Promoting proper education for sustainability: An exploratory study of ICT enhanced Problem Based Learning in a developing country

Amit Roy
University of Eastern Finland, Finland

Patrick Kihoza
Mzumbe University, Tanzania

Jarkko Suhonen
University of Eastern Finland, Finland

Mikko Vesisenaho
University of Jyväskylä, Finland

Markku Tukiaianen
University of Eastern Finland, Finland

ABSTRACT

One of the goals of education is to create responsible citizens who can adequately understand the problems faced by their societies and who can then act to help solve them. Such behaviour can be fostered through proper education that facilitates expert knowledge about social issues, nurtures the ability to think critically and learns the skills needed to pro-actively search for possible solutions. Through this study we aimed to develop an Information and Communication Technologies (ICT) supported pedagogical framework, *Children as Agents of Social Change* (CASC), as a possible vehicle to facilitate appropriate education about social issues. This article analyses the first implementation of the CASC framework carried out at schools in Tanzania. Forest fires in Tanzania are often caused by human activity and education about this pressing problem needs to be provisioned on a large scale. However, due to a lack of teachers and teacher expertise, this is not the reality. With help of the local community, we created a locally contextualised video supported by a Problem Based Learning (PBL) solution to connect local forest experts with school students. These students then creatively conducted PBL activities in order to help solve local environmental and conservation problems. Data was collected through pre- and post-tests of control-experimental groups and teacher interviews. Results suggest that the participants were enlightened as to a variety of active problem solving possibilities and that they ranked the CASC methodology as an effective approach to sustainability.

Keywords: *ICT for development, ICT supported pedagogical model, social issues, social awareness, Problem based learning, CASC*

1. INTRODUCTION

The key purpose of education is to prepare young people to meet the various challenges of life. The role of education as a vehicle for social transformation has been endorsed by philosophers such as Jiddu Krishnamurti and John Dewey. Psychologists, e.g. Gardner, refer to school as "the institution designed to change minds" (Dewey 1997; Krishnamurti 2002; Gardner 2006). Proper

education, which fosters understanding about one's society and its problems, can encourage personal transformation which, in-turn, can contribute towards a balanced and healthy social structure.

When education fails to provide opportunities for learners to connect abstract knowledge with their actual world; it only promotes inert learning. Learning which is aimed only at achieving academic results promotes narrow and individualistic activities and corresponding world views among the students. Without enabling personal transformation [through education], social reformations are susceptible to corruption (McWhittney & Markos 2003). Educational anthropologist, Ruth Benedict, argued that education is transformative as it can begin to resolve cultural issues by surveying "*the major wastages in our culture*" (Nash 1974).

School is an important cultural construct and therefore it is only sensible to promote proper education about social issues through schools (Schooling the world 2010). Mannheim strongly advocated that schools should cease to concentrate on "purely scholastic traditions" and that they should rather aim to "embody and impart humanisation qualities" among young people as schools are "uniquely qualified" to prepare pupils for life (Lawton 1975). Providing proper education regarding social issues at school level can help to make future citizens more responsible.

The United Nations Educational, Scientific and Cultural Organisation (UNESCO) holds forth that learning about issues of social importance is an important educational objective (UNESCO 2007; UN DESA 2005). School level initiatives such as *Design for Change* (DfC), which started out as a local initiative but has grown to global proportions within a few years with several thousand schools participating in its competitions (Design for Change 2012), bears evidence to the fact that school children feel connected to those problems that originate in their local contexts. Social problems can be used to create an opportunity for students to take responsibility for their transformation and to create a social change, even if it is a small one.

Proper education about social issues facilitates expert knowledge about social issues, nurtures the ability to think critically and supports learners in the development of skills needed to find solutions. Despite strong theoretical support, proper education about social issues does not readily take place in schools, especially not in developing countries. Educational administrators' inability to provide such proper education meaningfully is founded on two pragmatic problems: (1.) The severe lack of available teachers in developing countries (Olson et al. 2011; Tooley 2009) and (2.) most teachers are engrossed with meeting academic goals and they often lack the time, interest, support, capability or hands-on experience to facilitate the handling of actual issues of social importance (Tooley 2009).

When faced with their own limitations, humans often try to solve their problems through techniques and technology. Modern technologies e.g. *Information and Communication Technologies* (ICT) are often seen as a promising solution to overcome deficiencies in educational systems (Kozma 2005). However, ICT projects have continued to underperform in developing countries (Day & Greenwood, 2009). ICTs are not even explored as a viable option by many because of the high costs combined with unsure returns on investment. Many ICT based solutions have been noted to contain linguistic codes, cultural assumptions, social images and Western/European notions that underpin the choice of what constitutes desirable knowledge (Selinger 2009; Cox 2012). These underpins are untrue foundations, leading to ineffective solutions. Oliver argues that adopting a *social account of technology* would lead to better-integrated solutions, for instance, in the field of educational technology (Oliver 2012).

Our study is exploratory in nature and aims to create a pedagogical framework named *Children as Agents of Social Change* (CASC). CASC combines ICTs with a problem-based learning approach in order to promote awareness, critical thinking and skills to deal with the issue among

middle and high school children (Roy et al. 2013). Through CASC, our aim is to provide learner-centric, culturally sensitive, locally contextualised and cost effective interventions. CASC is based on the principles of the CASC Framework (pedagogical aspect) and CASC Media Artifact guidelines (ICT aspect) which were formulated by the first author while working in India with school children for a period of nearly two years. These guidelines were further refined through numerous discussions with several teachers as well as students in various schools in India. Discussions in Finland with various educational as well as technology experts have also contributed towards the enhancement and fine tuning of this model. The core principles of CASC and their implementation guidelines were finalised by the first author and this particular study was lead by the second author, who is a native of Tanzania (TZ).

In the current study, we analyse the first CASC implementation conducted in Tanzania for which we designed a video supported PBL intervention for environment conservation education. The video-based CASC media artifact implemented for the experiment aimed to highlight and educate pupils about the dangers of forest fires in Tanzania. The research questions of this study are:

1) Does ICT, combined with contemporary educational practices like problem-based learning, succeed in connecting local working-level experts to provide expert knowledge to middle and high school pupils in developing countries such as TZ?

2) Does ICT, combined with contemporary educational practices like problem-based learning, support the provision of proper education among middle and high school children in developing countries such as TZ?

3) Does this intervention, based on the CASC framework, attain its objectives of being a learner-centric, culturally sensitive, locally contextualized and cost effective educational solution?

In order to answer the above questions, we conducted an experiment in the Morogoro region of Tanzania. We used video to connect local environmental officers to secondary school students who, in turn, absorbed the expert information, discussed the local social problem in groups and carried out projects in order to find a solution to the identified social problem.

Section 2 discusses the CASC Framework in two parts: principles of the framework and guidelines for the development of the CASC media artifact. Section 3 imparts details related to Research Design and Methodology. Section 4 discusses CASC implementation in Tanzania and in Section 5 we examine the results of the intervention. Section 6 closes with a discussion, concluding remarks and acknowledgements.

2. CHILDREN AS AGENTS OF SOCIAL CHANGE - CASC FRAMEWORK

2.1 Principles of the pedagogical CASC Framework

2.1.1. Acknowledging and focusing on an authentic social issue

Social problems exist as a background to any educational domain. Proper learning about the social problems in one's society is vital to the overall advancement of the society. The success attained with social issues education (such as the Design for Change initiative) has proved that children do indeed connect to authentic social issues and try their best to effect change (DfC 2012). Education relating to such topics is vitally important as it helps to prepare students for real life where they do come into contact with these issues as well as the social and behavioural patterns that create and/or maintain these problems. Often school curriculums are so focused on

academic skills that they tend to ignore social issues, the very critical area in which pupils need guidance. This important gap can be bridged.

2.1.2. Using technology through CASC media artifact

In CASC, technology is used to overcome limitations such as the inadequate expertise of teachers when faced with addressing social problems. CASC uses ICTs to engage local working-level experts in the problem-domain by connecting them to schools and enabling them to discuss key issues involved in the understanding of the social problem. These experts know the problem area/s well; however, most often than not, they are not connected to the schools.

2.1.3. Use of contemporary constructivist pedagogy to enhance learning

Pedagogical practices based on constructivist contemporary pedagogy such as *Problem based learning* (PBL) have been found effective in engaging students in the learning process. PBL is an effective instructional method in conveying a variety of content areas in schools in urban, suburban and rural communities. In PBL the students solve a real-life problem, typically in groups of 3-4 students. It is effective among elementary, middle and high school student populations as well as low-income student groups (Hung et al. 2008). In the PBL approach, learners acquire the problem solving skills as well as the content and contextual knowledge that revolves around the problem (Hung 2006). PBL can equip students with skills in critical thinking, collaboration, communication and problem solving (Chung & Chow 2004; Hung et al. 2008). In CASC, students are asked to find their own solutions to solve a relevant social problem via projects conducted in groups.

2.1.4. Asking learners to share their solution

CASC asks students to present their work to their peers and this strategy urges the learners to carefully revise so that they improve their own learning efforts. When students prepare their lessons, as teachers, they have to familiarise themselves with their presentation topic in detail so that they will be able to answer questions and allay the doubts of their fellow students. This re-learning for teaching leads to a better understanding of some topical aspects and hence, the social issue.

2.2 CASC media artifact guidelines

An important component of the CASC framework is the *CASC Media artifact*, which is supported by meaningful pedagogical practices. Here we describe the core design principles and guidelines of the CASC media artifact.

2.2.1. Locally contextualized video-based media

The term 'educational video', in this study, is defined to include all media with moving pictures and sound used for educational purposes. Videos have been used in classrooms since the early days of filmstrips. The current trend is the prolific use of digital video to support student learning in various subjects (Mitra et al. 2010; Fill & Ottevill 2006). According to Choi and Johnson, video is a suitable educational media solution to support the learning of complex skills because it can expose learners to problems and events that cannot be easily demonstrated and understood verbally (Choi and Johnson 2007). Video can be used to gain students' attention, create anticipation among students and increase memorized content, among other potential outcomes (Fill & Ottewill 2006).

Situated cognition is a broad framework that "emphasises the importance of focusing on everyday cognition [and] authentic tasks" and *anchored instruction* is an instructional approach to implement situated cognition. "When people learn new information in the context of meaningful activities, they are more likely to perceive the new information as a tool rather than as an arbitrary set of procedures or facts" (CTGV 1990). The *anchored instruction* methodology (used by CTGV) uses a fictitious story to anchor the instructions. We posit that when the children see visuals from their everyday reality in particular contextual perspectives, they can understand such perspectives much better and sometimes they can also validate the authenticity of the issue from personal experiences.

2.2.2. Use of local human resources and knowledge

Easterly has suggested that the working-level experts in specific problem domains are a good resource as they understand social issues at a localized and in depth level (Easterly 2006). Many times these experts, who work hands-on within communities to resolve the social issues, have valuable knowledge about how to effectively deal with these social issues; but this knowledge may not be the common knowledge of the community.

Quality education must be meaningful to the learner. Vygotsky stressed that the concept of *community* plays a central role in the process of "making meaning". He also discussed the concept of *More Knowledgeable Others in Education* (Vygotsky 1978). While teachers may lack deeper knowledge about a relevant social issue, within the community there are experts who may be well-versed in the problem domain. CASC proposes the use of ICT based CASC media artifacts to connect this expert knowledge to the community via schools.

2.2.3. Use of local language

UNESCO has noticed in its study on languages that people afford special importance to their own language and that using the native language of participants fosters true participant inclusion which in turn achieves lasting results (UNESCO 2012). Studies have reinforced that children understand a problem more readily when the issue is discussed in their native language (Malone 2008; SEAMEO 2009; SEAMEO 2010). Several ICT based solutions make unrealistic assumptions about the learners' cognitive abilities to understand a non-native language. CASC emphasises the use of native language for instruction.

2.2.4. Cultural sensitivity

Vyogotsky advocated that culture affects individual development and that learning culture is the prime determinant in an individual's development (Vyogotsky 1978). ICT based educational technology solutions, in which content and method fails to authentically connect to the real cultural and social contexts of the learner, can raise the learner's *cognitive load* and limit the learning ability. To limit the cognitive load, learning materials should be designed and presented with content that the learners can easily relate to (Mayer 2001; Vesisenaho & Sutinen 2010).

2.2.5. World view sensitivity

World view is the fundamental cognitive orientation of an individual or society encompassing the entirety of the individual or society's knowledge and point-of-view, including natural philosophy; fundamental, existential and normative postulates; or themes, values, emotions and ethics (Palmer 1996). An attempt to understand the world view of the learners is an essential step towards designing effective solutions.

2.2.6. ICT infrastructure sensitivity

ICT infrastructures in different schools within the same urban or rural regions can vary greatly and a one size fits all approach is not viable. Depending on the ICT infra-structure available at the schools, various combinations of ICT devices can be used to connect the experts to the school students. Thus, the design needs to take into consideration the available technological facilities and resources.

3. METHOD

3.1 Research design

CASC's approach, along with its technical artifacts, slots into the domain of Design research's close cousin, Development Research (DR), also called research with a developmental goal. In design research, the focus is on extending the boundaries of human and organisational capabilities by creating new and innovative artifacts (Hevner et al. 2004, Peffers et al. 2007). According to Reeves, the DR process is based on iterative analysis, design, development, implementation and formative evaluation phases (Reeves 2000). Critical reflection leads to the refinement of problems, solutions and research methods during a DR process. This entails searching for practical and innovative solutions to real-world problems while also developing generic design principles. Innovative ICT artifacts and products are created and investigated to determine how and why they work (de Villiers 2005b). Development research is problem-oriented, constantly searching for new and innovative solutions, while also seeking findings that are transferable, practical and socially responsible (de Villiers 2005a).

As mentioned earlier, many ICT based solutions harbour euro-centric notions regarding knowledge, language, culture, social reality and world views which render them useless to the developing world (Selinger 2009; Cox 2012). Through this implementation of CASC based intervention, we have tried to derive certain generic principles in designing ICT based educational solutions meant to bolster social issue awareness whilst bridging the gaps that render such solutions inefficient.

3.2 Research methodology

This study took place in the Morogoro region, along the slopes of the Uluguru Mountains, in Tanzania. In this study we first designed a video supported PBL intervention for environment conservation education, specifically targeting the issue of forest fires in Tanzania. We created a video using CASC Media Artifact Guidelines discussed in Section 2.2. A description of the media creation process is provided in Section 4.3.

Two villages and four secondary schools were selected for this study: two schools each for the control and experimental groups. Morogoro and Kingo Secondary schools (comprising of 97 participants) were used as a **control group,** while Kayenzi and Kauzeni Secondary schools (comprising of 79 participants) were used as an **experimental group.** All four schools are public schools. Tables 1 and 2 describe the distribution of the population in terms of age and gender.

Table 1: Sample population based on age group

	Age (10-16)	Age (16-21)	Total
Experimental Group	18	61	79
Control Group	44	53	97
Total	62	114	176

Table 2: Sample population based on Gender-distribution

	Male	Female
Experimental Group	40	39
Control Group	44	53
Total	84	92

The two groups were similar in several ways e.g. the medium of education in all four schools was English while the students' native language was Swahili. The two control group schools were situated about 1-5 km away from the city centre whilst the two experimental group schools were located 5-8 km from the city centre. The average age of participants in each school was about 16 years old. Study material and books were not readily available in any of the schools and most students shared books in groups e.g. 1 book to be shared amongst 4 students. There was also a general lack of books for self-study, even in the libraries. One school in each group (Kayenzi Secondary School and Morogoro Secondary School) had a sufficient number of teachers while the other two schools were understaffed. Only the students belonging to the experimental groups were exposed to intervention that consisted of watching videos, group discussion, PBL and solution presentations by the groups. Students in both groups were asked to complete pre- and post-test questionnaires. These questionnaires, along with the analysis of students' projects and interviews conducted with the teachers from the experimental group schools, have been used as primary data sources. A mixed-method approach has been used to analyse these data sources. More details about data analysis are provided in Section 5, while in Section 4 we explain how the CASC Media artifact was implemented in the study.

4. CASC BASED IMPLEMENTATION IN TANZANIA

4.1 Local social issue: Forest fires in Tanzania

Forest fires are a serious social problem in Tanzania (Philemon 2011). Hunters, farmers, livestock keepers, charcoal makers and timber sawyers are responsible for most of the forest fires in Tanzania (Kilahama, Sawr, & Burgess 2009). Many farming communities use fire as a farm preparation method as it is cheap, simple and sometimes the only option available (Kibuga & Samweli 2010). The Controller Auditor General in TZ has stated that TZ is losing an average of 420,000 hectares of forests annually through uncontrolled fires and rampant tree felling (Philemon, 2011). The effects of the forest fire problem are severe as, apart from the loss of resources, forest fires also result in a major increase in forest fragmentation and the destruction of the landscape (Martínez et al 2009).

It is agreeable that for the sake of all humanity "sustainability needs to become part of people's thinking, their way of life and their value system" (Wals 2010). This requires learning processes

that transcend traditional ways of transferring knowledge. It is essential to involve and arouse the interest of the younger generation if one wishes to find a sustainable solution to the forest fire problems (Doggart 2009). There has been a lack of sufficient educational structures and programmes to address the forest fire problem in local communities (Kilahama et al. 2009).

Such educational programmes do not generally take place in Tanzanian schools where the instruction is still mainly teacher-centric and lecture-based. The general teacher-student ratio is calculated as 1:46 by the government (United Republic of Tanzania 2011) and 1:66 in some regions by an NGO (Oxfam International 2012). The high teacher-student ratio combined with a lack of time, interest, capability, support or hands-on experiences of the teachers are the major obstacles to properly educating students about forest fires.

4.2 Background work

The main reasons for choosing this particular area for our study included the availability of forest reserves, the historical existence of a forest fire regime, the availability of suitable forest fire experts and the proximity of forests to the schools/actual world of the children. Our first step was to meet the village officials after which our four target schools were identified (Kihoza 2011). The head teachers of these schools were consulted and their thoughts and opinions regarding the study were noted. Secondly, we set out to explore the educational traditions and ICT infrastructure in the schools. During the school visits it became apparent that the most common educational approach was text-book based and teacher-centric and that the students had no prior experience of PBL. Thus, before the students in the experimental group started to work with the problem-solving process, they were shown a video explaining the PBL process.

4.3 Process of CASC artifact creation

After the social issue and the forest regions were identified, *local working level experts* were identified with the help of village chairpersons. These experts work as local forest officials and knew the local forests well. These experts share the same *culture and world view* as the targeted learners. Digitally recorded interviews with Forest Experts were conducted in *the local forests*, in *Swahili.* These interviews covered topics such as the causes of forest fires, the role humans play in forest fires as well as possible solutions. These videos were edited to create a short educational documentary about forest fires. In addition to the CASC media based video; two other useful videos were downloaded from the internet and also used for this intervention. The first external video showed an example of a forest fire in another context, while the second video was a short introduction to the project based learning process. Project based learning and problem based learning are very closely-linked approaches as they are both based on constructivist pedagogical principles.

Table 3: Details of the video used for the intervention

Video	Duration	Language in Audio
Video 1: CASC Educational Documentary about Forest Fires	26:59	Swahili
Video 2: Raging Forest Fire in California	4:11	English
Video 3: Project based learning Explained (BIE, 2010)	3:50	English

4.4 Intervention process

An initial survey of the schools revealed that the experimental schools had no ICT infrastructure like projectors and computers. The availability of electricity could not be guaranteed and so equipment and a power-generator adequate to support a laptop, LCD projector and sound systems were transported to the experimental group schools.

The first step in the study was for the students to watch the three videos: a local CASC media artifact, the forest fire video from another context and a video explaining the PBL process. In Figure 1, the students in the experimental group are watching the local CASC artifact video.

Figure 1: Students watching CASC video

After the students had watched the videos, they were divided into self-organised groups of 9-11 students. All groups were balanced based on gender and class level uniformly. Groups discussed the issue and were asked to come up with ideas on how they could work together to address the forest fire problem (as seen in Figure 2). After 30 minutes of discussion, student groups identified eight projects (Table 4) which were to be completed one week hence in addition to their regular studies. The teachers were informed of the project topics so that they could offer support if necessary.

Figure 2: Students discussing the issue of forest fires

Table 4: Details of the eight projects planned by the eight groups

School	Project Title (Size of the group)	Venue	Task Accomplishment Plan
Kauzeni Secondary School	Reducing dependence on forest products as a source of energy in the community (9)	Indoor	Preparation of project report and oral presentation
	Demonstrating the effects of unplanned forest harvesting (10)	Indoor	Preparation of project report and oral presentation
	Planting trees (9)	Indoor and Outdoor	- Planting trees - Preparation of project report and oral presentation (posters)
	Community education on the effects of forest fires and illegal forest harvesting (11)	Indoor and Outdoor	- Visiting nearby community - Preparation of project report and oral presentation
Kayenzi Secondary School	Community awareness on the importance of forests (10)	Indoor and Outdoor	-Visiting nearby community - Preparation of project report and oral presentation
	Side effects of forest fires (11)	Indoor	Preparation of project report and oral presentation
	Protecting planted and natural trees (10)	Indoor	Preparation of project report and oral presentation
	Organized felling and planting of trees (9)	Indoor	Preparation of project report and oral presentation (posters)

After the groups had identified their topic, they were given one week to work on their projects (Kihoza 2011). Up to this point, researchers had been involved with the students but from this point onwards the teachers were provided with a list of project titles and it was suggested that they provide the students with guidance, if and when required. The groups had to complete the projects in addition to their regular classes. The research team did not contact the groups during this week. The groups produced a theoretical document and showed, in practice, that the knowledge regarding environmental conservation had been well understood.

Figure 3: Student presenting and explaining her group's project

Figure 4: Student presenting and explaining his group's project

In the final stage of the PBL process the students were asked to present their projects. The aim was to describe the problem from a chosen viewpoint, summarise their understanding of the problem and discuss their solutions. Some of the presentations were conducted inside the

classroom while others were conducted outside. Each presentation was followed by a question and answer session during which the presenters answered questions about the projects.

Two different sets of post-test questionnaires were administered that included questions in Swahili. The questions concerned with environmental conservation and forest fires were the same for the control and the experimental group. In addition, the experimental group was asked to answer questions related to the effectiveness of the video supported PBL approach. After the post-tests, teachers in the experimental group schools were asked to share their reflections on the whole intervention procedure.

5. RESULTS

Mixed-method data analysis based on pre- and post-test questionnaires from experimental and control groups, analysis of the learners' projects in the experimental group and post-intervention interviews of two experimental group teachers' were used as data sources in the following sections.

5.1 Pre-test questionnaire

The pre-test questionnaire showed that prior knowledge regarding forest fires and environmental education of the experimental and control groups were on a similar level as shown in Figure 5. In addition, their prior knowledge and experiences regarding environmental conservation were on a similar level. Both the groups, for instance, had already studied this topic in different courses in their school. The majority of students in both the groups strongly agreed that issues like environmental conservation are not only the responsibility of government officials or parents, but that they also have a responsibility towards the environment. Based on this data, we can safely conclude that students aspired to change the circumstances around them.
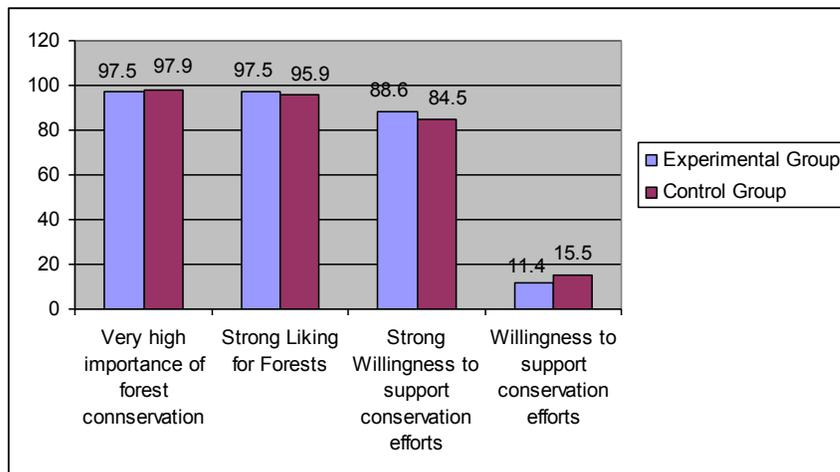

Figure 5: Students' interest in Environmental Conservation

5.2 Post-test questionnaires

In the post-test, the students were asked to identify at least two things which they would like to do in the future to help address the problem of forest fires and their devastating effects. The experimental group expressed interests in more diverse activities compared to the control group. The majority of students in the control group mentioned community education as their prime activity of interest (81.4%) as shown in Figure 6. This shows that the intervention process awakened the participants' interest to many more possibilities.
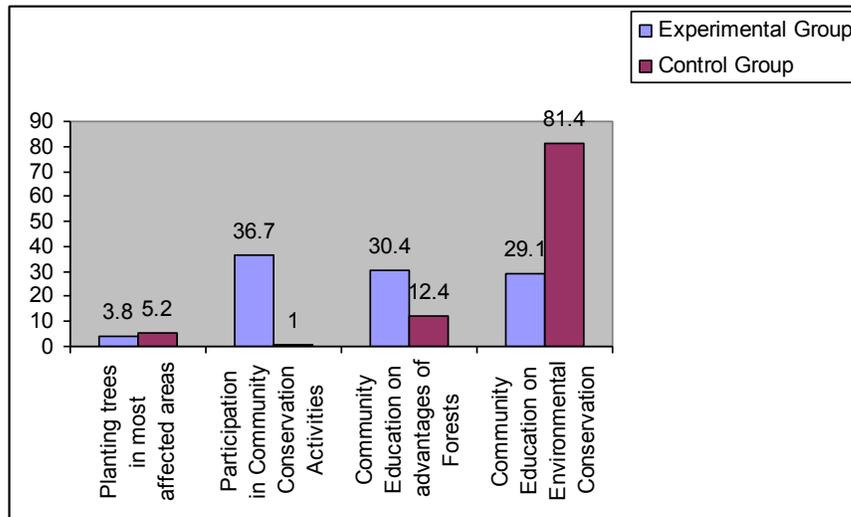
Figure 6: Future interest projections of students

The students in the experimental group were asked to share their opinions regarding the effectiveness of the PBL and video approach (Table 5). Altogether 79 students answered this question, and 88.6% of the respondents agreed that, in their opinion, the video supported PBL approach was an effective way of providing environment conservation education.

Table 5: Effectiveness of the intervention (N=79)

	Agree (%)	Disagree (%)
Kayenzi Secondary School	82.5	17.5
Kauzeni Secondary School	94.8	5.2
Kauzeni and Kayenzi Combined	88.6	11.4

We also asked the experimental group to identify the most important thing which they had learned from the video. Responses to the questionnaire revealed that students in the experimental group (70.5% in total) mostly learned about general forest conservation. Other aspects such as the advantages of forest conservation (10.3%), disadvantages of forest burning (5.1%), both disadvantages of forest burning and advantages of forest conservation (7.7%), planting trees

(1.3%), the use of advanced technology in fighting forest fires (3.8%) and good agricultural practices that support forest conservation (1.3%) were mentioned less frequently.

We also asked the participants to evaluate and then indicate whether they had gained extra knowledge from the videos. A total of 84.8 % of the students agreed that they had gained new and valuable knowledge from the videos as seen in Table 6.

Table 6: *Extra knowledge gained from watching the videos (N=79)*

	Gained extra knowledge (%)	Gained little knowledge (%)	Gained no extra knowledge (%)
Kayenzi Secondary School	90	10	0
Kauzeni Secondary School	79.4	17.9	2.7
Kauzeni and Kayenzi	84.8	13.9	1.3

5.3 Content of the projects

In Table 7 we expand Table 4 by showing the achievements of the eight projects carried out by the experimental group.

Table 7*: Identified results of the projects*

School	Project Title	Achievements made by the group
Kauzeni Secondary School	Reducing dependence on forest products as a source of energy/fuel in the community.	Suggested various low energy consumption cookers and other low cost sources of energy were presented.
	Demonstrating the effects of unplanned forest harvesting.	Recommended and explained the concept of regular tree planting and Community Empowerment.
	Tree-planting.	*Planted 30 trees* during the one week project. They also explained the importance of trees in our lives sufficiently.
	Community education on the effects of forest fires and illegal forest harvesting.	*Cleared a bush to separate a forest area and farm area.* Sufficiently explained the effects of forest fires on living things and its impact on climate change.
Kayenzi Secondary School	Community awareness about the importance of forests.	Spoke to youths who may cause forest fires when they hunt in the forest.
	Side effects of forest fires.	Explained the side effects of forest fires and how to avoid it sufficiently.
	Protecting planted and natural trees.	Presented the idea of making roads to separate the forest and farm areas clearly.
	Organized felling and planting of trees.	Explained the harvesting and planting of trees in an organised way sufficiently. Also explained why we should not harvest natural trees randomly.

The projects identified and focused on the four main areas of *prevention*, *avoidance*, *detection* of the worst affected areas and *aiding* recovery by planting trees. The students identified: *education* though community visits, *discussions* with relevant groups of people and *direct participation* as concrete methods which can be used to help solve the problem of forest fires.

5.4 Teachers' reflections on the experience

The reflections of the teachers in the experimental groups varied greatly. Teachers from the first experimental group commented that:

> *"Through this [CASC implementation's design i.e. use of video, group discussion, project-based-learning and presentation], I have realised that the forestry topic taught in the second year has been well understood within a short time compared to the time we use in classroom. Secondly, school has gained [appreciation for students] by seeing students voluntarily planting trees with no teacher's instructions. I wish we can have projects like this frequently so we can learn and face more challenges for improving our environmental conservation efforts."*

The teacher in the second experimental school stated:

> *"[CASC intervention] has reminded us that students have been missing a big part of education when they learn without study tours and project based activities. We are planning to integrate forest tours so that they can learn and see the effects of forest burning and illegal trees cutting."*

6. DISCUSSION AND LIMITATIONS OF THE STUDY

Sustainably is an important life-skill and lack of expertise among teachers is a chief obstacle in the quest to provide proper education about sustainability. Not all teachers in developing countries like Tanzania are qualified or capable to suitably teach pupils about forest fires. We wanted to see whether technology could be used to overcome these constraints. It is important to note that for this intervention the teachers did not receive any separate or extra training. The visible contrast in Figure 6 clearly illustrates that the intervention successfully introduced the students to new possibilities i.e. they were empowered to connect the subject matter which they had learnt to the real world in which they live.

The content of the intervention was easily understandable for the learners; and by incorporating respect for the learners' choice of projects and their creativity in the design of the intervention, we were successful - to a large extent - in conveying expert knowledge to the learners. Though some groups chose to research the problem, two groups chose pragmatic projects: one team cleared a bush to help separate a forest area from farmland and another team planted 30 trees. Students discussed forest fires with other people who may likely cause them. The intervention empowered students by giving them an opportunity to effect small, yet positive changes, to their immediate milieu.

Forest officials need community support and they were pleased to discover a way in which they could connect with the community at large. Working-level experts had a deeper understanding of the problem of forest fires and, through the CASC media artifact they could augment the lack of teachers' in-depth knowledge about this pressing social issue. Empirical data proves that this intervention was successful in connecting working-level experts to the schools with whom they would have otherwise had no, or limited, contact.

It was clear from the teachers' comments that they also gained valuable new knowledge about aspects of constructive pedagogy because of the CASC intervention. All the student participants ranked the CASC artifact as an effective solution to addressing environmental education. This created a win-win situation for all the stakeholders.

6.1 Limitations of the study

Children often need some support in the form of a teacher/s and a neutrally positive adult presence also exerts a positive influence on them. Influenced by our technological bias, we did not perform any detailed investigation as to the level of the teachers' involvement in the projects completed by the students and teacher's prior familiarity with PBL approach. Although children were free to ask any questions related to the videos, video remains a dynamic media and the pupils had no control over the pace of the video which was a technological limitation in this study. Despite the schools in both groups sharing key characteristics with 'normal' schools across Tanzania, the sample size was limited and the sample was not precisely random.

7. CONCLUSIONS

Vyogotsky advocated the idea that culture is the prime determinant of individual development (Vyogotsky 1978) and from this point of view, educational technology solutions developed by culturally-alien technicians who do not understand the local contexts, world view and culture of the targeted learners may be technically deterministic. Many ICT based educational interventions have been based on Western notions that underpin the choice as to what constitutes desirable knowledge (Selinger 2009).

Hidden behind these surface-level facts are two larger issues. Many developing nations seek or are given assistance in the form of aid to promote better education. Effective aid in education can become an investment in the firm foundation and long-term development of a country. However, aid is often expensive and comes at a high cost. Some of the global educational aid is spent on the development of ICT based educational solutions by foreign experts. These practices may however not be very effective, especially in the domain of social issues. Oxfam has noted that "as much as 70 per cent of aid for education globally is spent on technical assistance, much of it to highly paid Western consultants" (Oxfam 2006). Such aid can put nations in vicious circles of international debt. We wanted to negate the identified incorrect ways of doing such a project. The aim of this implementation of CASC was to ascertain whether such projects could be done at a very local level, by local people and at much smaller costs compared to other ineffective aid-funded projects. In addition, CASC does not wish to dilute the quality of the learning experience.

The second pertinent issue is that technology is being pushed onto the educational domain. Brummelhuis and Kuiper define *technology push* as a learning process "driven by capabilities of technology without any specific need from the perspective of the teacher, the learner or the learning content" (Brummelhuis and Kuiper 2008). We agree with Selinger that "ICT is a powerful tool that, when it is implemented appropriately, can catalyse and accelerate educational reform and development" (Selinger 2009). However, this observation must also be balanced by the fact that *technology push* in developing countries can create serious inequities within the system. It forces educational systems to use their very limited resources to procure and maintain technology whilst ignoring basic priorities like the availability of schools, educational infrastructure and well-researched teacher training programmes. Lack of clarity in a decision maker's mind about what is of primary importance and what is secondary, can be exploited by technology pushers looking to acquire more gains in terms of power and/or resources.

In developing countries, appropriate educational technology solutions using technology along with pedagogy should be preferred; not only for their cost effectiveness but also for the quality learning which they promote. By combining contemporary pedagogical practices like PBL along with ICTs, CASC promotes a deeper learning experience among learners as well as self-reliance within the communities. Its approach encourages social responsibility amongst children by giving them a chance to act as problem-solvers rather than passive bystanders.

Students 'acted' in response to the problem via their projects hence, CASC also advances a participatory world-view. Learner's actions, in form of their group work, upset the rooted dynamics of indifference which are socially patterned into them through enculturation and socialization. This new attitude makes the youth a strong resource for their communities. Due to the technical advantage of scalability, the same CASC media artifacts can be used in multiple schools without any expensive redundant efforts and without disturbing the experts' regular work which may very well be outside the educational domain.

Through this approach, local experts shared their knowledge about an authentic social problem and this knowledge was used in a learner-centric way which makes CASC intervention a meaningful learning experience for students. Based on the evidence, we claim that interventions based on CASC framework principles can create ICT based solutions that are learner-centric, culturally sensitive, locally contextualised and cost effective. Artifacts based on CASC principles can be created by an individual, organisation or community. This framework highly limits the need for huge budgets, for foreign experts or heavy technical expertise.

Use of CASC will not uproot a social problem right away but this approach is useful and important in raising a generation of learners who will have learnt important life-skills to help them resolve social issue and would therefore make a positive contribution towards their respective societies. The CASC framework can be used to make quality education about social issues widely available to larger student populations through educational systems in developing countries. The CASC framework is suitable for agencies like UNESCO that seek to promote understanding about important social issues through their Decade of Education programmes. This approach can be useful to individuals, schools or Non-Governmental Organisations to better prepare youngsters to meet the challenges of life beyond the boundaries of the school walls and hence make education a truly meaningful experience.

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