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Opportunities of Botanical Garden in Environmental and Development Education to Support School Based Instruction in Ethiopia

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Abstract
The research describes the opportunities and foundational schemes of the first and the only Botanic Garden in supporting the school based environmental education routine in Ethiopia. The main objective of the study were to systematically evaluate the existing general education Syllabi and the potential of Gullele Botanic Garden (GBG) in supporting quality education and enhancing environmental cognitions in Ethiopia. The study were conducted in Ethiopia at reference center of GBG with benchmarking the existing general education Syllabi. The data were collected through document review, site visits and expert discussion. The study highlighted and observed all relevant contents of competencies in the Syllabi that are required to be associated with the obtainable potential of botanic gardens in supporting the educational system and providing outcome based intensive environmental education delivery. Moreover, special emphasis were given to skills and attitude of their program of study in agreement with the tangible demands and intended audiences. It observes the current school based environmental education demands and the obtainable potential of the botanic garden in providing practical based intensive environmental education delivery. Descriptive statistical were used to analyze and compare the observations of syllabi contents against the identified potential of GBG. Accordingly, 18.0, 24.1and 19.3 percent of the unit category of grades 1-4, 5-8 and 9-12 were found linked with the potential of GBG in respective order. Moreover, 14.6, 23.5% and 11 percent of the sub-unit category of grades 1-4, 5-8 and 9-12 were found linked with the potential of GBG in respective order. The overall analysis shown that 20.7 percent of the unit category and 15.8 percent of the sub-unit category were resulted potentially linked to the botanic garden. Moreover, based on the site visit conducted along with the supplementary document review, 81% of the GBG facilities were found potentially used for educational purpose. Subsequently, 18 foundational educational program were designed on the basis of identified potential of GBG. The key conclusions of the research were that botanic garden play a great role and create a comfortable learning opportunities, processes and settings in acquiring a range of contents and competences related to the environment and development. This study suggested and proposed the initial garden based education program to be tested in the botanic gardens. The research further recommends additional research to be conducted in the area of garden based environmental and green developmental education.
Keywords: Botanic Garden Potential, General Education Syllabi, Environmental Education, Educational Program,

1. Introduction and Background

Botanic gardens have an obvious and vital role to play in conserving plants but conservation cannot succeed without education. Gardens are uniquely placed to teach people about the importance of plants in our lives and in the global ecosystem. By highlighting the threats that plants and habitats face, gardens can help people look at ways in which biodiversity can be protected (BGCI, 1994). Botanic gardens make excellent outdoor classrooms and can be used to teach a wide range of curriculum subjects, such as biology, geography, science, social sciences, mathematics, art, history and languages (European Botanic Gardens Consortium, 2000). Botanic gardens and arboreta offer a unique window to the wonders of the plant kingdom (BGCI, 1994). They also provide superb settings for non-traditional subjects such as information technology, futures education and education for sustainability. Teaching in a natural environment enables children to gain knowledge and to deepen their understanding of their relationship with nature and the importance of sustainability (European Botanic Gardens Consortium, 2000). The consortium also added that Gardens should support teachers to bring their classes to the garden independently and to make the most of their trips by developing activities for before and after their visits. Support can be offered in the form of training, advice and materials.

Botanic gardens may present the only opportunity for some peoples to be closed to the nature and to learn about plants (BGCI, 1994). For many children living in urban environments, school grounds provide their first experiences of nature. Botanic gardens have expertise and resources for a range of natural science topics and can offer advice and materials to schools to create more conducive environments for learning which, in turn, will have a lasting effect on children's attitudes towards nature (European Botanic Gardens Consortium, 2000). According to Willison, J. (2006), there has been a growing interest in Education for Sustainable Development (ESD) by using botanic garden educators over the past few years. All the major international strategies for

biodiversity conservation and sustainable living (Convention on Biological Diversity, Agenda 21, International Agenda for Conservation in Botanic Gardens, Global Plant Conservation Strategy), have emphasised the importance of education in the fight to stop biodiversity loss. Moreover, UNESCO's recent documents labelled that sustainable development is the "ultimate goal of the Man-environment relationship"; thus, the whole educational process should be "reshaped for sustainable development." Botanic gardens have an important role to play in implementing these strategies and contribute for the achievement of one of the three pillars of human development, environmental protection, proposed by UNDP in an inclusive, equitable and secure manner.

The Gullele Botanical Garden (GBG) is a newly established conservation initiative and it is the first botanic garden in Ethiopia located at the north-western tip of the Addis Ababa City Administration. The fundamental reasons behind the establishment of GBG is the fact that a number of Ethiopia's endemic plant species are facing extinction and require protection. One way to safeguard their survival is via establishing an in-situ botanical garden where endangered plants are grown, conserved and nurtured, creating a living gene bank. The main objectives of the botanical garden are to safeguard the future survival of a diverse set of species, conduct plant research, create an urban park for recreation, and enhance the practical knowledge of students and the general public concerning on plants and their importance in supporting the entire life on earth. Among the many values of establishing a botanic garden, the most important one is the awareness that it creates on environmental issues and the educational value that it will bring about to all sectors of the society.

As tried to concisely state in the paragraph above, one of the objective of GBG is to offer environmental education for sustainable development by streamlining with special attention to the nature; provide training on sustainable gardening, horticulture, floriculture, urban agriculture and urban forestry. Promoting the potential resources of GBG to be used as a center for environmental education at all levels including general education is described as the desired specific objective of the garden. In this regard, according to the MoE (2008), the Ethiopian general education comprises grades 1 to 12. Primary education lasts 8 years and is split into grades 1-4 (primary first cycle) and grades 5-8 (primary second cycle). Secondary education is also divided into two cycles, each with its own specific goals. Grades 9-10 (secondary first cycle) provide general secondary education and, upon completion, students are streamed either into grades 11-12 (secondary second cycle) as preparation for university, or into technical and vocational education and training (TVET), based on performance in the secondary education completion certificate examination. Education Sector Development Program IV also included Early Childhood Care and Education (ECCE), and Functional Adult Literacy. Thus, identifying the potential of botanic garden as an outdoor class room service center and ensuring the schools at any level to use the garden as resource center would play a pivotal support role in quality education.

A visit to the botanic garden is an ideal opportunity for above-mentioned level of students to learn and engage with the natural environment through encouraging to experience the different parts of the Garden and provide an exciting opportunity to learn about plants, their uses and their habitats to their corresponding level of subjects. Schools for general education use the Garden as a living museum to learn about the fascinating world of plants and their importance to all life on earth. Plants are of fundamental importance for all life on Earth. They interact with animals, micro-organisms and the non-living components of the planet - oceans, atmosphere, freshwaters, rocks and soils - to form one interdependent system, of which we are an integral part. The vast variety of species means that we can use plants in every aspect of our lives, enabling us to adapt to changing circumstances and environments. Hence, linking the potential resources of botanic garden with the general education system will provide a wide-range of opportunities for quality learning experiences and offer a comprehensive account of spaces for a variety of hands-on activities to help physically interact with nature. The main reason of the study to focus on the general education was that, according to Valsala *et al.* (1999) youngsters are the most suitable target population to receive environmental education since they are more receptive and responsive to the environment as well as being the future guardians of the environment and are the potential decision and policy makers of the future.

The overall objective of this article is to systematically evaluate the existing relative linkage scopes of general education Syllabi with the botanic garden and identify the potential of GBG in supporting quality education and enhancing environmental cognitions in Ethiopia. The primary task of this article is to evaluate contents of the general education syllabi and opportunities of Botanical Garden to identify their basic linkages and assist the design of comprehensive environmental education program and enhance environmental awareness by presenting different school of thought. These outreach tasks will highly contribute to promote an affection to the natural environment, support and encourage future generations of sustainability oriented professionals and culture.

2. The rationale for the research

Gullele botanic garden (GBG), is the first and the only botanic garden in Ethiopia, located at the outskirt of Addis Ababa, the capital city of Ethiopia. According to United Nations Economic Commission for Africa (UNECA) (2012), Addis Ababa, where GBG is located, is the largest city in Ethiopia, with a population of

3,384,569 according to the 2007 population census with annual growth rate of 3.8%. The city is composed of people from different regions of Ethiopia – the country has as many as 80 nationalities speaking 80 languages and belonging to a wide variety of religious communities. It is the place where the African Union (AU) and its predecessor the Organization of African Union (OAU) are based. Addis Ababa also hosts the headquarters of the UNECA and numerous other continental and international organizations. Addis Ababa is therefore often referred to as "the diplomatic capital of Africa" or "the political capital of Africa" due to its historical, diplomatic and political significance for the continent (UNECA, 2012). Moreover, the 2006 E.C. (2013/14) Ministry of Education's annual abstract for education statistics described that, the city is the setting of 993 general education schools and 861,895 annual Gross enrolment including early childhood care and education (ECCE).

Even though the city has such a remarkable features, its dwelling students and the general public at all levels lack a single opportunity of comprehensive and systematically organized hands-on and outdoor based awareness mounting and education centres along with the corresponding programme to help the city residence learn, engage and acquire hands-on experiences concerning on the natural environments. In this regard, there are a number of various forms of parks established in the city. But most of them are considered invaluable in addressing educational and scientific demands of the public, and off limits from the general public as they are run by private businesses and widely used as a regular place for recreational services for residents including hosting weddings and cafeteria services, some parks are blamed by the some city residences for their act of improper watch over and allowing city's youth to undertake prohibited actions in the park. Therefore, this study, as the first in the country, will open the way and provide some insights regarding the existing relative linkage of general education syllabi with potentials of botanical garden, to be able to use the garden's potential resources for effective supplementary learning environments in a way that complement the formal school-based requirements and learning set-ups. Moreover, this study will have a paramount role in creating a perceptible kind of concern for nature in grass root minds so that students grow up with a practical awareness and experience that would lead them to action.

3. Methodology

3.1. Location and Site Description

According to the information available at the official web address of Gullele Botanical Garden (GBG), the garden is located in the north-western part of the capital city Addis Ababa, about 4.3 km away from the center of the city within Gullele and Kolfe-Keranyo Sub-cities. Geographically, it belongs to the central plateau of Ethiopia with co-ordinates extending between latitudes of 8^0 55'N and 9^0 05'N and longitudes of 38^0 05'E and 39^0 05'E. The area is characterized by hot and cold weather conditions. The hottest month is February (20.7 ^{O}c), followed by March, May with 20.2 and 20 ^{O}C respectively, while the coldest month is December (7.5 ^{O}C). The mean annual rain fall is 1,215.4 mm and there is shortage of rain from March to May. The site covers an area of 705 hectares on the south-western slopes of the Entoto mountain ridge, which forms the natural border of the urbanized area. The area is representative of the central plateau of Ethiopia. The area is characterized by mixed vegetation. Most of the area consists of exotic tree plantations of Eucalyptus globules, with only a few patches of natural afro-montane forest subsisting along the streams crossing the garden from north to south. In the garden there are over 240 plant species (trees, shrubs, herbs, and climbers) which belong to 66 families and 163 genera. Among these plant species 71 are medicinal and 28 are endemic to Ethiopia. The site is generally characterized by the presence of streams, remnants of the original vegetation, topographic variations as well as a proximity to the City.

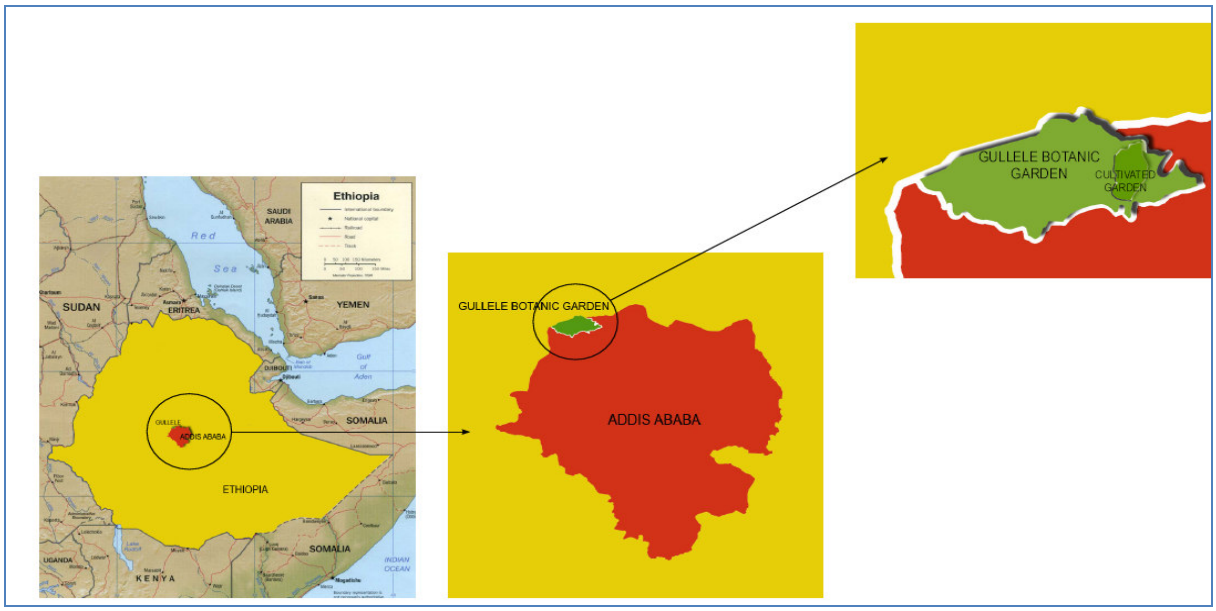

Figure 1: Location of Gullele Botanic Garden in Ethiopia and Addis Ababa (Source: Landscape design and implementation, Phase 2: Preliminary Design (GBG, 2010).

3.2. Study Approach

Identification of the potential of the botanic garden and its relative linkages with the general education syllabi contents for prompting environmental / ecological was the major focus of this investigation. The study implemented a simple and conventional approach in order to conduct the critical assessment, review / desk research and comparison of the intended set of information. Two simplified indexes were pre-identified to conduct the study, namely the present general education demand index and the botanical garden prospective resource index through which all the required information were acquired via document review, expert discussion and site visit. The pre-stated indexes were analysed and integrated via descriptive statistics. Hence data collection consisted of a combination of theoretical and empirical methods. Afterwards, analogous educational program were developed with subjective reference of the identified and analysed indexes.

4. Major Findings

4.1. Overall Relative Linkage of General Education Contents to Botanical Garden

The primary phase conducted during the study was that analysis of the existing general education syllabi against the pre-identified situation of the botanic gardens potential with the intention of finding out the role of botanic garden to supplement the knowledge, skill and attitude gained from classroom teaching delivery. Consequently, according to the assessment made via review of general education syllabi, a total of 714 units and 2,647 sub-units were tallied in respective order. 20.4% out of the unit category and 15.8% out of the sub-unit category were identified as a practical linkage with the potential botanical garden (Table 1). Moreover, 3.6% of the unit category and 4.4% of the sub-unit category were found strongly related while 10.8% of the unit category and 6% of the sub-unit category were found less related (Table 1).

Table 1: Relative linkage of contents of general education syllabi to the botanical garden.

Level of Education	Grades	Units						Sub-Units						% of Unit Category linked with the existing potential of GBG	% of Sub-Unit Category linked with the existing potential of GBG
		Total	Strongly related	General related	Partly related	Less related	Unrelated	**Total**	Strongly related	General related	Partly related	Less related	Unrelated		
Primary basic education (1st cycle)	1-4	**128**	8	1	1	13	105	**384**	16	6	5	29	328	18.0	14.6
Primary general education (2nd cycle)	5-8	**261**	13	1	20	29	198	**941**	67	10	68	73	720	24.1	23.5
Secondary general education (1st cycle)	9-10	**138**	3	5	9	17	104	**534**	16	4	24	23	467	24.6	12.5
Secondary preparatory education (2nd cycle)	11-12	**187**	2	0	6	18	161	**788**	17	2	20	35	714	13.9	9.4
Total		**714**	**26**	**7**	**36**	**77**	**568**	**2647**	**116**	**22**	**117**	**160**	**2229**	20.4	15.8

The contents of primary general education (2nd cycle) or grade 5 to 8 were top ranked with scoring highest percent of relative linkage with the botanical garden potential while contents of secondary preparatory education (2nd cycle) or grade 5 to 8 were found least linked (Figure 1).

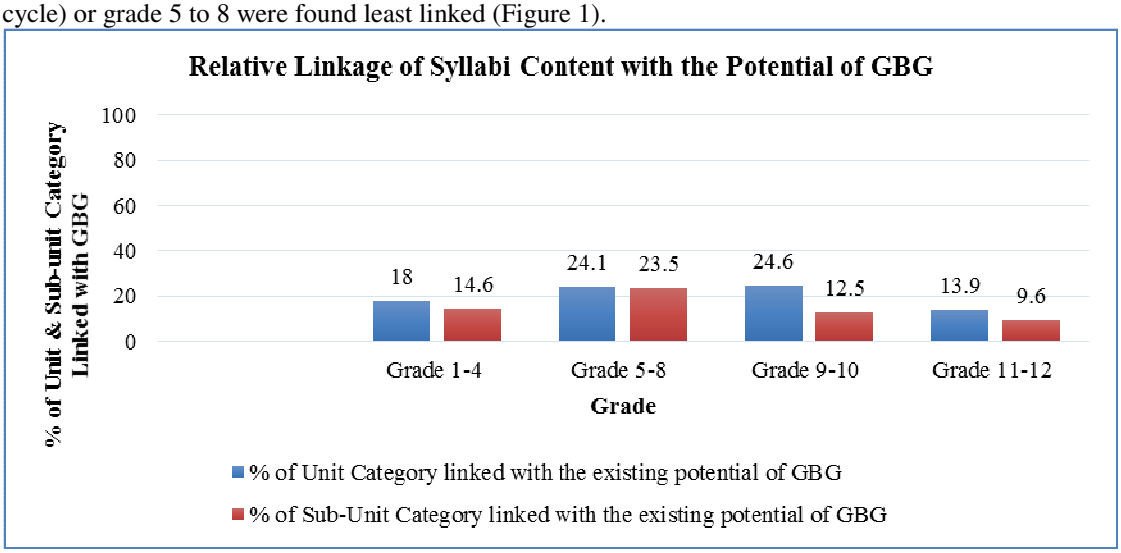

Figure 2: Relative linkage of syllabi contents with botanical garden potential in various level of education

4.2. Relative Linkage in different level of education with the corresponding subjects

When we look at the relative linkage of general education contents to botanical garden in various level of education with the corresponding subjects.

4.2.1. Primary basic education (first cycle)

The assessment of the contents of primary basic education subjects were revealed that environmental science was found top ranked with scoring highest percent of relative linkage while contents of Mathematic was found least ranked. Moreover, the subject entitled art and physical education was also found comparable with environmental science in relative linkage (Figure 3).

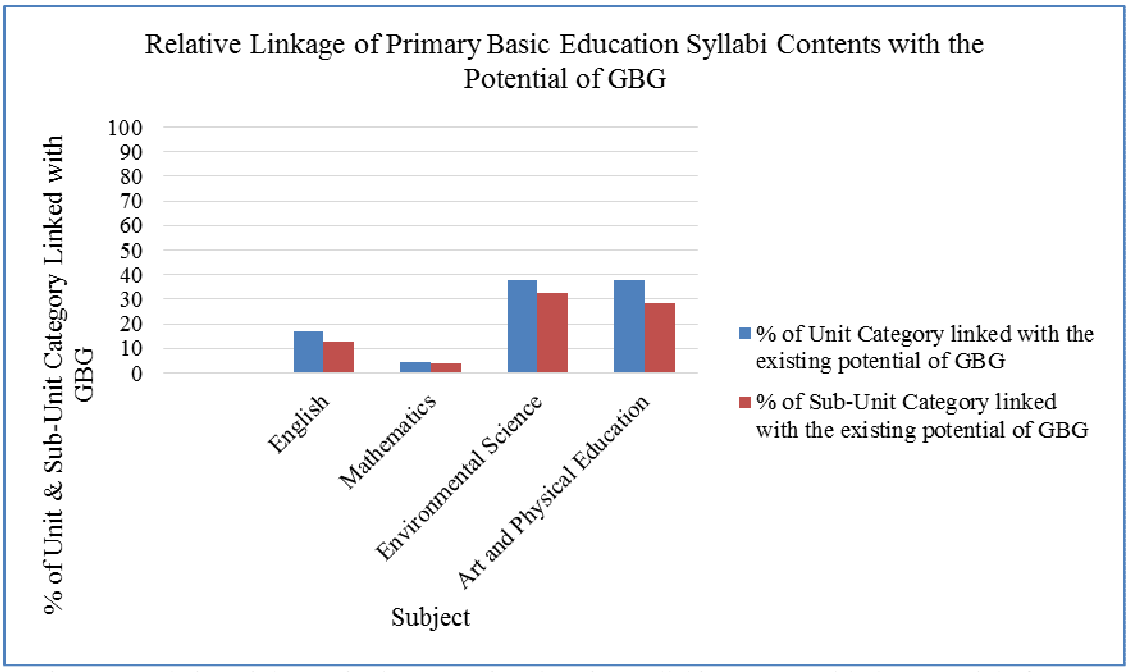

Figure 3: Relative Linkage of Primary Basic Education Syllabi Contents with the Potential of GBG

4.2.2. Primary general education (second cycle)

In this level of education, Biology and Integrated Science were identified as the top ranked linkage with the botanic garden, whereas, Mathematics was found with no substantial linkage with the botanic garden potential (Figure 4).

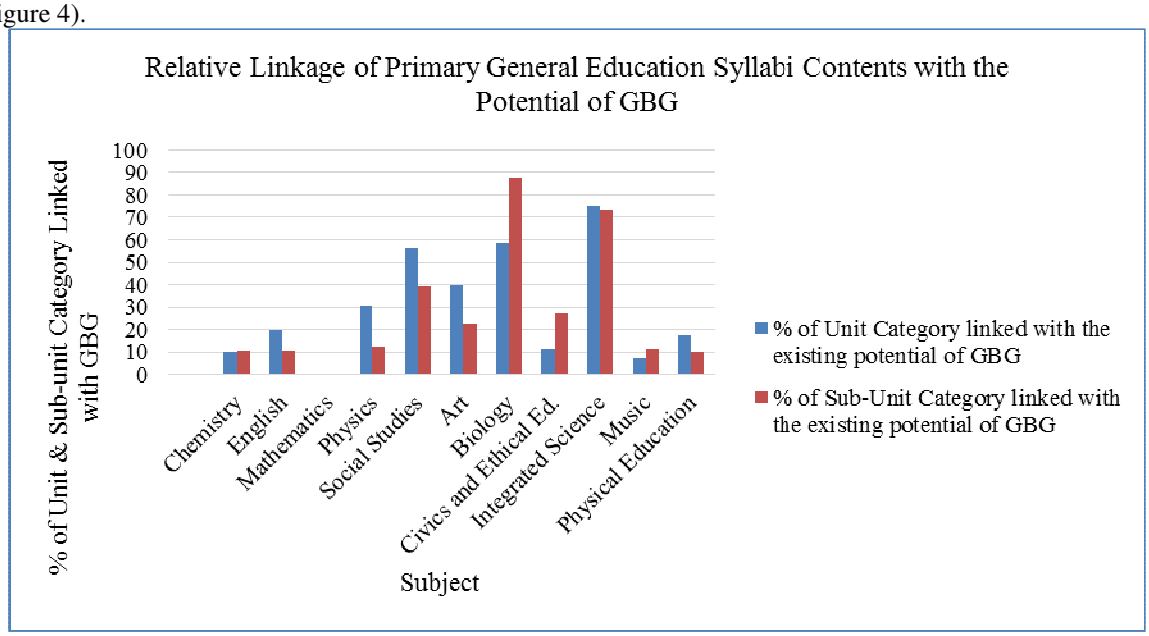

Figure 4: Relative Linkage of Primary General Education Syllabi Contents with the Potential of GBG

4.2.3. Secondary general education (first cycle) and Secondary preparatory education (second cycle)

The result of the study confirmed that Geography and Biology placed on top linking Subjects with the botanic garden while History, Information and Communications Technology (ICT) and Mathematics found no substantial linkage with botanic garden instructional potential (Figure 5).

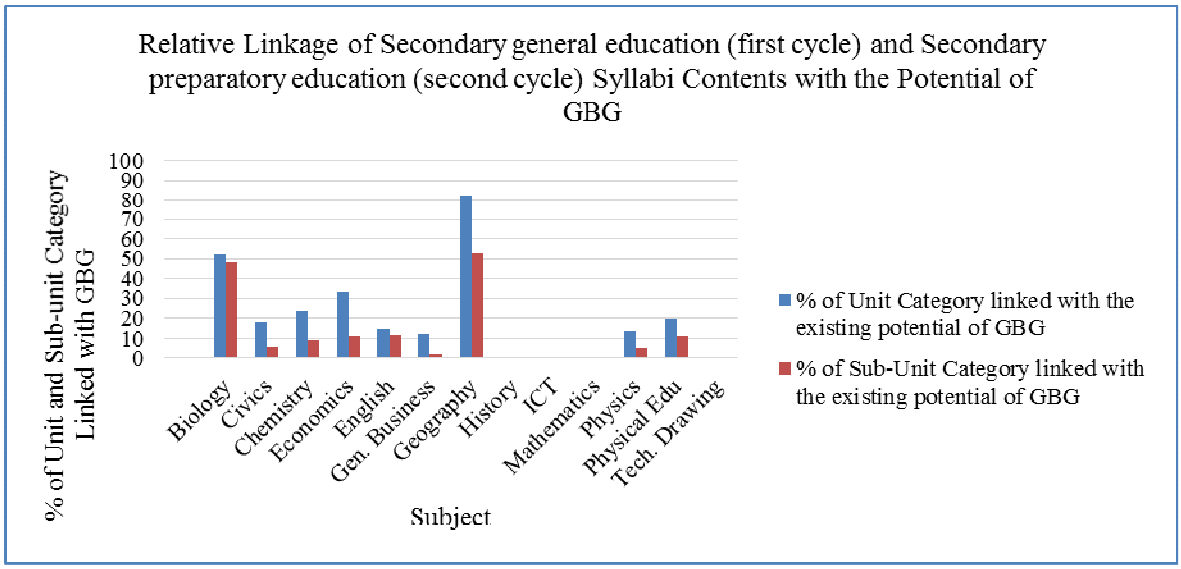

Figure 5: Relative Linkage of Secondary general education (first cycle) and Secondary preparatory education (second cycle) Syllabi Contents with the Potential of GBG

4.3. Linkage of Major Natural and Man-made Indoor and Outdoor Potential Resources of GBG with the Contents of General Education Syllabi

Eleven major natural and man-made potential resources and facilities were identified for the purpose of corresponding appraisal against the abovementioned contents of general education syllabi. The analysis of the identified potential resources of GBG exposed that the potential resources such as research, technical and recreational buildings and all the facilities and infrastructure associated; stimulatory agro-ecological reconstitution areas of the cultivated garden; and natural and artificial vegetation and landscape were found top linked resources with the contents of general education Syllabi while suspension bridge and bird aviary; cultural /traditional houses; and city interface were confirmed least linked (Figure 6).

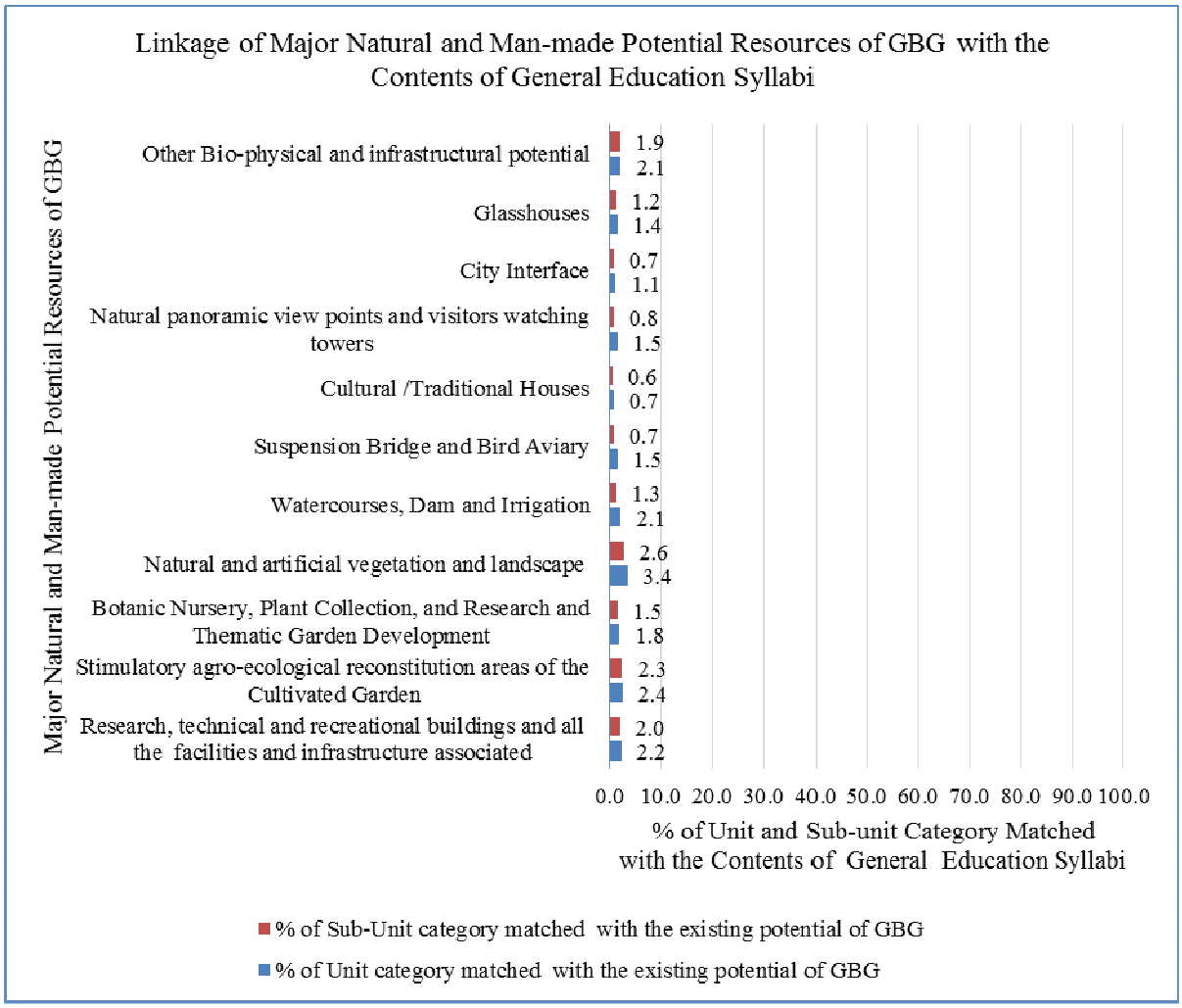

Figure 6: Linkage of Major Natural and Man-made Potential Resources of GBG with the Contents of General Education Syllabi

5. Discussion

5.1. Overall Relative Linkage of General Education Contents to Botanical Garden

General education is filled with younger generations in which these group of the society are considered as the fitting receptive and responsive of first-hand topics as well as they are future protectors of the natural environment, and the potential decision and policy makers of the future, which made the level most suitable to address the issue. According to Agenda 21 of the United Nations (1993) environmental education is one of the most important strategies for protecting our environment. UNESCO (1977) described that, it is being recognized that a better understanding of the environment can only come through environmental education. Environmental education, properly understood, should constitute a comprehensive lifelong education, one responsive to changes in a rapidly changing world. It should prepare the individual for life through an understanding of the major problems of the contemporary world, and the provision of skills and attributes needed to play a productive role towards improving life and protecting the environment with due regard given to ethical values.

The apparent establishment of responsive education program for the selected target group based on the obtainable potential of selected demonstrative sites would greatly support the exerting efforts of reducing destructive impact of human activity on the natural environment and assist the practical aspects of the education delivery system in natural science subjects. In this regard, botanic gardens present the best opportunity for many students living in urban environment school grounds to experience and learn about the natural environment. This implies that, according to European Botanic Gardens Consortium (2000) botanic gardens have expertise and resources for a range of natural science topics to mount a lasting effect on children's attitudes towards nature.

However, such kind of determinations require a critical assessment of the existing potential of botanic gardens and the corresponding demands of the education system, and fill the gap of peoples' competence at all level about their relationship with their surrounding environment. Social inclusion and environmental issues are interlinked; they can both be regarded as moral issues and issues of social justice. Most gardens have some

education provision, mainly programmes for schools (Jocelyn and Ceri, 2010). Education programs in botanic gardens are usually designed based on the prevailing competence need analysis and the corresponding potential of botanic gardens. The information posted on the official website of Royal Botanic Garden Edinburgh displayed that the garden's school education programme offers curriculum-linked sessions for Nursery, Primary, Secondary and Teacher Education Centers and use its outdoor space and plant collections to increase awareness and understanding of the natural world. These description is complemented with the resulted linkage of Ethiopian general education syllabi contents with the potential of GBG. The overall analysis of the specified syllabi content against GBG potential resulted that 20.4% out of the unit category and 15.8% out of the sub-unit category relative linkage of general education contents to the potential resources of GBG. Such analysis of linkage and design of program was also identified by Jocelyn and Ceri (2010), Oxford offers learning programmes for primary and secondary schools and the public. Their programmes are more about contemporary issues and developing a socially responsible attitude towards the planet rather than focusing on traditional subjects like botany.

Therefore, appropriate translation of the identified linkages of the general education contents in to the equivalent botanical garden educational program would considerably support the traditional school based instructional practices and enhance student's awareness and concern about the human impact upon the environment. In this regard, tailor designing and practically linking the theory with practical applicability of competencies would substantially boost learner's real life hand-on experiences, their practical level of responsibility and familiarity with tangible problem solving capability in relation to natural environment. BGCI (2000) also described that botanic gardens bring people into direct contact with the natural world and demonstrate how the natural world benefits us. On the word of Saunders (2007), education techniques that emphasize the 'whole child' and cater for creative, physical, intellectual, spiritual and emotional needs, have long been linked to the benefits of having early experiences in the natural world. Engaging children with living plants has long been held as a valuable means of supporting their learning through a discovery-based pedagogy (Saunders 2007).

5.2. Relative Linkage in different level of education with the corresponding subjects

Most education programs in the botanic garden have established in agreement with the subjects of formal school based education and the programs requires active involvement of learner so that learners are encouraged to make a direct contact with the bio-physical environment and get practical experience on it. The potential opportunities of botanic gardens would play more targeted role if they are assorted with the level of education and the corresponding complexity of the existing education system of Ethiopia that the first cycle of primary education concentrates on functional literacy while the second cycle focuses on preparation for secondary education. In view of that, the anticipated syllabi linked education programmes would be ranged from simple, easily replicable to moderately complex programmes carried out on a large scale. Shava (2003) noted that, environmental education includes the varied learning processes that provide opportunities for people to learn knowledge, skills, and attitudes that enable them to act out within their community in an environmentally responsible way.

General education embraces multiple-subject matters and broader key audiences running with opportunities of wider period of time in delivering botanic garden based education. According to the new structure of Ethiopian education system, primary education lasts for eight years (age group 6-14) and is divided into two cycles: basic education (Grades 1-4) and general education (Grades 5-8). Grades 7 and 8 have become the two upper classes of the second cycle of primary education. Subject matters of primary education includes: Languages (mother tongue, Amharic), English, Mathematics, Environmental science, Natural science (Physics, Chemistry and Biology in grades 7 and 8), Social science (grades 5 to 8) and Aesthetic education. Secondary education is divided into two cycles: the first (Grades 9 and 10) or general secondary education, and the second cycle (Grades 11 and 12) or preparatory secondary education. The second cycle prepares students to continue their studies at the higher education level or select their profession. The secondary school second cycle (grades 11 and 12) continues the Natural science and Social science streams. Secondary school (grades 9 to 10) continues subjects taken in primary school: English and a national language, Mathematics, Natural Sciences (Physics, Chemistry and Biology), Social sciences (Civic education, Geography and History) and Physical education. Common subjects are English, Mathematics, Economics and Physical education while electives are a national language and foreign language (other than English) and a science course for the Social science stream.

Provision of interconnected multi-leveled and multi-disciplinary botanic garden based education to students on the beauty, qualities, uses of plants and their key position within the ecosystem will support in orienting the students positive manner. Beyond that, such delivery will have positive impact to the large public in addressing environmental and sustainable development issue. Among the goal of environmental education, Stapp *et al.* (1969) described that the development of knowledge and understanding of the biophysical environment and interactions of all its components, and awareness and concern for the environmental quality as well as the

development of responsible behavior matter. O'Sullivan (1999) suggested that a radical shift in education is necessary if we are to create change agents who can put an end to the current ecological crisis.

According to GBG (2010), education in GBG would focus on a wider, ecological understanding of plants and their relationship with the natural and human environment, as well as on the sustainable use of plants in various domains of everyday life and economy, such as in households and gardens, agriculture and medicine. Environmental education should happen by means of a good pedagogical display of plants as well as practical experience. By means of workshops and training courses knowledge needs to be transmitted and exchanged between scientists, gardeners, farmers, people who practice traditional plant medicine, teachers, students, parents and children, from Ethiopia and abroad. Thus, GBG would be an instrument of education on all levels from primary schools until universities and adult training.

Jocelyn and Ceri (2010) also labeled that there are seven key areas where they found botanic gardens - at different levels of motivation and sophistication - were concerned with being more socially relevant. These are: Broadening audiences (audience development), enhancing relevance to communities (meeting the needs of communities) education, research which has socio-economic impact locally and globally, contributing to public (and political) debates on the environment, modelling sustainable behavior, actively changing attitudes and behavior. General education is the foundation of acquiring basic elements of knowledge, skill and attitude. Therefore, linking each levels of general education and their corresponding subject matters with the botanic gardens will play a considerable role in optimistic social transformation. And so, appropriate design of educational program with proper consideration of pre-established relative linkage of each level of education with the corresponding subjects will dynamically support the existing general education delivery, impact on student achievements in traditional subjects, and promote change in society.

5.3. Linkage of Major Natural and Man-made Potential Resources of GBG with the Contents of General Education Syllabi

Botanic gardens have a long tradition and history in the field of education and are well established as providers of education; formal and informal, from nursery-age children through University students to adult and well placed to educate the public on conservation issues and the human role in environmental change (Jocelyn and Ceri, 2010). They are also well recognized contributors in producing a citizenry that is knowledgeable concerning the biophysical environment and its associated problems, aware of how to help solve these problems, and motivated to work toward their solution. This is supported by the potential resource analysis of GBG and results of the relative linkage. Accordingly, 81% of potential resources of GBG were found suitable for educational purpose which could help design and offer various types of multi-sensory, action oriented and hands-on comprehensive learning programmes. It is now being realized that botanic gardens are excellent and appropriate centres for delivering issues related to environmental. Heywood (1985) observed that today, in accepting a major conservation role, it is the botanic gardens with rich flora that have a clearly defined role to play.

However, a reasonable portion the garden will be dedicated to scientific research only (no public access). A series of experimental lots is incorporated in this garden; they are cultivated and exploited for research and sustainable development (GBG, 2010). The specified limitation of some elements of the garden to public access would in return affect in exploiting and prompting its comprehensive potential resources for educational purposes. This implies that, GBG offers many learning opportunities for schools, students and people at all stages of education, from curriculum visits for school pupils to specialist training courses for professionals with a reasonable limitations. The supplemented BGCI (2000:1) which described, in a time of increasing concern about the impact of human activity upon the environment, botanic gardens are potentially well placed to inform and encourage action against the loss of the world's plants species, and the impact that this will have upon the people and animals which rely on them.

6. Conclusion

Education in botanic gardens is a new theme in Ethiopia. Botanic gardens are valuable and effective instrument in supporting the general education and at the same time play vital role in raising awareness on the environmental issues, promoting the role of plant for sustainable development, as well as contribute for shaping people's outlook and keeping the alert in national and international agenda for plant conservation. Botanical gardens should tangibly react to the key need of the public, while at the same time satisfying the public need for other services. The potentially valuable resources of botanic garden and their observable linkage with existing educational content, and the analogous damaging impact of human activity on the environment requires systematic analysis and delivery of versatile solution. Botanical gardens provide an excellent medium in linking the natural environment and the general public at all level through engaging them in many different ways. Incidentally, systematic linkage of the formal education with botanic garden would have a multidirectional support for exerting effort in quality education and at the same time increasing awareness and concern about the

human impact upon the environment. Botanical gardens would fairly respond to the needs of the general public. Development of systematized and outcome based environment oriented bioscience education programme can help the student and the general public at all level to mount greater environmental awareness and make themselves familiar with the issue of plant conservation and sustainability. Therefore, considerable further research effort is needed, development of the best linked and suited environmental education programmes in a way that the designed program is principally linked to the identified demand and address all issues of the targeted group of people. Recognizing botanic gardens as a player of public-facing role and making use of their most valuable infrastructure provided through systematically linking their potential role with the identified need would further contribute in the achievement of sustainability goals. Decision-makers need to recognize the multifunctional role of botanic gardens and should act accordingly.

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Appendices

Appendix 1: Identified potential of GBG and its relative suitability to the contents of general education

Major Natural and Man-made Potential Resources	Relative Suitability Scale of Units (No. of Units)						Relative Suitability Scale of Sub-Units (No. of sub-units)						% of Unit category matched with the existing potential of GBG	% of Sub-Unit category matched with the existing potential of GBG	Remark
	Total Units Evaluated	Directly Suitable	Highly suitable	Moderately suitable	Marginally suitable	Unsuitable	Total Sub-Units Evaluated	Directly Suitable	Highly suitable	Moderately suitable	Marginally suitable	Unsuitable			
Research, technical and recreational buildings and all the facilities and infrastructure associated	714	4	3	4	5	698	2647	11	11	13	17	2595	2.24	1.96	
Stimulatory agro-ecological reconstitution areas of the Cultivated Garden	714	5	3	4	5	697	2647	16	9	15	22	2585	2.38	2.34	
Botanic Nursery, Plant Collection, and Research and Thematic Garden Development	714	2	4	3	4	701	2647	10	12	8	11	2606	1.82	1.55	
Natural and artificial vegetation and landscape	714	5	4	6	9	690	2647	17	18	15	20	2577	3.36	2.64	
Watercourses, Dam and Irrigation	714	2	3	3	7	699	2647	5	7	9	14	2612	2.10	1.32	
Suspension Bridge and Bird Aviary	714	1	2	3	5	703	2647	3	4	5	7	2628	1.54	0.72	
Cultural /Traditional Houses	714	1	1	1	2	709	2647	4	3	2	6	2632	0.70	0.57	
Natural panoramic view points and visitors watching towers	714	2	2	3	4	703	2647	6	3	5	7	2626	1.54	0.79	
City Interface	714	0	1	3	4	706	2647	0	2	5	11	2629	1.12	0.68	
Glasshouses	714	2	3	3	2	704	2647	6	6	8	11	2616	1.40	1.17	
Other Bio-physical and infrastructural potential	714	2	4	4	5	699	2647	8	13	14	16	2596	2.10	1.93	
Total	714	26	30	37	52	569	2647	86	88	99	142	2232	20.31	15.68	
Total (%)	100	3.64	4.20	5.18	7.28	79.69	100.00	3.25	3.32	3.74	5.36	84.32	20.31	15.68	

Appendix 2: Relative linkage of primary basic education (first cycle) contents with the potential of GBG.

Subject	Units						Sub-Units						% of Unit Category linked with the existing potential of GBG	% of Sub-Unit Category linked with the existing potential of GBG
	Total	Strongly related	General related	Partly related	Less related	Unrelated	**Total**	Strongly related	General related	Partly related	Less related	Unrelated		
English	**53**	0	0	1	8	44	**159**	0	0	3	17	139	16.98	12.58
Mathematics	**43**	0	0	0	2	41	**124**	0	0	0	5	119	4.65	4.03
Environmental Science	**16**	4	1	0	1	10	**55**	9	6	2	1	37	37.50	32.73
Art and Physical Education	**16**	4	0	0	2	10	**46**	7	0	0	6	33	37.50	28.26
Total	**128**	8	1	1	13	105	**384**	16	6	5	29	328	17.97	14.58
Total (%)	**100**	6.3	0.8	0.8	10.2	82.0	**100.0**	4.2	1.6	1.3	7.6	85.4	17.97	14.58

Appendix 3: Relative linkage of primary general education (second cycle) contents with the potential of GBG.

Subject	Units						Sub-Units						% of Unit Category linked with the existing potential of GBG	% of Sub-Unit Category linked with the existing potential of GBG	Remark
	Total	Strongly related	General related	Partly related	Less related	Unrelated	**Total**	Strongly related	General related	Partly related	Less related	Unrelated			
Chemistry	**10**	1	0	0	0	9	**47**	4	0	0	1	42	10.00	10.64	Grade 7 & 8
English	**51**	1	1	3	5	41	**153**	3	2	4	7	137	19.61	10.46	
Mathematics	**23**	0	0	0	0	23	**68**	0	0	0	0	68	0.00	0.00	
Physics	**13**	0	0	0	4	9	**88**	0	0	0	11	77	30.77	12.50	Grade 7 & 8
Social Studies	**16**	4	0	0	5	7	**59**	12	0	8	3	36	56.25	38.98	
Art	**30**	0	0	7	5	18	**75**	0	0	10	7	58	40.00	22.67	
Biology	**12**	4	0	2	1	5	**33**	14	0	9	1	4	58.33	87.88	Grade 7 & 8
Civics and Ethical Ed.	**44**	0	0	0	5	39	**194**	0	8	17	28	141	11.36	27.32	
Integrated Science	**12**	3	0	6	0	3	**68**	30	0	16	6	18	75.00	73.53	Grade 5 & 6
Music	**27**	0	0	2	0	25	**87**	4	0	4	2	77	7.41	11.49	
Physical Education	**23**	0	0	0	4	19	**69**	0	0	0	7	62	17.39	10.14	
Total	**261**	13	1	20	29	198	**941**	67	10	68	73	720	24.14	23.49	
Total (%)	**100**	4.98	0.38	7.66	11.11	75.86	**100.00**	7.12	1.06	7.23	7.76	76.51	24.14	23.49	

Appendix 4: Relative linkage of Secondary general education (first and second cycle) contents with the potential of GBG.

Subject	Units						Sub-units						% of Unit Category linked with the existing potential of GBG	% of Sub-Unit Category linked with the existing potential of GBG	Remark
	Total	Strongly related	General related	Partly related	Less related	Unrelated	**Total**	Strongly related	General related	Partly related	Less related	Unrelated			
Biology	**21**	4	0	2	5	10	**75**	21	0	7	8	39	52.38	48.00	
Civics	**44**	1	0	0	7	36	**182**	3	0	4	3	172	18.18	5.49	
Chemistry	**21**	0	0	2	3	16	**102**	0	0	6	3	93	23.81	8.82	
Economics	**18**	0	2	2	2	12	**73**	3	0	4	1	65	33.33	10.96	Grade 11 & 12
English	**48**	0	0	4	3	41	**240**	1	0	9	17	213	14.58	11.25	
Gen. Business	**8**	0	0	0	1	7	**51**	0	0	0	1	50	12.50	1.96	Grade 11 & 12
Geography	**17**	0	3	5	6	3	**74**	5	6	14	14	35	82.35	52.70	
History	**31**	0	0	0	0	31	**111**	0	0	0	0	111	0.00	0.00	
ICT	**21**	0	0	0	0	21	**60**	0	0	0	0	60	0.00	0.00	
Mathematics	**34**	0	0	0	0	34	**133**	0	0	0	0	133	0.00	0.00	
Physics	**30**	0	0	0	4	26	**125**	0	0	0	6	119	13.33	4.80	
Physical Edu	**20**	0	0	0	4	16	**45**	0	0	0	5	40	20.00	11.11	
Tech. Drawing	**12**	0	0	0	0	12	**51**	0	0	0	0	51	0.00	0.00	Grade 11 & 12
Total	**325**	5	5	15	35	265	**1322**	33	6	44	58	1181	18.46	10.67	
Total (%)	**100**	1.54	1.54	4.62	10.77	81.54	**100.00**	2.50	0.45	3.33	4.39	89.33	18.46	10.67	

Appendix 4: Foundational inclusive educational program of GBG and its description designed on the basis of identified potential and demand to be further tailored to the general education

Program Titles	Program Description	Recommended Target Group
Introduction to GBG	This program aims to provide the trainees with the awareness of reasons for establishment or evolution of the garden, objectives, reasons for site selection, contribution to the overall national development objectives, development progress, services, GBG before and after. This programme topic is recommended for learners or other visitors visiting the garden for the first time. Learners or visitors are introduced to the main areas in the Garden by following a simple map. It includes exploring the diversity of plants in the natural and cultivated garden sections and visit popular sites such as the natural panoramic landscape view, the nursery site, thematic garden, dam, watching tower, ponds, roadside plants, soil water conservation structures, garden design and building facilities. Younger learners are encouraged to use their senses to explore the variety of plants and animals in the garden.	All
GBG and its environment	This program aims to provide the trainees with the skill, awareness and attitude of identification and protection of environment. This programme topic is recommended for learners or other visitors of particular interest. Learners or visitors are familiarized to the biophysical environment with special focus of Natural Resources in GBG. It includes classification of environment; exploring the biotic and abiotic factors surrounding of an organism or population (factors that have an influence in their survival, development and evolution); study a habitat, food relationships.	All
Ecology/Ecosystem	This program aims to provide the trainees with the knowledge, awareness and attitude of interactions (interrelationship and interdependencies) among organisms and their environment, such as the interactions organisms have with each other and with their abiotic environment; construct pyramids of numbers and biomass from measurements made in the field; measure environmental variables in different habitats found in the garden; hypothesis-testing; sampling; collecting & analysing data. This programme topic is recommended for learners or other visitors of particular interest. Learners or visitors are familiarized to the biophysical environment and find out how plants are constructed and where photosynthesis occurs and conduct vegetation analysis along environmental gradients. It includes the diversity, distribution, amount (biomass), number (population) of organisms, as well as competition between them within and among ecosystems. Concepts such as food chains & webs, succession, symbiosis, pollination and seed dispersal, can be explored in the forested areas found at GBG. Learners also become aware of the effect people are having on our fragile ecosystems; study a habitat, food relationships. Looks at the place of birds in the ecosystems of the pond. Ecosystem processes, such as primary production, pedogenesis, nutrient cycling, and various niche construction activities, regulate the flux of energy and matter through an environment.	Selectively applied for learners at all level
Plant and people	This program aims to provide the trainees with the	Selectively

Program Titles	Program Description	Recommended Target Group
	knowledge, awareness and attitude of different ways of interaction and dependence of people on plant. This programme topic is recommended for learners or other visitors of particular interest. Learners or visitors become familiarize with the human interaction, exploitation and management of plant. It includes the uses of indigenous plants for many everyday products. The medicinal, ecological, aesthetic and economic importance of Ethiopian plants are discussed as well as issues around sustainable use of this valuable resource with modern and indigenous knowledge, with special reference to plants are recognized.	applied for learners at all level
Plant and climatic change	This program aims to provide the trainees with the knowledge, awareness and behaviour of special effects of plant on climatic change and vice versa. This programme topic is recommended for learners or other visitors of particular interest. Learners or visitors become familiarize themselves with the essential role of plants to play in mitigating the effects of climate change and science-based approach to conserving plant life helps to combat climate change and protect our future. It includes examination of the effects of climate change on plants (from individual plant responses to entire ecosystem changes); description of impact of climate change on plants will affect the animals and humans who depend upon them; explanation of species most at risk of extinction; appropriate actions needed to ensure a future for the world's plants.	Selectively applied for learners at all level
Habitats and Adaptations	This program aims to provide the trainees with the knowledge, awareness and behaviour of the need and mechanisms of adaptation to the changing environment. This programme topic is recommended for learners or other visitors of particular interest. Learners or visitors become familiarize themselves with the Adaptations develop over time and generations as a response to the ever changing environment. It includes how plants allow an organism to reduce competition for space and nutrients, reduce predation and increase reproduction; several factors that can limit these adaptations: availability of water, light, predation and temperature.	Selectively applied for learners at all level
Biomes	This program aims to provide the trainees with the knowledge and awareness of Geographic and environmental conditions. This programme topic is recommended for learners or other visitors of particular interest. Learners or visitors appreciate Forest and grassland biomes, as found in GBG. Different types of plants and animals found in different biomes. The value of each biome is discussed and learners consider the pressures and threats to each biome. It includes the world's major communities; classification according to the predominant vegetation and characterization by adaptations of organisms to that particular environment; Understand the plants, animals and climate that characterize each biome of the world.	Selectively applied for learners at all level
Plant Classification/ Taxonomy	This program aims to provide the trainees with the knowledge, awareness and behaviour of classification of plants according to certain characteristics. This programme topic is recommended for learners or other visitors of particular interest. Learners or visitors become familiarize	Selectively applied for learners at all level

Program Titles	Program Description	Recommended Target Group
	themselves with the purpose of classification; simple classification of plants; classification according to their habitat and stem type; classification based on whether they have flowers and seeds or not; and classification based on means of reproduction. It includes general description of plants, classification process, types of plants, and method of naming (vernacular, common, botanical name), plant body parts and their function.	
Plant Reproduction	This program aims to provide the trainees with the knowledge, awareness and behaviour of plant reproductive system. This programme topic is recommended for learners or other visitors of particular interest. Learners or visitors become familiarize themselves with both of the systems, sexual and asexual plants reproduction. It includes general features of reproduction, methods of reproduction, structure and usage of asexual reproduction, sexual morphology. It also include the study of evolution of plants over time; the differences in reproduction between the mosses, ferns, gymnosperms and angiosperms; examination of the difference between monocotyledonous and dicotyledonous plants, and their reproductive structures; investigation of agents of pollination; as well as the importance of seeds. The place of plants in the ecosystem is also analysed, together with the threats faced by ecosystems.	Selectively applied for learners at all level
Sustainable Tourism and Botanic Gardens	This program aims to provide the trainees with the knowledge, awareness and behaviour of plant based sustainable tourism systems and GBG as a tourist destination. This programme topic is recommended for learners or other visitors of particular interest. Learners or visitors become familiarize themselves with variety of issues related to plant based eco-tourism. It includes developing pro-conservation awareness, interests and motives; promotion of gardening and garden design; promotion of native plant species; variety of issues related to horticulture, sustainability and biodiversity; encourage the public to support conservation and protection efforts; generators of change towards a more sustainable lifestyle to relax and enjoy nature and its tranquilities; understand the use of '*green*' ecologically sensitive *design*, construction and maintenance; developing a marketing tool for the garden.	Selectively applied for learners at all level
Natural Resources in GBG and its Conservation	This program aims to provide the trainees with the knowledge, awareness and attitude of Natural resources derived from the environment and their conservation. This programme topic is recommended for school groups. It includes classification (Biotic resources and Abiotic resources/ Renewable and non-renewable resources); exploitation/extraction; depletion; protection; management of natural resources. The program further aims to learn about the ecology of terrestrial and aquatic ecosystems, and how these systems can be managed to conserve biodiversity and protect ecosystem functions while providing sustainable benefits to society.	Selectively applied for learners at all level
Biodiversity and its Conservation	This program aims to provide the trainees with the knowledge, awareness and behaviour of plant species diversity and primary contributions of GBG to their conservation. This programme topic is recommended for	Selectively applied for learners at all level

Program Titles	Program Description	Recommended Target Group
	learners or other visitors of particular interest. Learners or visitors become familiarize themselves with the concept of biodiversity; the great variety and endemism of plants variety of issues related to plant based eco-tourism. It includes General Measures for Conservation; In situ Conservation; Ex situ Conservation; Sustainable Use of the Components of Biological Diversity; Contribution to species recovery activities; biodiversity for ecosystem services. It also considers how different plants came into being in response to changes in environmental conditions on Earth and how they are adapted to the conditions in which they live. The effects of Climate Change on biodiversity are also considered in with special focuses of Global Warming lesson.	
Botanical Arts, Crafts and Photography	This program aims to provide the trainees with the knowledge, awareness and behaviour of engaging senses, discovering hidden talents, and exploring a more personal relationship with plants and the environment in GBG. This programme topic is recommended for learners or other visitors of particular interest. Learners or visitors become familiarize themselves with drawing, painting, and colour theory that will help you develop technical skills and further understanding of art and the creative process. It includes learning from nature; collection and making of natural sculptures; enjoying the Garden as studio; explore talents in arranging flower; watercolour, wreath-making; photography, painting, sketching, drawing, garden art, holiday crafts, calligraphy, and jewellery making.	All
Sustainable Gardening and Landscape Design	This program aims to provide the trainees with the knowledge, awareness and behaviour of planning, designing and establishing eco-friendly appropriate plant nursery; and sustainable gardening. This programme topic is recommended for learners or other visitors of particular interest. Learners or visitors become familiarize themselves with variety of issues related to sustainable landscapes; garden types; garden features; horticultural techniques; sustainable landscape/garden design; sustainable site selection; organic gardening and the use of native plants for gardening. It also includes sustainable nursery establishment and management; appropriate site selection; using appropriate plants; managing soils; managing waste; proper use of water; protect, restore and enhance the ability of landscapes to provide ecosystem services that benefit humans and other organisms; understand the use of '*green*' ecologically sensitive *design*, construction and maintenance; variety of innovative methods to apply and promote sustainable design	Selectively applied for learners at all level
Environmentally Sound Green Technologies	This program aims to provide the trainees with the knowledge, awareness and behaviour of exploring and using green technologies; environmentally-friendly technology and design; and concepts in environmental friendly materials geared to engage students in inquiry learning in GBG. This programme topic is recommended for learners or other visitors of particular interest. Learners or visitors become familiarize themselves with integrating issues such as resource use, alternative energies, green roofs, water	All

Program Titles	Program Description	Recommended Target Group
	conservation and more that have strong technology and engineering connections. Discover technologies that make a place more environmental friendly. It includes understand the use of '*green*' ecologically sensitive *design*; environmentally friendly building materials and native plant landscaping; environmentally friendly construction and maintenance; variety of innovative methods to apply and promote sustainable design; the impact waste on environment and its management; recycling of recyclable materials; energy efficient technologies and building systems; water saving technologies.	
Outdoor Nature Walks and Navigation of GBG with Map	This program aims to provide the trainees with the knowledge and awareness of self-exploration and appreciation of the garden through self-guided tour. This programme topic is recommended for learners or other visitors of particular interest. Learners or visitors appreciate the garden using map. It includes the learners or visitors of GBG to experience exploring interesting plants; interpret informative signs; use of Symbolism. It also requires the learners or visitors to experience **map reading (identifying location/position,** features**, direction, relief and etc. on a maps).**	All
Outreach and Community Mobilization for Nature	This program aims to provide the trainees with the knowledge, awareness and attitude of developing communal gardening, provision of gardening services and ensuring active involvement of the community. This programme topic is recommended for learners or other visitors of particular interest. The program further aims to promote communal gardening in social housing communities, and on nearby locations, making significant contribution to improved social cohesion, crime reduction and public health in both urban and regional areas.	Selectively applied for learners at all level
The Schoolyard gardening	This program aims to provide the trainees with the knowledge, awareness and attitude of development of sustainable hands-on school and home greening/gardening. This programme topic is recommended for school groups. The program further aims to promote school and home yard restoration, greening and gardening.	All

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