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Integrating the Concepts of Meteorology and Environmental Education Concepts in the Certificate of Secondary Education Geography Syllabus: Tanzanian Context

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Abstract: **This article analyses the experts and teachers views to determine the adequacy and relevancy of the concepts of meteorology and environmental education (EE) in raising awareness of secondary school students' on management of environmental problems and conservation. The study involved collection of the interview responses from the experts of environment, meteorology, forest and secondary school geography teachers that were used to analyze the content of the syllabus. It was found out that the concepts of climate change, meteorology and environmental education; are included in the syllabus but not comprehensively because they are not linked to one another and with the concepts dealing with human activities. Therefore establishing such a link is a means for raising students' awareness on management of the environmental problems. It is recommended that some concepts of meteorology and environmental education found in the geography syllabus should be integrated with subjects such as chemistry, biology and civics.**

Keywords: **Environmental education, meteorology, geography syllabus, climate change.**

1. INTRODUCTION

Following various environmental problems, such as climate change, ozone layer depletion and global warming, the United Nations General Assembly emphasized that climate change is one of the key action themes of the Decade [1]. It has been established that meteorology and environmental education can be used to teach topics on climate change by infusing concepts such as ecology, degradation, environmental science or instruction about any other issues related to the environment [2]; [3]. The complexities of climate change require it to be addressed using a holistic approach that draws upon a range of disciplines and areas of expertise, including climatology, policy, law, ethics, sociology, economics and culture, with the aim of an effective and inclusive knowledge sharing approach [4].

In Tanzanian context, environmental aspects in the school curriculum had been featuring since 1990s. However, the concepts were found in various syllabuses like Geography, Biology and Civics/General Studies instead of being combined [5]; [6]; [7]. The last secondary school curricular review in Tanzania, which was done in 2005 incorporated concepts of meteorology, environmental education and climate change in the geography syllabus and intended to make: '*students acquire skills for environmental conservation and management'* [8]. The objective reflects on the National Environmental Policy (1997/2004) that focused on raising awareness on environmental conservation and individual responsibilities in environmental management among the students.

Benson [9] indicated effective collaboration between researchers, scientists, and teachers is needed to develop a workable team work for raising society's awareness on environmental issues. Such an inclusive approach enables teachers to educate their students about evaluating environmental risks and developing behavioural skills needed to mitigate the

negative impacts and adapt to the upcoming changes in the environment. Akker [10] suggested that collaboration between environmental experts and curriculum experts or implementers is a means of merging the intended and the implemented curriculum.

Studies conducted in Tanzania e.g. [11]; [12]; [13]; [14] that focused on the problems of implementing of Environmental education in schools left gaps on how to address disparity between the intended or formal curriculum and the implemented curriculum. For example such studies did not consider that students' achievement levels could increase if the intended curriculum and the implemented curriculum are more closely aligned [4]. Such alignment is salient especially in the developing world including Tanzania, where research is to address serious gaps or misalignments between the two [15]. Therefore in order to determine the adequacy and relevancy of the meteorology and environmental education concepts integrated in the school curriculum in this era of climate change, the researchers gathered experts and Teachers' views as a basis for analyzing the concepts of environmental management in the geography syllabus before giving suggestions.

2. METHODOLOGY

The aim of this study was to determine the extent to which the concepts of environmental education and meteorology found in the certificate of secondary education syllabus are adequate and relevant in addressing the issues of climate change and environmental management. The study employed qualitative approach and it was conducted in Morogoro region. The region was randomly selected from other regions in the country. The study involved six experts: two meteorologists, two environmentalists and two forest experts. Each researcher interviewed one expert from each field. These experts were purposively selected considering their high experience in their fields of specialization and also willingness to spend their time with the researchers for interview. The study engaged also 40 secondary school geography teachers in focus group discussions. The teachers were selected from 10 secondary schools selected randomly from both rural and urban Morogoro. From each school, 1 geography teacher was selected from each form; i.e. 4 teachers were selected from each school. In schools where there were more than four geography teachers, random procedure was used to select the 4 teachers. 4 focus group discussions were carried out each involving 10 geography teachers. Responses from the experts' interviews as collected by the two researchers were merged and then used as a basis for the teachers' focus group discussions. Therefore the two sources of responses guided both the reflections and recommendations given. This was possible because the two researchers used the same guides for focus group discussions and interview with the experts. During analysis, the teachers and experts' responses were used as perspectives of the ideal curriculum while the geography syllabus was used as a formal curriculum and that the two represent the intended curriculum. This is by considering the observation that the effectiveness of the implemented curriculum depends significantly on the quality of the intended curriculum [15]; [10]; [4].

3. EXPERTS AND TEACHERS' RESPONSES

The researchers wanted to know if climate change may necessitate an increased utilization of weather forecast information, the meteorologist clarified that adaptation measures to the effects of climate change for instance in agriculture and disaster management need effective utilization of weather and climate information. He added that:

> *'Most members of the general society know that major function of weather forecast is all about whether it will rain or not, but forecast is far more than that, it is for productive activities, disaster management and the general life, for example, the society needs to be informed if at all there is likely to be a dangerous cyclone etc including measures they may need to take'.*

Upon discussing with teachers regarding this response, the teachers were of the view that there is a weakness in the syllabus because it stresses on the knowledge of the elements of weather, the skills on measuring and recording the elements of weather and also some highlights on the applications of the elements of weather and climate information but it does not clarify whether climate change will have any impact on the utilization of weather and climate information. The meteorologist added that the society needs to be aware that the effects of climate change are not homogeneous throughout the country. He exemplified that: *'There will be variations on fluctuations of temperature and rainfall patterns which may need localized means of adaptation to the effects of climate change'.*

This response further poses a challenge to the syllabus content because the teachers observed that the syllabus indicates that students should study the causes and effects of climate change but this does not mean that the syllabus users may necessarily consider the expected spatial and temporal variations of the effects of climate change. This challenge becomes prominent because of the vulnerability of our country to the effects of climate change as pointed out by the meteorologists that:

> *'Although climate change is a global issue, developing countries like Tanzania will suffer more from the extreme weather patterns of drought, floods and tropical storms associated with climate change because of over-dependence on rain-fed agriculture and poor technology for dealing with natural disasters and providing timely and reliable weather and climate information. This sets an inevitable necessity of combined efforts of all members in the society for adapting and mitigating the effects of climate change'.*

Heterogeneity of the effects of climate change on the environment was also clarified by the forest expert when the researchers wanted to know specific environmental resources which will be affected mostly by climate change as he responded that:

> *'The society needs to be aware that the impact of climate change on the link between forests and water resources can be more catastrophic than losing all direct harvests from forest resources. But if the society is not aware of this it is difficult for the costly initiatives of afforestation and re-forestation to win voluntary compliance among the society members'.*

This expert elaborated that forests are the important reservoirs of waters that appear in different forms; being rainfall, surface run off or underground water tables that support all forms of life directly and indirectly through its social economic activities.

The expert of environment showed his concern on the degradation of aquatic ecosystems due to environmental pollution, unsustainable mining activities and climate change. He gave examples of unsustainable fishing activities that do not discriminate mature from young varieties of fishes. He further exemplified that:

> *'It should be noted that as people pay less concern on wastes treatment, such wastes get discharged into the water bodies when it rains such that other wastes become poisonous to the aquatic organisms while the rest nourish aquatic vegetation that eventually starve the animal species due to oxygen deficiency*'.

When the researchers wanted to know if such aquatic disturbance is also linked with climate change; the expert concluded:

> *'Climate change is likely doing the same thing as temperature rise favours photosynthetic rate of such aquatic plants. This will be intensified by the increasing rates of discharging both debris and eroded materials due to floods which may be caused by the same phenomenon'.*

Environmental degradation in the aquatic ecosystems due to various activities such as fishing, and transportation are highlighted in the syllabus but such concepts suffer deficiency because they are not linked with the effects of climate change as substantiated from the discussions with teachers.

Although the syllabus indicates that causes and effects of climate change and various aspects of conservation should be discussed it does not go further on the efforts that every one of us need to take during conservation by considering the effects of climate change. This seems to be a shortcoming as pointed out with teachers because it does not reinforce measures that need to be taken against climate change alongside conservation techniques. This is mainly by considering the fact that it may be difficult to instil the attitude of seriousness into the minds of students when taking measures against climate change; under the current condition where there are arguments against climate change as the expert of meteorology highlighted that there are some scientists who oppose existence of climate change.

The expert clarified that while counter arguments may be friendlier to some policy makers who may wish not to spend any resources for mitigating or adapting the effects of climate change on one side, the general society is left at a cross roads without knowing what to do when one speaks of causes, effects or measures against climate change. He added that the society needs to be aware that scientific evidence supporting climate change far outweighs that which supports counter-arguments.

When the researchers needed to know from the meteorology expert if there are other basic issues that secondary school students need to be aware of regarding climate change and if at all there are any efforts taken by Tanzania Meteorological Agency (TMA); the response was: *'Schools in Tanzania need to be sensitized on several issues regarding weather, climate and climate change including adaptation and mitigation measures'*.

These initiatives show that TMA admits that there is an immediate need of sensitizing the society on the issues of climate change as its effects touches almost all aspects of life; for instance, effects of climate change seems to have serious impact on agriculture which accounts for nearly one-half of the GDP, employing 80% of the work force, and providing 85% of exports [16]. The expert referred a case of 1997/8 El Nino as an example of the effects of climate change. The incidence which led to drought and flooding, and triggered a national food emergency with severe food shortages, flying food prices, increase in power rationing, and extensive food, cattle and cash crop losses [17].

Teachers were of the view that such examples of events characterizing climate change may be clear to students when they discuss the effects of climate change. But the geography syllabus does not indicate that both teachers and students need to discuss measures to be taken when such events happen or ways of minimizing possibilities of their occurrence in the future.

Another issue of concern revealed from the interview was that holistic approach by the society and individual efforts for either adapting or mitigating climate change are necessary for any tangible outcome to be realized. This was raised when researchers wanted to know from the forest expert if the campaigns for afforestation and reforestation can real match with the rates of carbon dioxide gas production and the extent of desertification. The expert's response was:

> *'Success will depend on the efforts taken by every one of us, being individual, experts, voluntary groups, government etc. While on the part of the government it depends on the policies set if they focus on sustainable utilization of the environmental resources, individual commitment when implementing such policies is highly required and our role as experts needs to be that of advising both the government and the society'*.

Following a short discussion on this response led this expert to pinpoint that commitment from the society members among other things depends considerably on 'awareness' on the side of the government and individual members in the society and that levels of awareness on an issue also matters; he exemplified that: '*Someone may be aware that the most effective way for preventing global warming is by preventing deforestation and carrying out afforestation and reforestation but he/she may not necessarily know how, when, where or the extent of doing it'*.

Regarding this response, discussion with teachers revealed that; the syllabus seems to be lacking an important section directing discussions especially on encouraging individual responsibilities of performing simple roles such as minimizing the use of power and preventing environmental pollution.

In addition, the forest expert cautioned that holistic approach does not only involve raising awareness by transmission of knowledge or simply carrying out conservation activities like planting trees but also involves developing awareness on the necessity to protect nature and the environment including the complexity of both the environment and the interactions between man and nature. For example, when an individual is already knowledgeable on the causes and effects of environmental pollution; he/she needs to develop an attitude of reporting incidences of environmental pollution to the right place so that immediate actions can be taken. This was also demonstrated by the expert of the environment that: '*The society is now considerably aware on environmental problems as you could see people's reactions on the polluted rivers due to effluents from North Mara gold mine industry*'.

Then the researchers asked on how such environmental pollution could happen if there is an appropriate means of controlling industrial wastes production and disposal; the reply was: '*Before private investment is approved, environment impact assessment procedure should be followed which control issues of environmental pollution concerning with the investment. Hence, discharging pollutants in to the environment whether intentionally or accidentally, the investor should be held accountable'.*

Despite this provision, this expert raised his concern on the possibility of further increase in environmental pollution in this era of globalization characterized by market liberalization and growth of private investment. However, he showed the way the government has tried to solve this problem by pointing the opportunities given to every member of the society following the provisions of the 1997 national environmental policy that was amended in 2004 about public participation in private investment that:

> *'The National Environmental Management Council (NEMC) prepared Environmental Impact Assessment Guidelines and Procedures in 1997 to guide investors to carry out development projects in an environmentally responsible way. These guidelines and procedures hold particular importance in so far as they have sought to incorporate issues of public participation and access to information in environmental decision-making processes in respect of projects with likely environmental impacts. The policy specifies that, in order to ensure satisfactory public involvement, the investor should initiate a public information campaign in the area likely to be affected by the proposed investment. The information should include background information on the nature of the proposed investment, i.e. purpose and need for the investment, proposed actions, location, timing, method of operation, likely impacts and how to deal with them'.*

This indicates that the society needs to be aware on the environmental policies governing private investments in this era of market liberalization. The same expert added that: *'Now the government has taken more initiatives by establishing environmental committees starting from the regional to the local levels so that all environmental matters can be easily reported and discussed at any level'*. Further discussions with the teachers regarding the experts' views as related to the current environmental policy led to a conclusion that integration of such policies in the more relevant subjects such as civics in secondary schools rather than piling all EE issues in the geography syllabus may promote better understanding to students. Also, the teachers advised that if all the EE concepts were to be addressed by the geography syllabus alone there was supposed to be a teacher's guide specifying particular issues to be covered. However, geography teachers' aid was not found in any of the visited schools.

4. ALIGNING THE GEOGRAPHY SYLLABUS TO THE IDEAL CURRICULUM

Analysis of the experts and the geography teachers' views reflects a disparity between the ideal and the formal curriculum. Therefore a number of suggestions on the way various concepts of meteorology, environmental degradation and conservation measures can be linked with the aspects of climate change are given based on both experts and teachers' views

Integrating concepts of Meteorology and environmental degradation in the Curriculum:

Responses from both teachers and the experts indicate that the government has set in place constitutional strategies which provide more opportunities for individual participation in environmental protection especially with regard to environmental degradation due to private investments. It would be more appropriate if an objective that requires students to identify their role in environmental management according to the environmental policy is added in the geography syllabus just after the objective that, "students should analyze the causes, extent and effects of pollution and waste management" [8]. This should further be followed by another objective like, "students should propose ways of preventing environmental pollution". However, other issues of environmental management in the environmental policy such as the responsibilities of both government and environmental experts can be covered more effectively in other subjects like civics as it deals with policy issues more widely.

Also, the environmental expert's concerns about the effects of climate change on the aquatic resources seems as if they are addressed in the geography syllabus by an objective like, "students should describe the methods used for extracting resources from water and explain the problems caused by extraction of water resources" [8]. However, such an objective does not give room for a syllabus user to explore problems beyond those due to extraction of water resources; for instance climate change. Hence, the objective could be broader like, "students should explain the problems that threaten water resources". Such an objective would also give an opportunity for climate change mitigation and adaptation strategies to be considered for the following objective which states, "students should describe various ways of conserving water resources" [8]. Never the less, other environmental issues like, analysis of the chemical composition of industrial and domestic wastes which are destructive to the aquatic ecosystems may be more appropriately linked with the concepts of quantitative and qualitative analysis in chemistry subject rather than in geography.

Integrating the Concepts of Conservation Measures in the Curriculum:

Respondents' views reveal that life is impossible in the absence of forests. Tanzanian curricular experts probably identified this; this is the reason why there is a topic in geography syllabus on 'sustainable use of forest resources' [8]. This shows that a user of this syllabus can lead one to look for general concepts like: forests at high altitudes collect fog

and rain, which filter down to groundwater and underground streams [18]. This is because there is an objective on the importance of forests [8]. But the objectives need to be more contextualized so that students can establish a link between forest sources of water and human survival; for instance, by providing a link between a balanced forest ecosystem and sustainable utilization of water resources which is of a great concern on climate change. It implies that since the syllabus requires students to 'describe the problems facing forestry resources and harvesting' without any link with climate change it is likely that syllabus users may only link all forest destruction practices with common issues of illegal logging and forest fires and forego the complex impact of climate change on the forest destruction and diseases. For example, there is evidence that there is a very close link between forest fires and spread of diseases to humans, for instance, the extensive smoke from the massive 1997–1998 forest fires in Southeast Asia is thought to have led to the fruiting failure of many forest trees, forcing frugivorous bats to switch to fruit trees in pig farms. The bats, which host the Nipah virus, are likely passed to the pigs, from which the viruses then are taken up by people [19].

This implies that an objective, "explain the relationship between vegetation and water supply" and "explain the problems caused by extraction of water sources" in the geography syllabus [8] would direct teachers to the information shown above if such objectives were linked with climate change. For this case, in order for a student to link appropriately vegetation with water resources on one hand and climate change on the other, a topic on 'Water management for economic development' [8] would follow after a topic on 'sustainable use of forest resources'.

If such topics are presented in that order; the objective on explaining the organization, benefits, problems and prospects of Rufiji Basin Development Authority (RUBADA) and Tennessee River Valley Authority can be related with climate change with contextualized examples. This is because sustainability of such basins could appropriately be linked with the impact of depleting ice cap on Mount Kilimanjaro and its associated destruction of forest belt on Rufiji, Pangani and Ruvu rivers [20]; [21].

Establishing relationship between climate change and Mount Kilimanjaro ice cap and its forest belt ecosystem that support the most prominent water sources provides opportunity not only for students to learn the impact of climate change on forest ecosystem and water sources but also provides an appropriate link with the other topics such as tourism, manufacturing industry, sustainable use of power and energy resources and Agriculture [8].

The syllabus should further include an objective that requires students to identify problems facing manufacturing industries including proposing solutions, to orient students not only towards identifying other direct and indirect problems related with climate change that face manufacturing industries but also be able to propose solutions that include climate change adaptation and mitigation means.

Also, it should be considered that agriculture is clearly the most important sector of the Tanzanian economy as over 80% of the population of the country relies directly on agriculture [22]; and also a sector which is projected to be affected most by climate change [23]. Thus, for a topic on agriculture [8] to be able to address the way it will be affected directly by climate change and indirectly through the other productive sectors it needs to be studied after studying the rest of the other human activities. This is because agriculture depends on all other human activities discussed above. It means agriculture will be affected by climate change directly and indirectly by declining productivity of the other sectors. For instance, decreased industrial output due to decreased raw materials and insufficient power supply will lead to scarcity of agricultural inputs; hence low agricultural productivity. This condition will accelerate illegal exploitation of forest resources, a condition which will further reinforce climate change.

The syllabus has an objectives like: "students to demonstrate ways of controlling soil erosion through the application of various conservation techniques, analyze various ways of conserving environment and practice environmental conservation and management at school level by planting trees, grasses, flowers, collecting garbage and cleaning the school compound" [8]. However, detailed knowledge on the required species of trees or other plants for replacing the decreasing vegetation may require more details such as species extinction, ecological succession or plant physiology which are best dealt with in biology. For instance, one biological study reports that, elevated CO2 concentration due to climate change is likely to increase plant productivity, especially that of species utilizing the C3 photosynthetic pathway (mainly woody plants and temperate grasses), such that there have been suggestions that fuel production will increase in the future [24]. Such information can be clear to the learners if linked with concepts of C3 and C4 processes of photosynthesis in biology.

In addition, considering the significance of the coastal ecosystems, it is important to modify the objective, "students should describe types and effects of soil erosion to social and economic activities" of the geography syllabus [8] so that it reads: "students should describe types and effects of soil and beach erosion to social and economic activities". The word "beach" should also be added for the objective, "describe ways of controlling soil erosion through the application of various conservation techniques" [8]. Such objectives will ensure that the effects of sea wave actions along the coast can be taken into account. Such a modification of objectives will give chance for a syllabus user to consider reclaiming coastal land as a means of adapting climate change for the objective, "students should explain the major aims for land reclamation" [8].

Therefore it has been suggested that climate change needs to be linked with all section in the syllabus dealing with human activities, power use and management of both water and forest resources. Also, some of the concepts of environmental education seem to be more relevant if integrated with other subjects such as chemistry, biology and civics than including all of them in the Geography syllabus.

5. CONCLUSION

Concepts of meteorology, environmental education and climate change are included in the geography syllabus for the sake of raising students' awareness on the cotemporary environmental problems. But there is a disparity between the formal curriculum and the ideal curriculum because issues of climate change are treated in isolation as they are not related with environmental degradation or conservation measures. In addition the given teachers guide does not address all the concepts found in the syllabus. This means most of the concepts found in the syllabus may not be uniformly addressed by all teachers. Therefore it has been suggested that climate change needs to be linked with all section in the syllabus dealing with human activities, power use and management of both water and forest resources. Also, some of the concepts of environmental education seem to be more relevant if integrated with other subjects such as Biology and Civics than including them in the Geography syllabus.

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