Technology Education for Sustainable Futures

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Abstract

The article develops the argument that Technology Education has a particular and important role in achieving sustainable futures within different societies. The starting point for this article is an observation of two boys making toys out of materials that would normally be thrown away. Implicitly these activities contribute towards sustainable futures through utilizing waste and using fewer resources. However, how these activities can be transformed into classroom activities, so they would be the part of education for sustainability learning and contribute more to sustainable development, and how they would be different for different contexts are the questions addressed in this paper.

Activity theory, and the model of an activity system, developed by Engestrom (1987) are used to analyse the differences in unstructured and structured activities of the children involved in the creation of toys and the conclusion is made that the differences are related to almost all components of the activity model. Then, the comparison is made between structured activities within different contexts. The conclusion is drawn that the main difference is concerned with the object of activity.

The case study of Russia is used to analyse the specificity of a particular context (Nizhny Novgorod region) and to identify the object of activity relevant to technology education classroom within this region. The conclusion is made that a theoretical analysis on the basis of activity theory and a case study approach demonstrate that Education for Sustainability (ES) can be effectively addressed via technology education. However, it is necessary to pay particular attention to the object of students' activity, so it would be relevant to the particular context.

Key words

Technology education, education for sustainability, cross-cultural comparison, Russian concepts and practice of sustainable development and education for sustainable development.

Introduction

In two different parts of the world (a developed country and a developing country) two primary school age boys were making toys out of materials that would normally be thrown away[1]. Both boys enjoyed their activities, used available resources and had fun playing with their toys (Pictures 1-5). What do these two observations tell us about the role Design and Technology/Technology education[2] can play in helping society move towards sustainable futures? What did the children learn? What were their motives? Can these individual activities be transformed into collective activity in the school environment? In what ways will these activities be different in different countries? Will the role of D&T be different?

Pictures 1 & 2

Notes

[1] Although these boys belong to particular countries, the author has chosen to make the generalized distinction between 'two worlds'. A number of different criteria exist for defining whether a country is considered a developing country or not. The definitions usually relates to the country's right to receive development aid. For example a list of the least developed countries can be found on the following web site: http://www.un.org/special-rep/ohrlls/ldc/list.htm.

[2] The subject has different titles in different countries. Two common titles are Design & Technology and Technology Education. They are used interchangeably in this article.

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Pictures 3, 4 & 5

This article analyzes the nature of these activities using activity theory and argues that the activities can provide the basis for important learning in D&T classes within a range of different contexts. Activity theory is used because it provides an examination of learning that goes beyond the activity of individuals, to include consideration of such features as rules, mediating artifacts and the object of activity (Engeström, 1999a). Activity theory is described in more detail later in the paper. The Russian context is considered as an example.

Sustainable futures

The concept of sustainability has been a part of international discourse since the early 1980s. Government and non-government organisations around the globe have become aware of and are expressing their concern about the future of humanity and the quality of life of future generations. The most common definition of sustainability refers to 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (World Commission on Environment and Development, the Brundtland Commission, 1987). However, because sustainability is considered as an ethical matter; there is no single model of a sustainable society (Robinson, 2004). The analysis of tensions in current political interpretations of sustainable development (SD)[3] could help to understand the differences across the various models. Tensions are present at different levels: international, national and local. The most significant one is the tension between international and national interests at the *international level* in both interpretation and action concerned with sustainable development. International discourses were stimulated by the process of globalisation, in particular, by the increasing interdependence between the world's regions. As argued by Held et al (1999): "The concept of globalization implies, first and foremost, a stretching of social, political and economic activities across frontiers such that events, decisions and activities in one region of the world can come to have significance for individuals and communities in distant regions of the globe" (15).

Note

[3] Although in the literature there is discourse about terminology, in this article sustainability and sustainable development are used interchangeably.

Understanding of sustainable development at the international level relates to two broad areas. The first one is focused on efforts to limit major disasters such as 'greenhouse gases' and the threat of global warming and rising ocean levels, the destruction of the world's forests and expansion of the deserts, outbreaks of war and mass migration. These are examples of economic and environmental tensions. The second area relates to the promotion of national interests. The tensions here are between justice and equity and economic prosperity. Tensions at the international level are the most visible ones.

The tensions at the *national level* such as those between economic, social, cultural and environmental aspects of sustainable development are sometimes overlooked.

The balance between the national aspects of SD in terms of priorities for developments that maintain and improve the quality of life for both the present and future generations is different for individual countries. In some developed countries, sustainable development is largely interpreted in terms of environmental issues, and therefore 'education for sustainable development' is simply a new twist to the notion of 'environmental education' (UNESCO, 2001). In a developing country the emphasis on economic and social issues is seen as more important.

At the local level, the concept of sustainability again can be approached in different ways. For one particular community conservation of water might be the main issue, for another, maintaining traditional dancing might be seen as an emerging concern. Sustainability of products designed for different contexts can also have a different nature with more emphasis on eco-design or cultural meaning.

Education for Sustainability (ES) is seen as a major contributor towards achieving sustainable futures through promoting an awareness of the issues at all levels, developing particular values and attitudes, and influencing behaviours consistent with SD. Education for sustainable development (ESD)[4] has gradually become an important issue for many educators internationally. UNESCO, for example, specifies that since the Rio conference on SD, there has been increasing recognition of the critical role of education in 'promoting sustainable consumption and production patterns in order to change attitudes and behaviour of people as individuals, including as producers and consumers, and as citizens carrying out their collective activities' (UNESCO, 2001: 3).

The place of Design &Technology in Education for Sustainability

Many articles have been written, particularly in the UK, about the role Design and Technology (D&T) subject can play in ES. Academics from outside the field mainly focus on ecological design, appropriate technology and the contribution of D&T towards cross-curricula approaches (Huckle, 2005). Academics from inside the field have developed ideas about all aspects of SD and curriculum materials designed by them reflect this understanding. One example is a successful scheme that has been running in England and Wales since 2003, called the Sustainable Design Award (see Practical Action, www.sda-uk.org). Another example is the Sustainable Technology Education project started by the Intermediate Technology Development Group, a small education team that has produced courses for D&T teachers and a wide range of materials (see for example Practical Action, www.stepin.org; Miller & Pitt, 2000; Pitt & Miller, 2002; Pitt & Lamb, 2004). These materials incorporate a large number of case studies from different parts of the world.

However, within academic discourse the different contributions that D&T education can provide in different contexts in terms of ES have not been explored. I use the example of the two boys mentioned earlier to analyse the nature of their activity and the ways it can be transferred into classroom activity in the different contexts. In doing so, I will use activity theory.

Note

[4] Again both terms ES and ESD will be used interchangeably in this article in accord with the specific contexts they apply to.

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Activity theory

Activity theory is a conceptual tool developed to help in understanding the process of learning that is situated within a particular cultural-historical context. Developed by Vygotsky (1978, 1987), then Leont'ev (1981) it looks at the complex interrelations between the individual subject and his/her community. The theory was further developed by Wertsch (1991) who introduced Bakhtin's ideas (1981, 1986) on dialogicality and by Engeström (1987, 1993, 1995, 1999) through the developing of ideas on multiply perspectives and networks of interacting activity systems. Figure 1 represents the model of human activity.

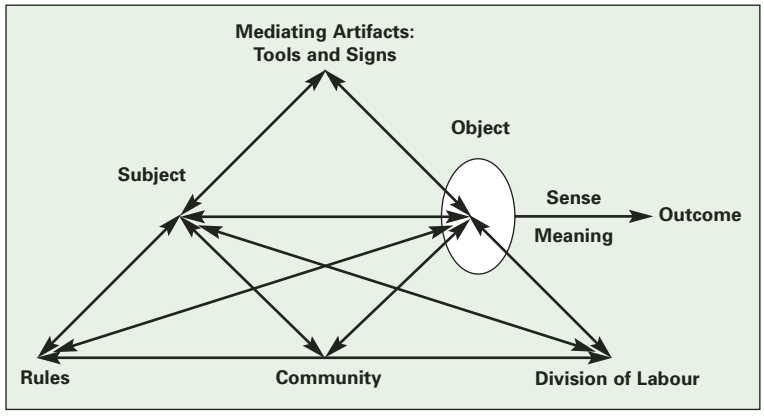

Figure 1: The structure of a human activity system (Engeström 1987: 78)

Boys' natural activities

The boys' individual activities described in the introduction can be presented as follows:

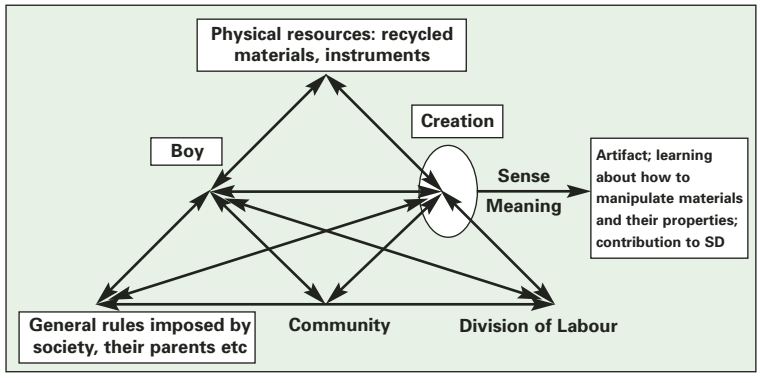

Figure 2: The structure of the 'natural' activity of the boy.

When activity is individual and not organised within a classroom it is mainly based on intrinsic motivation related to the enjoyment of making things. One of the arguments within the philosophy of technology is that technology constitutes a second nature of human beings. This ontological perspective is based on the perception that technological activity occurs by instinct, and thus an innate part of the nature of all human beings (Rapp, 1985/1989). So there are strong non-rational determinants of technical activity in people. Historically, technical activity by people was a reaction to the pressure from nature, now - it is regarded as a cultural necessity. Human beings have been technicians from the very first. "Technique is a mirror of humanity. We project ourselves into it and in it extends our nature artificially" (Ellul, 1987/1990: 139). Thus, the two boys satisfy their deep instinctual drives to create and to solve problems.

Another motivating factor for children to engage in the activity is necessity. For developed countries it can be related to parents' interference: the child is not allowed to spend all their time playing computer games, thus, to avoid being bored the child start creating something. For developing countries it can be a different type of necessity: to have something to play with. An application of activity theory also suggests that 'cultural necessity' is different for different contexts. It includes general rules imposed by society and communities and these influenced the boys' activity. Probably they both observed adults and the sort of activities they were involved in, limitations in the ways things can be done and/or the types of the artifact that can be made. Thus, the object of activity is creation.

Implicitly, this activity contributes in a limited way towards sustainable futures by dealing with waste in both cases, overconsumption in one case and economic necessity in the other. However, it does not contribute towards ES that implies an understanding of the major issues of SD and the development of particular attitudes and behaviours. Thus, what should be changed in the boys' activity so that it would be directly relevant to ES? Would the changes be different for different contexts?

Same activities in the situation of classroom learning

When the same activity is organised within the classroom context, components that influence the outcome will be changed in a number of ways, so the students will learn about issues associated with sustainability. In constructing a learning activity to achieve a particular set of outcomes, all components of the model should be adjusted to match these requirements. The model presented in Figure 3 demonstrates that cultural tools such as concepts of sustainable development should be introduced. The model also implies a radical expansion of the object of activity. To be successful, ES models should present a learning process as a creative interplay between everyday concepts and scientific concepts (Vygotsky, 1987) (making a toy from scrap material vs. making a toy from scrap material and understanding the relationships between the concepts of recycle, reuse, waste management, social justice).

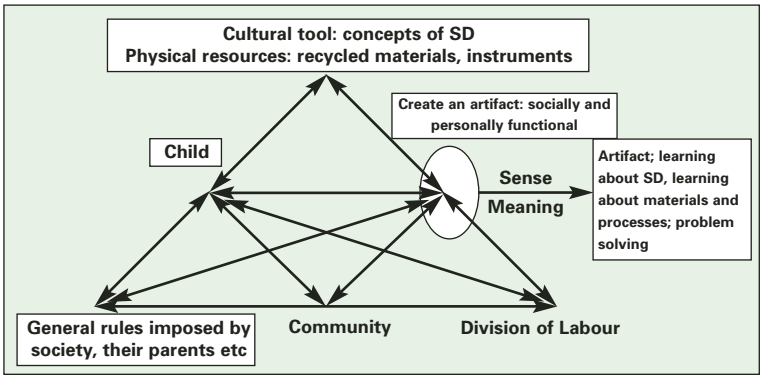

Figure 3: The structure of the classroom activity.

However, how different would the activities be that were relevant to the context of developed and developing countries? There are number of limitations that influence such an analysis. Firstly, the object of activity is a 'moving target' (Engeström, 1999a) that is closely related to the particular context at a particular time. In the example used here time is not accounted for. Secondly, almost all countries have their developed and developing sections, particularly in relation to ESD. Both developed and developing countries differ widely in both the extent to which they have raised issues of sustainable development and the extent to which they have addressed it. Thus, both the ideal developed country that has SD policy and addressed SD via education and the least developed country are considered here. Also, two extremes on the scale of economic wealth are applied here to highlight the differences in the models. When activity theory is used to analyse the differences, they tend to be highlighted in the object of activity. They are summarised in Table 1 (overleaf).

Differences in the object of activity are closely related to tensions in interpreting sustainability at the international, national and local levels. At the national level, for example, for the developed country, the tensions can be between economic and environmental aspects of SD. For the developing country the tension between economic and social aspects can be the most important one. Although on the surface students will be involved in similar activities in the classroom, the learning that would take place will be different and models of ES, if they are to be effective, should reflect the differences.

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Table 1: The object of activity.

The object of activity	Developed country	The least developed country
Economic (reasons)	Reuse, recycle, waste management	Mainly reuse
Social importance (reasons)	To minimise the use of resources; Understand an issue of limited resources and pollution, think about broader communities, increase awareness of the local community (Mainly ecological aspect)	Have no other resources or materials; Improve the quality of life for the local people by creating a toy that meets the real need (Mainly social aspect)
Personal importance (reasons)	High, Enjoy	High, Enjoy
Environmental (reasons)	Among the major reasons	Almost a side-effect of the activity

In reorienting the technology education curriculum towards ES and sustainable futures, the object of activity should reflect the following aims of technology education.

Students should:

- Know and understand problems/issues associated with sustainable futures;
- Contribute towards promotion of SD and increasing awareness of sustainable development issues through projects/activities;
- Design and make products using eco-design principles (see for example, Ecodesign Tools and 10 Golden Guidelines, www.pre.nl/ecodesign/ecodesign.htm);
- Work in accord with SD practices (Pavlova, in press).

Building on the examples of activities analysed above, differences in the object of activity in the different contexts constitute an important basis for the development of ES models. Both educational knowledge and educational policies need to re-examine assumptions behind the belief in the universal validity of approaches designed within the context of developed countries.

Case study Russia

The above scenario presented an analysis of two extreme possibilities from a broad spectrum of different contexts within which ES is and should be addressed through technology education. The Russian approach to SD is briefly considered below to highlight the importance of accounting for specific contexts when developing ES models for technology education. It is aimed at demonstrating the mixture of parameters influencing the development of ES via technology education and the nature of the object of activity.

Theories and politics

In Russia the historical development of ideas about sustainability goes back to the beginnings of the 20th century when the Russian scientist Vernadsky advanced a conceptualisation of the idea to harmonise the interrelationships between environment and the world community. His concept of noosphere or the 'sphere of wisdom' (tsarstvo razuma) is grounded in his research in the physical sciences and the stages in earth development. The transition to noosphere requires profound changes in values and actions of humankind, and in that sense, it is closely related to the current concept of

sustainability as a frame of mind advocated by a number of authors in the UK (see for example, Huckle, 2005). ES should develop a capability in students to view nature in a way that is "essentially poetic and non-manipulative" (Huckle, 2005: 15).

Recent developments in political acknowledgements of SD in Russia (summarised by Pavlova, 2005) started in 1994 with the Presidential decree on *The state strategy of the Russian Federation for the protection of the environment and ensuring of sustainable development* (Ukaz, 1994). The decree demonstrated an official commitment by the Russian government to sustainable development. Further development of the issue was presented in another Presidential decree (Ukaz, 1996) that states: 'The advancement of humanity to sustainable development ultimately would lead to the emergence of the sphere of wisdom (the noosphere) foreseen by Vernadsky, when the spiritual values and knowledge of humankind, existing in harmony with the environment, will become the criterion of national and individual wealth' (Ukaz, 1996, p.5). The next official document titled the *Main ideas of the strategy of the sustainable development of Russia* (Shelehov, 2002) emphasised the role education should play in the implementation of the Strategy. The document highlighted the scientific principles behind the concept of SD. It is heavily referenced to Vernadsky's work and uses the concept of noosphere as a fundamental concept for the Russian interpretation of SD. 'The sphere of wisdom that was discussed in his work represents a philosophically rethought image of our desirable future, the one that we now call sustainable development' (Shelehov, 2002: 9). Noosphere is the final aim that should be achieved through sustainable development. In the light of this interpretation, the main aim of education should be up-bringing of the new personality that is oriented towards the system of ecological wealth, but not the wealth of the consumer society. Only a society that unites people with new values would be capable of sustainable development. As a result, education should provide both an instrument for, and a method of transformation for sustainable development.

The same document stated that without a rebirth of its spiritual potential Russia would not be able to develop along the pathway to SD. It is necessary to link the concept of SD with the development of spiritual and moral values that are oriented towards the survival of the whole of humanity but balanced with the national interests of Russia. To realise the ideas of SD it is important to change the world outlook to one that incorporates a global understanding of noosphere as belonging to all humanity, however, the idea was originally Russian and has been a part of Russian psyche. Thus, interpretations of SD as a 'frame of mind' and the tensions between international and national interests are clearly stated in most political discussions in Russia.

The role of education is interpreted in this Strategy in terms of: development of an ecologically oriented world outlook, development of responsibility for SD, development of lifelong ecological education for all, providing access to information about solving problems of SD and reinforcement of all of these components, at all levels of education. The development of new ethics, based on a particular attitude towards the biosphere should be seen as the foundation for life. Furthermore it is a necessity to follow the logic of its development. This involves considering such factors as limitations, a viable economy, limits to consumption and development of healthy lifestyles, and tolerance in international and inter-religious relationships. Thus, the specificity of interpretations of SD as a noosphere and a long lasting tradition of linking education and up-bringing creates an opportunity to develop a unique values education in secondary schooling in Russia.

Current practice in Russia

However, the current reality is different. The ways in which SD is included in the school curriculum in Russia have been analysed by

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Zevlakova (2006), an activist of the non-government organisation that promotes SD and approaches for ESD, as follows:

Traditional environmental education renamed "Education for sustainability"
Historically, the first experts who displayed interest in ESD were environmental educators. In Russia those are generally biology and ecology teachers. They continue to provide knowledge about ecology on the basis of the assumption that deep knowledge of ecology is needed for sustainable development. Usually they use traditional methods of 'transferring' knowledge.

Education through practical action
Another common approach to ESD relates to practical environmental actions at schools and at students' homes such as waste reduction, tree planting, optimization of water and energy consumption (turning the lights off), "clean the river" campaigns, collection of recyclable waste, environmental monitoring. The main idea is that students must be taught "how to act sustainably".

Education about Sustainable development
The popularity of this approach is increasing. Education about Sustainable Development is implemented as a separate subject in curriculum. The messages that the students are getting (save water and energy, refuse to buy things) ask students to limit and change their consumption patterns without creating the image of sustainable future as attractive and worth working for. This approach is based on the same assumption as traditional environmental education (knowledge equals behavior) without an holistic approach towards SD, as there are no changes made to the other subjects and school management.

Education for solving environmental problems
This approach represents an attempt to create special programs that are aimed at developing systemic thinking through strategies for solving environmental problems. This approach requires fundamental changes in teaching practices, school management, redesigning the content of the school curricula. It can be seen as a way of putting ES forward. Currently it is not widely used.

Education for sustainable development – call for systemic change in educational institutions
This approach is aimed at helping students to realize *the scale of un-sustainability* and the *real causes* of the problems, as well as to offer positive, attractive and realistic alternative for the future, empowering the students' beliefs in the possible positive changes. The ESD content includes some examples of solutions that are adequate to the scale of the problems. Then the students are able to understand that solutions are needed to eliminate the causes of the problems, but not the symptoms and effects. This is an emerging approach.

Technology education teachers' focus group
There are no 'official' documents that state the place of technology education in the overall strategies for SD. The approaches described above also do not focus on the place of technology education in ES and in school practices, technology teachers are not really involved in ES. However, elements from all above strategies can be seen as contributing towards ES via a technology education model. To identify the possible ways of introducing ES in technology education a focus group of 20 technology education teachers involved in an in-service training program in Nizhny Novgorod was chosen for this case study.

The purpose of this focus group was to reflect on SD concepts and issues introduced at the seminar, reflect on their current practices and identify activities that meet the aims of ES and develop ideas for new activities that can be used in technology education classroom and across the school curriculum. Half of the participants were experienced technology teachers who were going through on-going in-service training and action research on implementation of a design-based approach to technology education in the Russian context. The remaining participants were new in-service trainees who had just started the development

of their understanding of what design is, and means, in terms of technology education. Although 'experienced' teachers led the discussions, newcomers were fully involved and contributed their ideas.

After a two-day seminar in August 2005 on the concepts of SD, issues associated with ES, and the ways it can be addressed via technology education (some materials from the Design Award web site were used for the seminar, see Practical Action, www.sda-uk.org), teachers were asked to reflect on them and trial some activities. In November 2005 teachers from the focus group were asked to reflect on their practice, to define ES and identify activities that could be used in technology education to address ES.

The majority of participants defined ESD as developing moral values and responsibilities and changing the way people think. Examples of responses are:

> Teaching the students the notion of interdependence of all aspects of life on our planet: link between technological innovations with the consequences of their impact on economic, environmental, moral and other changes in the life of further generations. **Developing moral issues and responsibility for their lifestyle** and for what they produce.
>
> Teaching to live not only today, but also **think** how the future generations will live.
>
> ESD means developing your own decisions on the basis of the obtained knowledge while teaching various technologies of making products. Feel joy and satisfaction; understand your own responsibility in the process of doing tasks. Evaluate the consequences of human activities and look for solutions. [Consider] sustainable and unsustainable technologies. **Developing students' social responsibility.**
>
> Education that creates the way of thinking that provides harmonious resolution of contradictions in various spheres. It makes it possible to improve the situation in economy, industry, environment and relationships between various nationalities.

Some responses also relate to the 'technological fix' approach:

> This is teaching for priorities in economic, social and environmental aspects of human activity through **developing of technology and using it** for the sake of all people in the world.
>
> To teach students **use or develop such technologies** for making various products that wouldn't harm the environment, people and saved energy. Products must be easy to dispose.

These statements relate to two categories identified by Robinson (2004) when he summed up environmental responses addressing the relationships between humanity and nature as represented in English language literature. He identified technical fix and value change as two major approaches towards SD. They reflect the debate about the relative importance of technology and individual human responsibility that has been an emerging theme in the environmental literature since the early 1970s: individual attitudes towards nature vs. more pragmatic and collective approaches, oriented towards efficiency gains and improvements in technology at the political level. Russian tradition fits better under the value change paradigm. The majority of teachers expressed similar views.

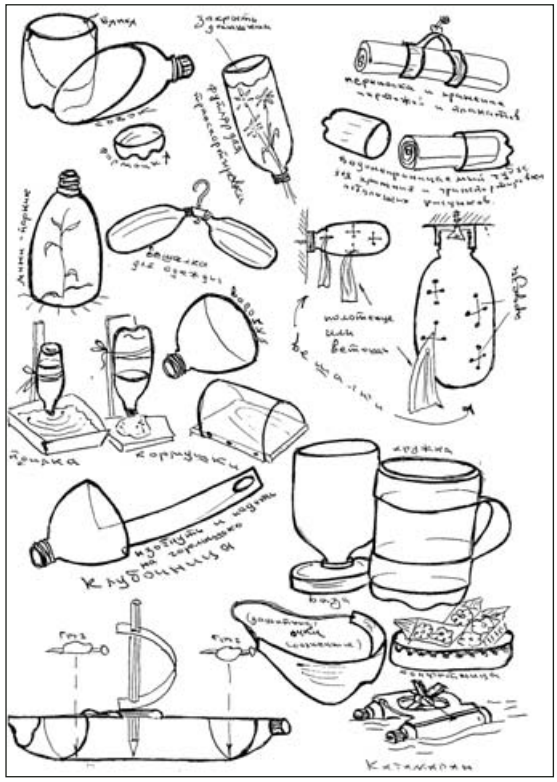
When proposing the types of activities to be used or which had been used in the classroom teachers, identified four major possibilities:

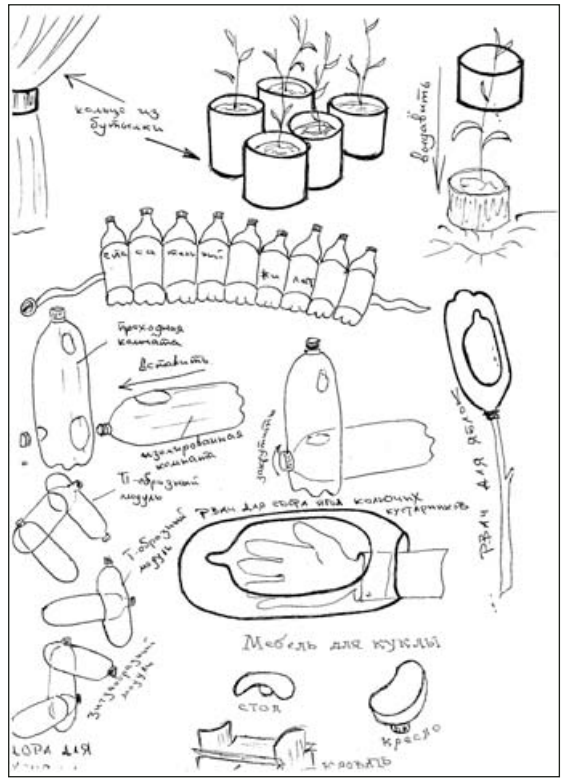
- Re-use of products/packaging (see Pictures 6 & 7, students developed ideas on how to re-use plastic bottles. This activity is not detached from the context, in the countryside see Picture 8 and in the city see Picture 9, students can see examples of bottle re-use);
- Use of industrial waste (timber, textile – patchwork, toys for the childcare, metal) to design and make new products;
- Eco-technologies (alternative energy sources, interior design from natural forest materials);
- Social and cultural aspects of sustainability (re-born of traditional crafts).

Although these activities are summarised under broad headings that are appropriate to all contexts, there is well-identifiable specificity in them (see example with the plastic bottles).

It is also important to understand how teachers see the result of their ES teaching, how a well-educated person in terms of sustainable development should look. Five small groups presented the results of their brainstorming and discussions. They concluded that a student who had received a suitable ES through technology education would be:

- Attentive, conscientious, have an active life position, responsible, well educated, adapted to modern life and problems of the modern life, healthy.
- Ready to work under any social and economic conditions; be able to develop himself and aimed at self perfection, be able





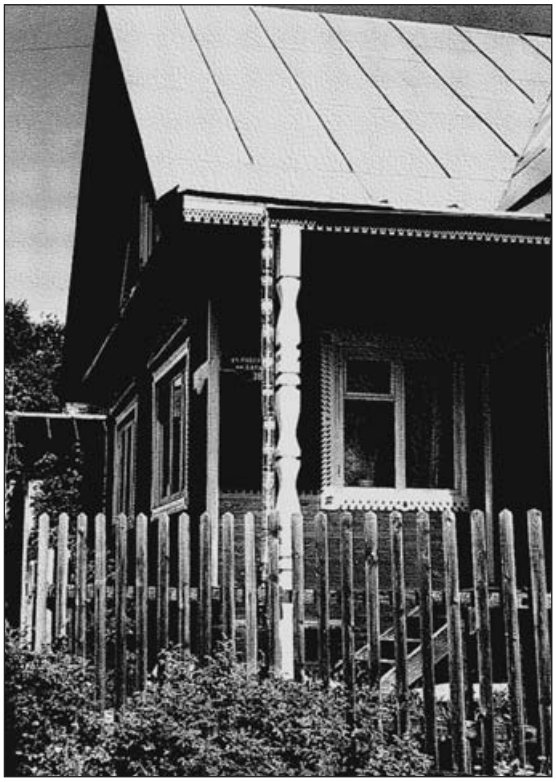
Pictures 6 & 7

to adapt to constantly changing world, striving to improving life (his own and other people), tolerant, be able to work on his own, having mastered knowledge and skills, be able to make decisions and accumulate experience.

- Well brought up, have good manners (he throws his cigarette into a bin, not near it); must do sport, have a well balanced diet; be aware of SD and tell his peers about it; surround himself with the goods that meet the requirements of SD; have a good sense of humor – it makes life more sustainable.
- Clever, knowledgeable, decent, kind, morally sustainable, technologically educated, taking care of his own health and the health of the people surrounding him, hard working, creative, intellectual.
- Well educated in various spheres; must be literate in environmental aspect, have environmental culture; must be able to apply his knowledge about SD in practice; must be an optimist, be not afraid of obstacles, learn how to overcome difficulties; be morally sustaining; must believe in what he knows about SD and what he is doing.

These combined characteristics of the person who is well educated in terms of SD present a positive character: knowing, believing and acting in accord with an educated vision of sustainable future. Through its work, this focus group also described mediating artifacts (cultural tools and physical resources) and the object of activity.

What are the features of the object of activity for this particular context? On the one hand, it is closely related to the 'developed country' model – the object of activity is to reuse,



Pictures 8 & 9

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recycle, manage waste, minimise the use of resources; understand the issues of limited resources and pollution, think about broader communities and to increase awareness of the local community with SD issues. On the other hand, it is also related to improvement of the quality of life for the local people by creating products that meet the real everyday needs of the people who may be better off saving money by not buying similar products from the shop (see reuse of the bottles example) and through the revival of traditional crafts.

This case study demonstrates that a complex mixture of factors that represents a specific context should be a starting point in developing approaches towards ES via technology education. This mix will be different even for the different regions within a particular country.

Conclusion

The contribution of technology education towards sustainable futures has been discussed. The analysis was based principally on activity theory. The conclusion is drawn that through the nature of students' activities technology education can be very responsive to the particular context and can contribute, as a special learning area and as a part of cross-curricula learning to ES and towards sustainable futures.

The argument developed in this article through the use of activity theory and case study demonstrates that through technology education, learning for sustainable futures can be successful if the object of activity is closely related to a specific context. The same activities in different contexts will contribute differently to ES and sustainable futures. Students will learn about a number of similar and different aspects of sustainability and although the contribution of D&T is different in different contexts, the joint effort across countries should lead to a more sustainable future of our planet.

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