JPlus-Platform – Independent Learning with Environmental Information in School

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Abstract

During the UN Decade "education for sustainable development" (ESD) all educational institutions are challenged to adjust their concepts according to the constituent competencies. Two secondary schools face this challenge with the project "Environmental Monitoring in Schools – Development of Cultural Landscapes in Biosphere Reserves", which has been executed regularly in the biosphere reserve "Oberlausitzer Heide- und Teichlandschaft" since 2008. Continuous development towards the contents and the working tools has been made during recent years. The software *JPlus* presented in this article is another part of the project idea.

1 Motivation and Classification of the Subject

Biosphere reserves, according to the UNESCO, have the purpose of enabling environmental research and environmental education. The developments which have been applied to the educational sector in recent years have also been discovered for the biosphere reserves and thus the focus on sustainable development has been increased. The project "Environmental Monitoring in Schools - Development of Cultural Landscapes in Biosphere Reserves" realised in the biosphere reserve "Oberlausitzer Heide- und Teichlandschaft" has made a big contribution toward this development.

Using new media techniques and GI-technologies like geographical information systems, remote sensing and GPS, students had the opportunity to work scientifically over three to five days. Besides teaching basic physics, mathematics, history and social studies the monitoring of a certain aspect of the changing cultural landscape marked a highlight of the whole project. The task of the students was to detect changes using aerial photographs and satellite images, which had been taken at different times (change detection; KARRASCH 2008).

Environmental education, as part of education for sustainable development (ESD), has a high significance in schools. The economical, ecological, social and cultural focus of the educational concepts involving the ESD can especially be met by the holistic approaches of environmental monitoring. KARRASCH et al. (2009) were able to point out possibilities for students to look into the subject of cultural landscape change, for example in biosphere reserves. At the same time the results of KARRASCH et al. (2009) showed that the willingness of teachers to use these concepts is very high (see Fig. 1).
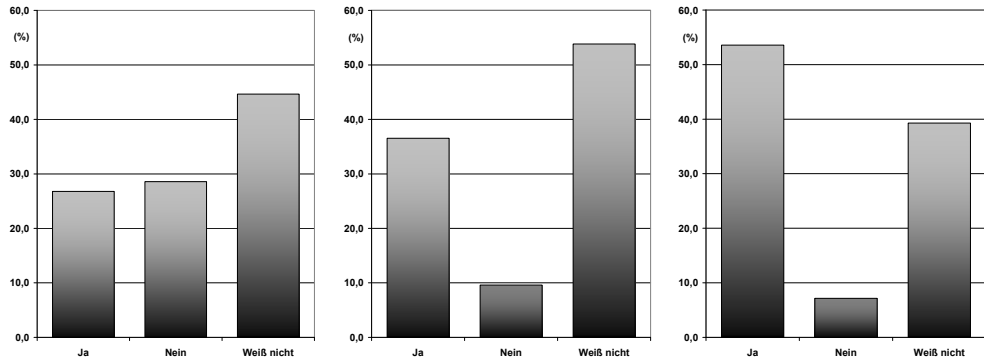
Fig. 1: Willingness to use geographical information systems (Saxony); left: elementary school (n=56), middle: secondary school (n=52), right: academic high school (n=28); (KARRASCH et al. 2010).

In the past these concepts have been realised with commercial software. The main advance of these products is a high functionality. This complexity, however, is often overwhelming for students. The goal is to provide specific tools which allow accomplishing the demands of the ESD-concepts. This has been achieved by a learning environment, realised in the programming language Java, which has been developed in order to considerably simplify the work with the students.

2 Goals and Requirements towards the Learning Environment

JEKEL (2008) declares that the utilisation of GI-Technologies during class has the danger of "ending up as some kind of software training, whose educational value is hard to relate because of the short half life of the technology on the one hand and the missing real life applications on the other." Therefore just using GI-Technologies in order to make the geography classes more interesting is not enough (see STROBL 2004, JEKEL 2008). The primary goal has to be the promotion of spatial thinking and action. The use of GI-technologies comes after this. The Area of the biosphere reserve provides an excellent opportunity to work problem-oriented and with GI-Technologies.

The utilisation of geographical information systems, remote sensing and GPS is put into context. Thus, not only orienteering and illustration competences which are almost always considered by GI-Technologies are promoted. In the context of the changing cultural landscape other competences can be included (KMK 2005). These are:

- issue competence
- orienteering competences
- methodical competences
- illustration competences
- social competences

Besides the problem-orientation (see GRÄSEL 1997, REINMANN-ROTMEIER et al. 1994). BARTH (2007) also regards self-monitoring (see SHIN 1998, FRIEDRICH & MANDL 1997,

GNAHS et al. 1998) and collaboration (KOSCHMANN 1996, SCHULMEISTER 2001, ARNOLD 2003) as the main elements of computer based competence acquisition.

The task at hand is to provide tools which arrange learning environments in terms of sustainable development. These tools should offer an open and explorative learning process to allow an individual, trainee-centred and self-organised learning (see SCHULMEISTER 2005, ELEN et al. 2000, ZIMMER 1997).

In the case of "Environmental Monitoring in Schools - Cultural Development in Biosphere Reserves", commercial software, such as ERDAS Imagine, was used. During 2010 the available network of the biosphere reserve "Oberlausitzer Heide- und Teichlandschaft", the participating schools and the Institute of Photogrammetry and Remote Sensing made it possible to start the development of a tool, which was able to fulfil the requirements given by the project concept. These requirements apply to the technical components (see table 1) and the competence orientation.

Table 1:   Requirements towards a digital-image-processing-tool for adolescents within the project "Environmental Monitoring in Schools – development of cultural landscapes in Biosphere Reserves".

tools	handling	terms of use
multispectral classification	simple handling	free of charge (biosphere reserve)
change detection between different time periods	clearly arranged and comprehensible (transparency)	platform independent
distance image of the feature space	specialised controls for teachers	executable without installation
display of classification statistics	feasibility during one learning unit (90 min).)	detailed help function
implementing of overlay functions	scientific layout	capable of handling free or low-cost satellite data
display of maps		TIFF as standard format
zoom feature for improved orientation		
printability of all documents		

From these requirements JPlus, a Java application for **p**latform independent **l**earning with environmental (**U**mwelt) information in **S**chools was developed.

3 Implementation of the Learning Environment

3.1 Structure of the computer program and spheres of competence

The program structure and the involved tasks are oriented to the competences provided by the KMK (2005), which were described in section 2. Table 2 displays the tasks of the students and accordingly the course of the program.

Table 2: Program flow of JPlus (tasks, tools, spheres of competence).

tasks	tools	spheres of competence
orientation inside an image	zoom feature	orienteering competence
creation of training areas	class editor	orienteering competence methodical competence
illustration land use and land cover	classification algorithm *minimum distance*	illustration competence
estimation of the quality of own work	classification statistic	methodical competence illustration competence
illustration of change in land use und land cover	change Detection	issue competence illustration competence
evaluation of change	based on results/ export as pdf	social competence

With the help of the zoom feature students are able to navigate autonomously. The goal is to "orientate in virtual reality and to put this in relation with the real world" (KMK 2005).

The following tasks of classification of land use and land cover requires as a first step the definition of training areas. This also requires orienteering competences. Furthermore, the usage of "different work techniques of geography for gathering, processing and displaying of information" made an important contribution towards the methodical competence (KMK 2005). The available class editor gives the students the possibility to get an individual result through independent work.

During the following section the actual classification of the data set will be done and displayed as a simple cartographic image on an individual basis of the training areas. This gives students the ability to "present geographical circumstances graphically as a special from of technical communication" (KMK 2005; displaying competence). The aim is that every student has the opportunity create an individual map of the area he is analysing. This individuality shows the students that their work is no tedious completion of tasks but rather that their actions have a direct impact on the result of the classification.

Besides the task of classifying a satellite image, the quality of work is an important aspect of the analysis done by the students. This is the only way for them to reflect their own actions and a possibility to understand the limits of remote sensing data. In order to allow this, two features were implemented, which make this possible in two different ways. The pupils

have, for example, the possibility to add an overlay image with the classification results over the original satellite image in order to make statements towards the precision of the classification process. This shows which land use classes were especially difficult to classify.

Another way of visualising classification accuracy is the display of classification statistic. This is done by giving a normative standard of evaluation for each pixel. Students gain quantitive data about the grade of their work. The data is scalded from very good to fail. It is calculated with the reference areas chosen by the students (training areas) and it is based on the statistical spread of the reference pixel around the centre of the respective land use class in the spectral feature space. The normative rating is then done by multiplying the standard deviation (see Fig. 2).
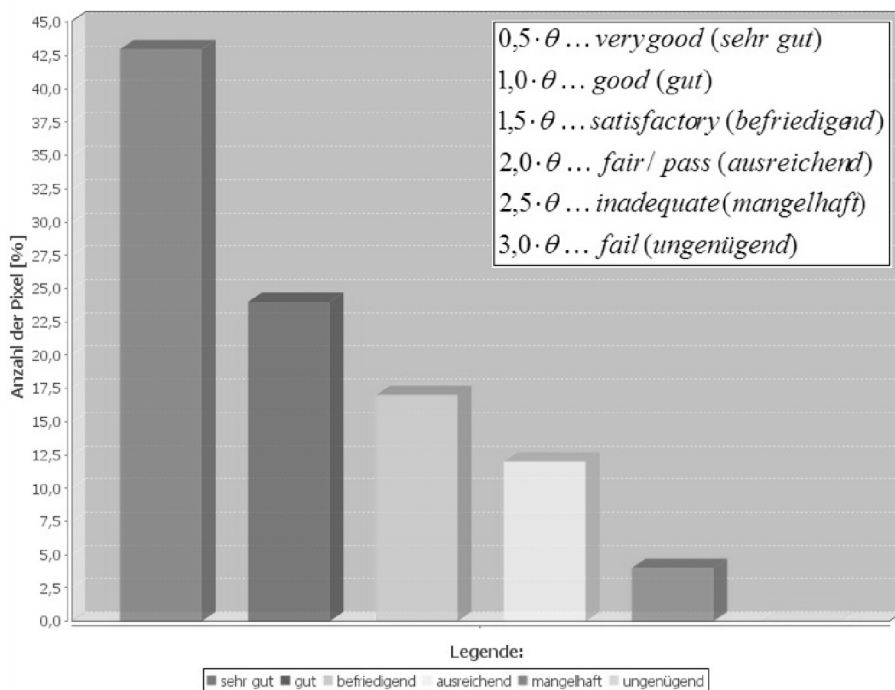

$0,5 \cdot \theta \ldots very good \ (sehr \ gut)$
$1,0 \cdot \theta \ldots good \ (gut)$
$1,5 \cdot \theta \ldots satisfactory \ (befriedigend)$
$2,0 \cdot \theta \ldots fair / pass \ (ausreichend)$
$2,5 \cdot \theta \ldots inadequate \ (mangelhaft)$
$3,0 \cdot \theta \ldots fail \ (ungenügend)$

Fig. 2:   Classification statistic – JPlus (own illustration)

Besides the ability of teaching of illustration competences by which "complex connections can easily made evident" the statistic enables the students to analyse the "theories and models towards their information value" (KMK 2005).

The execution of *change detection* itself makes a contribution in terms of teaching illustration competences. The primary goal of this part of the tasks is however the enhancement of issue competences. First and foremost is the detection of human-range relations. Based on the biosphere reserve the *change detection* gives students the possibility to "get to know

different ecological, political and socio-cultural influences in processes of spatial development and find approaches to resolve competing claims among interest" (KMK 2005).

The comprehension of aerial photographs and satellite images at different times is based on the absolute and relative difference between equal image layers. The most suitable layer can be chosen based on the respective task (near infrared for change of vegetation for example).

Experience shows that sustainable knowledge can best be gathered by student if the right teaching aids are available. The supply of this software is possible, however it is questionable to what extend the students would keep on using it in the future. For this reason the program offers an export of the results as a pdf-file. This makes it possible to print out the personal results and append them with the other coursework.

The aim of the whole program is to evaluate the results of the classification and change detection process. Students at this point have learned that cultural landscapes have changed. This can have different forms and relate to a change in vegetation or different forms of post-mining landscapes. The task of the students is it to evaluate and take a stand on these processes. The impact on the cultural landscape and the behaviour of the students themselves and their reaction form the basis of the conflicts between the human being and the environment.

The goal is that students "are able to make justified evaluative and value judgements based on different perspective on conflicts" (KMK 2005). Working in groups and adding different stakeholders from around the biosphere reserve underlines the significance of the social competences.

3.2   Graphical user interface of JPlus

Most of this program was realised as part of student research project. The learning environment was completely written in Java, a solid object orientated programming language which runs on almost every platform (e.g. Windows, Linux). In contrast to many other programming languages, the Java compiler first generates Java bytecode which is later translated by the Java Runtime Environment (JRE) into platform-specific machine code at the program execution time. This requires the runtime environment (Java Runtime Environment - JRE), to be preinstalled on the respective system. The JRE can be downloaded for free at http://www.java.com. When designing Java, Sun Microsystems attached great importance to platform-independency, robustness and security.

The design of the programming language reduces the possibility of a crash dramatically (robustness). This makes Java especially useful for school computers with different specifications. This fulfils many demands (table 1), especially in the field of requirements.

3.3   Availability of the software

It is scheduled at this time to make the software available for representatives of environmental education, or rather education for sustainable development in German biosphere reserves, for free. Any further use by different groups needs the authorization of the authors. A demo version of the software that only has the classification feature with three classes can be found under http://BfNe-Sachsen.de.
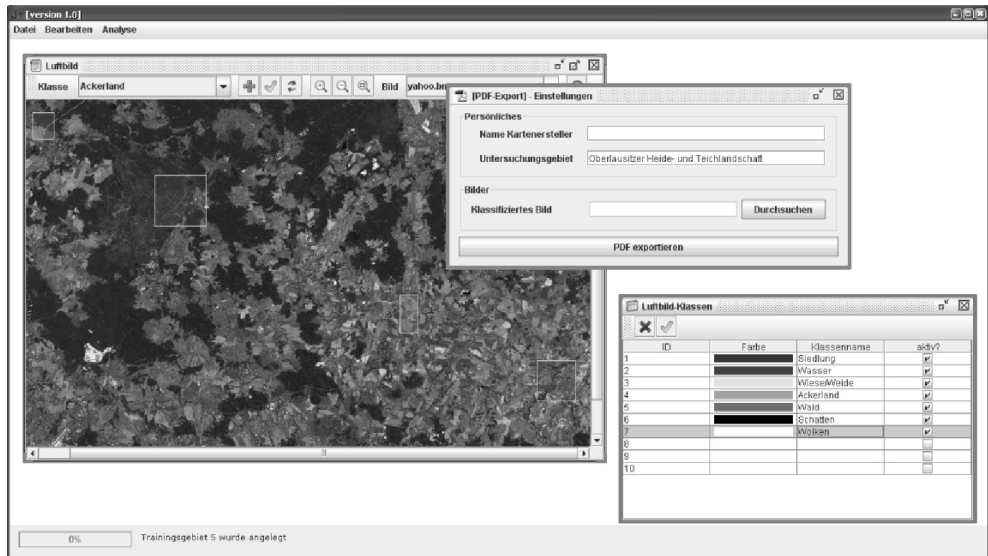
Fig. 3: Graphical user interface (GUI)

4 Conclusion

The software JPlus is another component of the project "Environmental Monitoring in Schools – Development of Cultural Landscapes in Biosphere Reserves". With this software it is possible to edit digital images goal-oriented, adapted towards the work of students. The design of the software was clearly oriented towards the central goal of decision-making and responsibility. Nevertheless it is mainly a tool to archive the goals of education for sustainable development. The structure of the program enables continuous expansion of the function volume.

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