

*Journal
of
Teacher
Education
for
Sustainability*

Volume 10, 2008

Editorial

Journal of Teacher Education for Sustainability (JTEFS) welcomes the authors and Editorial Board on the publication of tenth issue of JTEFS.

I would like to express my sincere gratitude again to all the members of Editorial Board and also to the language editors for their expertise, devoted work and interest in teacher education and sustainability.

The 10th volume of JTEFS contains the contributions from Latvia, USA, Malta, Finland, and Hungary. This volume of journal represents the collection of research papers (both with quantitative and qualitative methodology) connected mostly to the teacher education and work of teachers at school oriented toward the aim of sustainability.

The 10th volume of JTEFS starts with the description of educational action research for sustainability that is a part of larger action research conducted in Daugavpils University and aimed toward the construction of learning and research environment in teacher education. The contribution explains the frameworks and means for constructing a vision for the future in teacher education. Next article presents the analysis of research and learning environment and activities that promote the development of students' research skills in one of Latvia's secondary schools. It displays the research methods and means identified in students' research works, and evaluates the research environment in the school. The article by the authors from the University of South Florida depicts the challenges and successes described by two Grade 8 teachers as they attempt to use robotic technologies to integrate their mathematics and science curriculum in an interdisciplinary manner. The authors argue that for robotic technology to be used as a model to support Education for Sustainable Development (ESD), specific curriculum, adaptable to local contexts, needs to be readily available. Further, the researchers from Malta explore how to use Vee Heuristics and Concept Mapping in ESD as pedagogical tools within the context of primary school learners' different learning patterns. The next two articles of this volume are based on a quantitative research aiming to find out the perceptions of next teachers about the study process and their own professional competence. The research conducted in Tallinn University shows how student teachers perceive intentionality, contextuality, constructivism, collaboration, feedback, and transfer of knowledge in the general studies of Educational Science and Psychology. The investigation in Daugavpils University suggests that both students and teachers see the necessity for the further development of students' professional competences while encounter with ESD principles mostly elicits the need for the higher standards of professional competences and more critical stance toward the achieved level. The current volume of journal concludes with an article describing the role of media in students' life and their environmental education on the basis of survey of students aged 13 to 17.

The website of Institute of Sustainable Education www.ise-lv.eu is available for a further acquaintance with *Journal of Teacher Education for Sustainability* (see section PUBLICATIONS) and currently its main function is to inform you about the annual JTEFS conference "Sustainable Development. Culture. Education" that will be held

May 5-8, 2009 in the Daugavpils University, Latvia. The Institute of Sustainable Education invites you to follow the information about the Conference <http://www.ise-lv.eu/index.php?show=49> and to submit articles for the next volumes of JTEFS. The terms for article submission are December 15 for the spring volume and June 15 for the autumn volume of JTEFS.

Editor-in-chief: **Anita Pipere**

EDUCATIONAL ACTION RESEARCH FOR SUSTAINABILITY: CONSTRUCTING A VISION FOR THE FUTURE IN TEACHER EDUCATION

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Abstract

This article discloses a fragment of a broader action research aimed to design the learning environment facilitating the research skills in teacher education. Presented case reflects the possibilities to construct a vision for the future in an educational action research in the context of four-dimensional model of sustainability. The next teachers used this model to structure their viewpoints on the sustainability situation in Latvia. They identified the most typical features of current situation and evaluated features worth to preserve and develop in the foreseeable future to reach the sustainability. Qualitative and quantitative data analysis endorsed to discern the common vision for the future – reflecting the features of sustainability and non-sustainability identified in each dimension of sustainability. Among the features singled out from the viewpoints of students, actions and action results prevailed. At the end of the action research the strategy employed in presented research was compared with one often employed in the public space to construct a vision for the future through community involvement.

Key words: educational action research; sustainability; teacher education; future vision.

General context of research

The given research is conducted drawing on the most essential feature of educational action research – instigation of reflection. Currently teacher education focuses on the preparation of teachers for reflective practice and suggests that teacher conducting reflective professional activities has to be also a researcher. It is argued that teacher has to be educated as the action researcher. The reflective nature of teachers' professional activities is accepted as self-evident by educational researchers (Kyburz-Graber et al., 2006). Discussions and studies on teacher as researcher and conditions for the realization of this professional function of teacher are in progress (Gray et al., 2007). In line with it, recently the debates have started about the usage of action research in teacher education, teacher professional activities and designing of school environment (Hoy, Tarter & Woolfolk Hoy, 2006; Grišāne, 2007).

The action research already for a long time has warranted its potential as a tool to diminish the hindrances for the solutions of complex issues in society. Exploring the

historical sources of action research, Neilsen (2006) indicates that the introduction of concepts of action research and social action research and distinction of these concepts is owed to J. Collier and K. Lewin. Colliers made a larger emphasis on democratic cooperation while Lewin approached these concepts in more empirical way. Analysing the principles of action research designed by Lewin, Bargal (2006) quotes Lewins' idea that "there is nothing more practical than a good theory" (p.384) therefore acknowledging the epistemological essence of action research.

Besides, there is a view suggesting that the theory by Dewey (1916) can be perceived as an introduction to the idea of action research (Bargal, 2006).

Onset of action research has influenced the educational research giving the chance to expand the inquiry with the epistemology that uses the experienced, practical and fosters the creation of constructs necessary for problem solutions (Dick, 2006). Undoubtedly, any action research has a potential for designing the research and learning environment, however, the closer inspection suggests that educational action research is dominating over the other types of action research (Dick, 2006; Pipere & Salite, 2006). Educational action research envisions the improvement of quality of action in education while "taking a systematic look at some educational practice and recording what was done, why it was done, collecting data, analyzing the data and reflecting on how the results might influence future teaching endeavors" (Action Research Network, 2005). Educational action research is covered in a wide scope of sources designed for teachers and young researchers willing to study their own experience. This literature envisages the growing trend toward the acknowledgement of developmental dynamics from the personally relevant experience to personally relevant theory (Whitehead & McNiff, 2006). The changes, transformation and innovations are keywords in the literature on action research.

The action research can be used for instigation of sense and awareness of sustainability since some authors call the participative action research "an antidote to oppressive forces" or "a form of resistance to all forms of control limiting our freedom to pursue a reasoned, compassionate, committed and democratic knowledge base" (Pyrch, 2007: 199). Action research is also recognized as a tool to diminish the influence of contemporary "culture of fear" (Pyrch, 2007), which is clear evidence of unsustainability of present situation.

The experience collected regarding the application of action research lately has been extended with a new suggestion – to develop the action research pedagogy (Brydon-Miller, Greenwood & Eikeland, 2006) discerning its capacity for the improvement of practice while deepening the common understanding about the topical issues and reviving meaning in teacher education (Hostetler, Macintyre Latta & Sarroub, 2007).

One of the most viable advantages of action research is reflective learning environment it offers for research participants. Higher education is becoming more and more interested in learning and learning environment based on activity and reflection. Rising interest of universities in action research has been invoked by local and global changes challenging the higher education to undertake the unique responsibility for the solution of developmental issues. The action research entered the higher education as a deeper approach to learning used both to deliver the university study courses (Peters & Gray, 2007) and to implement the study programmes (Taylor & Pettit, 2007).

Taylor and Pettit (2007) characterise the usage of experiential action research in the programs of higher education from the point of view of university teachers: "We

found that we need, as educators, to move beyond a narrow methodological or pedagogical approach in order to teach action research. We need to understand and work actively with the multiple dimensions and levels of learning and knowledge involved in transformative action research” (p. 244). The action research is used as a context in (1) organizing the work of doctoral study programs (Peters & Gray, 2007), (2) engaging the university teachers in reorientation of teacher education toward the aim of sustainability (since 2000 UNESCO/UNITWIN project by York University) and (3) locally – in the education of university teachers (Barazangi, 2007).

Levin and Martin (2007) tried to reveal the experience of teaching action research in universities asking (1) How do you teach someone to be an action researcher? and (2) How does anyone learn to be an action researcher? The authors have concluded that there is no reflection in research literature on how one is learning to conduct the action research and how we develop skills necessary for action research.

Action research is not a single method; it is a strategic approach to knowledge production, integrating a broad array of methods and methodological approaches. It suggests different specific ways to create new understanding and construct new knowledge. In this process, various feelings of research participants play an important role. Enosh, Ben-Ari, and Buchbinder (2008) are convinced that different feelings are starting point for the production of knowledge if the construction of knowledge is viewed on the levels of ontological, epistemological, and moral analysis.

The action research has a long history in teacher education. The necessity for it is voiced not only in publications analysing the results of action research but also in the studies focusing on the problems of teacher education and teachers’ professional activities (Allan & Clark, 2007; Brady, 2000; Graham & Phelps, 2003; Gray, Chang & Radloff, 2007; Harpe & Radloff, 1999).

Specific context of research

In the Daugavpils University, action research conducted in the context of teacher education aims to design the learning environment as a catalyst for the development of research skills of teachers both in pre-service and in-service teacher education programs (Salite & Pipere, 2006; Pipere & Salite, 2006; Salite et al., 2007). The main aspiration conducting the educational action research here is to develop teacher education oriented toward sustainable development. Education with such an aim is inclined toward the quality of sustainability. In the teacher education such quality can be reached by the pre-service and in-service teachers’ ability to explore the real situation and to design the learning environment fostering the sustainability in education.

Sense of sustainability and conviction about it are linked with the nature of pre-service and in-service teachers’ subjective beliefs. The subjective beliefs along with several other sources maintain the teachers’ activities in the context of sustainability. The research by Levin and He (2008) confirms that teacher education programs can influence the future teachers beliefs about the most significant aspects of teacher’s work and they successfully do so.

In the presented educational action research, the research activity involving both research participants and researchers is used as a learning environment. During the previous activities of larger action research, the research participants already learned about the oppositions as a means of activity stimulation (when discussing ecological/

non-ecological person, well-organised/poorly organised democracy, sustainability/unsustainability) (Salite et al., 2007).

Research and learning environment was organised using the interrelated four-dimensional (ecological/economic/social/cultural) frame of reference for sustainability (Hawkes, 2001). Without putting the emphasis on any of the dimensions this model was suggested to research participants to help them describe the current sustainability situation in Latvia. Therefore, non-oppositional stance for identification and evaluation of the students' individual experience, were applied at first. The participants used their personal experience and beliefs to select the content that would characterise the current situation with sustainability in Latvia.

Study was organised in two subsequent stages to identify:

- (1) next teachers' views on the current sustainability situation in Latvia and their future vision of the situation in 2030 using the non-oppositional stance toward the different dimensions of sustainability;
- (2) evaluation of application of non-oppositional and oppositional (dilemma) stance in research and learning activity oriented to sustainability.

The second stage was instigated by the current events in the social-political space of Latvia. Today, the oppositional (dilemma-based) approach is rather popular in political discussions and various forums in Latvia. During such activities, discussions are often initiated and directed by a dilemma (at the early stage of the discussion, participants encounter a fragmented and split interpretation of a complex issue that has a complimentary nature) and the participants of the discussion are invited to choose the most significant aspect of the content (phenomenon) as well as comment on and substantiate their choice. Forum managers often comment on the dilemma by illustrating it with the contexts that are popular in society.

Educational action research: cooperation of researchers and research participants

Stage 1. Features of sustainability/unsustainability in four-dimensional model of sustainability

During this stage, research activity was oriented toward the discussion on the issue currently topical in Latvia "Our future vision of Latvia in 2030". In order to construct the vision for future, the research participants were involved in a constructive activity using the above-mentioned four-dimensional model of sustainability with a non-oppositional stance.

The research participants (N=114) – full time and part-time first year students of pre-school and basic school professional teacher education programmes could perform the activity individually, in pairs or in groups of three.

Initially, *participants* were asked to select freely any characteristic features for the different dimensions of sustainability.

They recorded their views on (1) the most typical features of the current ecological/social/economic/cultural situation in Latvia and (2) specified the views on their future vision of Latvia in 2030. Seventy-five records were obtained with 525 features in each of the dimensions and 2100 features in all four dimensions of sustainability.

The clarification of own views on the most typical features of the ecological/social/economic/cultural situation in Latvia allowed the students to prepare the answers on further questions: (1) immediate objectives for implementing sustainability; (2) immediate objectives for reorienting education to address sustainability; and (3) future vision of Latvia in 2030.

Researchers qualitatively analysed the features provided in each dimension and encoded them into categories and subcategories. The features (N=2100) were also analysed quantitatively in order to define the differences in groups of features that the research participants used to construct their future vision. The quantitative and visualized results (see Figures 1-5) were offered to research participants for further discussion and evaluation.

Stage 2. Evaluation of dilemma situation and comparison of approaches to investigation of sustainability

During this stage the *participants*:

- (1) learned about the proceedings of the regional forum organized within a national discussion (the forum used the dilemma strategy splitting and selecting the complementary parts of a phenomenon);
- (2) evaluated the dilemma situations that were proposed in the forum and argumentatively selected one of the proffered dilemma variants. The dilemma situations were related a) to the priority of global or local development in the context of sustainability and b) to the inclination toward regulative activity of the state or respect for the individual freedom in the context of sustainability;
- (3) compared non-oppositional and dilemma approaches and determined which of them is more authentic for application when creating research and learning environment oriented towards sustainability.

Researchers qualitatively analysed the data obtained in this stage of action research.

Quantitative and qualitative analysis of the results

Stage 1.

Qualitative analysis of data permitted to discern easily two categories in all four dimensions of sustainability: namely, sustainable and unsustainable features. Though, the features of sustainability were mentioned more often than features of unsustainability (see Figure 1).

In cultural, social and ecological aspects of sustainability the research participants identified the situation in Latvia according to the features of sustainability, whereas in economical aspect – mainly stressing the features of unsustainability.

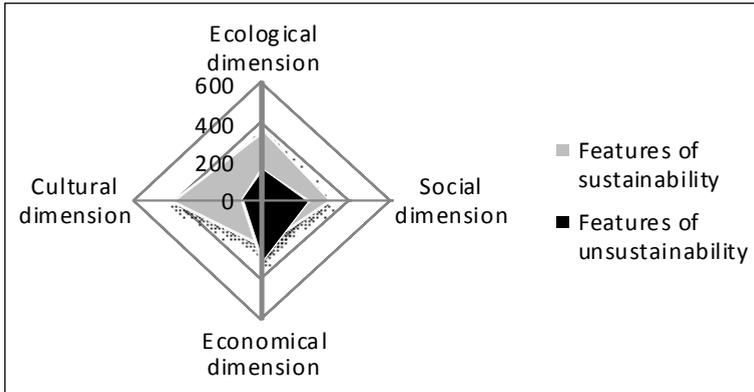


Figure 1. Current situation in Latvia according to the features of sustainability/unsustainability (N=2100)

The analysis of features of sustainability/unsustainability revealed three qualitative subcategories: features that characterise *attitude*, *action* and *action results*. Concerning the level of subcategories, a detailed perspective on each dimension of sustainability in contemporary Latvia was discerned (see Figures 2-5).

Research participants identified the ecological situation (Figure 2) mainly as sustainable one drawing on features that characterise *attitude* and *action*. Unsustainability in the ecological situation was identified mainly as the *result of activity*.

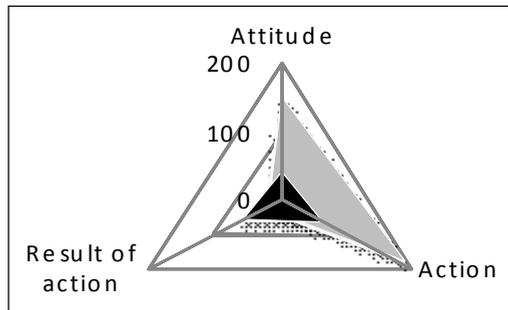


Figure 2. Sustainable/unsustainable attitudes, actions and result of action in the ecological dimension (n=525)

Research participants mostly identified the social situation (Figure 3) as sustainable one by drawing on features that characterise *attitude* and *action*. Unsustainability was identified in the result of a social *activity*.

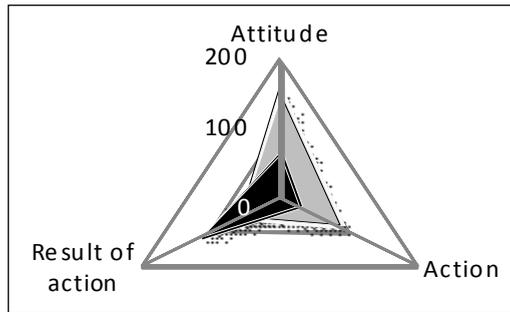


Figure 3. Sustainable/unsustainable attitudes, actions and result of action in the social dimension (n=525)

Research participants mainly identified the economic situation (Figure 4) as unsustainable one. Features of sustainability were used to characterise *attitude* and *action*, and these features were the least frequent in this dimension of sustainability.

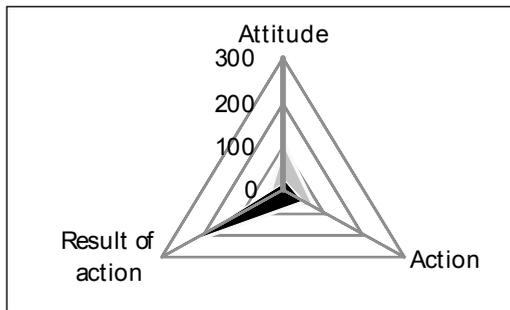


Figure 4. Sustainable/unsustainable attitudes, actions and result of action in the economic dimension (n=525)

The situation in the cultural dimension (Figure 5) was clearly identified according to the features of sustainability that were observed in sustainability-oriented *attitude*, *action* and *result of action*. Unsustainability at a low level can be discerned in the *activity results* of the cultural dimension.

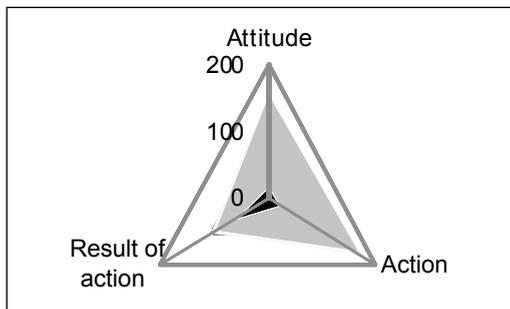


Figure 5. Sustainable/unsustainable attitudes, actions and result of action in the cultural dimension (n=525)

Research participants constructed their vision of future in the following way:

- (1) Articulating their views on the immediate objectives that have to be implemented to foster the development of sustainability. Thus, the participants proposed various transformations of the current situation in social sphere and culture. Few suggestions pertained to the economic sphere.
- (2) Setting the immediate objectives for reorienting education towards sustainability. Much more suggestions pertained to participants' further or current activity (part-time students). It was observed mainly in the social and cultural spheres, and slightly less in the economic and ecological ones.

Building on these two aspects, the research participants constructed their future vision of 2030 revealing great hopes and believes in the changes of social and cultural relations, whereas students' hopes for transformation of economic and ecological relations were less pronounced.

Stage 2.

In this stage research participants studied the proceedings of the regional forum where a discussion of the future vision was initiated by using a dilemma strategy. They evaluated the essence of this approach and tried to substantiate their choice of one of the two proffered variants of the dilemma. The participants of the research formed the fourteen workgroups at this stage.

Dilemma approach to the forum proceedings was suggested in order to evaluate:

- (1) participants' *inclination toward the global or national development* from the perspective of sustainability. Eight workgroups oriented their vision of future toward the global development, whereas five workgroups associated sustainability with the national development. One workgroup could not choose single direction and justified it in the following way: *both surmounting the barriers of age and strengthening social identity create a perspective of a bright future.*
- (2) participants' *inclination toward regulative activity of the state or respect for the individual freedom* in the context of sustainability. Five workgroups supported the need for the state to perform its regulative function; the idea of individual freedom was advocated by four workgroups, while five workgroups discerned the interconnection and mutual complementarity of these two principles.

Concluding the Stage 2 the research participants compared non-oppositional and oppositional (dilemma) approaches and determined which of them is more valid for application when creating research and learning environment oriented towards sustainability.

Four workgroups described the dilemma approach like this:

it is easier to discuss a certain choice, ... easier to discuss the issues within a familiar trail, ... the approach is good if one wants to lead a conversation in a particular direction, ... if one does not understand where the problem is and how to solve it, then this approach provides options so that one can decide 'for' or 'against'.

Ten workgroups recognised non-oppositional stance as a more suitable for constructing the vision of the future:

...because four dimensions of sustainability provide a better chance to define one's opinion rather than a choice from what is offered by others, ...one can see the specificity of the problems, distinguish diverse experiences (sustainable and unsustainable) ... look for the essential features rather than choose from what is offered ... possibility to find the essence in all spheres of life, no constraints ... a chance to express an opinion on personal problems and experiences ... suitable for those who have their own ideas ... a more comprehensible record structure, a chance to express one's opinions ... one does not have to make a choice between the specific items provided by others and can think independently ... a simplified approach ... a more comprehensible approach for defining one's opinion ... this approach is more suitable for choosing the future of our country ...the model easily structures experience, is visually attractive, everything is structured, one can see the general perspective ... one does not need to make a choice, instead, it is possible to build on personal experience, ... one can easily locate the problems and find ways to solve them ... one can easily identify features of sustainability in each of the dimensions ... it permits to identify questions that need to be answered ...one can find a more personalised, in-depth and comprehensive vision of the future ... it helps to distinguish more nuances and to comprehend a sustainability more deeply ... it unites people and calls for the preservation of traditions and diminishing aggression...

Conclusions

Reorienting the teacher education toward the aim of sustainability in dynamic and often unsustainable conditions of current society asks for responsible choice of means and approaches to organisation of learning. The choice of means for reaching this aim can either increase the interest and strengthen the links with research and learning needs or just hinder such a link. In this study, the non-oppositional and dilemma approaches were used to instigate research and learning situations. Both approaches had their advocates among the research participants, and still they were evaluated differently:

- dilemma approach was recognised as an approach suggesting ready-made trails already from the beginning and facilitating the choice of content by focusing on the proffered solutions and formulation of the future vision. Research participants called such a technique of initiating discussion simplified and shallow;
- non-oppositional means was recognised as a more comprehensible, easier perceivable frame of reference for organising research and learning activities that permits to structure one's experience and beliefs, reveal problems and distinguish factors restrictive for development and further directions of development.

While instigating research and learning activities and arousing interest in building a shared future vision from the perspective of sustainability, the non-oppositional approach gives an opportunity to discern the sustainable and unsustainable experience and its roots (attitude, activity and activity results) in the ecological/social/economic/cultural frame of reference of sustainability.

Nowadays, both globally and in local societies, the understanding of sustainability and unsustainability differ considerably. Intensive learning and attempts to understand the essence of these complex phenomena take place. In education, and teacher education in particular, it is necessary that the idea of sustainability is discovered and accepted in the students' minds as their personal and interest-sustained idea. In the conditions of heterogeneous social situations, we need to organise the research and learning environment for teacher education and education per se where action learning, action research, building a shared vision and decision-making represent the most typical solutions. Their functioning depends on the choice of means that initiates these research and learning activities and becomes the basis for decision-making support system that affects the individuals involved in these activities directly or indirectly influencing their interest.

While creating a learning environment that would promote interest toward the sustainability, the use of interest-sustaining means has a crucial importance for building a shared vision and for the form and content of sustainability used as a frame of reference. In educational action research, we can apply the alternating and participant-created view of sustainable development and sustainability and, by using certain means, broaden and deepen the existing outlook of participants. The means can generate various directions and as such either stimulate the participants' interest in the process of building their own and shared vision or suppress the interest in this activity.

This educational action research identified the need for critical choice and use of means, in order to consider and study their influence on the process of research and its aim as well as on building a shared vision for future. It also necessitates evaluation of the learning outcomes from the perspective of sustainable and unsustainable education that can be distinguished in the inclusive or exclusive approaches. This is one of the possible ways for the further development of teacher education oriented toward sustainability.

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Acknowledgements:

My special thanks to the researcher of the Institute of Sustainable Education at the Daugavpils University Dr Astrīda Skrinda for her help with the organization of action research.

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Received 29 May 2008; revised version received 24 November, 2008

DESIGNING ENVIRONMENT FOR RESEARCH AND LEARNING IN SECONDARY SCHOOL

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Abstract

Contemporary pedagogy searches for the ways to reorient teachers' and students' activity towards the aim of sustainable development. The teacher becomes involved both in teaching/learning activities and in researching the environment of his own activities in order to design the environment favourable for students' development. The article presents the analysis of research and learning environment and activities that promote the development of students' research skills in one of Latvia's secondary schools. It displays the research methods and means identified in students' research works, and evaluates the research environment in the school. Several types of environment were identified, which teachers can purposefully use to develop the research skills of their students. The results of analysis can be implemented by educational institutions, which organise students' research activities. The described methods and means can be used in learning environment with no supplementary material resources required and involving teachers in research of school environment therefore re-orientating their professional frames of reference to address sustainable development.

Key words: *learning environment; research environment; secondary school; students; teachers; research work.*

National Standards of primary and secondary education in Latvia orientate the content of education and instruction towards the development of students' research skills (*Regulations of the Cabinet of Ministers, 2006, 2007*). In conformity with the National Standards, each educational institution devises its own practical solutions how to develop students' learning and research skills. Educational institutions differ in terms of quality and scope of these activities as well as in public image and school environment.

Study of students' research works in one of Latvia's secondary schools revealed that students chose various research approaches and means. Specific types of environment were sought as to orient the students' research activity towards sustainability and evaluation was made of the link between subjective/objective and individual/collective contexts in students' research works. The study tries to identify frames of reference applicable for the analysis of school environment and organisation of secondary school students' research activity, linking theoretical ideas with relevant practical activities.

Grounding the research

Several broader and narrower theoretical perspectives were integrated as to provide the theoretical background for the study. The broader view of this study was the perspective of sustainability as the aim for education. The role of the learning in re-orientation of education towards the aim of sustainable development is widely described in pedagogical literature and has been substantiated from various perspectives (Ballard, 2005; Ferreira, Rayan & Tilbury, 2007; Hytonen, 2007; Lakatos, 2007; Pipere, 2006, 2007).

A more detailed view on the structure of learning reveals the significance of learning environment and its influence on learning and development of learning skills. Learning begins with a question and trying to find an answer on it (Gibboney & Webb, 1998). Thus, the essence of learning environment can be inferred from the very nature of learning – emergence of the question and interest that transforms into inquiry and research activity that provides an answer to the question. Therefore, the research activity and environment that favour the development of research skills constitute the most significant aspects of learning and simultaneously determine the environment favourable for learning.

Learning and research embedded in it is a process that provokes changes. The changes most needed today are orientation towards the sustainable development. In the 21st century, the critical directions in education is sustainability (Hildebrand, 2008), search for sustainability-related contexts (Ballard, 2005), evaluation of the subjective and objective in research and learning activity (Ballard, 2005; Bednall, 2006; Wilber, 2000), identification of the dimensions of sustainability (Hawkes, 2001; Bott, 2004; Salite, Ignatjeva & Salitis, 2007), use of specific potential of action research (Bednall, 2006; Pipere & Salite, 2006; Salite, 2006; Salite & Pipere, 2006), study of the issues of researcher's identity (Pipere, 2007a, 2007b, 2007c, 2008).

The study heavily draws on the works of Dewey complemented with the nuances of the 21st century (Hansen, 2002; Hildebrand, 2008). Phenomenological suggestions for action research and use of the subjective factor in research (Bednall, 2006; Creswell, 1994, 1998; Hostetler, Macintyre Latta & Sarroub, 2007) as well as the idea of teacher's personal experience theory (Levin & He, 2008) are also relevant to reach the proposed aims.

Dewey argues that educational environment at school should be simplified, purified, balanced and steady: (1) A "simplified" environment implies respect for students' present capacities and powers with an eye on extending them; (2) A "purified" environment draws out students' open-mindedness and willingness to listen to others; (3) A "balanced" educational environment can balance students' individual interests as well as their family-centred and community-centred outlooks; (4) A "steady" educational environment should help students to "coordinate" their understandings and dispositions and assist them in seeing their lives as a whole (Dewey, 1997: 20-22).

Dewey believes that teacher-created environment can foster not only student's learning but also development of teacher as a human being. Dewey concludes that teachers cannot make themselves more knowledgeable, careful and skilful outside the environment. They develop these characteristics through interaction with the environment, students, educational content and any other books, materials, ideas and colleagues or other people.

According to Dewey, the supreme aim of learning is students' engagement, involvement and engrossment. Research environment is an effective means to ensure

teachers' and students' practical activity towards reaching this aim. A good teacher "gives the students something to do, not something to learn; and the doing is of such a nature as to demand thinking, or the intentional noting of connections; learning naturally results" (Dewey, 1997: 154).

Nowadays, Ballard (2005) supplements Dewey's suggestion with a simplified model focused on three conditions that promote direction towards the aim of sustainable development: (1) awareness of what is happening and of what is required, (2) agency or the ability to find a response that seems personally meaningful and (3) association with other people in groups and networks. In direction towards sustainable development, all three conditions cannot be isolated; they should complement each other in order to achieve the core process of this direction – "action and reflection". In the presented study this model was used to define the conditions of research environment that direct changes towards the aim of sustainable development.

Furthermore, Ballard has grounded his model in Wilber's (2000) idea about contextual barriers that hamper change. Ballard has analysed Wilber's contextual barriers or factors (individual-subjective or values, worldview, etc.; individual-objective or the socially demographic, knowledge, etc.; collective-subjective or culture, common norms, etc.; collective-objective or the political, economic, technological, etc.) in the context of learning processes that promote changes towards sustainable development (Ballard, 2005).

For this study, the views of Ballard and Wilber were synthesised on the grounds of subjectivity/objectivity, which is particularly significant in research. Among the approaches used in research works and within the content of sustainability displayed by secondary school students, the individual/collective and the subjective/objective were identified in different proportions.

The performed procedures of qualitative analysis were based on phenomenological methodology (Bednall, 2006; Creswell, 1994, 1998; Hostetler, Macintyre Latta & Sarroub, 2007) that unites subjectivity and objectivity in a "truly" creative process. The truth is generated by epistemology, which is grounded in the subjective. In research works written by students, knowledge and the truth are also grounded in subjective experience. In the field of this experience, begins a dance between the connoisseur and the known and among the meaning, interpretation and truth (Ladkin, 2005). Torbert (2001) has called this phenomenon "the first-person dimension of inquiry".

Teachers' individual frames of reference begin with this first-person dimension, which eventually transforms into teachers' personal experience theory. The researchers have explored teachers' "practical knowledge", "practical theories", "relationships between teachers' beliefs and actions", "personal practical knowledge", "personal practical theories" (PPTs) and so on (see Levin & He, 2008). In all these interpretations teachers' beliefs become an important focus of educational inquiry acting as a filter through which teacher acquire and interpret new knowledge.

In this study the concept of PPTs can explicate the broader frame of reference that teachers create and develop in order to comprehend their relation to learning and research environment and their own idea of inquiry. With these PPTs in mind teachers design the learning and research environment favourable for development of research skills in secondary school. This phenomenon is also called the second-person inquiry in the action research (Torbert, 2001) and it exists as a cooperative inquiry into themes of shared interests, and in cooperative activities. Second-person inquiry provides support

for the first-person inquirer's capacity for critical abilities to live in the inquiry, reflect in action, conceptualise new learning and stay open to changes. Therefore the second-person inquiry fosters the development of the first-person inquiry. These two kinds of inquiry are complementary connected. Given study respects this connectedness, but in the qualitative analysis of learning and research environment in secondary school the focus are on already existing contexts of school environment. In this framework learning and research environments are not separated but viewed as complementary connected processes.

Therefore, the aim of study was to identify learning and research environment in secondary school. The inquiry was based on the central question: What types of learning and research environment are favourable for research work conducted by students in secondary school and what criteria can be highlighted in each type of learning and research environment?

Research approach and sample

The presented study is outcome of two-step qualitative research strategy. The current research is grounded on the results from the previous studies by author (Grishane, 2007a; 2007b; 2007c). These results obtained earlier through the phenomenological or concrete experience analysis (content or/and narrative analysis) of students' research works (N=1392) revealed the research approaches used in these works. Current study tries to determine 1) the types of learning and research environment used for research work in secondary school and 2) specific criteria of learning and research environment fitting to the students' research means and needs.

The sample providing the main research data consisted of 1392 students who have written and successfully defended their research works in one of the secondary schools of Latvia from 1999 to 2007. Majority of works received a high evaluation: 20.2% of works were evaluated as good (i.e., received a grade 7) and 57.7% were evaluated as very good, excellent or outstanding (i.e., received grades 8-10).

The types of learning and research environment were distinguished analysing the teachers' personal and professional experience and conditions created in school for organization of research work. The types were identified discerning their most typical features and summarizing them under the matching title. The features were elicited from the critical reflection on author's and her colleagues experience in organization of students' research work from 1999 to 2007. The results of this research in this article will be presented in descriptive form of qualitative analysis.

Approaches in students' research works

Students' research works (N=1392) were analysed qualitatively in order to identify most typical research approaches (Grishane, 2007b). It was concluded that approaches can be evaluated as (1) quantitative or qualitative, (2) phenomenological research or description of concrete experience. The variety of approaches used the combinations of these two basic strategies. Four typical research approaches were identified (see Table 1).

Table 1. Research approaches in students' research works (N=1392) from 1999 to 2007 (Grishane, 2007b)

Type	Percentage of works	Research approach
A	37.8	Qualitative phenomenological research
B	29.5	Qualitative research of concrete experience
C	16.7	Quantitative research of concrete experience
D	15.9	Quantitative phenomenological research

Means of research within students' research approaches

Qualitative analysis provided the possibility to reveal also the most typical research means used by students. Research means were conceived as the subcategories of research approaches. The discovered research means allowed to evaluate (1) students' needs for matching learning and research environment and (2) the correspondence of school environment, created by teachers, to explicated students' research means.

Qualitative research: Eliciting types of environment

The specific learning and research environments were distinguished using the following strategy:

- (1) general aspects of school's environment were selected on the grounds of above mentioned theoretical analysis: (a) organization of activity, (b) learning activity, (c) intellectual activity, (d) informative environment of learning, (e) internal and external environment of education, (f) context of thinking activities, (g) principles of subjective world view;
- (2) three criteria (sub-categories of general aspects) for every specific learning and research environment were discerned from the professional experience: (a) formal/non-formal/informal education (environment for organization of activity); (b) teaching/learning/practical activity (environment for learning activity); (c) knowledge/skills/attitudes (environment for intellectual activity); (d) information/narration/discussion (informative environment of learning); (e) external conditions of organization/inner conditions of organization/individual's life environment (internal and external environment of education); (f) global influence/local influence/individual choice (environment of contexts for thinking activities); (g) ecology/integration/spirituality (environment of principles of subjective world view).
- (3) each type of specific environment was evaluated in the context of students research approaches and means clarifying the possibilities to implement these approaches and means in learning and research environment designed by teachers' cooperative activities.

Results

In order to demonstrate the possibilities of school environment to foster the students' research work, the specific types of learning and research environments will be analysed further. The research approaches and means of secondary school students will be

displayed in Tables 2-8 that will be complemented with the descriptions of corresponding learning and research environments.

(a) Formal/Non-formal/Informal education

Analysing approaches and means of students' research works, it was found that experience obtained by students in formal, non-formal and informal education was applied. All secondary school students are involved in the formal learning process. The non-formal activities proposed in the school likewise involve all students; statistics show that on the average, each student takes part in several non-formal types of activity (hobby groups, special courses, projects).

Evaluation of students' engagement in the activities of formal, non-formal and informal education reveals that the activities proposed in the school promote development of research skills through the means of activity reflected in Table 2.

Table 2. Research approaches and means in environment determined by Formal/Non-formal/ Informal education

Research approach	Means of learning and research
A	Extension of the existing theory, interpretation. Descriptive narrative.
B	Extension of the existing theory, interpretation. Experience of a particular level or sphere chosen by the researcher.
C	Transference of the known to a new environment. Experience of a particular level or sphere chosen by the researcher.
D	Transference of the known to a new environment. Descriptive narrative.

Creating this type of environment, teachers proceeded from the following considerations:

- Formal education promotes the environment favourable for development of research skills as one of the normative types of activity. In a formal environment, students learn what the state deems appropriate at the particular period of time. Teachers incorporate research activity in their lessons (Grishane, 2007a).
- Non-formal education opportunities proposed are diverse in their form and content – interest education hobby groups (of art, sport, creation), extra-curricular activities (competitions, projects, conferences), special courses (art of philosophy, business etiquette, social relations, strategies of sustainable development, etc.). These activities create environment that integrates knowledge, develops skills and forms a habit of looking at problems from various perspectives.
- Informal education enables students to acquire life experience in communication with family, schoolmates and society in general. In research works, such experience serves as a catalyst for research of subjectively significant

phenomena and/or phenomenological processes and generates non-traditional research questions. Therefore, students begin their research by determining their opinions and personal experience and complement their personal experience with interests and life experience of diverse social groups.

(b) Teaching/Learning/Practical activity

The next environment was discovered by observing the integration of different skills applied by students. These skills were developed in (1) practical activities, and (2) mastering the theory.

Students' educational achievements are an important indicator of the quality of teaching and learning work at school, provided that they are not considered the only aim of education. For several years the average level of students' knowledge (indicator of objectively measurable results) is above 88% of ABC level achievement (average level of state secondary schools – 89%, average level of secondary education institutions – 64%).

Evaluation of teaching and students' involvement in learning and practical activities reveals that the proposed activities promote the development of research skills reflected in students' works as the research approach and means (Table 3).

Table 3. Research approaches and means in environment determined by Teaching/Learning/ Practical activity

Research approach	Means of learning and research
A	Suggesting new assumptions and research questions. Awareness of theoretically and practically tested values.
B	Suggesting new assumptions and research questions. Study of the sample selected by the researcher.
C	Testing the hypothesis formulated in the beginning of research. Study of the sample selected by the researcher.
D	Testing the hypothesis formulated in the beginning of the research. Awareness of theoretically and practically tested values.

Practical activities proposed in the school for creation of this type of environment:

- The teaching methods are sufficiently diverse to ensure an opportunity for all students to achieve the highest possible learning results. This is confirmed by the analysis of the observed lessons (Grishane, 2007a) as well as by the stable results in state examinations demonstrated over a considerable period of time (evaluation by external experts).
- Helping students to acquire learning methods is one of the priorities. Presentation of learning methods is integrated in both formal and non-formal education activities.
- Students are engaged in practical activities during lessons (e.g. laboratory work), within non-formal education (both during special courses and projects), participating in social activities and carrying out independent research work.

(c) Knowledge/Skills/Attitudes

Students tend to conduct the research grounded on the exploration of research object in its natural environment and reflecting its history. Selecting research approaches and means students use knowledge, skills, and attitudes obtained in classes and transfer them to their research work.

Content analysis of research works (Grishane, 2007b) reveals students' interest in particular disciplines and the correspondence of the choice of research topics to the educational programme mastered by the students. The activities of learning process also affect students' choice of research topic and means. The more diverse the teachers' work during the lessons, the more students choose to do their research in the respective discipline.

Teachers' cooperation with students in acquiring knowledge, developing practical skills and attitudes allows for the development of research skills that are reflected in students' work as the means of learning and research depicted in Table 4.

Table 4. Research approaches and means in environment determined by Knowledge/Skills/Attitudes

Research approach	Means of learning and research
A	Study of a phenomenon in its natural environment. Innovative suggestions for further research. Study of historical background of issue. Describing the essence of the phenomenon.
B	Study of a phenomenon in its natural environment. Innovative suggestions for further research. Study of knowledge (about something), convictions and/or skills. Person's attitude towards themselves, the world and others.
C	Building on a particular theory. Experiment. Study of knowledge (about something), convictions and/or skills. Person's attitude towards themselves, the world and others.
D	Building on a particular theory. Experiment. Study of historical background of issue. Describing the essence of the phenomenon.

Practical activities proposed in the school:

- Consulting students about their research works, teachers create environment in which a student realises the peculiarities and opportunities of a particular science. Part of the knowledge acquired through formal education gives an immediate return (e.g., IT, Biology, Health studies, etc.). The significance of knowledge acquired in some other subjects is revealed only with time (e.g., History, Ethics, History of Culture, Philosophy as bearers of spiritual values). Some subjects have double implications – for instance, students can perceive the Geography both as a natural and social science.
- Teachers create the possibility to engage in experimentation and analysis of obtained data. Activities and interactive teaching methods allow to enrich the individual research experience.

- To develop healthy attitudes, students have to experience conventional social relationships and comprehensive practical display of such attitudes in daily communication. This experience is obtained through collaborative culture and practice of teachers, students, and parents.
- The outcomes of attitude education that emphasises cooperation, dialogue, partnership, values education and acquisition of life skills are also integrated in students' research works.

(d) Information/Narration/Discussion

Searching for truth, students use different questions. The means of research is linked with the research questions and how the information is interpreted. The students use the questions characteristic both for qualitative and quantitative research approaches. Following modes were used: (1) collection of information, (2) comprehension of narration, and (3) discussion in relation to students' individual needs, interests and research skills (see Table 5).

Table 5. Research approaches and means in environment determined by Information/ Narration/Discussion

Research approach	Means of learning and research
A	The research work answers the questions: How does it happen? How is it manifested? Interviews. Interpretation and comparison of generally accepted opinions. General adaptation of information.
B	The research work answers the questions: How does it happen? How is it manifested? Interviews. Learning from specific experience. Characteristics of a specific situation.
C	The research work answers the questions: How much? How often? Questionnaires and analysis of the data. Learning from specific experience. Characteristics of a specific situation.
D	The research work answers the questions: How much? How often? Questionnaires and analysis of the data. Interpretation and comparison of generally accepted opinions. General adaptation of information.

The school provides these modes in following way:

- The availability, amount and significance of information are ensured by updating the school's resource basis and developing both students' and teachers' information processing skills. Activities in order to obtain and expose information characterise formal teaching (identified in the observed lessons), non-formal activities (e.g., special courses), and communication with family members.
- Informative narration provides students with a broad range of facts and gives an opportunity to learn about various opinions and choose criteria for formulating their own opinions. Students demonstrate a practical application of formulating, substantiating and coordinating opinions in extra-curricular activities.

- Discussion is sustained both by the availability of diverse information and by the ability to critically evaluate and analyse the obtained information, which lie at the basis of any research work. Students are involved in the national and international projects, discussions among groups of students, students and parents, students and teachers as well as in debates with politicians, municipal administration and professionals of different spheres.

(e) External conditions/Internal organisational conditions/Individual's life environment

Analysing the links between the research approaches and needs to study the objects from different perspectives, it was determined that students tend to examine the research themes grounded in their own experience, or on the analysis of external or internal organizational conditions.

These skills appear in students' work as the means of learning and research displayed in Table 6.

Table 6. Research approaches and means in environment determined by External Conditions/Internal organisational conditions/Individual's life environment

Research approach	Means of learning and research
A	A clear focus of research. Description of daily life, individual's problems, meaning of life. Comparison of personal opinion and theoretical verities.
B	A clear focus of research. Description of daily life, individual's problems, meaning of life. Cognition, adaptation, communication, acquiring of experience.
C	Statistics, data. Checking facts. Cognition, adaptation, communication, acquiring of experience.
D	Statistics, data. Checking facts. Comparison of personal opinion and theoretical verities.

Organisation of school's environment:

- In the contemporary globalised information field, the school provides students with broad opportunities to receive the necessary information as well as to develop IT skills and engage in international networks.
- Internal organisation is structured according to the cultural model of social relations and traditions, thus permitting students to practice relationships and certain patterns of behaviour. School staff purposefully creates the circumstances allowing practically apply the rules and norms of social relations. Suggested activities develop ability to agree and assume responsibility. Social behaviour is acquired mastering the traditions and characteristic models of cultural environment.
- The more students cooperate with others in the social life of the gymnasium and beyond (through formal, non-formal and informal activities), the richer is the content of their research works. Individuals integrate the experience of others and create their own "lifeworld".

(e) Global influence/Local influence/Individual choice

The students follow inductive or deductive perspectives in selecting the context for the research theme. They integrate these perspectives using the phenomenological or concrete experience methodology and therefore designing their individual perspective and understanding about the process or phenomenon under the research. Research skills manifested in students' works indicated environment allowing to (1) master the global context, (2) master the local context and (3) make the individual choice joining the global and local experience.

These skills appear in students' works as it is showed in Table 7.

Table 7. Research approaches and means in environment determined by Global influence/Local influence/Individual choice

Research approach	Means of learning and research
A	Research is mainly inductive. Details of experience. Analysis of regularities.
B	Research is mainly inductive. Solving practical problems. Study of time and/or space bound experience.
C	Research is mainly deductive. Solving practical problems. Study of time and/or space bound experience.
D	Research is mainly deductive. Details of experience. Analysis of regularities.

The school ensures the mastering of mentioned contexts in following way:

- Global influence is manifested at school as opportunity for students to acquire foreign languages and IT, get involved in international projects, and travel in virtual and real space. Learning involves the studies of processes in the world, determining factors and facts in a particular period of time and/or sphere, or researching the quantitative and qualitative capacity of global resources.
- The school proposes activities for research of local processes: studies of the community, sustaining and preserving cultural-historical traditions, involvement in practical activities. Enhancing the environment and charity campaigns enable students to learn about the needs of community and natural environment promoting awareness of values, ensuring understanding of equity, environmental sustainability and social security (education, healthcare, capacitated governance, etc.), as well as skills that enable students to enliven these values.
- Awareness of self is related to the global and local contexts and ability to perceive values, experience a sense of belonging and responsibility. Individuality is formed under the influence of family, school and society. Students identify themselves with individually significant norms and values of a particular culture and a certain lifestyle.

(f) Ecology/Integration/Spirituality

The students' research work shows the need for the reflection on the societal development and wish to search for the solutions to improve the quality of relationships or phenomena. The interaction between the learning environment, students' research skills and thematic contexts fosters the skills to analyse the social activities from the point of view of sustainable development. The students' research work contained the three principles of sustainable development – ecological, integrative and spiritual principle. These principles determine the students' individual frames of references and they are used and interpreted differently in students' works.

Evaluation of these interpretations in the context of sustainable development revealed the means used in students' research works (see Table 8).

Table 8. Research approaches and means in environment determined by Ecology/Integration/Spirituality

Research approach	Means of learning and research
A	A clear aim set by the researcher. Reflection on the significance of the process.
B	A clear aim set by the researcher. Aim – to improve the quality (of work, life, etc.).
C	Researcher detached from the subject of research. Aim – to improve the quality (of work, life, etc.).
D	Researcher detached from the subject of research. Reflection on the significance of the process.

The principles of sustainable development are applied at school using the following strategies:

- At school, the ecological principle is proposed as the rational use of resources and development of considerateness. This principle is understood by students in their research as providing ecological safety and preservation of biodiversity.
- The social aspect of integration is proposed to students as freedom of choice and respect for traditions. Students participate in discussions and activities learning the principles of just legislation, executive power and judiciary, social and intergenerational justice and developing their own frames of reference for evaluation of democratic processes.
- Spirituality develops when students reflect on and research attitude toward life and life sustaining system, relationships among people with an emphasis on moral and ethical issues – the rights of posterity to welfare, responsibility for biosphere, etc.

Each educational institution is able to create its own supply of activities grounded in the analysis of specific types of environment and the selected criteria that characterise specific means of activity. Purposeful practical activities that are part of the diversified educational process, influence students' research skills, create and sustain interest in research and develop research experience.

Conclusion

The given research indicates three conditions determining the design of schools' research and learning environment for secondary school students' research activities. Each of these conditions marks three dimensions discernible in school's research and learning activities:

- (1) integration of students' inquiry and teachers' individual professional view into initial *subjectively significant inquiry*. Such an inquiry is developed from (1) the students' individual interests and inquiry (initial selection of subjectively significant contexts and maturing research intentions) and (2) teachers' subjective perspective on students' research work in secondary school based on teachers' personal and professional experience.

Subjectively significant inquiry is open, active and reflective offer for school environment or **dimension of subjective inquiry in school environment**.

In the research described above it was realized through the qualitative analysis of students' research approaches, means and content as well as studying teachers' views on research and learning environment in school. Research on subjectively significant inquiry elicited the dialogue about the research-oriented environment in gymnasium.

- (2) *ability of school to design the environment* for coordination and complementarity of students and teachers research work. It is a search for the solutions how to offer the students possibilities to realize their subjectively significant inquiry on the one hand and give the teachers opportunity to develop their PPT on advanced school environment supporting the research and learning on other hand.

The second condition is also the invitation for teachers and students to engage in active research work and collaborative activities while designing the school environment. This collaboration and reflection on the school's environment manifests as a **dimension of identity of school's environment**. In this case the school's environment is evaluated as a common field for the realization of students' research work enabling the possibility to satisfy the different subjectively significant inquiries.

- (3) influence of school environment on the development of students and teachers' subjective *inquiry toward the aim of sustainable development*. This condition is based on the evaluation and reflection on research work. The first stage of evaluation concerns the influence of schools' environment on the research work, second stage suggests the evaluation of the further development of this environment in a more extensive context of sustainable development. This evaluation of research and learning environment as well as the reflection connected with it can be grasped as the **sustainability dimension of schools' environment**. The main task of this dimension is the evaluation of research and learning environment and outcomes of students' research work in a context of aim of sustainable development.

The results of this analysis can be implemented by educational institutions, which organise students' research activities. The described methods and means can be used in learning environment with no supplementary material resources required and involving teachers in research of school environment therefore re-orientating their professional frames of reference to address sustainable development.

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Received 21 August 2008; revised version received 22 November, 2008

**INTERDISCIPLINARY MATHEMATICS AND
SCIENCE EDUCATION THROUGH ROBOTICS TECHNOLOGY:
ITS POTENTIAL FOR EDUCATION FOR SUSTAINABLE
DEVELOPMENT (A CASE STUDY FROM THE USA)**

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Abstract

This case study pictures the challenges and successes described by two Grade 8 teachers as they attempt to use robotic technologies to integrate their mathematics and science curriculum in an interdisciplinary manner. We share our observations regarding the difficulties the teachers faced and their perceptions as they used the technology as part of classroom instruction. Our analysis indicates that the technology served as an effective management tool for teachers and a strong motivational tool for students. However, the data also reveal that the teachers struggled to integrate the technology in a manner that supported interdisciplinary instruction, particularly because they lacked time and appropriate curricular materials. Consequently, we argue that for robotic technology to be used as a model to support education for sustainable development, specific curriculum, adaptable to local contexts, needs to be readily available.

Key words: *teacher education; interdisciplinary; robotic technology; technology integration; education for sustainable development.*

To support sustainability in mathematics and science educational reform in the United States, the National Council of Teachers of Mathematics (2000) and the National Science Teachers Association (National Research Council, 1996) recommend making their respective disciplines meaningful to students by helping them recognize connections to the real world. Both organizations stress the need for inquiry-based learning approaches and emphasize integrating content across the curriculum (American Association for the Advancement of Science, 1990). Implementing such integrated approaches in mathematics, science and technology will require curriculum that supports teachers as they work toward instruction that is interdisciplinary and that empowers students for life-long learning as envisioned by international organizations (UNESCO, 2005). Such curriculum needs to consider contextual factors that influence teachers' beliefs and, consequently, their instructional practices (Grabovska, 2006; Pipere, 2006). Such factors include school culture, parental expectations, teacher expectations, and student demographics.

Many of today's students have grown up using sophisticated technologies. Teachers, parents and administrators readily see evidence of the motivation factor inherent in the use of technology to enhance learning school science and mathematics (Adams, Brower, Hill & Marshall, 2000; Park, O'Brien, Eraso & McClintock, 2002). Because children learn best when academics are contextualized in meaningful experiences, teachers are encouraged to integrate technology use into the classroom, not only for the teaching of mathematics and science but also to help students develop socially and intellectually (Bers, New & Boudreau, 2004; Murray & Bartelmay, 2005). Guerrero, Walker, and Dugdale (2004) concluded that appropriate technology use in middle grades mathematics can have positive effects on students' attitudes toward learning, confidence in their abilities to do mathematics, engagement with the subject matter, and conceptual understanding. As such, the use of technology contributes to student learning. Robotics, the example of technology examined in this study, has the potential to facilitate education for sustainable development by serving as a force for interdisciplinary connections between mathematics and science.

Because interdisciplinary education is an aspect of education for sustainable development (UNESCO, 2005), teachers need to learn to implement technology in the classroom in ways that cross traditional discipline boundaries. Therefore, the focus in this paper is on instructional practice and curriculum oriented toward this aspect of education for sustainable development.

Much has been documented about the difficulties teachers face in implementing new materials, particularly technology (Bright & Prokosch, 1995). Rochowicz (1996) determined that instructors are slow to utilize new technologies in their classrooms because they perceive that implementation requires too much time and effort. In order to ensure technology utilization, there is a need for appropriate curriculum that supports the use of technology. In addition, if technology is to be used for interdisciplinary instruction, particularly associated with mathematics and science, appropriate curriculum materials to support such interdisciplinary instruction need to be available. Concerns related to the economic sustainability of such technology also need to be considered. Pipere (2006) infers that the core idea of education for sustainable development (ESD) "is *SELF* actively engaged in this world and living out its unique experience in relationship with the environment" (p. 46). Thus, teachers and their students need to be actively engaged with the technology and how the technology interacts with their specific classroom environment. Both also need to consider how technology facilitates collaboration and encourages students to engage in teamwork.

In recent years, educational technology has included robotics to stimulate student learning of mathematics and science concepts and skills in situations that reflect the occupational workplace of scientists and engineers (Cutshall, 2003; Davis, 2006). Robots provide a context for teaching students about concepts important to technological literacy as well as mathematics and science concepts (Clark, 2002) and their use can produce high levels of motivation (Geissler, Knott, Vazquez & Wright, 2004; Reese et al., 2005). In case studies of three Grade 8 science teachers, Robinson (2005) found that robotics can promote inquiry and make learning more interesting than typical text-based instruction. Intriguing instruction that motivates students is often a critical component of empowering students for academic learning.

Overview of the robotic equipment

This study focuses on teachers' use of a specific technology, *robotic arms*, in mathematics instruction. The robotic arms were either operated through computer commands that put the robotic arm through a series of movements (Figure 1) or controlled by using joysticks (Figure 2). The robotic arms have rotational up/down movement at a *shoulder*, up/down movement at an *elbow*, and rotational movement at a *wrist*. In addition, a *hand* can be opened or closed to pick up/put down objects. Control of the robotic arm requires three commands: direction, magnitude of movement in centimeters, and degrees of rotation. Users learn to manipulate the arm with programming commands, as well as through completion of measurement and estimation activities.

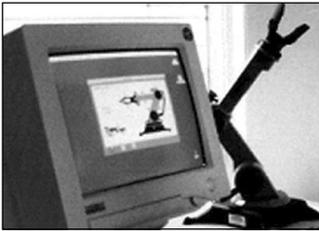


Figure 1. Robotic arms operated through the computer

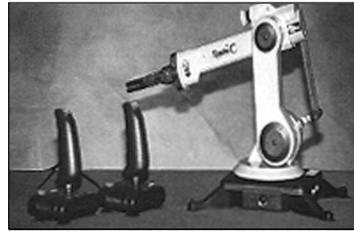


Figure 2. Robotic arms operated through the joysticks

Methodology: An intrinsic case study

The case study described in this article was initiated in late November and continued through the remainder of the school year. We describe the classroom environment, the use of the technology, challenges of implementation, and teachers' perceptions as two teachers at one school attempted to integrate the robotic arm into their mathematics and science curriculum. We also consider issues related to the use of robotic technology to integrate mathematics and science as a way to support ESD.

Design of the study

Stake (1994) describes “intrinsic case studies” as those that arise from an “intrinsic interest in [a] particular child, clinic, conference, or curriculum” (p. 237). For instance, our inherent and pre-existing interest in the integration of technology into mathematics and science teaching motivated the case study presented in this paper. The case is bounded (Miles & Huberman, 1994: 25; Stake, 1994: 244) by our focus on one school's implementation of a novel robotics technology, and further narrowed through the participation of one female mathematics teacher and one male science teacher, along with the 27 eighth-grade students they shared. Both teachers were in their late 30s and both had been teaching for over a decade in urban schools. The two teachers helped us unearth information and perspectives that illustrate important issues to consider in any professional development endeavor and particularly when introducing novel technology.

Data collection

Because we were interested in teachers' perceptions related to the robotic equipment, data collection consisted of teacher interviews before and after classroom implementation of the technology and classroom observations during technology use. Prior to data collection, a two-day technology training workshop was facilitated by the developer of the robotic equipment. In particular, teachers listened to lectures about the robotic technology, including how to direct robotic movements manually and how to program and sequence robotic movements. Minimal time was spent in hands-on activity to familiarize the teachers with the equipment.

Teacher Interviews. Author 4 developed the interview protocols. The initial interviews were conducted individually to ensure that information was solely the individual's perceptions; the final interview was conducted jointly with the two teachers, as they had been team teaching with the technology. These interviews were taped and fully transcribed. The initial teacher interviews occurred after the technology training workshop, but before its use with students to gain insight into the teachers' instructional philosophy regarding the potential for technology integration. In particular, the researchers were interested in any concerns teachers had about use of the technology, perspectives on preparation for its use and its potential to influence student attitudes, connections between the technology curriculum and the school's mathematics and science curriculum, and insights into the potential for collaboration between the mathematics and science teachers to teach in an interdisciplinary manner. At the end of the school year, the teachers were interviewed again regarding issues related to technology implementation, specifically about their experiences with the technology, the aspects of the technology curriculum they would keep and those they would change, how students interacted with the technology, and any additional support they needed prior to further technology use.

Observations. During the time in which students were engaged with the technology, the researchers (professors of mathematics education, science education and chemical engineering) observed the classroom instruction on four separate occasions and conversed with students as they worked on topics addressed with the robotic arms as part of their normal instruction. At most, two of the researchers observed on each occasion. We spoke with the science teacher before each observation about his instructional plans for that session. After each observation, we met separately with both teachers to discuss aspects of the class session that seemed relevant to our understanding of the pedagogy, instruction and learning we had witnessed. In addition, we collected artifacts in the form of teachers' plans and assignment sheets.

Data analysis

Our analysis was carried out collaboratively. Authors 1 and 3 conducted interviews with the teachers; Author 2 transcribed the interviews. We initially viewed the interview data separately, creating tentative themes to reflect what each of us independently perceived in the data. We then met to develop and refine our themes, as guided by our research paradigm. We noted that individual themes were similar, clustered them and chose appropriate language to describe them. Interview data were triangulated with data from our observations and from teachers' planning artifacts; representative interview

comments were identified to enrich our descriptions of each theme. This ongoing process of data reduction (Miles & Huberman, 1994) was finalized through our writing and re-writing of the findings sections.

The findings are organized to focus first on the professional development prior to implementation, second on initial perceptions about technology, and third on the teachers' experiences in the technologically enhanced learning environment. With each section, we include the themes that emerged through our analysis; where appropriate, we supplement interview findings with our classroom observations as students used the robotic technology. In the discussion that follows, we use the pseudonym "Jack" for the science teacher and "Diane" for the mathematics teacher.

Teachers' reflections on technology use

The case study findings are based primarily on teachers' perspectives of technology use in instruction, and on issues and challenges they faced. As such, this information brings light to issues related to using technology to implement interdisciplinary mathematics and science instruction striving for effective ESD. Although we focus the analysis from the teachers' perspectives, we also consider the students' experiences through the viewpoint of their teachers.

Teachers' interactions with the technology during training

During the initial technology training, Jack was curious about the technology and impatient to manipulate the robotic arms. In contrast, Diane was hesitant about using the technology, especially with conjecturing and estimating the angle of rotation when manually moving the robotic arms. As a result, Jack operated the robotic arm while Diane observed and took notes. Jack and Diane's different perceptions of and interactions with the robotics equipment illustrate an instance of the self in reaction to the professional development environment.

Jack believed the training was overly focused on general mathematical principles and did not provide enough opportunity for hands-on work with the equipment. The teachers felt they did not have time during the workshop to consider or create possibilities that this equipment might hold for enriching or supporting their curriculum. Jack stated, *I didn't have all that much time [at the workshop] to go into the details of the program.* The technology was complex enough that the teachers needed time to familiarize themselves with and understand how the technology functioned. As Jack summed it up, *I could have used it much more effectively this year if I had known how to use it.* Diane added, *I feel prepared to be prepared,* which is not the same as being ready to implement. Thus, although the teachers had some experiences with the technology, the professional development did not include opportunities for the teachers to consider how to integrate the technology into their existing curriculum to support attempts to engage in interdisciplinary instruction.

Teachers' initial perspectives about technology use

The teacher interviews, prior to implementation, accessed teachers' perceptions about the impact of the new technology on student learning, in addition to curricula integration.

Managing management. After the initial technology training, both teachers believed that their students would react positively to the robotic technology. However, both also expressed concerns about classroom logistics related to technology use.

Linking to the content. Although Jack believed the robotic technology could supplement the science curriculum, he also noted that the technology implementation *came a little late in the [academic] year for the opening section of physical science, which was tools and machines.* For mathematics, Diane believed the robotic arms could reinforce concepts related to estimation, fractions and percentages, stating that *estimation has generally been most problematic in our standardized scores.* Further, she believed that the robotics activities could help students hone their estimation skills as they estimated the degrees of rotation, both positive and negative, to move the robotic arm to a specific location and then combined their multiple rotations to a single rotation ending in the same location. Diane elaborated:

The positive and the negative of how far it went this way, and how far it went that way – the abstract concept of positive and negative integers is always difficult with them and when they do it this way [with the robotic arm], they can see that if it went this far it was probably the exact negative.

Diane appeared to believe that this technology could help students visualize and make physical some of the abstractions of mathematics. Despite recognizing potential benefits of the technology, both teachers indicated that they needed more knowledge about the operation of the technology before they could use it in whole class activities.

The comments from these teachers also suggest that not enough attention was paid to how the technology could be used in an interdisciplinary manner. Both teachers were focused on the use of the technology for their respective disciplines. The lack of curricular support for interdisciplinary instruction, coupled with their unfamiliarity with the technology, made it less likely that the technology could serve as a model of education for sustainable development.

Teachers' reflections on classroom use of the technology

The interview with the teachers at the end of the school year accessed teachers' perceptions about technology implementation and curriculum development as well as any insights on issues and challenges faced when attempting to use such sophisticated technology.

Challenges of implementation. The teachers discussed the challenges of the classroom use and their attendant lack of experience. These challenges prohibited the teachers from doing all that they had hoped in terms of their students' development of mathematics and science concepts, although there was some progress in this area. Both teachers highlighted several challenges related to the technology use. Neither felt that their initial training was extensive enough to help them fully understand how to use the technology in the classroom. According to Jack, *I could have used [the equipment] much more effectively this year if I had known how to use it.* As a result of insufficient time during

training and minimal support during implementation, the teachers had to learn how to operate the robotic arms, on their own, as the school term proceeded.

Impact on student attitudes. The most striking aspect of the teachers' discussion of the technology was its potential and actual influence on students' attitudes, particularly in terms of collaboration and motivation. Both teachers spoke of their goals with this technology as enhancing collaboration among students. They spoke even more strongly of the motivational and reward potential. In this sense, then, the technology appeared to be more powerful as a management device than as a content-learning tool.

Jack observed that students seemed to find the activities enjoyable, and that the technology had some effects on social skills, noting that the robotic arm technology *gives the hands-on kids a chance to participate with the non-hands-on kids.... So it was good for self-image.* When Jack and Diane assigned students to work in groups, they ensured that each group was comprised of a mixture of more and less academically-successful students. Jack noted the efficacy of this grouping in developing collaboration:

I would see the kids who were always in all the honors classes, and the kids who were always in the office – a couple of times, you could really see it, you could really see where [the lower performing students] were getting it and they were getting it as a part of a group.

Jack believed that because the technology required mechanical aptitude in addition to intellectual ability, the playing field was leveled; he noted that low-performing students gained respect from higher-performing students because of their aptitude with the technology. Thus, students who were often marginalized because of academics were empowered through the use of this technology.

Building self-esteem was another aspect of the students' interaction with the technology that these teachers viewed as a strong possibility. Diane said that many of her students were already more adept with technology than she and could instruct others; she continued, *They very rarely get called upon ... to show anybody anything. Some of my kids who don't usually get to be the ones to come and show somebody something, I think they'll be great with it.* Jack used an example to illustrate his belief that the collaborative approach allowed the growth of self-respect:

I saw a couple of times when the girls would say you do it' because they were in a [team] competition and they wanted [their team] to win the competition, so the guy they make fun of because he wasn't as smart as they were, but was adept with the joy-stick and computer games, suddenly became their stand-up guy.

Implications related to reorientation for sustainability

Throughout this article, we have focused upon two Grade 8 teachers' efforts to integrate robotic arm technology into their curriculum. This small study is a starting point for further examining issues involved with implementing new technologies and integrating associated activities into the existing curriculum. One issue that appears key to sustained implementation is the need for well-defined activities that specifically connect to the intended curriculum, in this case using robotics to facilitate interdisciplinary instruction. Technology integration is difficult when the goal is simply to use the robotics "because

they are there". Even creative teachers experience difficulties when there is a lack of related curricular support. Teachers do not have excess instructional time during the school year, so technology needs to connect to required objectives if it is going to be implemented and integrated into the mathematics and science curricula in a meaningful way; otherwise, implementation is difficult, if not impossible. On one level, this result is not surprising. Nevertheless, curriculum developers and researchers into new technologies often fail to account for this time in a realistic manner when materials are implemented in real classrooms beyond a pilot stage. Consequently, promising changes become unsustainable in the long term, as theory collides with practice.

Although there were difficulties with integration into the existing curriculum, the technology did serve as a motivational tool. The teachers found the robotics technology motivating, and possibly supportive of their students' learning. Although they would have liked to use it, the teachers were constrained by time and by lack of support in developing appropriate activities that integrated the technology into their required curriculum in an interdisciplinary manner. The technology was provided by the inventor and support mechanisms were finite and inadequate. As such, sufficient time was not available to prepare the teachers to integrate the robotic technology into their teaching repertoire in an effective manner.

Jack and Diane expressed concern for student involvement during regular class work, particularly problem solving as students used pencil-and-paper techniques to compute solutions. However, there were no such problems with involvement when the robotic technology was used; students looked forward to their time with the technology. Therefore, this study supports the findings of Adams et al. (2000), Park et al. (2002) and Guerrero et al. (2004), indicating that technology affords an environment capable of nurturing student motivation and engagement with classroom activity. Moreover, the study echoes the theoretical stance of Grabovska (2006) that sustainable education is an integral part of teachers' development of essential skills to adapt existing instructional resources according to local contexts. Although students are clearly motivated by the use of such technology, that motivation alone is not sufficient to sustain its use.

The issues and challenges shared in this article come from just two teachers but are similar to viewpoints echoed by others teaching mathematics and science (Groff & Mouza, 2008; Guerrero, Walker & Dugdale, 2004). Jack and Diane do offer a word of caution to university educators and curriculum developers interested in influencing change through high-powered or sophisticated technology. Such developers need to be cognizant of local contexts in order for teachers to implement changes in a sustainable manner. A one-size-fits-all approach in terms of curriculum and technology integration that is not amenable to adjustments to fit local conditions is often destined for failure (UNESCO, 2005). In order for any new reform to be sustainable, teachers require time to work with the equipment and plan instructional activities, and they require support during implementation. That support needs to be specific to teachers' classroom practice and their local curriculum, be easily accessed and systemically sustained. This small study is a starting point for further examining ESD issues involved with implementing new technologies and integrating associated activities into the existing mathematics and science curricula to develop an interdisciplinary approach.

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Received 17 June 2008; revised version received 13 October, 2008

INTEGRATING KNOWLEDGE, FEELINGS AND ACTION: USING VEE HEURISTICS AND CONCEPT MAPPING IN EDUCATION FOR SUSTAINABLE DEVELOPMENT

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Abstract

Although children are regularly showered with environmental knowledge, this is rarely transformed into concerned action, probably because it is not meaningful for the learner and/or is highlighted at the expense of a personalized process of learning. Research in Education for Sustainable Development shows that besides knowledge acquisition feelings, psychological factors and active participation while learning are important determinants of commitment. Fostering an attitude of responsible environmental action is not dependent on what knowledge is delivered, but on how it is delivered and experienced. This paper describes the use of Vee Heuristics and Concept Mapping as pedagogical tools within the context of primary school learners' different learning patterns. It provides illustrations of Concept Maps constructed before and after the learning programme and discusses some implications of the findings. This paper suggests that the use of Vee Heuristics and Concept Mapping along with an awareness of how the child prefers to learn may be steps towards tapping-in the child's internal talking so that educators can understand how each learner responds to incoming information. Learning about environmental issues becomes relevant, meaningful and, in the long run, conducive to improved environmental responsible behaviour.

Key words: Vee Heuristics; Concept Mapping; learning process; environmental education; metacognition; meaningful learning.

Education for Sustainable Development: Going beyond transmission of knowledge

Research and experience have shown that placing greater emphasis on the transmission of environmental knowledge does not significantly impact a learner's concerned action. Content matter needs to be meaningful for the learner and sensitive to the learner's personalised process of learning. Based on this premise, one assumes that what matters is not *what* knowledge is delivered but *how* it is delivered and experienced.

Different forms of Environmental Education (EE) were readily taken up by educational institutions – the most recent being Education for Sustainable Development (ESD) – as a means to improve quality of life and counter environmental degradation.

Although educational programmes succeed in promoting environmental awareness, they have very often failed to produce substantial changes in attitudes, values and committed action. These three original objectives were proposed by the Tbilisi 1977 Conference (UNESCO, 1980) and subsequently reaffirmed at the 1987 Moscow Congress (UNEP, 1987), the 1997 Thessaloniki Conference (Scoullou, 1998) and the 1997 Conference at Ahmedabad (CEE, 2007). The narrow monodisciplinary structures of formal educational institutions traditionally promote the transmission of subject content. In the traditional paradigm, cognition (i.e., the processing of information or knowledge) is highlighted at the expense of feelings and behaviour (Pace, 2000). However, the misconception that the transmission of environmental knowledge would be sufficient to trigger an attitude of responsible action evolved into something more complex where, “the way in which learning occurs is as important as the content” (Orr, 2004: 14).

Borden and Schettino (1979, as cited in Newhouse, 1990) also reveal that the more important determinant of commitment (action) is the level of feeling rather than the level of knowledge. Simmons (1991) defines responsible environmental behaviour not only through cognitive factors, but also through conative and affective factors such as problem-solving skills and psychological factors, including attitudes and the development of self-esteem. Making environmentally responsible decisions requires social and psychomotor skills, as well as affective attributes such as responsibility and commitment toward sustainable development, i.e. the development of a sustainable development ethic. In turn, this is dependant on whether “knowledge is interrelated to personal behaviour and social values, and if the learner experiences ethical demands in decision making” (Schleicher, 1996: 2).

One of the most important factors of commitment is environmental sensitivity, i.e. “a predisposition to take an interest in learning about the environment, feeling concern for it, and acting to conserve it, on the basis of formative experiences” (Chawla, 1998: 9). Furthermore, Chawla explains that formative experiences may be characterized as exchanges between an external environment (physical surroundings, social mediators) and an internal environment (how the child responds to the external environment). Any effective ESD programme, therefore, needs to place the learner and his/her personal development at the centre of the learning programme.

The Let Me Learn Process®: An advanced learning system

The present study delves deep into the learning process and reveals that if we only look upon cognition, we are only looking at one-third of who the child really is as a learner. This research highlights the Let Me Learn Process (LML), an advanced learning system, whose theoretical basis is the Interactive Learning Model (ILM) (Johnston, 1996, 1998), which proposes that learning is a process occurring because of the continuous interaction of no less than three mental processes: Cognition (I think), Affectation (I feel) and Conation (I act). ILM gives teachers, students, parents, and administrators another means of identifying how each student processes information, uses her/his personal tools for learning, and develops as a confident and successful lifelong-learner. Furthermore, the interaction between cognition, conation, and affectation forms interactive patterns of behaviour within each learner. These patterns consist of sequence, precision, technical reasoning, and confluence (see Table 1). Rather than placing individuals into categories, the Let Me Learn Process emphasizes that each learner uses each of these interactive patterns in concert and to varying degrees.

Table 1. Summarized description of the four learning patterns

Learning pattern	Learner prefers
Sequence	Order, plans, directions, linear logic, continuity
Precision	Facts, information, documentation, measurement, correctness
Technical Reasoning	Problem solving through design, structure, physical and pictorial representation without the burden of words, use of combat engineering to fix physical/abstract problems
Confluence	Risk taking, learning through failure, rapid ideation, extreme imagination, readiness to suspend rules and the limitations of reality in order to move beyond the known

To measure the degree to which each learner uses each of the patterns, Johnston and Dainton (2005) developed the Learning Connections Inventory (LCI) that has withstood empirical and theoretical testing for more than ten years in different countries around the world. The LCI scores reveal whether the learner uses a learning pattern at a “Use First” level, “Use as Needed” level or seeks to “Avoid” it altogether.

Information enters the brain through our sensory systems and some of it is processed in our working memory. Some of this information is stored for future retrieval in our long-term memory. Our working memory is similar to “a computer’s central processing unit” while our long-term memory is the “computer’s hard disk” (Bruer, 1993). Cognitive psychologists claim that long-term memory comes in an array of structures that can either be declarative memory (storing facts and events) or non-declarative memory (storing skills and procedures). Nonetheless, unlike a computer, we do not retrieve information by giving it “an address” in our brain, but by creating associative links between chunks of information. This suggests that new learning is integrated into pre-existing structures which psychologists call *schemas* that effect how we process and interpret incoming information. Bruer argues that “prior knowledge affects how we interpret school instruction and thus affects what we can learn. School instruction that ignores the influence of pre-existing knowledge on learning can be highly ineffective” (Bruer, 1993: 28) and, we add, potentially damaging to a student’s plans for further education as success within the system is dependent not on the competency of the learner, but on his/her ability or inability to adapt to the set menu offered by the school.

Similarly, the ILM suggests that when a stimulus enters the brain, the brain sends neural impulses to the mind that translates the impulses into symbols that it can store, process and retrieve while simultaneously checking prior experiences and where they belong within the declarative or non-declarative memory. This is where metacognition comes into play since it is suggested that these symbolic representations are transferred into the non-declarative memory through metacognition. More importantly ILM suggests that our learning patterns form the filter through which the stimulus is communicated to the mind when we are learning (i.e., one responds and interprets incoming information through these learning patterns which occur differently in each learner). Bruer defines metacognition as “the ability to think about thinking, to be consciously aware of oneself as a problem solver, and to monitor and control one’s mental processing” (Bruer, 1993: 67). It is an intrapersonal communication where time is given to quietly think and

reflect on what one is learning and on regulating how we go about learning (Vanhear & Borg, 2000).

Behaviourist learning models emphasise the multistage model of memory where practicing past tasks leads to over learning, resulting in resistance to extinction (Vanhear & Borg, 2000: 10). This model clearly promotes rote learning. However, ample research (e.g., Freire, 1970; McLaren, 1989; Novak & Gowin, 1984; Novak, 1998) reveals that the cognitive key to retention is meaningfulness. Metacognition focuses on the active role of the learner and challenges the transmissive view of learning and teaching. Georghiades (2000) reveals that primary school children who received metacognitive instruction performed better. This is because metacognition lends itself to a process of praxis (Vanhear, 2006). The equation is as follows: “by being reflective, revisiting the learning process, making comparisons between prior and current conceptions, and being aware of and analysing difficulties, learners gradually maintain deeper understanding of the learned material ... maintaining better understanding sets the bases for successful transfer” (Georghiades, 2000: 128).

Methodology

On the basis of the theoretical background presented above, the following research question was constructed: How can teachers help learners to reflect and act upon their knowledge and experience of the environment by helping them construct new meaningful knowledge? This research question revolves around the notion of the learners’ structures of knowledge and how they respond to it or as Gardner (1991: 253) argues “we must place ourselves inside the heads of our students and try to understand as far as possible the sources and strengths of their conceptions”. This is also what Bruner (1996: 49) sought for throughout his studies “I have long argued that explaining what children do is not enough; the new agenda is to determine what they think they are doing and what their reasons are for doing it”.

Consequently, this research made use of two validated tools namely: Vee Heuristics and Concept Mapping, with 6-7 year old pupils in a mixed ability girls’ primary school, to improve on meaningful learning of specific environmental knowledge related to biodiversity. Although a whole class participated in the learning programme of this research, only nine girls (with different learning patterns through the use of the LCI) were randomly selected for the in-depth study.

Since Gowin’s original Vee Heuristic was too complex for 6 year olds, the study opted for Ahoranta’s adapted version of Åhlberg’s improved Vee (Åhlberg & Ahoranta, 2002) to trace the learning process. The steps in the Vee Heuristic were used as questions in semi-structured interviews carried out with the sample to chart each learner’s individual learning experience. The interviews provided details about the learners’ knowledge and misconceptions about the chosen topic and how these developed to construct new meaningful knowledge. Concept Maps were constructed by the children **before** and **after** the learning process and the differences that emerged and their implications were discussed with the children. The different learning patterns of the pupils and their contribution to diverse structures of knowledge were taken into consideration, discussed and evaluated.

Data Analysis

This section of the paper will present, analyse and discuss in detail the learning patterns of two learners with two different learning profiles.

Maria (her LCI scores are summarised in the grid below)

Learning pattern	LCI Score	Preference
Sequence	16	Avoid
Precision	22	Use as Needed
Technical Reasoning	27	Use First
Confluence	20	Use as Needed

Maria is a dynamic learner (Johnston, 2005) who makes use of Technical Reasoning at a Use First level. She uses her Confluent and Precise processing as needed while she avoids Sequence processing. From this learning pattern, one can deduce that Maria does not like to write in detail, makes use of very few words to express herself, prefers to work by herself and needs to see the purpose for what she is doing. Furthermore, she tends not to read directions since she finds following directions quite confusing if not even frustrating.

On examining Maria's Vee Heuristic (Figure 1) one notes the difference in the answers on each side. On the left hand side, which reveals responses given before the learning programme took place, one can note this girl's uncertainty in going through the programme. Reply No.1 is quite vague whereas reply No. 4 shows that she is not sure from where she can get an answer. This observation is substantiated by her first drawing constructed prior the learning programme (Figure 3). This clearly conveys the message how lost this child felt before going through this learning programme.

Maria's reply to Question 5 substantiates her preferred way of learning. In fact, although the teacher carried out many lessons and activities such as poems and provided detailed information about insects, this girl mentioned only the outing, the computer, books and pictures as her primary sources for learning. This exemplifies how learners who score high in technical reasoning and "use as needed" the confluent and precise patterns prefer to learn.

On the other hand, the right hand side reveals a difference in this girl's confidence. Her response to Question 5 was quite immediate, detailed and sure, thus showing that her sense of security and motivation increased along the learning programme. Furthermore, it is quite appealing to note the response to Question 8: "*because now I know more and because I can show that I studied*". One of this learner's main concerns is not what she learnt, but how she is going to show it. In fact, this learner's learning patterns reveal that she finds it difficult to express what she knows, especially through tests, since she does not like writing in detail or following too many sequential directions. It is no wonder that she is concerned about this, she is aware that she has the necessary knowledge but she has difficulty expressing it. From reply No. 8 one can conclude she was satisfied she was able to externalize what she had learned. Concept Mapping offered her another way of expressing what she knows. When asked what she thought about her second Concept Map (Figure 4), when she compared it to her first (Figure 2), she replied: "*it shows that I have studied*", something learners who primarily uses technical reasoning are often accused of not doing because they do not consider it important to

tell others what they know! Referring this learner's learning patterns, it is clear that she avoids instructions and finds difficulty in expressing what she learns in words, instead she prefers to learn through hands-on experience and the responses given in the Vee Heuristic and drawings convey that this girl's motivation increased throughout this process since the learning experience was congruent with her preferred way of learning.

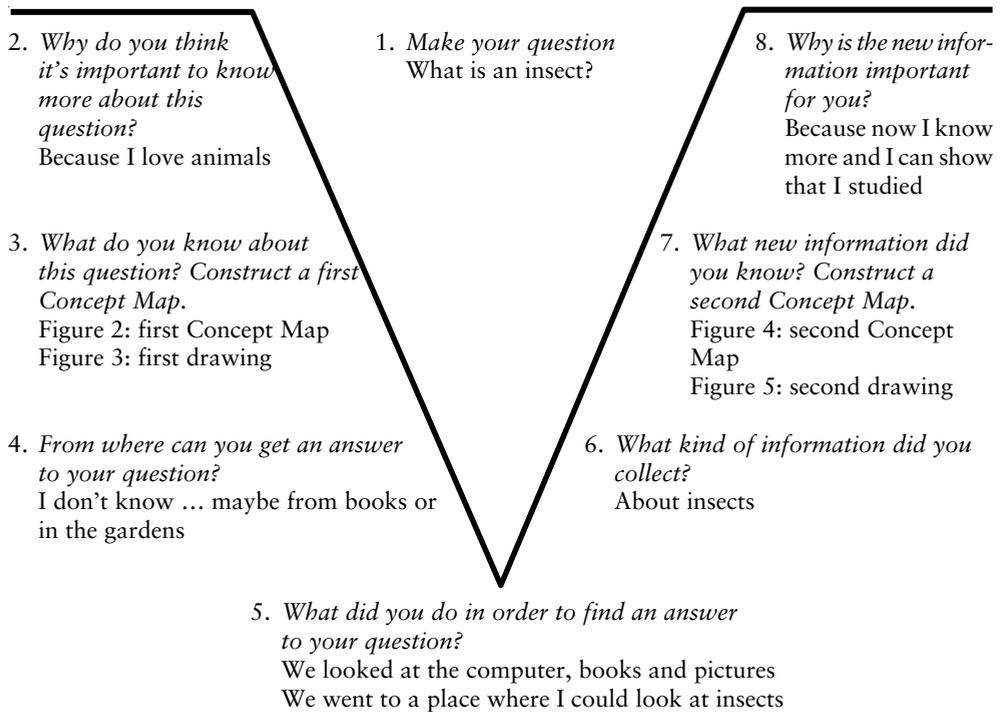


Figure 1. Maria's Vee Heuristic

Even a cursory comparison of the two Concept Maps, presented in Figures 2 and 4 shows that the number of concepts and propositions increased, indicating that significant learning had taken place. The interview with this girl revealed how quickly she was changing and adding to her map. This evidences her confidence and eagerness to show what she learnt and shows how easy it was for her to externalize her cognitive structures in this way. She enjoyed watching her map expand. Consequently, she was able to correct all the misconceptions present in the first Concept Map such as that "*insects have 2 or 4 legs*", "*insects are not useful*" or "*insects eat honey*".

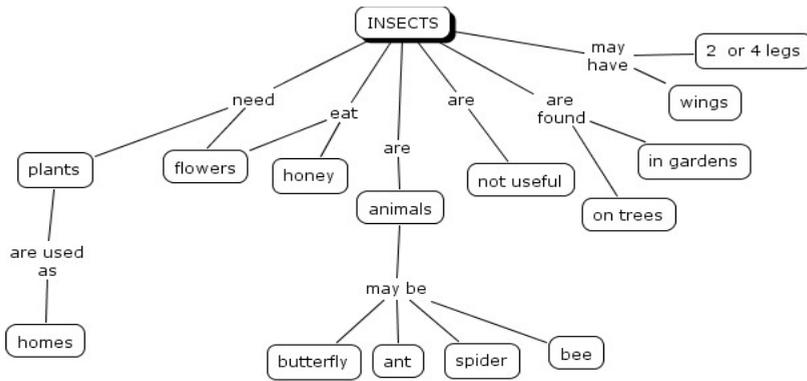


Figure 2. Maria's first Concept Map before the learning program

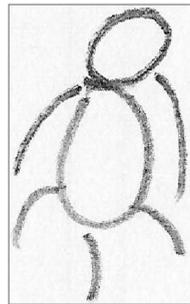


Figure 3. Maria's first drawing before the learning program

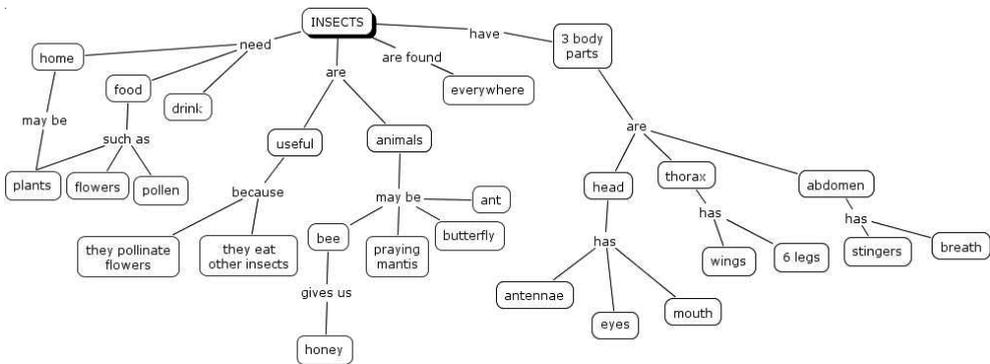


Figure 4. Maria's second Concept Map after the learning program

This learner's motivation through this kind of process of learning is also very explicit in her drawings. Figure 5 reveals the radical change that took place within this learner's motivation to learn. In fact, the second drawing gives more precise details than her initial drawing (Figure 3).

The changes present in the Vee, in the Concept Maps and the drawings clearly demonstrate that learning in this way increased the learners' motivation thus affecting

positively on their learning. Moreover, Concept Maps seemed to offer a practical and organised way to exhibit what they learned.

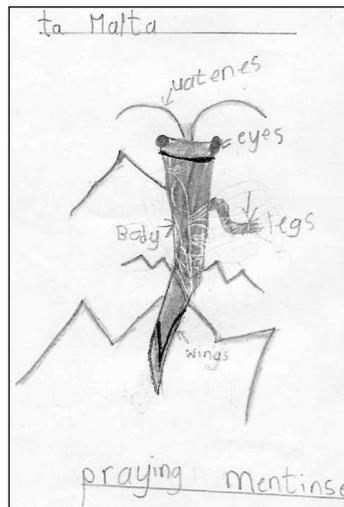


Figure 5. Maria's second drawing after the learning program

Rita (her LCI scores are summarised in the grid below)

Learning pattern	LCI Score	Preference
Sequence	28	Use First
Precision	26	Use First
Technical Reasoning	21	Use as Needed
Confluence	16	Avoid

Rita's LCI score reveals that she "uses at first" level her Sequence and Precise patterns, the Technical Reasoning pattern is "used as needed" while she "avoids" the Confluent pattern. This means that this learner needs clear step-by-step directions, wants to do her work neatly and wants to know whether she's meeting her teachers' expectations. She also tends to want thorough explanations and asks a lot of questions. She likes details and she prefers written work to show what she has learnt. When needed she can also learn through hands-on experience, while, on the other hand, this learner avoids taking risks and prefers her work to be as accurate and as correct as possible.

Rita's Vee Heuristic (Figure 6) discloses a lot of useful information about how she prefers to learn. The left hand side reveals why is it important for her to want to know more. Furthermore, her reply to Question 4 conveys how she plans to learn and with the knowledge of how her learning patterns work most efficiently for her, both the teacher and the student can together build a learning programme which would make sense to the learner. Rita plans to learn through books and the teacher (Sequence and Precision) but also through outings (Technical Reasoning). Her learning patterns are evidenced also in her reply to Question 5, which shows what the learner actually did in order to learn. This substantiates her learning patterns since she mentioned books, the computer, the outing and also a poem.

Therefore, her primary sources for learning occurred in the classroom setting but having a score of 21 in Technical Reasoning where she makes “use as needed” of this learning pattern, she also mentioned the outing as another source for her learning. The right hand side of the Vee Heuristic exhibits how the learner constructed and developed her knowledge. Her reply to Question 6 shows that she developed her knowledge about the importance of leaves as exhibited in her second Concept Map presented in Figure 6. In Question 8 she was able to compare her prior knowledge with the present knowledge and in fact, learners with this kind of learning pattern are very good in comparing.

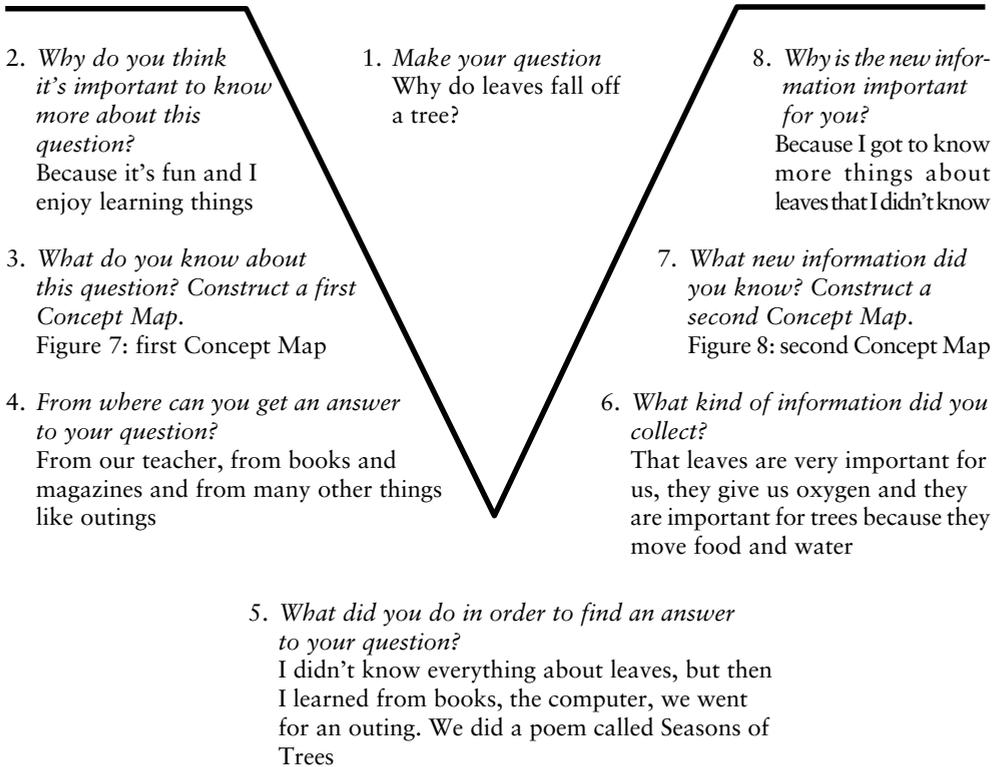


Figure 6. Rita's Vee Heuristic

By comparing the Concept Maps in Figures 7 and 8 which were respectively constructed before and after the learning programme one can easily note an increase in concepts and propositions. There is also evidence where prior knowledge was developed, misconceptions corrected and new knowledge constructed. This learner went into greater detail in her second Concept Map like, for example, on the concept “*different shapes*” she added “*compound*”, “*simple*”, “*narrow*” and “*wide*”, or to the linking phrase “*fall off*” she added four other different appropriate concepts. She was also able to correct her misconception that “*leaves fall off in spring*”. One of the most remarkable details was that she was able to exhibit the proposition “*in autumn comes out [they show] their real colour such as red, orange, yellow*”.

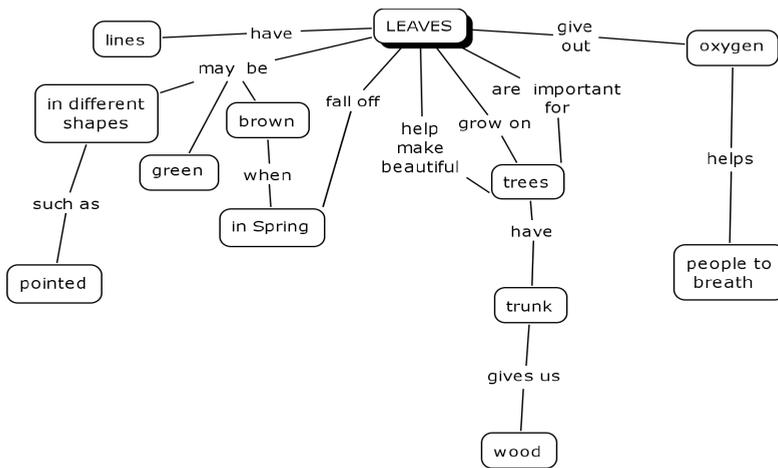


Figure 7. Rita's first Concept Map before the learning program

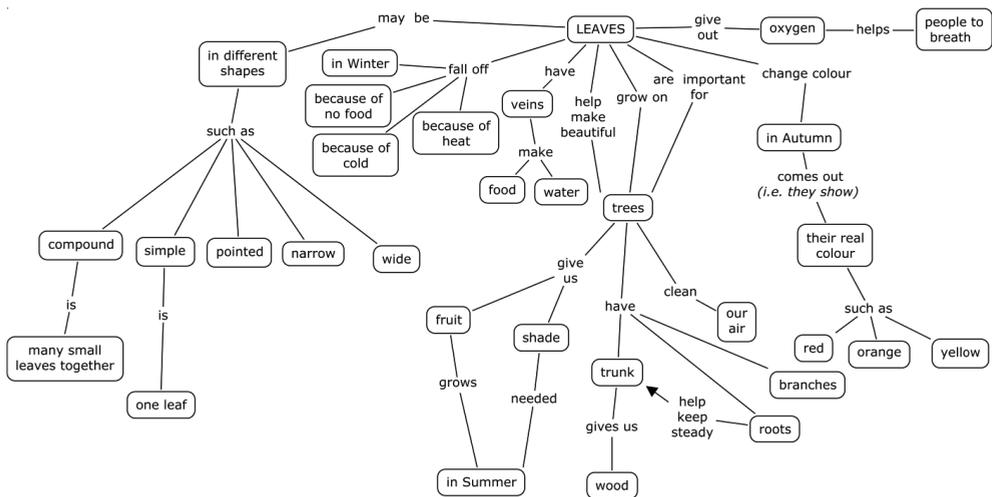


Figure 8. Rita's second Concept Map after the learning program

Discussion

The research data reveal that all of the learners were able to construct new meaningful knowledge when presented with a learning programme which suited their preferred way of learning and when they were actively involved in their own learning. Furthermore, since the Vee Heuristic process captures all of the three mental processes involved in learning, namely cognition (I think), conation (I act) and affectation (I feel), the learners' will to learn was increased and consequently their performance was enhanced. This research challenges conventional and restrictive classroom practices that emphasize rote learning at the price of meaningful learning because learners are considered passive recipients rather than dynamic actors who commit themselves to thinking, acting and

learning critically. The data collected in this research reveals that each learner processes incoming information differently and it is very unrealistic to expect all children to respond to whatever happens in class in approximately the same way. Furthermore, it reveals that different learners learn in different settings and therefore not all learners learn best in a non-traditional setting and vice-versa (Zelezny, 1999). The results confirm that, for a learner “*to take interest in learning*”, the teacher must be aware of the learner’s own preferred way of learning in order to address his/her needs and enhance his/her learning experience. This is where the LML can be valuable since it reveals how each learner prefers to learn and how he/she responds to incoming information.

The Vee Heuristic lent itself beautifully to a process of reflection and action, where the child’s internal talking became visually overt and explicit. In this way learners are taught to think aloud and reflect on what is going on in their heads and how they can proceed to act and develop it. Research has shown that new meaningful knowledge does not occur in a vacuum (Bruer, 1993; Johnston, 1996, 1998; Novak, 1998) and, therefore, prior knowledge has to be taken into consideration if we expect meaningful learning to take place. By constructing Concept Maps for the focus question under study, the children clearly conveyed at a glance, “*what they already know*” thus providing educators with the opportunity to build upon it. The two Concept Maps constructed before (on the left hand side of the Vee) and after (on the right hand side of the Vee) the learning programme were very effective in allowing both the teacher and the learner to easily see what prior knowledge was present, what new knowledge was constructed and how this was integrated within the pre-existing cognitive structure and elaborated. One has also to bear in mind that for learners who are used to learning through rote or memorisation of facts, Concept Maps may offer quite a challenging task at first and it may take some time before they feel comfortable working with them.

The integration of these metacognitive tools: the Vee Heuristic, Concept Mapping along with an understanding of how the learner prefers to learn, provides the teacher (and the learner) with a clear picture of how the learner responds to and acts upon incoming information. These metacognitive teaching strategies shift the control from the teacher to the learner (Bruer, 1993). Consequently, learners become the agents of their own learning since they are actively participating in their own learning process. Moreover, the learner exhibits how he/she plans to learn more and this is very important for the teacher to be able to collaboratively build a learning programme which would be relevant to the learner’s way of responding to new information and so prove to be truly motivating and meaningful.

Conclusion

ESD promotes a particular lifestyle which highlights not only knowledge but also feelings and attitudes that call for commitment and responsibility towards sustainable development. It is dependent on informed action and the development of autonomous critical learners. The methodology proposed by the study proved to be an effective way of giving the learner ownership of learning in a way that she/he is conscious of how she/he is learning and can, in this way, direct (i.e., is empowered) its course. A paradigm shift has to occur in the way we see things, prevailing discourses about learning have to be questioned and this is why various authors (O’Sullivan, 1999; Orr, 2004; King,

2005) are now calling for a transformative vision of learning – not just the transformation of students into functional citizens, but also the transformation of the learning institutions themselves to provide these enabling pedagogies. Effective ESD at formal education institutions is dependent on a change in praxis; and change is not always a welcomed alternative. Consequently, alternative methodologies are viewed with suspicion and need to be acknowledged and legitimized within the institutions' administrative structures for them to proceed.

Concept Maps and Vee Heuristics lend themselves to this process of transformation for both the teacher and the student. It is a process through which the prevailing model of education is challenged. This research has shown that the use of these two tools facilitates the achievement of ESD targets and may, in the long run, bring about desired environmental responsible behaviour. This is because these two tools present a process of praxis and through their use learners are trained in decision-making, reflective and problem solving skills by effectively identifying the child's "internal environment" and leading them to understand what is going on in their heads and why and how they respond differently to different situations. Equipped with such awareness teachers and students may form partnerships based upon the knowledge of each other's ways of processing incoming information and be able to create an atmosphere in which they have the opportunity to formulate specific techniques and strategies for developing meaningful learning. However, the characteristics of and how this translates from meaningful knowledge to responsible environmental action need to be studied further.

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This paper is just a very small part of a larger research project presented as a Masters in Education Theses for the University of Malta (Vanhear, 2006).

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Received 27 April 2008; revised version received 15 November, 2008

STUDENT TEACHERS' EXPERIENCES OF THEIR STUDIES IN EDUCATIONAL SCIENCE AND PSYCHOLOGY

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Abstract

General studies in Educational Science and Psychology provide for many subject teacher students their first contact with pedagogy. The experiences may influence students' desire to pursue teacher education studies and to continue in the profession after graduation. The aim of the study was to analyse how students perceive intentionality, contextuality, constructivism, collaboration, feedback, and transfer of knowledge. Further, the university teachers' intentions for creating a meaningful learning experience for their students were analysed. 341 student and nine teacher responses were collected. Contextuality was the most highly rated feature indicating that the presentation of the theoretical content and practical application is well balanced, but there is a need to develop practices of providing feedback on the students' learning and progress. It is vital that the general studies in Educational Science and Psychology provide students with meaningful experiences, which they can relate to past knowledge and future professional application. In order to support students' development into professionals who recognise their responsibility to promote sustainable development and life-long learning, initial teacher education needs to provide students with a sense of meaning and continuity.

Key words: *teacher education; constructive learning theory; meaningful learning.*

Introduction

This article describes student teachers' experiences of the meaningfulness of learning in the compulsory general studies in Educational Science and Psychology. The students were in their first year in the teacher education programme training to become subject teachers. The students had, according to the Estonian system, studied three years in a Bachelor programme within a subject area, and were now in their first year of Master level studies. After graduating with a Bachelor's degree the students have the opportunity to pursue studies towards a Master's degree either within their subject area, or in teacher education (Poom-Valickis & Eisenschmidt, 2007). The two-year master level programme in teacher education provides the students with the qualification to teach their subject area in comprehensive and secondary schools. The aim of the study was to understand how these students experienced intentionality, contextuality and constructivity of the

teaching, collaboration as a learning method, dialogue and feedback as ways of enhancing understanding, and transfer of knowledge in their studies. These components constitute what in this study is referred to as the meaningfulness of learning. Also teacher's intentions in creating the learning experiences were analysed. The study on which the article is based was conducted at Tallinn University (TLU) as a part of a project developing initial teacher education through Educational Psychology.

The general studies in Educational Science and Psychology provide for many students the first contact of a scientific nature with pedagogy, and as such are likely to influence the students' appreciation of the subject. The contents of these courses focus on the school and the teacher in society, the teacher's roles in the classroom, the learning environment, development and learning, special needs, and teacher research (Poom-Valickis & Eisenschmidt, 2007). In Estonian teacher education, the focus has been on developing the support structures for novice teachers in the early stages of their career (cf. Eisenschmidt, 2006; Poom-Valickis, 2007). In this article the focus is on students' experiences of their initial teacher education. The study utilises a quantitative survey design. The questionnaires on meaningful learning (based on Nevgi & Tirri, 2003 and Löfström et al., 2006) were used in a modified form.

The learning experiences of the students in teacher education are likely to shape what and how they think about learning, teaching and their relationships and responsibilities towards their community and beyond. In order to support student teachers' development into competent teaching professionals who recognise their responsibility to promote sustainable development and life-long learning in themselves and their pupils, as proposed in the European policy papers *Common European Principles for Teacher Competences and Qualifications* (2005), and echoed in *Improving the Quality of Teacher Education* (2007) initial teacher education needs to provide students with a sense of meaning and continuity in the studies. To make student teachers understand the interrelatedness of the environment, society, and economy and make it evident in their teaching and their lives as community members is one of the great challenges of Education for Sustainable Development (ESD) according to the *Guidelines and Recommendations for Reorienting Teacher Education to Address Sustainability* (2005).

Prior research on meaningful learning

Meaningful learning (see Ausubel, 1968; Jonassen, 1995; Ruokamo & Pohjolainen, 1999; Nevgi & Tirri, 2003) constitutes student activity, intentionality and reflection, contextuality and constructivity of teaching, collaborative and interactive nature of learning methods, and transfer of knowledge. This model of elements facilitating learning is based on a constructivist view of learning. The meaningfulness of learning arises from the student's own active and goal-oriented input in the learning process, but the teacher can act to support the students in creating a meaningful learning experience. Discussions, for example, can promote collaboration, interaction and activity, while a learning diary can be used to enhance reflection, activity and intentionality. The teacher can use the learning diary to give students feedback or present questions for further reflection and discussion (Löfström et al., 2006). Intentionality may be enhanced by making it possible for the students to focus learning activities according to their own interests. Students benefit from connections that the teacher and they themselves make

between the learned material and existing knowledge structures. Students should be encouraged to identify their own learning objectives within the scope of the curriculum and the subject taught.

Nevgi and Löfström (2005) and Löfström and Nevgi (2007a; 2008) investigated Finnish students' and teachers' experiences of the meaningfulness of learning in a web-based environment. Teachers generally felt that the students' learning was more meaningful than what the students experienced it to be. The greatest difference between teachers and students concerned the contextual nature of learning. The teachers may have had a clear idea of how the content taught related to practice, however, this connection may not have been well transferred into the teaching and learning situation, in which the students have had difficulties grasping the connections and relations. University teachers appear focused on how to facilitate student collaboration in their web-based teaching and less on how to contextualise the content or how to facilitate the transferability of the content taught into novel contexts (Löfström & Nevgi, 2007b; 2008). Common for these studies was that the teachers gave more positive evaluations of the meaningfulness of learning than the students. Collaboration was generally recognised by both teachers and students, whereas contextuality appeared to be less facilitated.

Method

Data collection and analysis

The study utilises a quantitative survey addressing the following questions: What is the learning experience like according to the students and teachers in teacher education in terms of meaningfulness? How do teachers' intentions and students' experiences of the meaningfulness of learning differ from each other? The instruments used were based on the meaningful learning questionnaires for students and teachers developed by Nevgi and Tirri (2003) and modified by Löfström with colleagues (2006). The questionnaires have demonstrated good reliability (Nevgi & Tirri, 2003; Nevgi & Juntunen, 2005). The latter set of questionnaires (Löfström et al., 2006) is a practical tool for university teachers to use in order to evaluate web-based teaching. The version used in the present study consisted of thirty-one items measuring seven aspects of meaningful learning. The final five sum variables formed based on the theoretical framework are provided in Table 1 along with reliability indices and sample items.

Table 1. Meaningful learning sum variables and sample items

Sum variable	Cronbach's Alfa	N of items	Sample item Students	Sample item Teachers
Feedback	.75	5	I got sufficient feedback on my learning from the teacher during the course (item 25)	Students got feedback on their learning from me as their teacher during the course
Learner intentionality	.68	4	I was aware of the course objectives (item 2)	Students were aware of the course objectives
Collaborative learning	.81	7	I was committed to joint work and took responsibility for the group's activities (item 23)	Students were committed to cooperation in the course and took responsibility for the group's activities
Contextuality and transfer	.70	3	In the course we dealt with real-life problems and examples which helped me to understand the topic (item 14)	I planned ways in which real-life problems and situations could be linked to the topics studied in the course
Constructivity	.80	7	I felt that the teacher had planned the course with the students in mind (item 7)	Before the course I gathered information about the students to help me plan a course that would meet the needs of this particular group

The questionnaires for teachers and students were translated into Estonian. The translation and the English language (originally translated from Finnish) versions were compared and minor modifications made. When translated into Estonian, all language versions were carefully compared with each other.

The items were measured with four response alternatives describing the degree of agreement (response rating: 3) or disagreement (response rating: 1). The fourth option (response rating: 0) could be used if the item was not applicable. Sum variables were formed based on mean sum scores for the items measuring each theoretical construct. Cronbach's Alpha for the meaningful learning scales ranged between .68 and .81 indicating acceptable or good reliability. The deletion of any items would not have substantially raised the Alphas. The two three-item scales (student activity and reflection) were the weakest scales, and due to poor reliability were excluded from further analyses. Analyses included means' comparisons (independent samples t-tests) and analyses of variance. Missing values (4-29 per item) were replaced with series means.

Background variables included gender, mother tongue, and the course for which the students evaluated their learning experience. There were also two open questions in the students' questionnaire. The first addressed which courses or contents the students

regarded as the most useful ones for them in their future work as a teacher, and why they regarded these courses as useful. There was also room for the students' own comments. Samples quotes are provided to complement issues arising from the quantitative data.

The sample consisted of both university teachers and Master's students. The students were MA students in subject teacher education and participants in general studies in Educational Science and Psychology. The university teachers were teaching these courses. Altogether 341 student and 9 teacher responses were collected. In 288 cases the respondents were female, and in 51 – male (information missing in 2 cases). Estonian was the mother tongue in 195 and Russian in 131 cases (information missing in 15 cases). Information on attrition is not available. The students were asked to fill in the questionnaire for two courses. The results are therefore treated on a course level, and not on the level of the whole data set, which could have distorted findings as the same individuals feature twice and are unidentifiable.

Validity and reliability. The questionnaire was used in another national context, and translated into another language. The lack of back translation cannot be entirely compensated for by the fact that the three language versions were carefully compared by two researchers. The use of the meaningful learning questionnaires in the Estonian context should be viewed as an exploratory investigation. The fact that a large number of the respondents filled out the questionnaire in a language other than their mother tongue may affect the reliability of the data. To avoid this problem, the questionnaires could have been translated into Russian.

It was decided that data from the teachers be collected so that the teachers' intentions could be compared with the students' experiences. The number of the compulsory courses in the first year of teacher education is limited, and consequently the number of teachers small ($n = 9$). Any statistical indicators on the teacher sample should be interpreted with caution.

Results

The students and teachers assessed the meaningfulness of learning in six compulsory courses in general studies in Educational Science and Psychology (in subject teacher education). The number of student responses was 41-71 per course. The age range of the students varied between 21 and 35 with 68-80% being in the age group 22-23. The number of female respondents per course varied between 41 and 61, and the number of male respondents between 5 and 13. The number of respondents with Estonian as their mother tongue was 27-38 per course, whereas the number of respondents with Russian as their mother tongue was 20-31 per course. Forty-five per cent of the respondents spoke Russian as their mother tongue. The university's records on entrance examination indicate that over the last years the number of Russian-speaking students in subject teacher education has increased whereas the tendency among Estonian-speaking students has been the opposite.

To avoid identification of the participants, references to course names, semester, and the number of teachers per course have been removed. Standard deviations for teachers are not reported as these would reveal the number of teachers teaching the course in question, which could make it identifiable. The means and standard deviations for the sum variables of the student sample are presented in Table 2.

Table 2. Means and standard deviations for the meaningfulness sum variables for the student sample

Component (study course number within parentheses)	Mean	SD	Teacher'(s') intention mean
Collaboration (1)	2.23	.51	2.86
Feedback (1)	2.24	.60	2.60
Intentionality (1)	2.31	.52	2.75
Contextuality (1)	2.48	.48	3.00
Constructivity (1)	2.45	.50	2.71
Collaboration (2)	2.37	.49	2.43
Feedback (2)	2.00	.65	2.10
Intentionality (2)	2.04	.55	2.63
Contextuality (2)	2.31	.59	2.67
Constructivity (2)	2.20	.49	2.36
Collaboration (3)	2.14	.48	2.52
Feedback (3)	1.93	.62	2.62
Intentionality (3)	1.99	.52	2.50
Contextuality (3)	2.37	.51	2.89
Constructivity (3)	2.10	.49	2.52
Collaboration (4)	2.36	.65	2.14
Feedback (4)	2.00	.84	2.20
Intentionality (4)	2.57	.49	2.75
Contextuality (4)	2.68	.52	3.00
Constructivity (4)	2.64	.42	2.77
Collaboration (5)	2.71	.36	2.48
Feedback (5)	2.48	.55	2.80
Intentionality (5)	2.77	.30	3.00
Contextuality (5)	2.84	.26	2.67
Constructivity (5)	2.71	.28	2.57
Collaboration (6)	2.42	.49	2.71
Feedback (6)	1.89	.83	1.40
Intentionality (6)	2.60	.37	2.00
Contextuality (6)	2.86	.23	3.00
Constructivity (6)	2.75	.21	2.29

As in prior studies, the students evaluated the course learning experience as less meaningful than the teachers. The teachers emphasized contextuality, and the supporting of student intentionality the most (Table 3). The students emphasized contextuality and constructivity the most (Table 4). In general, both students and teachers experienced that feedback was not promoted in the courses.

Table 3. Means and standard deviations for the teacher sample (n=9)

Component	Mean	SD
Collaboration	2.51	.35
Feedback	2.34	.64
Intentionality	2.58	.35
Contextuality	2.85	.24
Constructivity	2.51	.28

There is an explicit need for more feedback on the students' learning. The need for timely feedback is echoed in the following quotes from two students. The second student calls for clearer learning goals, which would support students' intentional studying:

The biggest problem in all subjects has been to get feedback, and grading that has taken a long time.... But a month or a month and a half is too long a time to wait for your grade (Student 001).

The objectives could be much clearer, feedback could be more concrete and the provision of it faster (Student 210).

The Russian-speaking students experienced more often than the Estonian-speaking students that feedback was a component of the learning experience. The differences were statistically significant (Table 4), yet the question remains whether or not the Russian-speaking students regarded the amount of feedback as sufficient. The results raise the question do the Russian-speaking students actually receive more feedback from the teachers, and do the teachers feel that the Russian-speaking students need additional support and help due to a language barrier? Further, to what extent is the language barrier a real or an imagined one? What are the potential consequences of Russian and Estonian-speaking students keeping to their own language groups?

Table 4. Independent samples tests on the meaningfulness of learning by mother tongue

Component (course number within parentheses)	Estonian mean	SD	Russian mean	SD	F	t	df	p
Feedback (1)	1.99	.66	2.58	.34	13.99	-4.07	40.7	.000
Intentionality (1)	2.16	.58	2.52	.37	10.27	-2.67	44.6	.050
Constructivity (1)	2.25	.54	2.73	.27	7.23	-4.00	39.7	.000
Intentionality (2)	1.89	.54	2.26	.48	0.58	-2.45	48.0	.050
Feedback (5)	2.37	.61	2.69	.36	2.02	-2.12	54.0	.050
Collaboration (6)	2.32	.58	2.55	.35	4.21	-2.05	60.5	.050
Feedback (6)	1.66	.86	2.15	.74	1.37	-2.49	66.0	.050

Ways of using peer feedback could be developed as a solution to the students' need for dialogue and feedback, both Russian and Estonian speaking. The Russian-speaking students also experienced stronger emphasis on their own intentionality as learners, which may be related to the fact that they experienced more feedback. Feedback on one's learning helps the learner to evaluate one's own progress towards a goal. This may increase the learner's sense of intentionality of his or her studying. *Intentionality*

refers to goal-oriented studying, and can be facilitated by supporting students to set objectives for their own learning. In another study in the Estonian context, Kukk and Talts (2007) found that teachers generally emphasize students' personal goal-setting.

Surveying and taking into consideration students' prior knowledge when planning the learning goals is an important element in a *constructivist* approach to teaching and learning. New information adds to existing knowledge, leading to increasingly developed information structures. Students relate new information to previously acquired knowledge, compare and evaluate it to decide on its meaningfulness. It is essential that students learn to detect and understand connections between subjects to create meaningful chunks of knowledge. Strikingly, in one of the courses students evaluated the course to be much more based on constructivist principles than what the teacher(s) evaluated. Apparently the teacher(s) had good knowledge of the students prior to the course and was able to plan it with the students' current level and learning needs in mind.

The *contextuality* of teaching can be increased by connecting content to authentic examples and materials. Simulations, games, video clips, documents, case examples or trigger materials of the type used in problem-based learning (PBL) can be used to facilitate contextuality. The teachers' ability to contextualise the content gained positive evaluations from students in all courses. In one of the courses (course 4) the teacher and the student experiences were strikingly alike. Both the teacher(s) and students experienced contextuality and constructivism as the strongest components, and feedback as the weakest one. The teachers' sense of how the intentions would translate into learning experiences for the students was accurate. Also Kukk and Talts (2007) found that teachers do try to connect their subject as much as possible to the surrounding environment, and encourage the learners to apply their knowledge. Increasing contextuality in teaching is a powerful method to promote the idea of sustainability. By relating the content taught to the surrounding environment, teachers can increase the learners' awareness of context and responsibility for his or her actions within that context.

The following expresses a student's appreciation of the strong connection of the content to practice:

The course was very important for teacher education students. I particularly liked the real-life examples. No lecture was only about theory, but the teacher always gave concrete examples. The teacher also spoke from her own experience. The topics were quite serious and to sum up I am very satisfied with the course (Student 336).

In the following quotes the students call for even more practical connections between theory and daily life in the school:

Everyday life – real life – could be a stronger part of the teacher education (Student 221).

The exchange of ideas among students can be facilitated through *collaborative* group work. Interaction is a key element in collaborative work. Collaborative learning aims to solve problems by making use of the experiences and ideas of others in an atmosphere of positive interdependence (cf. Johnson & Johnson, 1982). The strength of the group is best exhibited in problem-solving tasks where group members find it difficult to solve the problem on their own in a satisfactory manner, but where the group members' different skills and experiences can be combined to reach a good result. Further

support to collaborative learning comes from the group being able to choose problems based on the members' interests, which increases intentionality (Löfström et al., 2006). In general, collaboration was neither a particularly strong nor weak component.

The experiences of the meaningfulness of learning differed to some extent between the men and women, but appeared to cumulate to certain courses without a relationship with any particular component of meaningful learning.

Discussion

What is the learning experience like according to the students and teachers in terms of meaningfulness, and do teachers' intentions and students' experiences differ? Let us first consider the learning experience from the students' perspective. The Estonian university students recognised contextuality in their learning experiences. This was the most highly rated aspect in all courses. The result differs from that in Nevgi and Löfström (2005), who found contextuality to be among the least developed elements according to Finnish university students. The present study was conducted among teacher education students aiming for a profession with close practical application. This may be a reason why contextuality is emphasized in the education, and for why it was actually considered a strong component.

Feedback was rated the lowest in all courses. This indicates that there is a need to develop practices, as students clearly lack feedback on their learning and their progress. Ways of developing peer feedback could be a solution to students' need for feedback, and teachers' allocation of limited resources. At the same time, using truly collaborative methods instead of simply group work would likely have a strengthening impact on feedback as an important aspect in the learning process. Without feedback students may not have the tools to evaluate their own learning. This is a skill which develops gradually, but feedback from the teacher and their peers will help students to form their own set of evaluation criteria. Without evaluating one's learning, students will not be able to monitor whether or not they are reaching the learning goals. This again, will require reflective skills from the students. The teachers did in fact emphasize student intentionality supporting goal-oriented studying. However, the students themselves did not emphasize intentionality, which may indicate difficulties in setting learning goals. It thus appears as if feedback, collaboration, reflection and intentionality form a closely-knit entity in which a balanced presence of these features will best support a meaningful learning experience.

Collaboration was neither a particularly strong nor weak component. Kukk and Talts (2007) found that teachers were aware of the necessity to cooperate with different parties such as colleagues, local authorities and parents, but neither their skills were sufficiently developed, nor did they express the desire to develop these skills. Davidova and Kokina (2007) show that Latvian teachers' motivation to engage in innovative activity depends on cooperation with pupils, other teachers, school administration, and local authorities. Innovation and creativity, again, are necessary for orienting the society towards sustainable development (*ibid.*). Based on Kukk and Talts (2007), Davidova and Kokina (2007) and the present study, it appears that the implications of teachers' lack of skills and interest in cooperation may have far-reaching effects on development from a societal perspective. For instance, involving parents in discussions that concern the education and future of their children is likely to strengthen commitment to values that promote sustainability and life-long learning. Thus, there should be a strong emphasis

on collaboration in the educational subjects in order for the students to learn to appreciate the benefits of working together with others.

The study raises considerations for teacher educators: Are current means of providing students feedback mainly summative in nature or is there room for developing formative assessment methods of students' progress? Increasing the use of formative assessment methods may support students' in reflecting on their own learning habits and strategies. Further, contextuality was perceived as a strong component in the courses. In maintaining a balanced relationship between theory and practice, it may be worth considering problem-based approaches in teaching. Methods based on problem-solving help learners to make connections between the content learned and its relationship with the surrounding environment. Rohweder (2007) points out that when considering the learning goals and teaching methods of education it is useful to ask whether the aim of education is to transmit information that is relevant today or to develop in the learners an attitude and willingness to promote sustainability in the future. The development of a learner's sense of responsibility, knowledge, skills, values and attitudes are all important (*ibid.*). This is also the very core of life-long learning. Teaching methods that emphasize problem-solving, contextuality, collaboration, intentionality and dialogue through feedback are likely ways to develop the afore-mentioned characteristics in the learner.

Conclusions

The implications for teacher education are clear. Teacher educators function as role models for the students in teacher education. Their teaching will inevitably have an impact on the student teachers. Teacher educators need awareness of their responsibility in providing good teacher models for the future teachers. By setting clear goals for their teaching, and encouraging students to set learning goals for themselves, by contextualizing the content of their courses and making sure that the students' prior knowledge are taken into account, by using collaborative teaching strategies, and by providing feedback and encouraging students to provide each other constructive feedback teacher educators provide the students with a model for how to promote meaningful learning. To conclude, feedback is a component that needs to be strengthened in the teacher education in the context of this study. Peer feedback, as a way of working together and collaborating, could be used to facilitate feedback provision and teach the importance of working with others towards common and sustainable goals. It is not sufficient that the teacher educators set goals if the students themselves do not know what these goals are or how they relate to their development as student teachers.

Teacher educators appear to apply constructivist principles in their teaching taking into account students' prior knowledge. Yet, without sufficient feedback provision constructivism is not fully exploited and provides potential for further development.

The fact that contextuality was perceived as a strong component is certainly a positive feature in the teacher education worth further exploration, for instance, in the form of problem-based learning.

This study focused on students' experiences of and teachers' intentions for facilitating meaningful learning. It may be worthwhile in future studies to investigate how the students' experiences translate into their teaching once entering the teaching profession. This may also provide valuable feedback to teacher educators on how the models of teaching they provide to the students are put to practice by the novice teachers after

graduating from the teacher education programme. Another aspect worth further exploration, and which this study did not address is how students specializing in different subject areas experience the meaningfulness of learning. Different disciplines may entail different ontological and epistemological assumptions, which may influence students' experiences of their studies in Educational Science and Psychology in teacher education.

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Acknowledgements and funding sources:

The author would like to thank Dr. Katrin Poom-Valickis for valuable comments on earlier versions of the manuscript, and the three anonymous reviewers for their feedback and suggestions.

This study was conducted within a project funded by the European Union (project code 1.0101-0268) targeted at improving the teaching of Educational Psychology in teacher education in Estonia.

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Received 17 April 2008; revised version received 20 October, 2008

PROFESSIONAL COMPETENCES OF FUTURE TEACHERS: PERSPECTIVE OF DIFFERENT EVALUATORS AND CONTEXTS

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Abstract

The article presents research on professional competence for future teachers. The study provides the answers to the questions 1) what are the differences between the future teachers' desirable and real professional competences evaluated by students themselves, their University teachers, and their potential employers? 2) what are the differences in the evaluation of future teachers' professional competences provided by the students and University teachers from the study programs enriched with the principles of ESD and those who come from other programs? The future teachers (n=24) and teachers from the Daugavpils University (n=24) as well as the school principals of Latgale region of Latvia (n=25) filled out the questionnaire by Grecov and Popova (2005). It was concluded that both students and teachers see the necessity for the further development of competences while encounter with ESD principles mostly elicits the need for the higher standards of professional competences and more critical stance toward the achieved level.

Key words: *professional competences; future teachers; teacher training; self-evaluation; education for sustainable development.*

Introduction

The idea of sustainable development is the idea of harmonious coexistence of human beings and the surrounding world. Sustainable development and the surrounding world are connected by the concept of ecology. One of the challenges in this regard is the maintenance, conservation and restoration of natural resources after the human's intrusion into the process of natural life. Besides, currently we encounter the problem of maintenance, conservation and restoration of humans' individual resources in order to reach the sustainability. Humans are both biological and social beings. The social nature of humans in particular is revealed in their social relationships, in the support of human development by social institutions. Sustainable development and education for sustainable development (ESD) should be articulated according to the integrity of development, interpreted not only in an anthropocentric or cosmocentric sense, but according to a synthesis between world, subject and society (Salite & Pipere, 2006).

Today we can single out both pessimistic and optimistic views upon the essence and future of education in the world experiencing the intensive process of globalization. Generalizing the trends of world's social development, Kurbatova (2007) proposes the distrustful scenario stating that education today is a social quality of society in a state of crisis of socialization: "Today the humans' sensual universal nature, their spiritual world, general state has been threatened. Therefore, it can be concluded that contemporary education as a social institute is experiencing a deepest crisis" (Курбатова, 2007: 52).

The more optimistic vision is represented by educational research and scholars adhering to the ideas of ESD (Salite, 2006; Raudsepp, 2006; Henno, 2004, and others). For example, Mandolini (2007) singles out the following components of sustainable education – multidimensionality, multilateral development, attention to the pupil's personal subjectivity (ethics), cooperation, and spirituality and shows that it is possible to reach the real essence of being human through the education.

One of the major aspects of the interaction between the humans, society and natural environment is that of professional activity. The connection between the person and society is revealed in the professional choice and career development and in receiving social support doing this. The processes are closely connected with the formation of professional identity. Professional identity development in the early adulthood is most likely to take place according to the self-construction model (Guichard & Lenz, 2005) that presupposes the presence of internal and external aspects. The internal aspect is a desirable level while the external aspect is the real level of professionalism that includes also the professional competences. The process of professional identity formation and career development envisages the continuous comparison of the ideal and real situation. The efficiency of professional activity in this model correlates with the successful development of necessary competences.

Considering the two-fold nature of self-construction process, while evaluating the professional competences, it is necessary to take into account the students' needs for a certain level of competencies, the possibilities of the study programs to develop such competences, and employers' requirements for the professional competences of their employees.

Theories of professional competences

Since White (1959) introduced the term 'competences' to describe the knowledge, abilities, skills and features of the personality necessary to perform the work qualitatively and allowing forecasting the individual's successful professional activity in the future, a large number of theoretical and empirical studies of this phenomenon appeared in the literature.

Not only understanding of the phenomenon has been expanded. At present, two terms are used to denote this concept 'competence' and 'competency'. The notion 'competence' refers to the functional spheres (what one should be able to do), but the notion 'competency' – to behavioral spheres (how it should be done) (Le Deist & Winterton, 2005). In the 90s, Hamel and Prahalad used this notion to investigate the resources of management strategy (Hamel & Prahalad, 1994).

Within the framework of this research the competences are classified into the general ones characteristic of the majority of professions (Stasz, 1997) and the profes-

sional ones characteristic of the particular profession. At that, the notion of competence and the notions of informal and non-formal education related to it become very important in describing the structure and the meaning of lifelong education (*Common European Principles for Teacher Competences and Qualifications*, 2005).

Difficulties in understanding the essence of the phenomenon are reflected in the attempts to define it. In these definitions, either the functional sphere (competence), or the behavioral sphere (competency), is brought forward to the foreground. Thus, Elkin (1990) relates competences to the minimal admissible level of work performance, while competencies are related to higher management peculiarities. Regarding the teacher's activity it is manifested in the extent to which he/she has a command of the class during the lesson. Hartle (1995) expresses a different point of view. Using the notion 'competency' he points out that it is the individual's peculiarity ensuring the performance of work and including the visible part, i.e. knowledge and skills, and the hidden part, i.e. the character traits and motives.

The definition of competences depends on the strategy followed by a particular social institution. In the given research, by a social institution we mean the EU and UNESCO structures elaborating the guidelines and programs for the development of education.

The documents of the European Commission (Directorate-General for Education and Culture) reflect the strategies of lifelong education. In the document entitled *Common European Principles for Teacher Competences and Qualifications* (2005) we find the description of such key competences: work with others, work with knowledge, technology and information, work with and in society. Here, as we can see, the importance of social and cognitive competences is stressed.

The social and, especially, cognitive aspects of teacher training are explored in the studies conducted by Shulman (2004) and Grossman and Richert (1988). These works present the classification of knowledge, suggest a model of pre-service teacher training, discuss the ways of higher education development, and elaborate the criteria of effective teaching. However, the problem of competences on the whole is not considered here.

Presently, UNESCO is developing the conception of ESD that includes the lifelong education. However, not only social links and acquisition of knowledge are stressed in this regard. A person's understanding about how his/her activities change the natural environment is of major importance here. Knowledge is needed not only for progress, but also for the restoration of balance between humans and the environment.

Drawing on what is mentioned above, the classification of competences in tune with the principles of ESD will be presented further. Analysis of the literature shows that the conceptions of professional competences evidently can be classified into four groups according to:

- (1) the peculiarities of the scientific approach: behavioral, functional and multidimensional approaches to understanding of competences (Le Deist & Winterton, 2005);
- (2) the forms of psychological activity connected with the temporal continuum. An example here is the classification by Deisone and Dammans (2006) that distinguishes the competences connected with a) knowledge/skills (the individual's past); b) willpower/wishes/motivation (the individual's present); c) possibilities/hopes (the individual's future);
- (3) the types of interrelation with the environment that determine:

- a) educational-cognitive competences or the sum of abilities and skills of cognitive activity; mastery of mechanisms of planning, analysis, reflection, self-evaluation of success; mastery of actions in non-standard situations, method of problem solving; mastery of measuring skills, using statistical and other methods of cognition;
 - b) informational competences, or abilities to search, analyze, select and process the necessary information independently with the help of information technologies;
 - c) communicative competences or mastery of the skills to interact with the people, the ability to work in group, to perform different social roles (Князев, 2002);
- (4) the forms of carrying out professional activity.

Within the framework of the last approach Le Deist and Winterton (2005) suggest a holistic model of competences: functional ones (skills), cognitive ones (knowledge and understanding), social ones (behavior and relations), and meta-competences which facilitate the acquisition of other competences (Le Deist & Winterton, 2005).

Theory of competences by Grecov and Popova should be also referred to the fourth group in the classification. Having analyzed about 20 studies, they have come to the conclusion that all professional competences can be classified into three main groups: instrumental, interpersonal and systemic ones:

- **Instrumental competences** are the competences having an instrumental function. They include:
 - *cognitive abilities*: the ability to understand and use the ideas and thoughts;
 - *methodological abilities*: the abilities to deal with the environment; organization of learning time and strategy; decision making or problem solving;
 - *technological skills*: command of technical devices, skills of information management and computer skills;
 - *linguistic skills*: oral and written communication, knowledge of the second language.
- **Interpersonal (communicative) competences**:
 - *individual abilities*: such as the ability to express one's feelings, the ability of criticism and self-criticism;
 - *social skills*: interpersonal skills or work in a team, adherence to social or ethical values. These skills facilitate the processes of interaction and cooperation.
- **Systemic competences**: skills and abilities related to systems as a whole. They presuppose the combination of understanding, receptivity and knowledge which allows an individual to see the parts of a whole and their connections in the unity. These skills include the ability to plan changes in order to improve the existing systems and to develop the new ones. Mastery of instrumental and interpersonal competences is required as a basis for systemic competences (Греков & Попова, 2005).

The study described in this article draws on the last approach. The questionnaires suggested by Grecov and Popova (2005) were taken as the basis for creating the research method. The original questionnaires included the list of competences needed in order to conduct any professional activity.

The necessity of the given research was, first of all, dictated by the need to test the correspondence of future teachers' real level of professional competences to the desirable one (personality aspect). Secondly, speaking about the social aspect, one of the objectives of the research was to find out if the self-evaluation of professional competences by future teachers coincides with the evaluation of the teachers who conduct their classes. Besides, it was necessary to clarify to what extent the level of professional competences acquired in the process of studies at the University meets the employers' expectations. Also, the given research revealed the influence of the study courses enriched with the principles of ESD upon the evaluation of professional competences.

Therefore, the answers to the following questions were sought:

- What are the differences between the future teachers' desirable and real competences in students' self-evaluation and in the evaluation of university lecturers and employers?
- Are there any differences in the evaluation of competences by the students and teachers who study and work in the programmes aimed at sustainable development and those not included into these programmes?

Sample, research method, and procedure

The research has been carried out in the Daugavpils University located in the South-East of Latvia (Latgale region). The research sample consisted of 75 respondents. Among them there were 26 student teachers (14 of them studying in the programs enriched by the principles of ESD), 24 university lecturers (7 of them working in teacher training programs enriched with the principles of ESD) and 25 employers of teachers at schools. The university teachers involved in teacher training programs connected with ESD work also as the researchers at the Institute of Sustainable Education. These scholars not only conduct their research on ESD and create the relevant study programs, but also deliver the key courses (for example, History of Pedagogy, Pedagogy, Educational Psychology, Teaching Methods) for the future teachers. Thus, they have direct contacts with their students and they are well aware of their potential. The employers were the principals of comprehensive schools of Latgale region and their deputies employing the graduates of Daugavpils University's teacher training programs in the beginning of their professional career.

The questionnaire by Grecov and Popova (2005) contains 30 statements, 10 of which refer to the instrumental competences, 10 to the communicative competences, and 10 to the systemic ones. For instance, the statement *The ability to analyze, generalize and evaluate the information* refers to the systemic competences; the statement *The ability to apply knowledge in practice* – to the instrumental competences, and the statement *The ability to establish interpersonal relations* refers to the communicative competences. The content validity of this questionnaire allows measuring the competences described in theoretical works since it contains three the most recognizable general components of professional competences.

To evaluate the competences, the percentage scale was used where the highest ideal level of competences was 100%; a very high level constituted from 80% to 99%; a high level was in the range from 60% to 79%; the medium level was from 40% to 59%; the low level – from 20% to 39%, and a very low level – from 1% to 19%. 100% is the ideal level of competences that can only be achieved acquiring practical professional

experience. Statistical methods of data analysis tolerate using a small number of respondents if it is conditioned by objective circumstances, in this case – the limited number of each peculiar sample group.

All groups of respondents had to evaluate each competence from two points of view. The students were to evaluate their desirable and real levels of professional competences; the University teachers were evaluating the desirable and real levels of their students' competences; the employers had to evaluate the desirable and real level of professional competences of the University graduates who came to work to their school. The employers' evaluation of the real level of competences does not refer to the students who took part in the research, but is a generalization of their working experience with the recent graduates of Daugavpils University teacher training programs.

Results

The results of the research will be presented in the following order. First of all, the desirable and real levels of competences for the students included/not from the programs enriched with ESD principles will be compared. Next, the differences in the evaluation of the desirable and real levels of competences as seen by the students and their teachers included into ESD programs and by the respondents not included into these programs will be considered. Finally, the differences in the evaluation of the desirable and real levels of competences provided by the students and the employers will be in focus.

Numbers 1 to 6 used in the Figures 1-5 designate the following:

1. Desirable level of instrumental competences;
2. Real level of instrumental competences;
3. Desirable level of communicative competences;
4. Real level of communicative competences;
5. Desirable level of systemic competences;
6. Real level of systemic competences.

As the Figure 1 shows, both groups of respondents evaluate the real level of competences lower than the desirable one. With that, all the categories of competences were evaluated higher by the students included into ESD programs than by those not included into them.

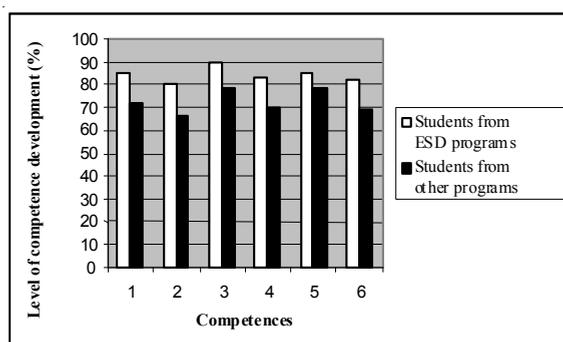


Figure 1. Self-evaluation of the desirable/real level of professional competences by the students from ESD programs and those from other programs

The teachers' expectations regarding the students' communicative and systemic competences are higher than the students' own expectations. With it all, the students' expectations also have high values (see Figure 2).

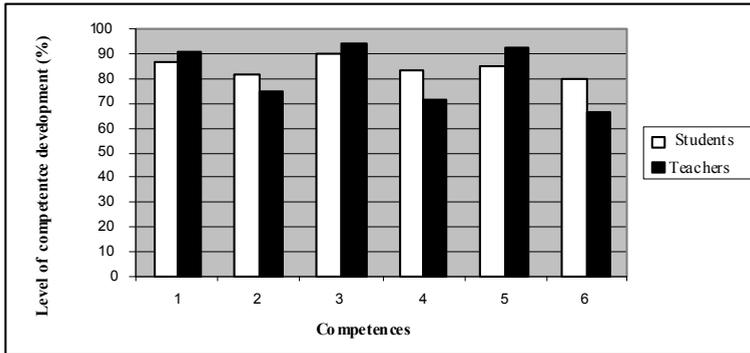


Figure 2. Evaluation of the desirable/real level of professional competences by the students and their teachers from ESD programs

As one can see from the Figure 3, here in all positions (with the exception of students' real mastery level of systemic competences) the teachers' evaluation is higher than that by the students.

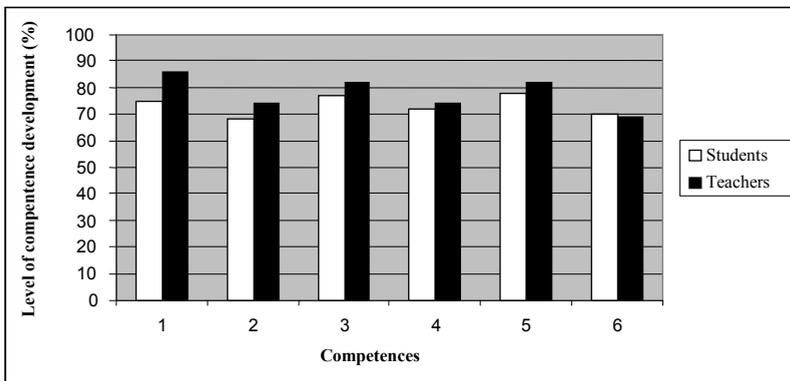


Figure 3. Evaluation of the desirable/real level of professional competences by the students and their teachers not included into ESD programs

Figures 4 and 5 will show the differences in evaluation of the desirable and real levels of competences given by the employers and students' self-evaluation.

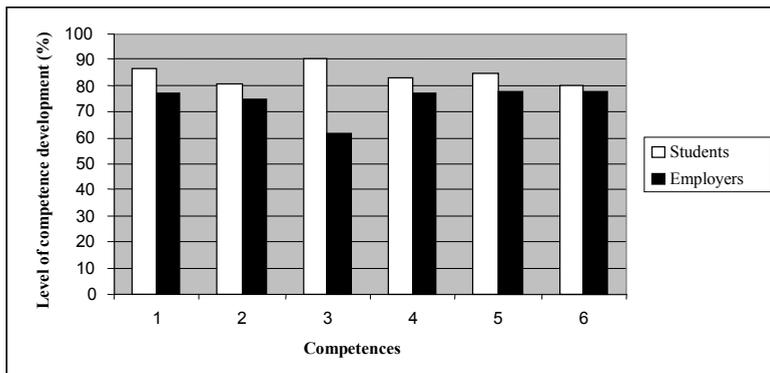


Figure 4. Evaluation of the desirable/real level of professional competences by the students included into ESD programs and employers

Unlike teachers, employers consider the real level of students' systemic competences as quite sufficient.

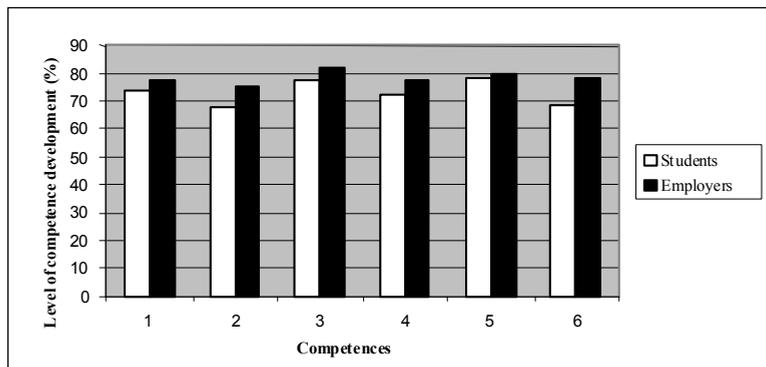


Figure 5. Evaluation of the desirable/real level of professional competences by the students not included into ESD programs and by employers

As it is seen from Figure 5, the employers' expectations and evaluation of the real level of competences have higher values than that of students who are not included into ESD programs.

Discussion

Speaking about the specific competences, the real level of instrumental competences is evaluated as the lowest one both by the students included and not included into ESD programs. It is not surprising, as instrumental competences are formed in the practical activities. In the process of training the development of systemic and communicative competences usually is stressed. It should be noted that all the evaluation values of both the desirable and real levels of competences are very high with all students in the sample.

Speaking about the students included and not included into ESD programs, the differences in all the positions for these groups of respondents (with the exception of differences between the desirable development levels of systemic competences) determined with the help of t-criterion are statistically significant at the level of 0.1.

Regarding the comparison of sample groups from ESD programs and other programs, the results presented in Figures 2 and 3 show that there exist differences in the evaluation of the desirable and real levels of competences by the respondents of two groups considered. The University lecturers involved in ESD programs evaluate the desirable level of competences in all cases higher and the real level of competences lower than the students. The evaluation of the lecturers of the second group is either higher or the same as given by the students. It was already mentioned that the evaluation of both the desirable and real levels of all competences is higher with the students included into ESD programs than with the students not included into ESD programs. Apparently, high expectations of teachers in relation to the students facilitate the formation of higher expectations with the students.

Besides, in the group of students and teachers statistically significant differences have been stated in the evaluation of the real level of communicative competences (on the level 0.1) and systemic competences (on the level 0.01).

While comparing the Figure 4 and 5, at first sight, the results received in the comparison of evaluation by students included into ESD programs and employers and by students not included into ESD programs and employers are completely opposite. In the first group, the evaluation of the desirable and real levels of competences is higher with the students than with the employers. In the second group it is the opposite. However, the statistical analysis shows that there are no significant differences in the evaluation of the second group. Thus, it can be said that the evaluation of the desirable and real levels of professional competences does not differ with the employers and the students not included into ESD programs. As to the first group, significant differences (on the level 0.1) have been stated between the evaluation of the real level of instrumental, communicative and systemic competences, as well as between the evaluation of the desirable level of competences.

The given research allows promoting the discussion about the quality of teacher training in Daugavpils University and also in other institutions. As pilot research it provides some realizations which in the future could help to determine the aims of further research, which, in turn, will possibly give rise to discussion of the contents and structure of training for future teachers.

The results show that the evaluation of the desirable and real levels of competences is higher with the students included into ESD programs than with the students not included into ESD programs. This outcome certainly not only gives the answer to one of the research questions, but also generates other questions as well.

Does the higher evaluation of professional competences by students included into ESD programs result from the reality that these programs are more efficient (integrated approach, group methods of training, understanding the social context of the events taking place) than the traditional ones?

What role do higher expectations and larger demands of lecturers included into ESD programs to their students play in this phenomenon?

How do the gender peculiarities influence the described phenomenon (there was only one male in the group of students included into ESD programs while in the second group the proportion between males and females was equal)?

Does the future professional activity influence the evaluation of the desirable and real levels of competences? The group of students included into ESD programs consisted of future preschool and basic school teachers while the second group included future teachers of sports, music and art.

Therefore, as pilot research, this study has some limitations that must be considered as much as possible or referred to as confounding variables while planning further investigation: 1) the number of respondents in all sample groups should be raised, 2) the gender and disciplines taught by future teachers should be equally represented in each sample group of students, 3) the employers should evaluate the professional competences exactly for the students under investigation, etc.

However, even these preliminary results allow us to formulate some groundwork suggestions for teacher training programs mainly focusing on the role of the principles of ESD integrated in teacher training programs in the constructive development of professional competences of future teachers.

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Received 15 June 2008; revised version received 7 November, 2008

**ROLE OF MEDIA IN STUDENTS' LIFE AND
THEIR ENVIRONMENTAL EDUCATION:
A SURVEY OF STUDENTS AGED 13 TO17**

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Abstract

Finding solutions to the problems of environmental protection and nature conservation, developing and performing environmentally conscious behaviour have become the main task of recent decade, this equally involves political, economic and social spheres. Beyond networking between these spheres, the media have to undertake a specific role in solving the above-mentioned problems and also attaining sustainability. A survey was conducted among 234 students between the age of 13-17, searching for the answers what connections students have to the media and whether and to what extent they are reached by the thematic channels and television programmes related to the environment and nature. It is argued that to deal with the issues raised by the results of the survey, a module dealing with environmental protection and nature conservation based on the application of different elements of media should be created for Hungarian schools.

Key words: *media; environmental education; students; role of television and Internet.*

Concerning our planet's fate people have several reasons for worrying about the distant future if we are reluctant to change our human-centred attitude. We can expect a change happening at present move towards a more positive direction only if we fundamentally transform our way of looking at things. A real break-through can be expected from the generation which turns to nature, recognizes its values, which submits himself/herself to its laws and grows up with a new way of thinking (Szabó, 2002). The future generation as well as the present day people have to know and understand the importance of sustainability and have to act and behave according to this in their daily life.

Environmental education can be realized within formal and non-formal frames and in informal forms as well. This latter form occurs in the family, in peer groups, during the activities organized by different institutions and through the media as well. The sustainable future requires much wider networks – the sectors of formal, non-formal and informal education working together (Lukk, Veisson & Ots, 2008).

Our society is more and more mediated which means that people get most of the information through the mass media, so the media communication can be a very effective and powerful tool for implementing any interests. While the general public become defenceless, the role of the journalists and decision makers of the media increases (Cselószki, 2000). Nowadays the wide spread of different media, especially television, contributes to the changes in the process of socialization. Besides the traditional elements of media such as newspapers, television, video, etc. the new and quickly spreading technologies play more and more important role in children and adolescence's daily life.

According to some critics of the mass communication, it develops a mass culture in which social relations have decreased into the minimum and through mass communication people become increasingly influenced by the effects of propaganda advertisements and commercials (Ankerl, 1991).

Several studies conducted on the diverse roles of the media have been described both in the Hungarian and international literature and they indicate that the means of mass communication have influence on the members of the society (e.g., Barta & Szijártó, 2000).

Since the second half of the 20th century television has played a determining role among the media. Except for the newly developed countries we hardly come across households where at least one television set is not present. The world and the events happening in it can be accessible through television. Children who used to get acquainted with the world with the help of their direct surrounding and their family, before television became widespread, nowadays spend more and more time watching television so being acquainted with the world and the way of thinking about it are shifted into another dimension for the individuals and for the whole human race as well.

Not only television has a great impact on people's life. Also the other means of media have determining role in the way of people's thinking. Szirmai and Vit (1997) investigated the role of printed press in developing people's environmental awareness at the stratum of readers in the Hungarian society. According to them, the electronic media could not replace the role of printed press although it gains less ground.

An aspiring and determining media element of the recent years is the Internet. The World Wide Web is accessible for more and more people in the society. The Internet is in a very determining position in the life of young people. This is proved by the research results presented in this article as well. The demand for implementing more and more elements of multimedia during the education process is drafted from their parts. The study by Coley, Cradler and Engel (1997) shows that the critical element of the successful application of technical devices at schools is the way in which teachers can be given help to integrate the media elements into the curriculum. Most of the teachers did not even get any help for the successful application of technical elements in the lesson during their teacher training courses.

McCombs and Shaw (1972) investigated the relation between the increasing spread of information and the society. Their research results proved that mass communication determines the topics people think about and not their opinion.

The media and environmental issues

One of the responsibilities of the media today is to show the environmental issues and way in what they present the problems; whether they admit the forthcoming ecological crisis or they make us believe that technology is above all, whether they inform us objectively or they give space to straining for effect, whether they allow rational disputes or they degrade the complex questions into loud headlines in order to raise people's attention (Cselószki, 2000).

Unfortunately, as the experience with the Hungarian media shows there is a very little time and space in the different media for the news and topics about the environment. When the news relevant to the environment gets into the media it is not yet known for sure whether it goes further to the public. Although the green movements do not think that people have become indifferent with environmental problems, they agree that the stimulus threshold of their perception has become higher which means that in order to raise interest we need more shrilling messages. One of the reasons of the sagging interest can be that the everyday people do not see any progress in environmental issues, they feel helpless, they do not see the relationship between the environmental problems and their own lives. Moreover, they cannot afford the financial burdens related to the environmentally-friendly way of life.

According to journalists, an average citizen has no idea about what the really threatening things are concerning the environment. In connection with this the responsibility of the media is raised because people have hardly any other sources of information and the situation will not be less difficult if programmes in connection with environmental protection will disappear from the media.

Method

The elements of media are considered to be important in the accomplishment of environmental education and in the pedagogy of sustainable development (Smith, 2000).

The quantitative methodology was applied to receive the information about the role of different media elements in teenagers' life and importance of environmentally oriented media or topics for them. The survey created by the authors of this article consisted of 20 questions and it was carried out to obtain information about the habits of using different media among the teenagers in Eger. All questions except of one were closed questions with alternative answers to choose from.

The objectives of the survey were to determine how often they listen to the radio, read daily newspapers and magazines, how much time they spend watching television and surfing the net. In the survey larger emphasis was put on the relationship of teenagers with the television, especially their favourite TV channels and programmes. Altogether nine questions in survey were related to the television.

The survey also aimed to receive the answers to the questions whether respondents are interested in environmental problems, what their opinions are about the role of television in environmental protection, to what extent they are interested in the news and problems concerning their living place and region, the newspapers and magazines dealing with environmental issues.

Research participants

The survey was carried out among teenagers because the puberty is a transition age between childhood and adolescence and this age group in Hungary is affected the most by various kinds of media, especially television, and their behaviour can be oriented in different directions in the most various ways. Therefore, school education should make the most of media at school as well and ought to give directions to students for their homework related to the media.

Two age groups, from the age of 13-14 (Grade 8), and from the age of 16-17 (Grade 11) were examined. At the beginning and at the end of puberty students are different in many aspects regarding their psychological and social development. Another reason for this choice was to get a view on the differences between these two grade levels as well since they represent the end of the elementary school and almost the end of secondary school in Hungary. The 17 year-old students have to decide what subjects they are interested in and which subjects are important for them at secondary school to choose from to take the entrance exam for the higher education.

The survey was carried out in December 2007 involving 240 students in three schools and in eight classes (four classes Grade 8 and four classes Grade 11) in a middle-sized Hungarian town, Eger. Most of the students gave relevant answers to the questions. The irrelevant answers were ignored; so 6 surveys filled in did not take part in the data analysis. Altogether the surveys from 116 research participants at the beginning of puberty and 118 at the end of puberty were analysed and their results are shown below.

The results of the survey

After filling in the survey, the results were pooled, summarized and interpreted. In this section of article the results coming from the questions most relevant to the general aims of the article are presented in detail.

1) *The popularity of media among the students*

The frequency of the usage of different media by both age groups is shown in Figure 1.

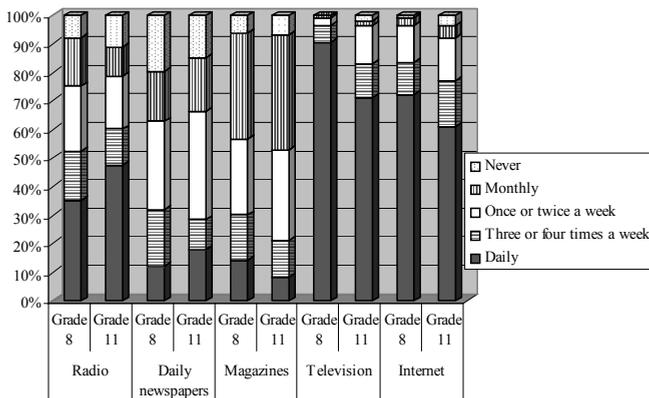


Figure 1. The popularity of different media among the students

The most popular type of media among the students is television. The majority of the students in Grade 8 and almost three-quarters of the students in Grade 11 spend some time watching TV. This later result is influenced by the fact that a higher proportion of students live in hostels and they are allowed to watch TV or use the net within restricted periods.

It was a surprising result that the Internet comes after television just with a little difference. Almost three quarters of the students in their early puberty use the Internet every day.

2) Students' habits of using television and Internet

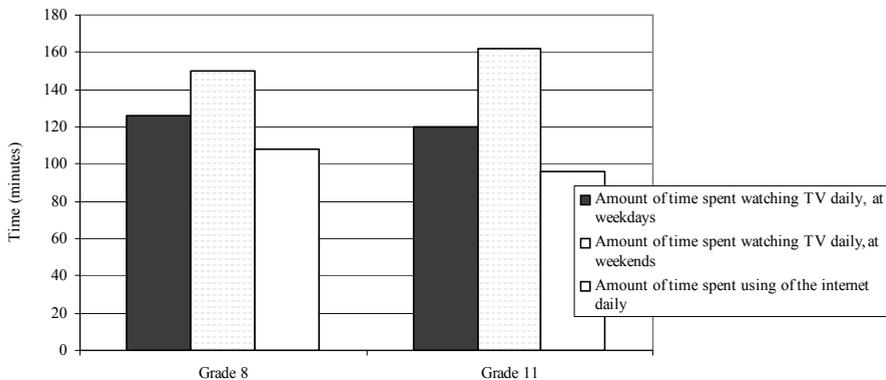


Figure 2. The time spent in front of the electronic media by students

Figure 2 indicates the amount of time students spend watching TV and using the Internet on the basis of the mean of the given answers. In the case of the Internet there were no questions referred to how much time students spend browsing on the net at weekends.

3) Students' favourite TV channels

Students had to rank the different TV channels on the given list, but it was also possible to add other channels. The total list of selected channels represented a wide choice of popular television channels. This proves that the students' households belong to the subscribers of some cable channels. The popularity rank of TV channels was made up on the basis of the students' votes according to the first four places of the certain channel. The results regarding two age groups are very similar. The most popular TV channel is RTL Klub, then comes TV2. The first two popular commercial TV channels are followed by the Viva music channel in both age groups. The next channels in the popularity rank are those broadcasting the documentary films on nature, programmes dealing with environmental topics (Discovery Channel, National Geographic and Eurosport, the national civil service channels and the movies channel). Neither of the groups of students shows interest towards the local TV channel, it gets the last place in the rank.

4) Rating indices of the popularity of different TV programmes among the students

One of the questions in the survey probed on the popularity of different TV programmes. Students had to rank the programmes on a five point scale which indicates how much they like them, how often they choose the certain programme. With the help of weighted average the rating index to the programmes was calculated so as to set up the ranks shown in Table 1 and 2 for both age groups.

Table 1. The ranks of popularity of programmes among the students in Grade 8

	Types of programmes	Rating index
1.	Music	3.96
2.	Serials	3.84
3.	Feature films	3.64
4.	Sports programmes	3.60
5.	Detective stories	3.50
6.	Shows	3.48
7.	Films on nature	3.44
8.	Documentaries	3.35
9.	Cartoons	3.34
10.	The News	3.32
11.	Quiz shows	3.30
12.	Magazines	2.54
13.	Talk-shows	2.48
14.	Commercials	1.51

Table 2. The ranks of popularity of programmes among the students in Grade 11

	Types of programmes	Rating index
1.	Music	3.70
2.	Cartoons	3.68
3.	Serials	3.41
4.	Films on nature	3.40
5.	Documentaries	3.31
6.	Feature films	3.12
7.	The News	3.10
8.	Shows	2.98
9.	Detective stories	2.94
10.	Sports programmes	2.93
11.	Quiz shows	2.71
12.	Talk-shows	2.44
13.	Magazines	2.39
14.	Commercials	1.64

Music programmes took the first place in the rank both among the students in their early and in their late puberty as well. In the case of students in Grade 8 serials and

feature films are in the second and the third place in the rank while in the case of Grade 11 cartoons are before the serials in the second place. Films on nature are not very popular in either of the groups, this type of programme stands on the seventh and on the fourth place.

5) *Students' interest in questions concerning the environment and nature*

Figure 3 shows that majority of the students in both age groups are interested in environmental problems and topics on nature and its protection. It is a surprising and a worrying result at the same time that the proportion of the students who are not interested in these problems is higher in Grade 11, as one third of the answers were "no" while only one quarter of the students in Grade 8 are not interested in these questions.

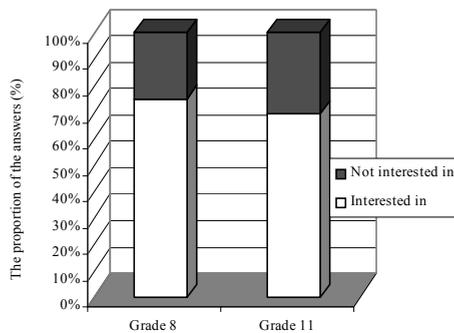


Figure 3. Students' interest towards the problems of environmental protection and nature conservation

6) *Students' perception on the proportion of TV programmes dealing with environmental topics*

In both age groups the majority of the students do not see the need for more programmes on environment and nature. More than half of the students in their early puberty (64%) and half of the students in their late puberty (55%) think that the proportion of these programmes is appropriate. However, a large number of students believe that we would need more programmes of such kind (see Figure 4).

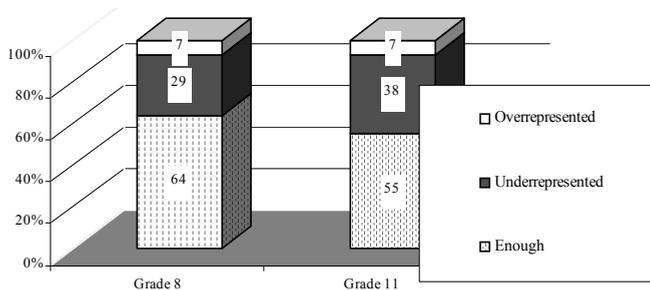


Figure 4. Students' perception of proportion of TV programmes dealing with the environment

7) Popularity of magazines dealing with the environment among the students

Besides the questions referring to the elements of the electronic media, survey contained the questions concerning the popularity of the printed media such as magazines on popular science, science and environment, nature. Results of the popularity of eight so-called “green” magazines are indicated in Table 3. The numbers in the Table 3 describe how many students per grade level agreed with the suggested type of answer.

Table 3. The popularity of “green” magazines among the students

Magazine	I don't know		I have heard about it		I occasionally read it		I regularly read it	
	Grade 8 (n=116)	Grade 11 (n=118)	Grade 8 (n=116)	Grade 11 (n=118)	Grade 8 (n=116)	Grade 11 (n=118)	Grade 8 (n=116)	Grade 11 (n=118)
<i>Élet és Tudomány</i> (Life and Science)	21	32	86	78	7	7	–	1
<i>Ma & Holnap</i> (Today & Tomorrow)	56	89	56	27	3	2	–	–
<i>National Geographic</i>	2	3	44	61	49	46	7	7
<i>Süni</i> (Hedgehog)	62	76	47	35	3	4	–	1
<i>Természet-Búvár</i> (Naturalist)	27	17	61	79	24	20	3	2
<i>Természet Világa</i> (The World of Nature)	47	59	53	49	12	8	2	–
<i>Vadon</i> (Wilderness)	50	68	48	38	15	10	2	2
<i>Zöld Újság</i> (Green Magazine)	89	95	22	18	2	3	2	1

The results of the table are very disturbing. Printed media do not seem to be popular. Magazines suitable for the different age groups are not really well-known for the students. The proportion of those students who regularly or at least occasionally read some of the magazines is very low.

8) The students' opinion about the role of media in the shaping of environmental awareness

Three alternative choices of answers (“negative role”, “positive role”, “they do not have any effects”) were provided to this question, however during the evaluation and processing the data four types of answers were distinguished. As the students could not always give one definite answer to the question, they were allowed to give two possible answers (positive and negative at the same time).

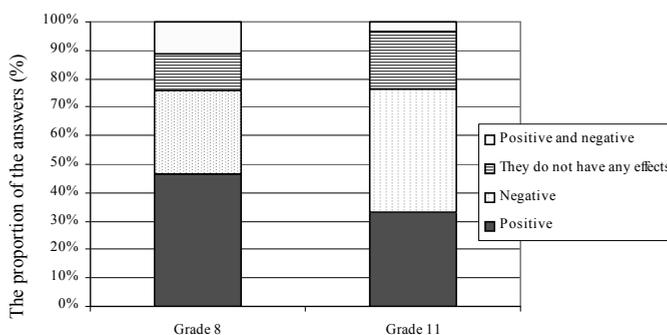


Figure 5. The students' opinion about the role of media in the shaping of environmental awareness

Students in their early teens and those in their late puberty see the role of media in shaping the environmental awareness differently. On the basis of the given answers it was inferred that teenagers think that the elements of media have quite diverse effects on the development of people's environmental awareness. Approximately half of the students (47%) in Grade 8 believe that media have positive role in this question. Almost one third (29%) of them think that media have negative effect.

In Grade 11 only one third (33%) of the students think that media have positive effect, while according to almost half (43%) of the research participants media are negative in this respect.

Aims and tasks: The increasing role of the media in education for sustainable development

On the basis of the results of international surveys (Howe & Disinger, 1988; Sharma, 2004) and research presented in this article one can say that the elements of media should take more responsibility in education for sustainable development as to reach sustainability. Getting information in an informal way through the media, especially for the young people, is determining in this regard.

The role of media and its techniques have to be strengthened in education generally, and particularly in environmental education and in education for sustainable development. This is, though, a very difficult task for the schools in general and for the teachers as well. Besides the high costs burdening the budget of schools the bigger problem is that teachers are not prepared for the handling of the tools of multimedia and information technology in a self-confident way, they do not have the proper theoretical and practical knowledge to do this. A solution to this problem can be a teacher training project or an integrated part of teacher training programmes in colleges which would show the latest innovative technological tools for the student teachers. Such project would introduce them with the possibilities of using the different media and IT tools in several practical ways. With the help of this knowledge and skills teachers would be able to apply the various educational packages, equipments and educational programmes either during the lessons or during out-of-school activities with self-confidence and could enrich their application with their own ideas. Students would

apply these programmes and tools with interest and pleasure as they are accustomed to using computers or other technological devices of IT in their daily life. In Hungary there are several so called “green multimedia educational packages” (Katona, Leskó & Kárász, 2007) which deal with different local and global environmental problems. These educational packages, however, are used by very few teachers in their teaching practice. The main reason for this is the lack of the technological background for the application or the lack of the teachers’ computational skills (Leskó et al., 2007).

The practical experience of the authors of this article shows that students are more motivated to apply the technical innovations and the information conveyed by them during the lessons than the teachers themselves.

In Hungary both at the primary and at the secondary level of education (in Grade 8 and 11) a subject *Moving Pictures and Media Knowledge* is built into the National Curriculum. Perhaps the aims and the requirements are not practical enough, as they do not include the pedagogical viewpoints of sustainability.

Important task within this course would be the analysis of the positive and negative impacts of the media by the students themselves in making effort for sustainability. Teachers should make their students realize that the media is a profit oriented “trade” in which the conveyed information is not always in line with the principles of sustainability. Also, an important task for the subject *Moving Pictures and Media Knowledge* would be the development of students’ decision-making skills since responsible decisions can be made only in the possession of adequate and correctly interpreted information.

The different elements of the media would be applicable also in strengthening the environmental education on a local scale. Students could work for local newspapers or magazines, radio and TV programmes as editors or writers who will be supported by the teachers dealing with environment education. The students’ way of thinking, their general view of life and their personal environmental attitude would be developed through engagement in local activities. As a result of these viewpoints the environmental conscious behaviour would evolve though the exercising it in daily life.

Teachers have the main role in making “green magazines” popular among the students as well. They have to find possibilities and solutions to draw their students’ attention to these magazines since different abilities and skills can be developed through them and several pieces of information cannot be conveyed without them.

The results of this quantitative research method and consideration of the tasks and possibilities regarding the environmental education and education for sustainable development have determined a solution for the spotted problems. The module dealing with environmental protection and nature conservation based on the application of different elements of media should be created for Hungarian schools. According to the plans, the module would contain 5-6 lessons built into the *Moving Pictures and Media Knowledge* subject that would be implemented initially as an experiment in the selected schools. The aim of the module is to draw the attention of students towards media elements dealing with environmental subjects, news and programmes. After reading, watching and listening to certain units about the determined subject, students would discuss the topics, role play them and participate in several projects aimed to develop their environmental attitudes. After the experiment it would necessary to survey the students on their environmental attitudes.

Conclusions

Nowadays media play an increasingly important role, they determine the life of the individuals and the whole society. This power should be used also in favour of environment protection and for the development of environmental behaviour in the civil society. In other words, there should be more people involved in taking the responsibility for both social and natural environment.

A survey was carried out on the role of media in students' life and their environmental education. As the results show – in comparison with other similar researches (Barta & Szijártó, 2000; Kósa, 2004), the most important and popular electronic media elements are television and Internet. Therefore, it can be concluded that these media elements are determining in the life of the teenagers. They gain the majority of their information from these media, so the students' way of thinking, behaviour, attitudes are constantly changing and developing.

According to the results, although some students are attracted to the current environmental issues and nature, most of them are not interested in these topics. In their opinion there are only a few programmes concerning such topics.

The promising result is that students often pay attention to the educational programmes and programmes of scientific channels although the popularity of films on nature are in the middle rank among the other programmes.

“Green” magazines and newspapers are hardly known among the teenagers. However, information conveyed through the printed media, the elements improving the different skills and abilities of students cannot be substituted for the electronic media, therefore the raising of the popularity of printed media among the students should be considered by schools and teachers. Therefore, we cannot ignore the necessity of drawing our attention towards the programmes and magazines dealing with environmental issues. One of the possibilities for this is building the environmental media module described above into the curriculum.

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Received 25 May 2008; revised version received 29 October, 2008

