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RESEARCH ARTICLE

PERCEPTIONS OF PHYSICS STUDENTS AND TEACHERS TOWARDS CREATIVITY

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ABSTRACT

One of the concerns in education today is low creativity among children, with wrong perception identified as an important militating factor. The purpose of this study was to establish the perceptions of students and teachers towards creativity. Its objectives were to (a) identify factors perceived as critical in enhancing creativity and (b) examine students' belief in own creative abilities. The study population consisted of 2,236 Form 4 physics students in Nairobi Province; while the sample comprised 763 students (386 girls and 377 boys) selected by simple random sampling technique. Data were collected using Creativity Perception Questionnaire for physics students, and teachers respectively. Both instruments were constructed by the researcher and validated by three experts in research methods from Maseno University. Students expressed confidence in own creative abilities and cited availability of materials, and encouragement by parents as the most important factors for creativity, while teachers perceived project work, science debate, and opportunity for creative work as the most important factors. The study recommends that (1) opportunity be created to engage students in creative work (2) necessary materials for creative work be provided and (3) design be encouraged as a major step in the creative process.

INTRODUCTION

Creativity is invariably considered by some educators and stakeholders in education as an important goal of education, while others believe it is the ultimate goal (Chien, 2010; Robinson, 2007; Shefield, 2011). The high premium placed on the construct is based on the realization that it is of critical importance in effectively addressing old and emerging challenges in virtually all areas of human endeavor: economic, social, and technological (Josu and Dion, 2008; Ogot, 2007). Proponents of creativity argue for an education that prepares children as divergent thinkers and innovators rather than mere consumers of existing technologies. Some of the leading crusaders of creativity education, Koray and Mustafa (2009), champion radical reforms to promote creativity and logical thinking for the purpose of developing technological improvements and utilizing them in today's continuously changing world. This, it is believed, will cultivate skilled scientists and engineers needed to create tomorrow's innovations (DeHaan, 2009). But the real essence of creativity goes beyond generating new ideas and products, as it is also recognized to enhance learning in a more economical way. Learning becomes much more interesting, meaningful and effective when people are given the opportunity to exercise creative thinking; and children in particular, learn better and often faster using creative methods rather than by memorizing information (Goff and Torrance, 1990; Puccio, 2001).

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Despite the wide consensus on creativity, however, previous studies point to its neglect in the teaching-learning process (Bronson and Marryman, 2010; Gale, 2001; Hechinger, 1993; Okeke, 2010; Resnick, 2004; Robinson, 2010). A number of theories have been advanced, in an attempt to interpret the prevailing scenario, one of them being lack of clear perception of creativity and the associated inability to device suitable creativity-enhancing strategies. Perception, the process of acquiring, interpreting, selecting and organizing sensory information, is viewed by some scholars as a prerequisite for creative production. Reflecting this view, Proust (2010) considers perception as probably the most important element in creative thinking, arguing that it is critical in shaping the general idea before one engages in the technical aspects of production. Pattern formation relies upon the way we choose to look at things, classifying, identifying and making predictions and judgment. These predictions and judgments are the essential building blocks which determine the potential for new ideas. People choose what to focus their attention on and constantly select what to give attention to. Proust (2006) as cited in Prince (2011) argues that most problems are not new; but the challenge is to view and interpret the problem in a new way. The more adept one is, the less likely it is that they will appreciate a different point of view or alternative ideas that may generate new approaches. De Bono (1970), as cited in Koray and Mustafa (2009) proposes a process of restructuring perceptions in many different ways to avoid repetitious solution patterns. Patterns give us the power to understand the world and consequently they become the rules according to which we live our lives. A common problem associated with this, however, is to become locked in one particular approach, method or strategy without appreciating that other approaches may be more appropriate. Since its emergence in the second half of the 20th century as an area of educational research, creativity has been emphasized by educators, who have also identified favourable environmental conditions for its development (Stenberg, 2003). Nonetheless, few attempts have been made to examine teacher and student perceptions of creativity. According to Fryer (1991), most studies have approached teachers' views in an indirect way through measuring attitudes before and after creativity workshops or concentrating on teachers' attitudes towards the personality characteristics associated with creativity. Amabile and Tighe (1996), Kim (2010) and Sternberg and Lubart (1996) include social, cultural and historical dimensions in their conceptions of creativity, arguing that culture sets standards for labeling products as creative. These standards can direct an individual's potential or inhibit a creative attempt. Fryer examined British teachers' perceptions of creativity, with regard to definition, factors believed to help and hinder creativity of children, methods useful for identifying creative pupils and creative school work, opinions about various teaching methods and educational goals. Results indicate that 90 per cent of teachers believed creativity could be developed, and that strategies to enhance creativity include building confidence, having a creative teacher, enjoying some free choice at home, having an involved and supportive family, and enabling pupils to have some degree of choice over learning methods. Characteristics of pupils, that impact on creativity were also identified and those believed to have positive effects on creativity were: computer access, projects, hands-on activities and activities that integrate academic subjects; while lack of awareness of own creative abilities was identified as an inhibiting factor. Proust (2010) and co-workers consider perception as probably the most important element in creative thinking. Prince (2011) has demonstrated that many students associate creativity almost entirely with creative art, creative writing and performing art. Whereas, these are important domains of creativity, such a limited view leads to contentment, totally ignoring the other all too important scientific creativity. Furthermore, the raging nature-nurture creativity debate witnessed in the past, with nature theorists such as Dehaene and Naccache (2001), Fuster (2002), Heilman (2001) and Jaffar (2004) on one hand and Baer (1993), Paulus and Nijstad (2003), Scott et al. (2004), and Sousa (2006) on the other, is a reflection of divided opinion on the nature of creativity. Teachers who view the construct as a purely natural trait may lack commitment and impetus to drive the creativity agenda in the classroom. This research was motivated by a desire to address some of the concerns raised about the ability of the education system to foster creativity and those emerging from a review of relevant literature. The purpose of this study was to establish the perceptions of students and teachers towards creativity; and its objectives were to (a) identify factors perceived as critical in enhancing creativity and (b) examine students' belief in own creative abilities.

METHODOLOGY

This study adopted a combination of ex-post-facto and correlation designs. The ex-post-facto component was incorporated since the study sought information on the extent of respondents' previous exposure to certain treatments in their normal school programme and at home, such as participation in project work, participation in Students' Congress on Science and Technology, and extent of interaction with toys and science materials; while correlation design facilitated the determination of correlations between these variables and divergent thinking. These designs were also based on ethical considerations. First, the respondents had already been exposed to childhood interaction with toys. In addition, the overall long-term effects of such interactions were unknown and consequently would not be manipulated on respondents. Other variables such as originality and critical thinking, not only had ethical implications but were likely to require prolonged exposure before they could have any significant impact on divergent thinking, rendering them unsuitable for experimental designs. No treatment was administered but the researcher applied statistical analysis of covariant data to determine pre-existing relationships.

Study Population

The population for this study consisted of 54 physics teachers 2,236 Form 4 (12th grade) secondary school physics students in Nairobi Province, Kenya. These were students who followed the local 8-4-4 curriculum and had opted to study physics upto the Kenya Certificate of Secondary Education (KCSE) level. Further, the population was hosted by schools that had consistently achieved a mean physics score of at least 6.0 (Grade C) on a 12-point scale in the national examinations (KCSE), during the three years preceding research. This selection criterion was to maximize the probability that the targeted population would retain the same performance category of 6.0 and above during the 2010 and 2011 national examinations. The decision to limit the population to this performance range (6.0-12.0) was based on the componential theory of creativity which recognizes good mastery of relevant knowledge, beyond a threshold level of competence, as a prerequisite for any meaningful creative output (Amabile, 1996; Asha, 1980; Karimi, 2000 and Mahmodi, 1998). These schools fell into various categories, including public, private, boarding, day, co-educational and single-sex schools. Students in this population came from diverse socio-economic backgrounds, with virtually all the 43 ethnic communities in Kenya represented. Nairobi was selected for its technology-rich environment perceived as having a unique influence on scientific creativity.

Sample and Sampling Procedure

The study sample consisted of 18 physics teachers and 763 physics students drawn from 18 secondary schools. First, stratified sampling was done, in which the schools as sampling units were divided into performance strata according to their physics performance in national examinations the previous year. Further sub-stratification was carried out within each stratum to categorize schools by gender to guarantee equitable gender representation and, more importantly, to facilitate the matching of schools with respect to particular characteristics in the sample. From the strata, purposive sampling was used to select schools so that each district received proportional representation, ensuring that both boys' and girls' schools were fairly represented.

At the school level, all Form 4 physics students who had participated in the Students' Congress on Science and Technology (SCST) by presenting physics exhibits or Talks were nominated, with the assistance of physics teachers, to participate in the study. Then, other Form 4 physics students, who had not participated in SCST, were randomly selected from the rest of the class to top up the sample to 40 students. However, this number varied slightly from one school to another, depending on physics enrolment. Schools with bigger enrolments contributed larger samples to cater for those whose enrolments fell below the target. The same procedure was applied to all the 18 sampled schools, giving a total of 763 student respondents, comprising 386 girls and 377 boys.

Research Instruments

The study employed two instruments: Creativity Perception Questionnaire for Physics Students (CPQPS), and Creativity Perception Questionnaire for Physics Teachers (CPQPT). CPQPS sought data pertaining to students' perceptions of own creative ability and the extent to which they considered the following factors as important for creativity: encouragement by teachers and teachers to be creative, availability of materials and equipment, access to Internet resources, access to materials on past discoveries and inventions, science news, thought provoking questions by teachers, assignment of project work by teachers, science talk, visit to science congress, and visit to agricultural and technology exhibitions. The instrument also prompted respondents to include other factors they considered important and to express their views about the importance of creativity or otherwise. CPQPT, sought teachers' perceptions regarding creative ability of students, important factors for enhancing creative ability of students, and those considered to impede creativity, the role of project work in creativity and the rationale for its emphasis in schools.

Validity of the Instruments

The instruments were validated to ensure they met the criteria to elicit the information targeted; and a number of measures were taken to achieve this. First, face validity was ascertained by three experts on Research Methods at Maseno University, who evaluated each item on the instrument to establish its, relevance, clarity and suitability and verified the adequacy of item samples. The instruments were then piloted on 244 Form 4 students and 5 experienced physics teachers in five schools within the study population; and based on feedback, unsuitable items were eliminated or rephrased accordingly.

Reliability of the Instrument

To obtain reliability, the students' questionnaire (CPQPS) was piloted on a sample of 224 Form 4 students in 5 schools, which represented 10 per cent of the study population. The questionnaire for physics teachers (CPQPT) was also administered to 5 physics teachers in the same 5 pilot schools. The quantitative data obtained were used to compute separate reliability coefficients for the two instruments. This computation yielded Cronbach's alpha values of .842 for CPQPS and .826 for CPQPT.

Data Collection Procedure

The investigator first sought research approval from the School of Graduate Studies, Maseno University, and proceeded to obtain research authorization from the National Council of Science and Technology (NCST). This facilitated access to the latest records, at the Provincial Director of Education's office Nairobi, regarding physics enrolment by district, school and gender for the purpose of sampling schools. The researcher then visited the sampled schools to explain the purpose and make arrangements with the principals and concerned physics teachers for the administration of instruments. A follow-up was made through telephone calls to confirm the appointments. The instruments were then administered in September, 2010 - two months before the respondents completed their secondary education course.

Analysis of Data

In the analysis, all the qualitative data were first coded. The codes, together with the quantitative data from both instruments were entered in two separate data files for teachers and students respectively and these were fed as data sets into the Statistical Package for Social Sciences (SPSS) Version 17.0. Using this statistical package, frequencies and percentages of responses were computed and tabulated in frequency tables. Popular responses to open-ended items were picked and highlighted in the report.

RESULTS AND DISCUSSION

Perceptions on factors influencing divergent thinking

Both teachers and students were asked to identify some activities and practices which they considered as important for divergent thinking and creativity in physics. This, they did by rating provided items in terms of their perceived strength of influence and adding any other factor they considered important. A number of factors were identified by the participants and these are discussed in the subsections that follow. Table 1 shows the mean ratings on the various items presented.

Table 1: Main factors perceived by students as important for creativity

Factor	Mean rating
Availability of materials in school	4.37
Availability of materials at home	4.37
Encouragement by parents	4.37
Visit to science congress	4.02
Challenge by teachers to be creative	4.01
Access to internet resources	4.01
Assignment of project work by teachers	3.86
Thought provoking questions by teachers	3.86
Materials on scientific discoveries and inventions	3.75
Visit to agricultural shows and exhibitions	3.42
Science news	3.29
Science Talk	3.24

Availability of materials in school and at home and encouragement by parents featured as the most important of all the factors presented, with all the three factors considered equally crucial in the development of creativity. Visit to science congress and challenge by teachers received the next highest rating in order of perceived importance. It should be noted that the assignment of project work, which is often associated with opportunity for creativity, does not rate highly as a determining factor. The materials referred to by learners include books, radio, TV, computer and materials required in experimental investigation, building models and fabrication of devices. In addition to the items on this list, the following suggestions featured quite prominently as other factors they consider would be important for enhancing their creativity: experiments in physics, symposia on physics, excursions to factories and opportunity for creative work. Regarding threats to their creativity, students identified lack of materials, lack of opportunity, lack of confidence in public speaking, lack of confidence in the subject, and too much curriculum content to be covered. When asked to explain why they had never participated in science congress, non-congress participants indicated that they believed they were not creative. Table 2 shows the percentages of students associated with each response.

Table 2. Main factors perceived by students as a hindrance to their creativity

Inhibiting factors	Frequency, *f*	Percentage of respondents
Lack of materials	51	6.7
Lack of interest	115	15.1
Lack of time and opportunity	507	66.5
Lack of confidence in public speaking	4	.6
Lack of confidence in physics	12	1.8
Lack of belief in own creative ability	8	1.2
Stiff competition during preparations for science congress	64	8.4

The largest percentage (66.5%) of students felt discouraged from creative work by lack of time and opportunity for creative work as much of the time was spent on academic work and other activities in the crowded school programme. Lack of interest (15.1%) also emerged as an important militating factor among some students; and this seemed to be even more important than lack of materials (6.7%). Although stiff completion was also identified (8.4%), it only applied to work specifically developed for presentation at the science congress. Some of the factors cited are concordant with previous findings. Lack of awareness of own creative potential has been identified in a previous study by Fryer (1989), and is usually linked to self-perception and an environment that fails to recognize, appreciate and encourage creativity. Students need to experience creativity much as they should experience success in other areas of skill development to build their confidence and discover their potential. Even though lack of materials is cited as a threat to creativity, and is indeed important in a creative production, it should be appreciated that some of the most critical stages of a creative process, including: identifying a problem, explaining the problem satisfactorily, identifying applicable principles, generating many alternative solutions, integrating knowledge from various domains, evaluating alternative solutions, designing a device and plan for investigations, demand no more than ideas, pen and paper; so it can be realized with minimal resources. Productive thinking as the most important component of creativity and which only demands no more than ideas, pen and paper and those materials need not be a major constraint. Investigations should involve small-scale experiments with predominantly local and improvised materials, so that any necessary materials are bought only after preliminary investigations show high chances of success and the idea is innovative with real potential to solve a problem. Despite the challenges identified, students displayed quite favourable attitudes towards project work, which is regarded as an aid to the development of creative abilities. When asked to explain what inspired them to undertake project work, study participants in general and science congress participants in particular cited various reasons. Some of the reasons were isolated or based on short-term interest but the following stood out as most frequent responses. The popularity of responses is expressed as percentages. Students engaged in project work for the following reasons: (47%) were aspired to make scientific inventions and viewed it as a vital preparation for achieving this purpose, (45%) desired to contribute to industrial and technological development of the nation, (12%) saw it as an opportunity to develop creativity, (17%) wanted to satisfy their curiosity, and (27%) viewed it as a forum for sharing their ideas and expressing their passion in physics.

Perceptions of teachers on project work

Perceptions of teachers

Six (6) factors were presented to teachers for rating to indicate whether they had high positive, positive, neutral, negative or highly negative influence on creativity in physics. At individual level, all the factors received ratings of between 0 and 2, indicating that they were all considered as either having no influence or positive influence on creativity. On average, however, the ratings on these factors ranged between 1 and 2 and the order was as follows (Table 3).

Table 3. Main factors perceived by teachers as important for creativity

Factor	Mean rating
Project work	1.79
Science debate	1.79
Independent search for answers by students	1.64
Competition among students	1.21
Group work	1.21
Independent work	.86

Project work attracted the highest rating (1.79), implying it was perceived by teachers as one of the most important factor influencing creative thinking among the factors presented. Receiving equal rating was science debate (1.79), recognized for its ability to build confidence of the learner in the subject and to provide training on public speaking. Coming third was: according learners an opportunity to carry out independent search for solutions to given problems (1.64), and this was considered important in encouraging good study habits and independence of thought. By attracting the same mean rating (1.21), competition among students and group work were viewed as equally important. These strategies are accepted and recognized as suitable for exchange and sharing of ideas while giving room for the learner to cultivate and exercise independence. On the basis of its status as a curriculum requirement and the high rating as a creativity enhancement strategy, the section that follows is devoted to further report on project work in schools.

Perceptions of teachers on project work

Teachers' views were sought on various issues pertaining to project work in physics. On whether project work should be made part of the secondary school physics curriculum, teachers overwhelmingly concurred on the need to offer project work as part of physics curriculum (83 per cent responded in the affirmative while 17 per cent did not indicate their opinion) but pointed out that any project work given should be appropriate to the level of the learner. Some of the reasons given in support of this position were: it enhances learning, enhances creativity, provides training on the design of experiments and investigations, and the ability to draw conclusion. It also develops confidence of the learner not only in the subject but also in their ability to create. A popular view expressed by participants is that project work prepares learners for active participation in scientific, industrial and technological development of the nation. The same views were shared by students, who also considered project work as essential to them as people who were seeking an opportunity to apply physics principles learnt to solve problems in the society and aspire to make inventions that would leave a mark in the world (47%). However, this overwhelming support for project work was not, reflected in the status of its implementation. When asked whether their students carry out project work as per the syllabus requirements, only 50 per cent of teachers responded in the affirmative. The rest either satisfied only part of the requirement by assigning some of the recommended project activities or did not give any project assignment at all. When project work was evaluated in terms of quantity, quality and originality, the data obtained indicated low values for each of the three aspects. Low quantity reflected the generally few projects assigned by teachers, inadequacy of materials and lack of self initiative by students to do extra work, especially if it is not to be examined. Quality was generally wanting in terms of various aspects, including workability, efficiency, and relevance while originality was hampered by the tendency to imitate other designs available in books, and an attempt to translate ideas as presented in physics curriculum into devices without any significant modifications. Consequently there was little creative input. The ratings by teachers on these aspects were as follows: quantity (1.4), quality (1.8) and originality (1.6), implying an overall rating of 1.6 on a scale of 1 to 3. This reflected low-to-moderate creative abilities with respect to project work.

A similar pattern was reported in the projects presented at the Students Congress on Science and Technology forum. Few of them were observed to reflect high creative input while majority bore similarities with previous works or were an expression of ideas available in other sources. Despite this, high creative potential of learners was acknowledged, with some of their works viewed as having a high potential for further development into useful technologies. One other important observation was that most students were interested in doing project work; but this inertest was notably high during preparations for science congress.

Efforts towards creativity

The study sought to determine any measures taken within the school to promote the development of creative abilities in physics. When teachers were asked to state the teaching strategies they normally employ to enhance creativity among students, the following were listed: group discussion, peer teaching, question and answer technique, emphasis on application of physics principles, student symposia, practical, high-order thinking (HOT questions), visit to factories and games. The school was also recognized as important in providing the right environment for out-of-class activities that enhance creativity; and these included project work, participation in science congress, science club activities, and school-based science competition normally used to nominate participants for science congress. Besides, good mastery of physics content was also perceived as having positive contribution to creative thinking. Nevertheless, some factors within the school environment and education system in general were observed to pose considerable challenge to the development of creativity.

Challenges and suggested remedies

A number of factors were identified by teachers as hampering creativity. These factors included: lack of laboratory equipment, lack of practical work, lack of materials, lack of exposure of students to creative works, too many activities on the school programme, an instruction that is too much focused on examinations, testing that focuses on knowledge of concepts and principles of physics, and lack of time. In the general education system, the following factors were reported as discouraging creativity: failure to test creativity in national examinations, overcrowded physics curriculum and the associated inadequate time, spoon feeding of learners with concepts, and examination oriented curriculum. These observations tally with the report by Fryer (1989), in which teachers also perceived insistence on one correct answer, drill work, timed testing, overloaded curriculum with too much content to cover and the associated lack of time for creative expression as factors that limit creativity. To address the identified threats, participants suggested the following remedies: revising the curriculum and examinations to incorporate creativity**;** inspiring and encouraging learners to undertake creative activities**,** including learning about past creative works in physics, according learners an opportunity for creative expression to showcase their creative potentials**.** Besides, basic laboratory equipment should be provided to facilitate investigations and testing of new ideas, while project work should be examined.

Conclusions

This study has established that encouragement by parents and availability of materials and equipment, both in school and at home, are perceived by students as the most important factors in developing their creative abilities. Additionally, visit to science congress and challenge by teachers to be creative, and access to Internet resources feature prominently as other important factors**,** while lack of interest and opportunity are considered as the most important creativity blocks. Teachers concurred with students on the need for confidence building and opportunity for creative work, but highly rated Project

Work, science debate, and independent search for answers by students as some of the most important strategies to enhance creative thinking. They were also generally aware of the important creativity blocks and creativity enhancement strategies. Most of the students were either neutral or had confidence in their own creative abilities, although there was no corresponding serious involvement in activities that reflect or enhance creativity. This situation puts in jeopardy the physics curriculum objective of developing creative abilities and achieving the goal of industrialization.

Implications

The findings of this study have important implications for enhancing creativity in physics. First, the development of creativity of children is an objective at risk and needs urgent attention by educators. Stakeholders in education need to be sensitized on the broader goals of education and specifically the importance of creativity, among other non-examined curriculum values. For teachers in particular, efforts to promote creativity should focus more on essential strategies and skills for enhancing divergent thinking, given their overwhelming support for creativity education. This may be effected through components of in-service training programmes geared toward the upgrading of professional skills in the teaching and assessment of creativity in physics. Equally, the interest and confidence generally expressed in own creative abilities imply favourable creative attitudes on the part of students. What students require is an opportunity and conductive environment for creative growth. Secondly, lack of materials to facilitate creative work is a major challenge that deserves adequate attention. This calls for devising suitable methods of providing essential materials needed for creative work, in a cost effective way. However, it should also be appreciated that some of the most critical stages of a creative process, including: problem identification and justification, recognition of relationships and applicable principles, generating many alternative solutions, integrating knowledge from various domains, evaluating alternative solutions, designing a device and planning for investigations, demand no more than the thinking process, pen and paper. Preliminary investigations may involve small-scale experiments with predominantly local and improvised materials to gauge the potential for success.

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