more accessible. It is therefore strongly felt that students' involvement during lessons must be enhanced to increase motivation, effective teaching/learning and lessons must be more interesting (Wambui, 2005).

Constructivists believe that human beings have the ability to construct knowledge in their own minds through the process of discovery and problem solving. Learning according to constructivists is a question of motivating an individual to attach new meaning to past cognitive experiences (Papert, 1993).

Constructivists believe that an education program that allows learners to be motivated, critical thinkers, problem solvers and meta-cognitionists will allow them to take ownership of the learning process. This is what the SMASSE recommendation was all about, letting students take responsibility of their learning. ASEI principle is based on the fact that students do not simply copy the science world; rather, they construct their own meaning of it. They must therefore be provided with opportunities to construct scientific knowledge through the interaction of their observations, prior knowledge and mental processes.

Good and Brophy (2003) explain the construction model of learning as the one that shifts emphasis from transmission of knowledge structured by the teacher to helping learners construct new knowledge by building on existing knowledge. The present study explored the teachers' intentions to adapt and adopt the ASEI/PDSI strategies in teaching as advocated through SMASSE in-service course.

STATEMENT OF THE PROBLEM

SMASSE project has been on-going since its inception and several mathematics and science teachers have undergone the training. Despite the fact that teachers have been trained on how to apply active learning strategies the performance in the mathematics and science is still very low. This study is aimed at establishing differences in teacher intentions to apply the SMASSE recommendations of using ASEI /PDSI approach to teaching/learning mathematics and science in secondary schools.

HYPOTHESES OF THE STUDY

Ho1: There is no statistically significant difference in Teachers' intentions to apply ASEI/PDSI teaching strategy by gender.

Ho2: There is no statistically significant difference in Teachers' intentions to apply ASEI/PDSI teaching strategy by working experience.

Ho3: There is no statistically significant difference in Teachers' attitudes to apply ASEI/PDSI teaching strategy by gender.

Ho4: There is no statistically significant difference in Teachers' attitudes to apply ASEI/PDSI teaching strategy by working experience.

THEORETICAL FRAMEWORK

Teaching is a human social behavior. Teachers' decision making has been shown to be as a result of intra and inter-personal processes, thus it seems appropriate to use a behavioral theory to examine this behavior. The conceptual framework of this study was based on the Theory of Reasoned Action (TRA) (Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975) and Theory of Planned Behavior (TPB) (Ajzen, 1985). Theory of Reasoned Action suggests that a person's behavior is determined by his/her intentions to perform the behavior and that this intention is a function of his/her attitude towards the behavior and his/her subjective norms. The best predictor of behavior is intention. Intention is the cognitive representation of a person's readiness to perform a given behavior, and it is considered to be the immediate antecedent of behavior. The Theory of Planned Behavior holds that only specific attitude towards the behaviour in question can be expected to predict the behavior. The assumptions underlying these theories are the core assumptions taken into consideration in the present study.

The TRA rests on the assumption that humans are rational, have control over their behavior, and seek out, utilize, and process all available information pending decisions before they take action (Crawley & Koballa, 1994). According to the TRA, a person's intention to engage in a behavior is determined by their attitude towards the outcome of the behavior and by the opinion of the person's social environment. Ajzen and Fishbein (1980) proposed that a person's behavior is determined by his intention to perform the behavior and that this intention is, in turn, a function of his attitude towards the behavior and his subjective norms. The TRA recognizes two constructs that function as the determinants of behavior intentions, these are: attitude towards behavior and the subjective norms.

The TPB holds that only specific attitude towards behavior in question is expected to predict that behavior. The TPB was proposed as an extension of TRA to account for the performance of behavior, which is not completely under the subject's control. Ajzen (1985) addressed the factors which include possession of the requisite information, skills and abilities to carry out the behavior, a person's perceptions, will power, emotions, compulsion, the time, opportunity, resources and co-operation from others can influence or interfere with intended performance of behavior. These factors contribute to a third construct to the model, that is, Perceived Behavioral Control (PBC), which has a direct impact on the formation of behavioral intention and its independence of contribution of attitude and subjective norms (Ajzen, 1985; 1988; 1989; Ajzen & Madden, 1986).

Learning that goes on, in mathematics and science classrooms is intended. It therefore follows that the methods and approaches that teachers apply are intended to meet certain instructional needs. The fact that a teacher uses a given approach shows that s/he has planned to use it. Based on TRA and TPB, Intention to teach using SMASSE techniques is determined by three things; attitude towards a specific behavior, subjective norms and perceived behavioral control. These three attributes determine the teachers' readiness to use SMASSE methods in teaching mathematics and science. The teachers' decision to use SMASSE approaches or not determines the learners' performance in mathematics and science.

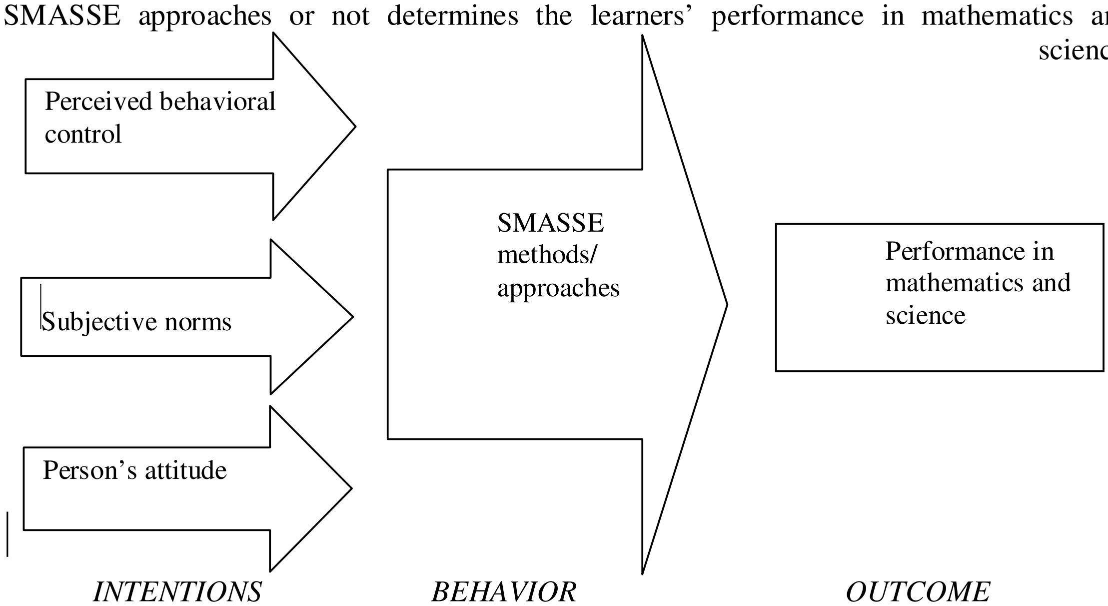

Figure 1. Relationship between variables

METHODOLOGY

This study employed an ex-post facto research design to establish teacher intentions to apply SMASSE recommendations to teach secondary school mathematics and science. The design is considered appropriate because teachers have undergone the SMASSE in-service training and are expected to have adapted or adopted the SMASSE approaches of active learning. The data was collected using a self-report questionnaire designed on the guidelines of construction of standard theory of reasoned action questionnaires (Ajzen & Fishbein, 1980). The collected data was analyzed to test for differences by gender and working experience using t-test and F-test respectively at $\alpha = 0.05$ level of significance.

RESULTS

Hypothesis one stated that; there is no statistically significant difference in Teachers' intentions to apply ASEI/PDSI teaching strategy by gender. Table 1 gives the mean score for general intentions to use SMASSE approaches to teach secondary school mathematics and science.

Table 1. Level of teacher intentions to use SMASSE methods in teaching mathematics and science

Group Statistics

	Gender	*N*	*Mean*	*Std. Deviation*	*Std. Error Mean*
General Intention	Male	90	15.7667	3.71468	.39156
	Female	32	15.9063	3.43003	.60635

The findings indicate that the female teachers have more favorable intention to apply SMASSE methods in teaching secondary school mathematics and science than the male teachers. This indicates that the female teacher is ready to adapt to changes in instruction than their male counterparts. Table 2 shows the differences in teacher intentions to embrace the SMASSE approaches in teaching secondary school mathematics and science by gender.

Table 2. Differences in teacher intentions to apply SMASSE approaches in teaching secondary school mathematics and science, by gender

Independent Samples Test

		t-test for Equality of Means						
		T	*Df*	*Sig. (2-tailed)*	*Mean Difference*	*Std. Error Difference*	*95% Confidence Interval of the Difference*	
							Lower	Upper
general intention	Equal variances assumed	-.186	120	.853	-.13958	.74985	-1.62424	1.34507
	Equal variances not assumed	-.193	58.691	.847	-.13958	.72179	-1.58404	1.30487

Df (1,120) $t_{critical}$ =1.658 P≥0.05

The findings indicate that there is no statistically significant difference at α = 0.05 level of significance in teacher intentions by gender to adapt/adopt the SMASSE approaches in teaching mathematics and science.

This indicate that though female teachers are more ready to embrace these methods the male teachers also apply the same approaches hence the disparity is not apparent. The null hypothesis is therefore rejected at α = 0.05 level of significance.

Hypothesis two states that; there is no statistically significant difference in Teachers' intentions to apply ASEI/PDSI teaching strategy by working experience. Table 3 shows the difference in intentions to use SMASSE approach to teaching secondary school mathematics and science by working experience.

Table 3 results indicate that the calculated F (0.574) is less than the critical value of f (3.07) at P≥0.05 hence there is no significant difference in teachers' intentions to use SMASSE

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approach to teach secondary school mathematics and science by experience. The null hypothesis is therefore rejected at $\alpha = 0.05$ level of significance.

Table 3. Differences in teacher intentions to use SMASSE approaches in teaching secondary school mathematics and science by working experience

ANOVA

General intention

	Sum of Squares	*Df*	*Mean Square*	*F*	*Sig.*
Between Groups	15.061	2	7.531	.574	.565
Within Groups	1587.713	121	13.122		
Total	1602.774	123			

Df (2,121) $F_{critical}$=3.07 P≥0.05

Hypothesis three stated that; there is no statistically significant difference in Teachers' attitude to apply ASEI/PDSI teaching strategy is by gender. Table 4 shows the mean score of teachers' attitude towards SMASSE approaches to teaching mathematics and science.

Table 4. Teachers' attitude towards SMASSE teaching approaches/methods

Group Statistics

	Gender	*N*	*Mean*	*Std. Deviation*	*Std. Error Mean*
attitude	Male	90	40.6889	20.41791	2.15224
	Female	32	40.0313	13.96882	2.46936

The results indicate that male teachers have a favorable attitude towards the approaches than the female teachers, however the difference is minute. Generally the teachers have a favorable attitude towards active learning methods recommended by SMASSE.

Table 5 gives the differences in teachers' attitude towards SMASSE approaches to teaching mathematics and science by gender.

Table 5. Differences in teachers' attitude towards SMASSE approaches by gender

Independent Samples Test

		t-test for Equality of Means						
		T	*Df*	*Sig. (2-tailed)*	*Mean Difference*	*Std. Error Difference*	*95% Confidence Interval of the Difference*	
							Lower	Upper
Attitude	Equal variances assumed	.168	120	.866	.65764	3.90297	-7.06996	8.38524
	Equal variances not assumed	.201	79.92	.841	.65764	3.27565	-5.86121	7.17648

Df (1,120) $t_{critical=}$ 1.658 P≥0.05

The findings indicate that there is no statistically significant difference in teachers' attitude towards SMASSE approaches to teaching mathematics and science by gender at α = 0.05 level of significance.

Hypothesis four states that; there is no statistically significant difference in Teachers' attitude to apply ASEI/PDSI teaching strategy by working experience.

Table 6 shows the mean scores of teachers' attitude towards SMASSE approach in teaching Mathematics and science in secondary school by work experience. The results indicate that the more experienced a teacher is the more favorable is the attitude.

Table 6. Teachers' attitude towards SMASSE approaches to teaching mathematics and science by working experience

Descriptive

		N	*Mean*	*Std. Deviation*	*Std. Error*	*95% Confidence Interval for Mean*	
						Lower Bound	*Upper Bound*
Attitude	one to five years	61	33.98	20.26	2.59	28.79	39.17
	six to ten years	27	46.07	15.71	3.02	39.85	52.28
	over ten years	36	46.94	14.55	2.42	42.02	51.86
	Total	124	40.37	18.78	1.68	37.03	43.71

Table 7 gives the difference in attitude towards teaching using SMASSE approaches to teaching. The F value of 7.739 is significant at α = 0.05 level of significance in favor of the most experienced group.

Table 7. Differences in teachers' attitude towards SMASSE approach to teaching mathematics and science by experience

ANOVA

		Sum of Squares	*Df*	*Mean Square*	*F*	*Sig.*
Attitude	Between Groups	4922.461	2	2461.231	7.739	.001
	Within Groups	38480.724	121	318.023		
	Total	43403.185	123			

Df (2,121) $F_{critical}=3.07$ $P \geq 0.05$

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Multiple Comparisons

Table 8. shows the post hoc results. This is to show which particular groups differ significantly

Bonferroni

Dependent Variable	*(I) teaching experience*	*(J) teaching experience*	*Mean Difference (I-J)*	*Std. Error*	*Sig.*	*95% Confidence Interval*	
						Lower Bound	*Upper Bound*
attitude	One to five years	Six to ten years	-12.09047(*)	4.12215	.012	-22.0979	-2.0831
		over ten years	-12.96084(*)	3.74799	.002	-22.0599	-3.8618
	six to ten years	one to five years	12.09047(*)	4.12215	.012	2.0831	22.0979
		over ten years	-.87037	4.54011	1.000	-11.8925	10.1517
	over ten years	one to five years	12.96084(*)	3.74799	.002	3.8618	22.0599
		Six to ten years	.87037	4.54011	1.000	-10.1517	11.8925

* The mean difference is significant at the .05 level.

The post hoc results show that there is statistically significant difference between those teachers with one to five years working experience and those of over six years working experience.

DISCUSSIONS

The findings indicate that female teachers have more favorable intentions of adopting the SMASSE methods of teaching. These findings seem to indicate that female teachers are more open to change than their male counterparts. The test for difference by gender shows that there is no significant difference. This seems to indicate that gender is not a factor to be considered when it comes to teachers' intention to apply any instructional method. It is also indicated by the results that there is no statistically significant difference in teacher intentions to apply SMASSE approaches to teaching mathematics and science by working experience. There is however a statistically significant difference in teachers' attitude towards SMASSE approaches in favor of the most experienced. This could mean that the teachers who have been in the field longer appreciate the new approaches of teaching while the new teachers see no much difference between the SMASSE methods and what they always use. This is probably because having just graduated from college; their training which emphasizes active learning just like the SMASSE techniques is still fresh in their minds.

Njuguna (1998) reported that baseline studies indicated attitudes, teaching methods and low content mastery was to blame for the poor performance in secondary school mathematics and science. SMASSE training was aimed at improving these attributes among the teachers. From the study, it is indicated that the teachers have a positive attitude towards the SMASSE approaches and have positive intentions of applying the methods in teaching. These favorable attitudes towards the SMASSE methods and positive teacher intentions could lead to better performance at secondary school science and mathematics. Wambui (2005) noted that improved performance in mathematics is a societal need in Kenya for industrial development and in producing scientifically empowered personnel. This can go a long way in realizing vision 2030 envisioned in the vision 2030 development plan. Papert (1993) points to the fact that constructivist motivates learners to attach meaning to past experiences and allow them to take ownership of the learning process. SMASSE recommends that teachers make their lessons come “alive” and “real” through high learner participation. The fact that teachers embrace the SMASSE methods is an indication that active learning will part of the teachers instructional practices. Research findings on learning and memory show that for effective learning to occur learners have to be actively involved (Shuel, 1993; Matlin, 1994). Constructivist approach to learning encourages teachers to activity approach to teaching and this is what SMASSE is all about.

CONCLUSIONS

From the findings the following conclusions are identified:

1. The findings indicate that there is no statistically significant difference in teacher intentions to apply SMASSE approaches in teaching secondary school mathematics and science by gender.
2. It is also indicated that there is no statistically significant difference in teacher intentions to apply SMASSE approaches in teaching secondary school mathematics and science by working experience.
3. There is no statistically significant difference in teachers’ attitudes towards SMASSE approaches in teaching secondary school mathematics and science by gender.
4. There is a statistically significant difference in teachers’ attitudes towards SMASSE approaches in teaching secondary school mathematics and science by teaching experience in favor of the most experienced.

Implications of the Study

The findings of the study indicate that both male and female teachers have favorable intentions to apply SMASSE approaches to teach secondary school mathematics and science. It is also indicated that the teachers had positive intentions and the difference was not statistically significant by teaching experience. These positive intentions imply that teachers are ready to embrace new approaches of teaching mathematics and science. The findings also indicated that the teachers had a positive attitude towards teaching mathematics and science using SMASSE approaches and the difference was not statistically significant by teaching. There was however a statistically significant difference in teachers’ attitudes towards teaching using SMASSE methods by teaching experience in favor of the most experienced. This implies that teachers who have been teaching for a longer time need to be retrained. These findings suggest that teachers need to be in-serviced frequently to update them on new pedagogic approaches in mathematics and science.

RECOMMENDATIONS

The following are recommendations used on the findings of the study for policy makers and for further research in this area:

1. An observational research should be done to establish whether SMASSE has had an effect on classroom practices during mathematics and science.
2. A study should be carried out to establish whether SMASSE in-service training has had an effect on students’ performance in mathematics and science in secondary school.

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3. SMASSE in-service training should train teachers on how to apply ICT in the teaching of mathematics and science.
4. The government should set a policy that requires teachers to go for in-service training possibly every five years of service.

REFERENCES

Ajzen, I. (1985). From intentions to actions: A theory of planned behavior. Kuhl, J. & Beckman, J. (Eds). *Action Control: From Cognition to Behavior* (pg 11-39). Berlin: Springer-Verlag.

Ajzen, I. (1988). *Attitudes, personality and behavior*. Milton-Keynes. Chicago: Dorsey press.

Ajzen, I. (1989). Attitude structure and behavior. In Pratkanis, A.R; Breckler, S.J. & Greenwald (Eds.). *Attitude structure and function. Hillsidale*, NJ: Lawrence Erlbaum.

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behaviour and Human Decision Processes, 50*, 179-211

Ajzen, I. & Fishbein, M. (1980). *Understanding attitudes and predicting social behavior.* Englewoods Cliffs, NJ: Prentice-Hall, inc.

Ajzen, I. & Madden, T. J. (1986). Prediction of goal-directed behavior: Attitudes, intentions and perceived behavior control. *Journal of Experimental Social Psychology, 22*, 453-474.

Arnold, S. Warner, J. W. and Osborne, E. W. (2006). Experiential Learning in SecondaryAgriculture Education Classrooms. *Journal of Southern Agricultural Education Research.* 30 56(1)

Artherton, J. S. (2009). Learning and Teaching-External Learning. http://www.learning and teaching.info/learning/experience.htlm

Biggs J. (2003). Teaching for Quality Learning at the University. (2nd Ed.) Maidenhead Bershire: open University Press

Borg, W. R. & Gall, D. M. (1989). *Educational Research (5th Ed).* New York: Longman.

Chi, M.T.H., Leeuw, N. & Lavancher, C. (1994). Eliciting self-explanations improves understanding. *Journal of Cognitive Science, 18*, 439-477.

Brahier, J. D. (2005). *Teaching Secondary and Middle School Mathematics*, Ally Bacon, Boston, USA

Crawley, F. E. (1990). Intentions of science teachers to use investigative methods: A test of the theory of planned behavior. *Journal of Research in Science Teaching, 27*(7), 85-697.

Crawley, F. E. & Koballa, Jr., T. R. (1994). Attitude research in science education: Contemporary Models and Methods. *Science Education, 78*(1), 35-55.

Derville, L. M. T (1996). *The use of Psychology in Teaching.* Kuala Lumpur: Longman Publishers.

Duffy, T. M. & Jonassen, D. H. (1992). Constructivism: New implication for instructional technology. Constructivism and technology of instruction: A conversation. New jersey: Lawrence Erlbaum Associates, 96-110.

Good, T. L. & Brophy, J. Looking in the Classroom. Boston: Allan and Bacon.

Haladyna, T. & Shaughnessy, J. (1982). Attitude towards science: A review. *Science Education, 66*(4), 547-563.

Hardin, J. Hildebrand, G. & Klainin, S. (1989). Recent international concern in gender and science and technology. *Educational Review, 45*(2), 185-193.

Hodson, D. (1993). Rethinking old ways: Towards a more critical approach to practical work in school science. Studies in *science education, 22*, 85-142.

Kathuri, N. J. & Pals, D. A (1993). *Introduction to Educational Research*. Njoro: Egerton University.

Kolb, A .Y. & Kolb, D. A. (2008). Experiential Learning Yheory: Dynamic Holistic Approach to Management Learning. Education Management in Armstrong, S. J. and Fukami, C. (eds). *Hand book of Management Learning and Development*. London, Sage Publication

Lederman, N. (1992). Students' and teachers' conceptions of nature of science: A review of the research. *Journal of Research in Science Teaching, 29*, 331-359.

Matlin, M. W. (1994). *Cognition* (3rd ed.). NY: Harcourt Brace..).

Mayer, D. P., Mullen, J. E. & Moore, M. T. (2000). *Monitoring School Quality: An Indicator Report, NCES 2001-030*. Washington, DC: National Center for Education Statistics.

Meyers, C. & Jones, T. B. (1993). Promoting Active learning: Strategies for the college Classroom. San Francisco: Jossey-Bass.

Mintezes, J., Wandersee, J. & Novak, J. (Eds.) (1998). Teaching science for understanding. San Diego, Ca: Academic Press.

Morrel, P. D. & Lederman, N. G. (1998). Students' attitudes towards school and classroom science: Are they a different phenomenon? *School Science and Mathematics, 98*(2), 76-83.

Muijs, R. D. (1997). Predictors of academic achievement and academic self-concept: A longitudinal perspective. *British Journal of Educational Psychology, 67*, 263-277.

Newsome, L. A., Wardlow, G. W. & Johnson, D. M. (2005). *Effects of Lecture Versus Experetial Teeaching Methods on Cognitive Achievement, Retention and AttitudesAmong High school AgriscienceStudents*. National AAAE Research Conference 146-156

Ng'eno, J. K. & Githua, B. N. (2006). Differences in Teachers, Attitude Towards Mathematics by Gender, Academic Qualificationand School Category in Kenya's Kericho District. *Journal of Technology and Education in Nigeria, 11*(2), 76-85

Njuguna, B. M. (1999). *The findings from baseline studies* by SMASSE Project, SMASSE Project bulletin (unpublished)

Nkapa, N. (1997). *Educational Research for Modern Scholar*. Enugu, Nigeria: Fourth Dimension Publishers.

Novak, J. D. & Gowin, D. B. (1984). *Learning how to learn*. New York: Cambridge university press.

Novak, J. D. (1991). Clarify with concept maps: A tool for students and teachers alike. *The Science Teacher, 58*(7), 45-49.

Novak, J. D. (1993). Human constructivism: A unification of psychological and epistemological phenomena in meaning making. *International Journal of Personal Construct Psychology, 6*, 167-193.

Novak, J. D. (1998). *Learning, creating, and using knowledge: Concept maps as facilitative tools in schools and corporations.* Mawah, NJ: Lawrence Erlbaum.

Novak, J. D. (1993). A view of the current state of Ausubel's Assimilation Theory of Learning. Proceeding on the Third International Seminar on Misconception and Educational Strategies in Science and Mathematics (1st-4th April, 1993). Misconception Trust: Ithaca, NY.

Nsubuga, E. O. K. (2000). *Fundamental of Education Research.* Kampala, Uganda: Mk Publishers (U) Ltd.

Papert, Seymour (1993). *The children's machine: Rethinking school in the Age of the Computer.* New York: HarperCollins Publishers.

Okere. M. (1996). *Physics Education*. Njoro: Egerton University Material Center & Lectern publication limited.

Opare. J. A (1996). Boys and girls in science: Does the gender composition of the school matters? *Zimbabwe Journal of Education Research,* 5, 26-48.

Ormerod, M. B. (1981). Factors differentially affecting science subjects preference, choices and attitudes of girls and boys. In Kelly. A. (Ed). *The Missing Half* (pp 100-112). Manchester, England: Manchester University Press.

Osborn, R. & Frayberg, P. *learning science: the implication of learning science.* Auckland, Heinemann publishers.

Paker, L. H. & Rennie, L. J. (1995). "Gender equity". In Barry, J.F. 7Walberg J.H. (Eds). *Improving Science.* Chicago: The National Society for the study of Education.

Ramsden, P. (1992). *Learning to teach in higher education.* London: Routledge.,

Rene. M. (1971). "Introduction". In Philip & Hadassah. G. (Eds) *Science and Technology Education in Developing states. Proceedings of the 5th Rehovar Conference.* New York: Praeger Publishers.

Republic of Kenya. (2006). *Ministry of education strategic plan 2006-2011.* Nairobi, Government printers.

Rennie, L. (2003). Understanding gender differences in science education. In Rogers, C. (Ed). *Vision for Science Education*. London: Routledge Falmer.

Shayer, M. and Adey, P. (1981). Towards science of science teaching: cognitive development and curriculum demand. London: Heinemann Education Books.

Shuel, T.J. (1993). Towards an integrated theory of teaching and learning. *Educational Psychology,* 28 (4), 291-311.

Trowbridge, W. L. & Bybee, R.W. (2004). *Teaching Secondary School Science: Strategies for Developing Scientific Literacy.* New Jersey, Pearson Education, Inc.

Wambui, N. N. (2005). *A study of mathematical achievement using the climbing method in Kenyan secondary schools.* SMASSE project

Watson, R. & Fairbrother, B. open ended work in science project: managing investigation in the laboratory. *School Science Review, 75*(271), 31-38.

Weistein, C. E. & Mayer, R.C. (1986). The teaching of learning strategies. In M.C. Wittrock (Ed), *Handbook on Research on Teaching* (3rd edit.) 315-327. New York: Macmillan.

Woolnough, B. (1991). *Practical science*. Buckingham: Open University Press.

Yager, R. E.(1993). Science technology society as reform. *School Science and Mathematics, 93*(3), 145-151.

Yeung, A. S. & Lee, F. L. (1999). Self-concept of high school students in china: confirmatory factor analysis of longitudinal data. *Educational and Psychology Measurement, 59*, 431-450.