Journal of Education and Learning; Vol. 5, No. 1; 2016
ISSN 1927-5250 E-ISSN 1927-5269
Published by Canadian Center of Science and Education

Secondary School Biology Teachers' Perceptions of Scientific Creativity

Grace C. W. Ndeke[1], Mark I. O. Okere[1] & Fred N. Keraro[1]

[1] Curriculum, Instructional and Educational Management Department, Egerton University, Egerton, Kenya

Correspondence: Grace C. W. Ndeke, Curriculum, Instructional and educational Management, Egerton University, P.O. Box 536-20115, Egerton, Kenya. Tel: 254-720-87-5167. E-mail: ndekegrace@yahoo.com

Received: October 27, 2015 Accepted: November 19, 2015 Online Published: December 15, 2015

doi:10.5539/jel.v5n1p31 URL: http://dx.doi.org/10.5539/jel.v5n1p31

Abstract

The purpose of this study was to investigate secondary school biology teachers' perceptions of scientific creativity. Cross-sectional survey research design was employed. The population of the study comprised all biology teachers in public secondary schools in Kericho and Kajiado counties in Kenya. A sample of 205 biology teachers' was selected from a population of 347 using proportionate random sampling technique. A Biology teachers' questionnaire was used to collect data. Data were analyzed using descriptive statistics. The findings show that a high percentage of the biology teachers have correct perceptions of general creativity but only a small percentage have the correct perceptions of scientific creativity. The findings have also yielded valuable information that informs curriculum developers, teacher trainers and policy makers that the majority of teachers have inadequate perceptions of scientific creativity and this may influence their classroom practices. It is recommended that science teacher education programmes emphasize scientific creativity in their methodology courses to empower teachers to provide learning opportunities that would enhance learners' creativity in science lessons. Curriculum developers also need to prepare curriculum materials that include more classroom activities that enhance scientific creativity.

Keywords: teachers' perception, biology, scientific creativity

1. Introduction

1.1 Introduce the Problem

Science education aims at producing a scientific community that is beneficial to society. It also aims at promoting scientific ideas and practices (UNESCO, 1986). The production of a scientific community contributes to the social economic development of a country (Yoong, 1986). Science education also aims at preparing learners to study science and technology in higher education, hence preparing them to become future scientists (Mc Gregor & Bazo, 2001). According to Bybee, Powell and Trowbridge (2008), the ability to use the method of scientific inquiry is a goal of science education. Scientific inquiry is a method that is recommended in the instruction of science in order to inculcate scientific creativity (Longo, 2010).

Secondary school science education in Kenya includes three main disciplines, biology, chemistry and physics. Through the teaching and learning of biology, learners are expected to acquire scientific knowledge, cognitive and manipulative skills, and positive attitudes toward science (Maundu, Sambili, & Muthwii, 1998). The cognitive skills include, asking thought provoking questions, classifying based on criteria, making accurate records of observations, control of variables in an experiment, objective interpretation of data, drawing valid conclusions and seeking explanations based on empirical evidence. Learners are also expected to develop positive attitudes towards science. These include; curiosity, open-mindedness, self-confidence, desire to seek evidence for assertions, genuine interest in science and resourcefulness. These characteristics are also associated with creativity.

Isaksen, Treffinger and Brian (2000) argue that knowledge is expanding and becoming more and more specialized. They recommend the provision of a conducive environment that allows for knowledge sharing and hence productive use. Learning institutions can do that by fostering curiosity, exploration, openness, and reaching towards new horizons. All these are characteristics of creativity. The constructivist theory of learning recommends provision of learning opportunities that allow learners to construct knowledge for themselves

(Talsma, 1999). Talsma further argues that in a science classroom this would require learning environments where learners spend more time on activities around questions they generate rather than listening to lectures or completing worksheets and recipe like activities. This can be achieved through fostering of creativity in science lessons.

According to Cramond (2001), creativity is a multidimensional construct that all people demonstrate to some degree. This is supported further by Treffinger, Young, Selby and Shepardson (2001) who argue that creativity is not innate but can be learned and nurtured. Simonton (2002) argues that creativity is among the most important and pervasive of all human activities. It is recognized as one of the driving forces of change, progress, and transformation. Creativity is a pre-requisite for innovation and discovery (Draeger, 1991).

Vernon (1989) views creativity as a person’s capacity to produce new or original ideas, insights, restructuring, inventions, or artistic objects, which experts accept as being of scientific, aesthetic, social, or technological value. Creativity is the ability to offer new perspectives, generate novel and meaningful ideas, raise new questions, and come up with solutions to ill-defined problems (Beghetto, 2007). According to Amabile (1996), Sternberg and Lubert (1999), creativity is the production of novel ideas and works. Ayas and Sak (2014) note that in both general and scientific creativity there is production of novel and useful products. However, for scientific creativity in addition to production of novel and useful ideas or products, the new ideas should be consistent with the existing knowledge.

Creativity is the key element in science without which science turns into a sterile manipulation of set rules and their establishment without tangible output Moravcisk (1981). Moravcisk further describes creativity to constitute a key element in building scientific infrastructure. He argues that creativity can manifest itself in the conception of new ideas contributing to scientific knowledge. This is in the formulation of new theories of science, in the devising of experiments to probe nature’s laws and in the development of scientific ideas applied to particular domains of practical interest. It is also in the realization of new organizational facilities of scientific research and of the scientific community, in the novel implementation of plans and blueprints for scientific activities, and in trail-blazing undertakings to transmit the scientific outlook into the public mind. He further argues that knowledge is open and that creativity lies in adding new components to this knowledge, which is a fundamental assumption ignored in science education.

Andiliou and Murphy (2010) point out that teachers are expected to nurture each child’s creative potential by facilitating development of knowledge, skills, and attributes associated with creativity within the context of formal education. According to Runco and Johnson (2002) and, Chappel (2007) teachers often encounter a variety of learners’ behavior that manifest creativity. For example, teachers recognize the contribution of creative thinking in learning when learners apply newly acquired strategies to novel tasks or when they use their critical creative skills to argue, make decisions, evaluate and assess arguments. Hong and Kang (2009) examined science teachers’ conceptions of creativity in science education using a sample of 44 South Korean and 21 US secondary school science teachers. The results showed that each individual teacher’s conception of creativity was considerably limited. A study by Aljughaiman and Mowrer-Reynolds (2005), on teachers’ conceptions of creativity and creative students in Idaho Moscow, found that teachers possessed inaccurate concepts regarding what constitutes creativity. This could contribute to misconceptions about creativity having no place in the classroom or viewing it as synonymous with originality (Plucker, Beghetto, & Dow, 2004). This causes one to believe that only the highest level of creative contribution counts as creative and focusing too little attention on the role of classroom environments in supporting creativity.

Newton D. P. and Newton L. D. (2009a) argue that teachers are often urged to nurture creativity and yet their conceptions of creativity in specific school subjects may have limitations, which weaken their attempts to do so. There is minimal documented evidence which show biology teachers’ perceptions of creativity in Kenya. Therefore, this study investigated biology teachers’ perceptions of scientific creativity.

1.2 Statement of the Problem

Science Education in Kenya aims at improving scientific and technological skills of learners. These can be achieved through the teaching and learning of creativity in science. At the end of the secondary school cycle, learners are expected to have acquired both the scientific skills and knowledge to help them solve problems that they meet in modern life. It has been found that scientific creativity among secondary school learners is low. Some of the reasons contributing to this could be that teachers are not providing learning experiences that would enhance creativity. This could be contributed by science teachers’ perceptions of creativity that are at variance with the accepted meanings. Teachers’ perceptions of creativity could influence their classroom practices and therefore either enhance or inhibit the development of scientific creativity in learners. In addition, the value teachers place on creative traits in their learners could also influence their classroom practices. Thus, this study investigated biology teachers' perceptions of creativity

1.3 Importance of the Study

The findings of this study are useful to the science curriculum developers. The findings have brought into the fore the importance of designing curricula and instructional materials that enhance the development of creativity in science education. In addition, the findings of the study have provided information to the curriculum developers and teacher educators that will enable them develop programmes that will prepare biology teachers who are able to provide learners with appropriate teaching and learning experiences that will enhance scientific creativity. The findings of the study give guidance to the Directorate of Quality Assurance and Standard in the Ministry of Education to make a follow up of biology teachers to ensure that they provide appropriate learning experiences during biology lessons for learners to acquire and develop scientific creativity. The findings will also inspire biology teachers' to make an effort to employ teaching strategies that enable learners acquire creative skill.

1.4 Objective of the Study

The main objective of the study was to explore secondary school biology teachers' perceptions of scientific creativity.

1.5 Limitation of the Study

The limitation of the study was on the sample. The sample used in the study was drawn from public secondary schools in Kajiado and Kericho Counties. Kericho is a highly agricultural area while Kajiado is mainly pastoral. This implies that the findings of the study can only be generalized to secondary school teachers' who are in areas, which have similar characteristics.

2. Methodology

2.1 Participants

The target population comprised all biology teachers in public secondary schools in Kajiado and Kericho Counties. The accessible population comprised of biology teachers from public schools who have undergone professional training. The study also focused on teachers' who have taught for at least three years. This ensured that teachers selected for the study had adequate teaching experience and pedagogical skills.

2.2 Sampling Procedures

2.2.1 Sample Size and Sampling Procedures

According to Kajiado and Kericho county directors of education, the estimated population of biology teachers in the two counties are 131 and 216 respectively. This gives a total of 347 biology teachers'. A sample of 205 teachers was selected using proportionate random sampling technique (Kothari, 2003). Each county contributed a sub sample proportionate to its population. Thus, Kericho County with a population of 216 biology teachers contributed 128 teachers to the sample, while Kajiado County with a population of 131 biology teachers contributed 77 teachers. Kericho and Kajiado counties have five sub counties each. Lists of all biology teachers in each sub county was drawn and used as sampling frames. Biology teachers in each sub county formed their own strata. Each stratum then contributed to the sample a number that is proportional to its size of the population. Simple random sampling technique was used to select the biology teachers that participated in the study.

2.2.2 Research Design

The cross-sectional survey research design was used in this study. Through descriptive research, one obtains pertinent information concerning the status of a phenomenon and draw valid conclusions (Koul, 1993; Kothari, 2003). The cross sectional survey design is appropriate because a lot of information is collected in a relatively short time (Gall, Gall, & Borg, 2003). The design involves collection of data at one point in time from a random sample that represents a given population at a particular time (Wiersma & Jurs, 2005). The cross-sectional survey gave information on biology teachers' perceptions of scientific creativity and general creativity.

2.3 Instrumentation

The Biology Teachers' Questionnaire (BTQ) was used to collect data on teachers' perceptions of scientific creativity. The items were adapted from Aljughaiman and Mowrer-Reynolds (2005) and validated by five experts in science education. The BTQ had seven open ended items that solicited information on teachers' understanding of scientific creativity. The open-ended items encouraged the respondents to express in their own words what they feel and understand about scientific creativity. The responses were subjected to content analysis.

The responses to each item were categorized as non-responsive for those who did not give a response, valid if the response had a scientifically acceptable meaning and invalid for those that had scientifically un-acceptable meanings. Some teachers gave more than one valid response for some items. Each valid response was tallied and expressed as a percentage.

Five experts in science education validated the content validity of the research instrument to ensure that the measure included adequate and representative set of items that tap on the variable being measured. Once the research instruments were validated, they were pilot tested using 30 biology teachers in Nakuru County. The teachers in Nakuru County did not take part in the main study and hence no contamination. The results of the pre-test were used to refine the items.

The BTQ was self-administered to the sampled biology teachers' to ensure higher return rate. An accompanying authorization permit from the respective county directors of education encouraged teachers to respond to the questions. The respondents were given enough time to respond to the items, some were collected immediately but in some cases, they were collected after one week as requested by the respondents.

3. Results

Teachers were required to read each item and respond to it to the best of their understanding.

Item 1: Meaning of creativity within the context of biology

In this item 187 (91.2%) teachers' responded to the item out of which 65 (31.7%) gave invalid responses while 122 (59.5%) gave valid responses. Eighteen (8.8%) teachers' were non-responsive.

Table 1 shows valid responses on teachers' conceptualization of creativity. The responses were categorized by combining those responses that had a repetition on a concept.

Table 1. Teachers' meanings of creativity

Response	Kajiado N=77		Kericho N=128		Overall N=205	
	Frequency	%	Frequency	%	Frequency	%
Create something/product new	5	6.5	12	9.4	17	8.3
Come up with a new process	4	6.2	7	5.5	11	5.4
Recognition of relationship	8	10.4	7	5.5	15	7.3
Generate new ideas/ concepts	8	10.4	20	15.6	28	13.7
Apply knowledge acquired to solve a problem	7	9.1	17	3.3	24	11.7
Improvise	19	24.7	30	23.4	49	23.9

The results indicate that 8.3% of biology teachers think of creativity as coming up with new product while 5.4% think of creativity as coming up with a new process of doing things. The results also indicate that 11.7% of teachers think of creativity as application using acquired knowledge to solve a problem while, 7.3% of biology teachers view creativity as recognition of relationships. Only 23.9% of teachers' perceive creativity to be improvisation especially during practical activities.

Thirty one point seven percent of teachers gave invalid responses. Examples of the invalid responses include,

- Ability to experiment
- Through science congress
- Taking up leadership roles through discussions
- Use of various content delivery (stimuli) methods.
- Relaying imagination to facts

Item 2: Indicators/characteristics of creative learners

In this item, teachers' were asked to name characteristics that they would use to identify creative learners. Ten (4.9%) teachers were non-responsive, 125 (61%) gave invalid responses, while 70 (34.1%) gave valid responses. The valid responses from biology teachers on the above item are presented in Table 2.

Table 2. Teachers' indicators of creative learners

	Kajiado N=77		Kericho N=128		Overall N=205	
Indicator	Frequency	%	Frequency	%	Frequency	%
Imaginative	2	2.6	1	0.8	3	1.5
Initiative	1	1.3	0	-	1	0.5
Intelligence	3	3.9	3	2.3	6	2.9
Curiosity	2	2.6	10	7.8	12	5.9
Exploratory	3	3.9	1	0.8	4	2.0
Intuitiveness	1	1.3	0	-	1	0.5
Bold/courageous/confident	3	3.9	1	0.8	4	2.0
Recognize relationship	8	10.4	10	7.8	18	8.8
Manipulative	2	2.6	4	1.3	6	2.9
Adventurous	1	1.3	4	3.1	5	2.4
High divergent thinking	1	1.3	2	1.6	3	1.5
High sensitivity	2	2.6	2	1.6	4	2.0
Inquisitive	0	-	14	10.9	14	6.8
Apply knowledge	7	9.1	23	9.1	30	14.6

The results indicate a low percentage (34.1%) of teachers' having an idea of some of the characteristic that are associated with creative learners. Among the characteristics identified by the teachers' is being able to apply knowledge which had the highest percentage (14.6%) followed by been able to recognize relationships (8.8%). Kajiado teachers' only identified the trait of being initiative and intuitiveness while that of being inquisitive was only identified by Kericho teachers'. Characteristics such as having a sense of humor, playfulness, fantancy, risk taker, and tolerance of ambiguity were not identified by teachers at all. This shows that 65.9% of biology teachers, cannot identify characteristics associated with creativity and, therefore, they are unlikely to enhance learners' creativity.

Examples of invalid responses include,

- Not sure
- Projects for science congress
- What to do in class

Item 3: Relationship between Creativity and Knowledge

Teachers were asked to give their views on whether creativity can be taught without subject matter. Eighty two percent of teachers indicated that creativity cannot be taught without subject matter while 16.5% indicated that creativity can be taught without subject matter. Three teachers were non-responsive.

Further biology teachers were asked to justify their responses. Twenty three teachers (11.2%) ' were non-responsive, 107 (52.2%) gave invalid responses while 75 (36.5%) gave valid responses. A summary of the valid responses is presented in Table 3.

Table 3. Teachers' reasons why creativity cannot be taught without subject matter

	Kajiado N=77		Kericho N=128		Overall N=205	
Reason	Frequency	%	Frequency	%	Frequency	%
Subject matter enhances the assimilation of skills	1	1.3	0	0	1	0.5
Subject matter helps in problem identification which creativity tries to solve	1	1.3	2	1.6	1	1.5
One must learn first as a starting point since creativity is triggered by knowledge	16	20.8	9	7.0	25	12.2
Subject matter stimulates imagination which directs creativity	4	5.2	6	4.7	10	4.9
Learners need subject matter to be able to conceptualize and come up with something new	8	10.4	19	14.8	27	13.2
Subject matter stirs interest and curiosity which awakens creativity	1	1.3	2	1.6	3	1.5
Subject matter broadens the mind and helps learners to apply it or be innovative	2	2.6	4	3.1	6	2.9

The results indicate that although a higher percentage of teachers (82%) indicated that creativity in biology cannot be developed without subject matter, fewer teachers' (36.5%) could explain the reason why subject matter is important for one to develop creativity in biology. Thirteen point two percent of the teachers think that subject matter is a prerequisite for creativity. One point five percent of the teachers' felt that subject matter helps learners' to identify problems to study while another 1.5% felt that subject matter stirs in curiosity which is an important characteristic in creativity.

Some of the reasons given by those who feel that creativity in biology can be taught without subject matter include;

- Through a combination of applied scientific approaches
- Creativity is in-born
- Skills like drawing, curving and painting do not require prior knowledge
- Creativity is not something you need IQ to accomplish as it is about connecting experiences and coming up with something new
- Some creative people have not gone to school
- People have made aeroplanes even though they were poor in classwork

Examples of invalid responses

- Creativity is developed by following the procedures
- Content drives subject matter
- Atmosphere must be conducive
- Subject matter increases confidence leading to creativity
- Creativity comes from what we know

The responses given by biology teachers as to why they think creativity in biology can be taught without subject matter, seem to allude to the idea that creativity is inherited or inborn and so prior knowledge is not required. These responses indicate that teachers have correct perception on general creativity.

Item 4: Teachers' perceptions on instructional methods that enhance creativity

Teachers were asked to give their views on whether a particular instructional method can be used to enhance learners' creativity. Twenty five point eight percent (25.8%) of the teachers indicated that creativity cannot be developed using a particular instructional method while 1.5% were non responsive. Seventy two point seven percent of the teachers indicated that a particular instructional method can be used to enhance learners' creativity. The percentage is however lower than 83.2% who had earlier indicated the need of subject matter to enhance creativity in biology. Teachers who responded yes were further asked to identify some of the teaching methods that can be used to foster creativity. Their responses are presented in Table 4. In this item 13 (6.3%) of the teachers' were non-responsive, 35 (17.1%) gave invalid response while 157 (76.6%) gave valid responses.

Table 4. Teaching methods that foster creativity in biology

	Kajiado N=77		Kericho N=128		Overall N=205	
Teaching method	Frequency	%	Frequency	%	Frequency	%
Discussion groups	17	22.1	43	33.6	60	29.3
Hands-on activities (practical's/experiments) which stimulate creativity	32	41.6	70	54.7	102	49.8
Use of ICT	5	6.5	3	2.3	8	3.9
Symposium/science congress/projects	6	7.8	0	0	6	2.9
Interactive learning	1	1.3	0	0	1	0.5
Field trips/excursions	12	15.6	10	7.8	22	10.7
Learner centered approach	6	7.8	9	7.0	15	7.3
Role play	6	7.8	1	0.8	7	3.4
Improvising	3	3.9	1	0.8	4	2.0
Tasks that require application of knowledge	4	5.2	3	2.3	7	3.4
Group work	1	5.2	2	1.6	3	1.5
ASEI/PDSI	0	0	1	0.8	1	0.5
Establishing relationships	1	1.3	0	0	1	0.5
Discovery method	0	0	2	1.6	2	1.0
Brainstorming	0	0	2	1.6	2	1.0

The results indicate that 49.8% of biology teachers view practical activities as a method that enhances creativity, while 10.7% have identified field trips as a method that enhances creativity. Only 1% identified discovery method as an approach that can be used to enhance creativity in learners.

Examples of invalid responses

- Provision of audio-visual aids
- Question/answer sessions
- Making charts
- Preservation of specimens, dissection
- Leaving students to do animations

Some of the reasons given by teachers' who were of the view that creativity in biology can be taught without using a particular instructional method (No) include,

- Creativity is not necessary for one to acquire knowledge
- Creativity is in-born talent
- Requires abstract reasoning
- All methods enhance creativity
- Method depends on the task to be handles
- Methods depends on the student

The justification for teaching creativity in biology without using a particular method reveal that most biology teachers do not have a clear understanding of creativity as seen earlier. This indicates that most teachers' have a correct perception on general creativity.

Biology teachers were further asked to identify activities that they would include in their biology lessons to foster or enhance creativity. In this item 17 (8.3%) of teachers were non-responsive, 13 (6.3%) gave invalid responses while 175 (85.4%) gave valid responses. The valid responses are presented in Table 5.

Table 5. Learning activities that foster or enhance creativity

	Kajiado N=77		Kericho N=128		Overall N=205	
Activities	Frequency	%	Frequency	%	Frequency	%
Students' generated solutions to problems (e.g. design an experiment for a given task)	4	5.2	5	3.9	9	4.4
Hands-on exercises (practical's, experiments, projects)	56	72.7	92	71.9	148	72.2
Group discussions	15	19.5	26	20.3	41	20.0
Role plays	7	9.1	2	1.6	9	4.4
Improvising	4	5.2	6	4.7	10	4.9
Relating ideas	1	1.3	2	1.6	3	1.5
Brain storming	0	0	1	0.8	1	0.5
Probing questions	9	11.7	3	2.3	12	5.9
Exercises that require divergent/critical thinking	1	1.3	3	2.3	4	2.0
Exercises that require application of what has been learnt	2	2.6	6	4.7	6	2.9
Freedom to do experiments without guidance of a teacher	1	1.3	1	0.8	2	1
Use of ICT in teaching	0	0	2	1.6	2	1
Excursions/fieldtrips	1	1.3	12	9.4	13	6.3

The responses indicate that 72.2% of biology teachers identified practical is as an activity that is used to develop creativity in learners. Earlier on, the same had been identified as a method that can be used to develop creativity in learners. This shows that biology teachers are not able to differentiate between teaching method and teaching activities. Only 4.4% of teachers identified generation of solutions to problems by the students, while 20% identified group discussions as activities that can be used to enhance creativity in learners.

Examples of invalid responses include

- Use of memory reminders to identify order or classification of things
- Peer teaching
- Drawing

4. Discussion

The results presented have shown that a small number of biology teachers' conceptualize creativity as coming up with something new as either a product, idea or process. Others described creativity as application of knowledge. These definitions are in agreement with the accepted definitions. Rosenfield and Servo (1984), Barron (1988), Beghetto (2007) define creativity as generating new and novel ideas or works. Seltzer and Bentley (1999), define creativity as application of knowledge and skills in new ways to achieve a valued goal. Moravcsik (1981) and Okere (1986) describe creativity as manifesting itself in the conception of new ideas that contribute to scientific knowledge, which also includes formulation of new theories. This requires one to recognize relationships between variables for one to formulate theories. However, the teachers did not elaborate if the new product, idea or process is accepted as creative works whether trivial or novel (Moravcsik, 1981). Hu and Adey (2002), Mumford (2003) argue that the quantity of ideas generated however trivial, can stimulate the production of ideas that may be both novel and useful. 23.9% teachers' think of creativity as improvisation especially in laboratory equipment. This is looking for alternatives where the main item is lacking but still carry out same function.

The results also show that the meanings of creativity given by teachers are limited. There was no mention of divergent thinking, which is a key element in the definition of creativity (Runco, 1994). Teachers did not mention identification of new problems as a definition of creativity but instead dwelt on coming up with new solutions to a problem. A study by Aljughaiman and Mowrer-Reynolds (2005) found that teachers conceptualization of creativity was at variance with what constitutes creativity. According to Bjorner and Kofoed (2013); Hu and Adey (2002) creativity constitutes three aspects; the creative product, creative process and the individual person in terms of personal characteristics.

Biology teachers' responses on manifestations of learners' creativity is narrow. Some of the characteristic identified by teachers such as intelligence, sensitive, manipulative, exploratory, are those that are loved by teachers' since they cause no disturbance in class (Aljughaiman & Mowrer-Reynolds, 2005; Guncer & Oral, 1993). Teachers did not identify characteristics such as risk takers, playful, humorous, tolerance of ambiguity and independent of judgment, which are highly associated with creativity. This could be attributed to teachers' consideration of some of these traits as being nonconforming and therefore irritating (Reffel, 2003). This is consistent with other studies (Aljughaiman & Mowrer-Reynolds, 2005; Stoycheva, 1996), in which teachers' did not identify characteristics which Aljughaiman and Mowrer-Reynolds describe as not likeable by teachers because they cause disturbance in class. They further argue that teachers tend to overlook creative students who manifest negative behaviors' or low achievement scores and only recognize students who demonstrate personalities they appreciate. This, indeed, is likely to stifle learners' creativity. Runco and Johnson (2002) in their study found out that that teachers characterized creative students as being independent, flexible, and open to experience, risk-taking and curious. However, the same teachers held negative attitudes and little tolerance for certain creative behaviors and attributes such as risk taking and independence.

Eighty two percent of biology teachers were of the view that creativity in biology cannot be taught without subject matter. However, when asked to justify their position, only 36.5% were able to do so. Most of them indicated that subject matter broadens imagination, which leads to creativity. The findings are consistent with those of Liu and Lin (2013) who found out that teachers recognized the importance of scientific knowledge as a basis for articulating and evaluating ideas for their appropriateness. Ward (2007) argues that knowledge is a key building block to creative accomplishments because it provides learners with some raw materials that is needed for creative thought. According to Okere (1986), knowledge in science is a pre-requisite for scientific creativity. Jonassen (2000) supports this by arguing that learners must be able to ask questions, explore and asses what they know, for them to be active creators of knowledge. Newton D. P. and Newton L. D. (2009b) suggest that during science lessons creative process may be exercised by applying scientific knowledge to solve a practical problem. According to Dunbar (1999) scientists use known knowledge to understand a concept or a problem solved or explained. This, therefore, emphasizes the importance of enlightening biology teachers on the significant role of subject matter in enhancing creativity.

When teachers' were asked to justify their position that creativity in biology could be enhanced without subject matter, they indicated that creativity is inborn. This is in agreement with Kampylis, Berki and Saariluoma (2009); Diakidoy and Kanari (1999) findings, that teachers believe creativity is a rare gift and not a characteristic of all people. The results also reveal that 72.7% of teachers think that creativity in biology can be enhanced using a particular instructional method. However, only 1% of the teachers identified the significant role of the use of the discovery method in enhancing learners' creativity. Newton D. P. and Newton L. D. (2009b) argue that teachers mainly focus on practical investigations on matters of facts. This, therefore, excludes opportunities that would enhance creativity that would involve for example imaginative processing of scientific information and construction and testing of explanations. According to Schwartz, Lederman and Crawford (2003), and Haigh (2010), scientific inquiry is one of the main approaches that aid in the development of scientific creativity. Longo (2010) states that inquiry learning meets the needs of a learning environment for facilitating scientific creativity. This is because learners are encouraged to engage in investigative activities and are given the opportunity to think and make decisions in the scientific process. Inquiry learning also promotes creativity by increasing motivation, wonderment and curiosity while assisting learners in the process of discovering knowledge for themselves.

Eighty five point four percent of the teachers did identify activities that can be used to develop creativity in learners. These activities include students generating solutions to problems (4.4%), brainstorming (0.5%), role play (4.4%) and use of probing questions (5.9%). The use of probing questions has been identified as stimulating creativity (Liang, 2002). A teacher's response to learners' questions would determine the degree of creativity that may occur. A study by Denise de Souza (2000) found that both teachers and students believe that a classroom environment which enhances creativity provides students with choices, accepts different ideas, boosts self-confidence and focuses on students strength and interests while an environment where ideas are ignored, teachers are controlling and where excessive structure exist creativity is inhibited. Okere (1986) identified activities that can be used to cultivate creativity in learners to include reformulating of general statements into testable ones, criticizing experimental procedures, describing sequence of investigations devising and describing investigations, selecting correct hypothesis from given alternatives, generating hypothesis from one topic are or many topic areas.

5. Conclusions and Recommendation

Secondary school biology teachers have a correct perception of general creativity however, only a small percentage has a correct perception of scientific creativity. This shows that biology teachers' may not effectively enhance scientific creativity among their learners. This is due to their limited understanding since they cannot effectively identify indicators of creativity in their learners or identify classroom activities that can be used to enhance creativity in their learners.

In view of the findings of this study, it is recommended that in-service programmes for practicing biology teachers be provided in order for them to broaden their knowledge on scientific creativity. Science teacher educators should include scientific creativity especially in their methodology courses so as to improve their perceptions. This will provide adequate training at all levels of teacher preparation and practice to be able to actualize scientific creativity in their learners. Also, this will enable teachers to identify creative characteristics in learners and encourage them and also provide an appropriate environment for its development.

References

Amabile, T. (1986). Creativity in Context. Update to the social psychology of creativity. *American Psychology*, *56*(4), 333-336. http://dx.doi.org/10.1037/0003-066X.56.4.333

Aljughaiman, A., & Mowrer, R. E. (2005). Teachers' conception of creative and creative students. *Journal of Creative Behavior*, *39*(1), 17-34. http://dx.doi.org/10.1002/j.2162-6057.2005.tb01247.x

Andiliou, A., & Murphy, P. K. (2010). Examining valuations among researchers and teachers conceptualizalation of creativity. A review and synthesis of contemporary research. *Educational Research Review*, *5*, 201-219. Retrieved September 9, 2011, from *http://*www.elsevier.com/locate/EDUREV.(doi:101016/j.edurev.2010.07.003

Ayas, B. M., & Sak, U. (2014). Objective measure of scientific creativity: Psychometric validation of creative scientific ability test. *Thinking Skills and Creativity*, *13*, 195-205. http://dx.doi.org/10.1016/j.tsc.2014.06.001

Barron, F. (1988). Putting creativity to work. In R. J. Sternberg (Ed.), *The Nature of Creativity*. New York, Cambridge University Press.

Beghetto, R. A. (2007). Does creativity have a place in classroom discussions? Teacher responses preferences. *Thinking Skills and Creativity*, *2*(I), 1-9. http://dx.doi.org/10.1016/j.tsc.2006.09.002

Bjorner, T., & Kofoed, L. S. (2013). How academic teachers perceive and facilitate creativity. *European Journal of Engineering Education*, *38*(5), 556-566.

Bybee, R. W., Powell, J. C., & Trowbridge, L. W. (2008). *Teaching Secondary School Science: Strategies for Developing Scientific Literacy*. Ally & Bacon, Pearson Education Inc. Retrieved July 12, 2011, from http://www.education.com/reference/article/basic-goals-science- education/?page=2

Chappel, K. (2007). The dilemmas of teaching for creativity: Insights from expert specialist dance teachers. *Thinking Skills and Creativity*, *2*, 39-56. http://dx.doi.org/10.1016/j.tsc.2007.01.001

Cramond, B. (2001). Fostering creative thinking. In F. A. Karnes, & S. M. Bean (Eds.), *Methods and Materials for Teaching the Gifted* (pp. 399-444). Waco TX, Prufrock Press.

Draeger, W. (1991). *Innovation-Invention-kreativetaet: Durch Evneurung zum Erfolg-ein Leifadin Fuer den Kreativen Ingenieur und unternehmer Deuesseldof VDI-verlag*.

Denise de Souza, F. (2000). Teacher and students perceptions of creativity in the classroom environment. *Roeper Review*, *22*(3). http://dx.doi.org/10.1080/02783190009554022

Diakidoy, I. N., & Kanari, E. (1999). Students Beliefs about Creativity. *British Educational Research Journal*, *23*(2), 225-243. http://dx.doi.org/10.1080/0141192990250206

Dunbar, K. (1999). *Beyond the Myth of the Unexpected: Are Scientist the Victims of Chance?* (Manuscript under review). Nature.

Gall, M. D., Gall, J. P., & Borg, W. R. (2003). *Educational Research: An introduction* (7th ed.). Pearson Education Inc.

Guncer, B., & Oral, G. (1993). Relationship between Creativity & Non-conformity to School Discipline as Perceived by teachers of Turkish elementary school children by controlling for their grade and sex. *Journal of Instructional Psychology*, *20*(2), 208-214.

Haigh, M. (2010). Science classroom cultures and practices that foster Creativity. In C*reativity Fostering, Measuring and Contexts*. Nova science Publishers Inc. Retrieved June 13, 2011, from www,education.auckland.ac.nz/webdav/site/…/December- newsletter10pdf

Hong, M. S., & Kang, N. (2009). South Korean and U.S Secondary school teachers' conceptions of creativity and teaching for creativity. *International Journal of Science and Mathematics*, *8*(5), 821-843.

Hu, W., & Adey, P. (2002). A Scientific Creativity Test for Secondary School Students. *International Journal of Science education*, *24*(4), 389-403. http://dx.doi.org/10.1080/09500690110098912

Isaksen, S. G., Treffinger, D. J., & Brian, D. K. (2000). *Climate for creativity and Innovation: Educational Implications*. Centre for Creative Learning, Inc.

Jonassen, D. H. (2000). *Theoretical Considerations Constructivism*. Retrieved September 3 2011, from www.quasar.ualberta.ca/teacher/theory/constructism/htm

Kampylis, P., Berki, E., & Saariluoma, P. (2009). In service and prospective teachers' conceptions of creativity. *Thinking skills and Creativity*, *4*(1), 15-29. http://dx.doi.org/10.1016/j.tsc.2008.10.001

Kothari, C. R. (2003). *Research Methodology: Methods and Technique* (2nd ed.). Wishwa Prakashan, India.

Koul, L. K. (1993). *Methodology of Educational Research*. Vikas publishing Hse pvt ltd.

Liang, J. C. (2002). *Exploring Scientific Creativity and Eleventh Grade Students in Taiwan*. Retrieved June 10, 2011, from http://adsabs.havard.edu.abs/2002PhD...1826

Liu, S., & Lin, H. (2013). Primary teachers' beliefs' about scientific creativity in the classroom context. *International Journal of Science Education*. http://dx.doi.org/10.1080/09500693.2013.868619

Longo, C. (2010). Fostering creativity or teaching to the test? Implications of state testing on the delivery of science instructions. *A Journal of Educational Strategies, Issues and Ideas*, *83*(2), 54-57. http://dx.doi.org/10.1080/00098650903505399

Maundu, J. N., Sambili, H. J., & Muthwii, S. M. (1998). *Biology Education: A Methodological Approach*. Lectern Publications ltd.

McGregor, E., & Bazo, F. (2001). *Gender Mainstreaming In Science and Technology. A Reference Manual for Government and Other Stakeholders* (pp. 51-52). Commonwealth secretariat, London. http://dx.doi.org/10.14217/9781848597327-en

Moravcsik, M. J. (1981). Creativity in science education. *Science Education*, *65*, 221-227. http://dx.doi.org/10.1002/sce.3730650212

Mumford, M. D. (2003). Where have you been, Where are you going? Taking stalk in creative research. *Creativity Research Journal*, *15*(2-3), 107-120. http://dx.doi.org/10.1080/10400419.2003.9651403

Newton, D. P., & Newton, L. D. (2009a). Some students and teachers' conception of creativity in school science. *Research in Science and Technology Education*, *27*(1), 45-60.

Newton, D. P., & Newton, L. D. (2009b). What teachers see as creative incidents in elementary Science lessons? *International Journal of Science Education*. http://dx.doi.org/10.1080/09500690903233249

Okere, M. I. O. (1986). *Creativity in Physics Education* (Unpublished PhD Thesis). University of London.

Plucker, J. A., Beghetto, R. A., & Dow, G. T. (2004). Why isn't creativity more important to Educational psychologists? Potential, pitfalls and future directions in creativity research. *Educational Psychologist*, *39*, 83-92. http://dx.doi.org/10.1207/s15326985ep3902_1

Reffel, J. A. (2003). Creative Teachers Value Creative characteristics in their Students. In D. Treffinger (Ed.), *Creative Learning Today Newsletter*. Centre for Creative Learning, Sarasota. FL.

Rosenfeld, R., & Servo, J. (1984). *Business and Creativity Making Ideas Connect. The Future*. Retrieved June 17, 2011, from http:// www.buffalostate.edu/orgs/cbir/Bibliographies/models.asp

Runco, M. A. (1994). *Problem Finding, Problem Solving and Creativity*. Norwood, NJ. Ablex. Retrieved March 2013, from https://books.google.com/books?isbn=1567500137

Runco, M. A., & Johnson, D. (2002). Parents and teachers implicit theories of children's creativity. A cross-cultural perspective. *Creativity Research Journal*, *14*(3-4), 427-438.

Schwartz, R. S., Lederman, N. G., & Crawford, B. A. (2003). Developing views of nature of science in an authentic context: An explicit approach to bringing the gap between nature of science and scientific inquiry. *Science education*, *88*(4), 610-645.

Seltzer, T., & Bentley, K. (1999). *The Creative Age: Knowledge and Skills for the New Economy*. Demos, London. Retrieved June 6, 2011, from http://www.amazon.com/creative-Age-Knowledge-skills-Economy/df/1898309701

Simonton, D. K. (2002). Creativity: Cognitive; Personal development and social aspects. *American psychologist*, *55*(1), 151-158. http://dx.doi.org/10.1037/0003-066X.55.1.151

Sternberg, R. J., & Lubert, T. I. (1999). The Concept of Creativity: Prospects & Paradigms. In R. J. Sternberg (Ed.), *Handbook of Creativity*. University press.

Stoycheva, K. (1996). *The school: A place for children's creativity?* Paper presented at the European Council for High Ability Conference, Vienna, Austria. Retrieved September 9, 2011, from www.eric.ed.gov/ERICWebPortal/recordDetail?accno=ED422126

Talsma, V. L. (1999). *Philosophy of Science Education*. Retrieved August 6, 2011, from http://homepage.mac.com/vtalsma/philo-ed.htm

Treffinger, D., Young, G., Selby, E., & Shepardson, C. (2001). Definition and Characteristics of Creativity and Creative Thinking. In D. Treffinger (Ed.), *Creative Learning Today*. Centre for Creative Learning, Sarasota, FL.

UNESCO. (1986). *Handbook for Biology Teachers in Africa*. UNESCO.

Vernon, P. E. (1989). The nature-nurture problem in creativity. In J. A. Glover, R. R. Ronning, & C. R. Reynolds (Eds.), *Handbook of creativity: Perspectives in individual differences*. NY. Planum Press. http://dx.doi.org/10.1007/978-1-4757-5356-1_5

Ward, T. B. (2007). The multiple roles of educators in children creativity. In T. Al-Girl (Ed.), *Creativity: A Handbook for Teachers*. World Scientific Publishing Co. Pte. Ltd.

Wiersma, W., & Jurs, S. G. (2005). *Research Methods in Education. An introduction* (8th ed.). Pearson Education Inc.

Yoong, C. S. (1986). Making science and technology education relevant to youth. In *common wealth secretariat. Making Science, Technology and Mathematics Education Relevant*. Report on the sixth biennial Asia regional workshop, Institute of education Singapore, Commonwealth secretariat.