Remote Sensing, New Media and Scientific Literacy – A New Integrated Learning Portal for Schools Using Satellite Images

Kerstin VOSS, Roland GOETZKE, Henryk HODAM & Andreas RIENOW

Abstract

The project FIS – **F**ernerkundung **i**n **S**chulen (German for "Remote Sensing in Schools") – aims at a better integration of remote sensing in school lessons. Respectively, the overall objective is to teach pupils from primary school up to high-school graduation all basics and fields of application of remote sensing. The results achieved to date reveal that many teachers have great interest in the subject "remote sensing", being motivated to integrate this topic into teaching, provided that the curriculum is considered. In many cases, this encouragement fails because of confusing information, which ruins all good intentions. For this reason, a comprehensive and well-structured learning portal on the subject remote sensing is developed. This will allow teachers and pupils to have a structured initial understanding of the topic. Working with remote sensing data opens up new and modern ways of teaching. The developed learning portal provides extensive material for this.

1 Introduction

Satellite data can be used efficiently in class for all present relevant phenomena and processes listed in the educational standard for the subject geography (e.g. earthquakes (KRAAS et.al. 2010), floods (GOETZKE et.al. 2008a, REUSCHENBACH 2007), disparities (KRAAS et.al. 2008), and resource contentions (GOETZKe et al. 2008b).

The use of satellite images in class offers in addition to the strengthening of natural science education and working on present questions further advantages, e.g. a high degree at descriptiveness, a motivating effect of the imagery, as well as ways for problem-oriented working, the strengthening of spatial orientation competence, method competence, and evaluating and practice skills (SNEIDER 2000, VOSS et al. 2010, WHITE 2001). Due to these advantages we want to integrate remote sensing into school education, because there is no better tool to investigate some specific problems.

The results of a teacher's survey across the German federal state of North Rhine-Westphalia reveal a great interest in the topic and thus a motivation to integrate the subject remote sensing into the lessons in a curriculum-corresponding way. In many cases, this encouragement fails because of confusing, difficult, or ineffective didactical preparation of information. Hence, despite numerous efforts, integration of remote sensing into school lessons depends on personal commitment of the individual teacher.

To overcome the determined problems, currently a comprehensive and well-structured learning portal on remote sensing is developed in the course of the project „Remote Sensing in Schools (FIS)". This will allow teachers and pupils to have a structured initial under-

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standing of the subject. By means of a great range of digital and interactive learning material, all fundamental aspects of remote sensing are considered. Furthermore, the learning portal follows the paradigms of an increasingly constructivist-influenced teaching.

2 Didactic Principle

In the course of school education, the providing of media literacy is regarded as a main educational task more and more frequently, and an education regarding the handling of "*new media*" is requested (AUFENANGER 2003, PÜTZ & REUBNER 2001, KAPPAS 2001). Additionally, the pupils take on a more active role in the course of an increasingly constructivist-influenced teaching (SCHUBERT & UPHUES 2009).

According to this, the learning portal's development is based on the didactic principles of constructivism. Constructivism regards learning as an active process. Through learning, present perceptive, thinking, and behavioural patterns are adjusted to new information, so that new insights emerge (MANDL et. al., 2002). The constructivist learning theory is based on the assumption that learning results from an own construction performance of the learning person, not from teaching (RINSCHEDE 2007). Therefore, learning is an independent and social process. Individual experiences, dialogue and the effort to understand are most relevant in the learning process.

On the basis of constructivist learning theory, the learning portal's realisation is oriented towards four design principles for learning environments according to MANDL & KOPP (2007):

- *Authenticity and relevance to application* – learning environments ought to be designed, so that the dealing with real problems and authentic situations is possible and/or encouraged. Correspondingly, the pupils are confronted with authentic exercises which encourage gaining application-oriented knowledge.
- *Multiple contexts and perspectives* – learning environments ought to be designed, so that specific contents can be seen from multiple points of view and in different situations. In this way, the knowledge transfer can be promoted.
- *Social learning arrangements* - For working with complex problems and questions, and for a deepened knowledge, co-operative learning is of key significance. Thereby, the pupils gain social competences of co-ordination, communication and co-operation.
- *Instruction and support* – self-active and individual working with complex exercises and manifold information resources are a challenge for many pupils. For this reason, instructional commentaries and support, like exercise instructions, accompanied group processes & feedback are of great importance.

On this account, the development of the web 2.0 gains in importance for school education; because web based training (WBT) allows a teaching method in which the teacher takes on a moderating role (GRAF 2007). In the course of the trend from a passive user to an active creator, the media competence as well as a greater activity of the pupils can be promoted and supported through the web 2.0. In particular *"the Geospatial Web promises to revolutionize the ways in which students explore concepts of space and place at geographical scales from the local to the global"* (HARRIS et al. 2010: 63).

To achieve this, the FIS learning portal is designed according to the general criteria for multi-media learning environments of BLOH & LEHMANN (2002), MESCHENMOSER (2002) and PÄTZOLD (2007). According to KERRES (2006), multi-media preparation of learning material supports cognitive learning processes. Equivalently, all different learning materials are multi-medially prepared, thus the contents are provided through different means of coding (texts, images, animations, films, figures etc.). Different forms of coding encourage multi-perspective thinking. The exercises provided in the learning material are an orientation for the pupils. Additionally, the exercises allow the integration of the pupils' daily life experiences.

The digital learning modules implemented on the platform allow a high degree of interaction. Moreover, specific tools for research, analysis, and exchange are integrated (3.3), thus independent working and discovery-based learning is encouraged in terms of a practice-oriented approach, as well as the platform allows the pupils to have an internal network. Hence, parallel to gaining methodical competences in the field of remote sensing and digital image processing, dealing with new media on the whole is encouraged. Through practical working with learning modules and the coupled experimenting, researching and analysing, the pupils shall learn to deal with new media in a differentiated way by reflecting the methods at hand critically. Altogether, interactive confrontation with remote sensing data can make a contribution to the preparation for studying and the working world, because secure handling of IT is a basic prerequisite in many professions today.

Moreover, the manifold supply of different learning materials opens up different ways for working with the topics, thus the pupils can handle the material differently according to their prior knowledge (BLOH & LEHMANN 2002, MESCHENMOSER 2002, PÄTZOLD 2007). Especially through integrating tools like research tools for interactive exchange among the pupils (e.g. blogs etc.), active learning is encouraged because they can expand and broaden their prior knowledge targeted. The aim is to counter the development of passive knowledge.

3 FIS Learning Portal

3.1 Structure of the Learning Portal

Through the learning portal, information about the application of remote sensing in school lessons as well as material in a structured manner, easy to understand and with specific curriculum-related suggestions shall be made available to teachers for the use in school lessons. The learning portal is divided into seven sections:

1) About FIS
2) Teaching material
3) What is remote sensing?
4) Research tools
5) Analysis tools
6) Evaluation
7) My class

To put the networking between the pupils forward, well-structured interaction space and, at the same time, encouragement of the community through support of permanent and sustain-

able interaction, is needed. Therefore, the learning management system contains a teacher's and a pupils' blog. This provides the possibility to exchange experiences among teachers and pupils. Furthermore, pupils and teachers can give a feedback about the provided material through the integrated evaluation (6).

3.2 Target Group of the Learning Portal

The new learning portal on remote sensing primarily appeals to three groups of users. Because a topic usually is brought to class them, teachers belong to the most important target group. Through providing a great range of information on remote sensing, they shall be appealed. For this reason, on the one hand, specific teaching material shall be provided and, on the other hand, information and additional materials shall be made accessible, which enable teachers to increase their knowledge of the topic and therefore create material and ideas for teaching themselves.

The pupils belong to the second user group. Primarily, the portal appeals to pupils aged 10-19, but educational games and information for pupils aged 6-10 shall be provided as well.

Other people generally interested in remote sensing belong to the third user group. Because information on this subject is highly dispersed and badly prepared or outdated in the web, the portal can serve as a central information point for the topic "remote sensing". Students shall be addressed as much as ordinary persons interested in satellite images.

3.3 Teaching Material of the Learning Portal

At the centre of the learning portal is, despite the instruction of basic theoretical techniques, the self-interpretation of remote sensing data to solve specific problems. Correspondingly, for combining theory and praxis in a sustainable way, aspects like independent working, creativity and critical reflection are of fundamental importance. The concept includes a problem-oriented and explorative working on questions using the different materials provided, and therefore an exploration of new fields of knowledge and development of approaches to solve the problem by the pupils.

3.3.1 Learning Modules

The core part of the learning portal consists of digital and interactive (Flash) learning modules which teach remote sensing topics following the curriculum for specific school grades. To cover different aspects of remote sensing, learning modules for the subjects of geography, biology, physics, maths and informatics are developed. Despite physical basics and questions of image formation, the fields of visual image interpretation, image enhancement and pre-processing are covered through this interdisciplinary approach. On top of that, derivation of image information as well as thematic analysis is dealt with. Therefore, the wide range resulting from involving different subjects is the basis for a profoundness of topics in remote sensing. Focused collaboration of different subjects improves the network thinking, interdisciplinary references and a holistic view of the pupils. This makes it easier for teachers to integrate remote sensing in their lessons (VOSS et. al 2009a).

The design of the learning modules enables the user to do classical remote sensing analysis by using interactive tools. The complexity of the analyses is lower than in conventional

remote sensing software, thus usability as well as functionality of the digital learning modules is adapted to a pupil-friendly standard. For the purpose of constructivist didactic, these interactive learning modules improve the pupil's independent working ability. The teaching units encourage the independent development and solution of problems by providing additional background information, figures, animations and exercises.

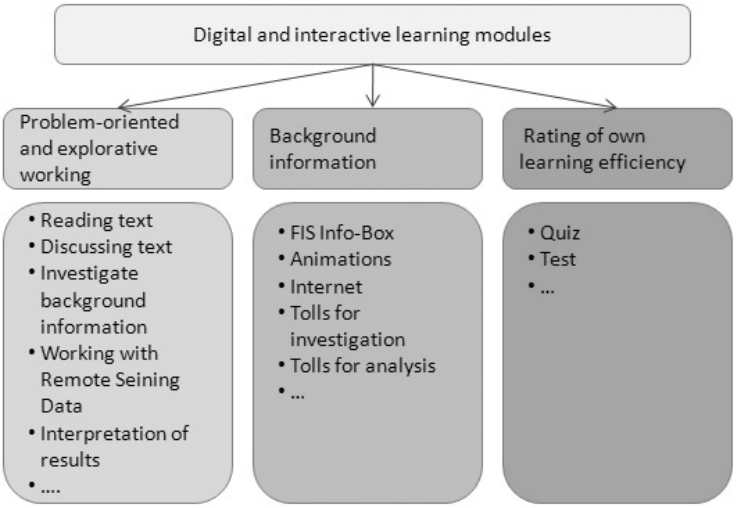

Fig. 1: Characteristics of digital and interactive learning modules (Source: Author's design)

The digital learning modules are not only limited to working with a computer, but contain working suggestions as well which encourage e.g. discussions in small working groups. In accordance with this, collaborative periods take turns with e-learning periods, thus altogether, the learning modules can be assigned to "blended learning". While collaborative periods serve the introduction to a subject and the expansion of knowledge as well as mutual exchange, e-learning periods concentrate on gaining knowledge through individual and self-controlled learning (KERRES, DE WITT & STRATMANN 2002). Through combining and taking turns, the *"social aspects of collective learning relate to effectiveness and flexibility of electronic learning forms"* (MANDL & KOPP 2006: 6). It is of essential importance that these different periods are not separate, but interlaced and related to each other.

3.3.2 Research Tools

The enclosed learning modules contain multiple background information which can be used by the pupils for working on the learning modules according to their previous knowledge. To preserve clarity of the learning modules and improve the pupil's individual and discovery-based learning, the pupils find extensive background information provided by research tools in terms of a digital glossary (Info-Box) and an image gallery. The Info-Box is a digital encyclopaedia for terms and basics of remote sensing. To make a contribution to the pupils' different previous knowledge, the Info-Box is presented in three versions, named

"easy", "medium", and "difficult" (VOSS et. al. 2009 b). Additionally, the pupils can search consciously for supplementary visual material. Searching options exist for images regarding specific regions or matching specific keywords.

3.3.3 Analysis Tools

Additionally, individual learning is put forward by different analysis tools. The pupils have the chance to analyse single images directly. The **SatCalculator** helps to perform simple arithmetic calculations with digital images, for example the calculation of the, and basic change detection and time series analysis.

Maps have a key role especially in teaching geography. They relate to national education standards because the following spheres of competence are addressed:

- Spatial orientation competence: The pupils learn to orientate themselves in space and therefore gain topographic orientation knowledge.
- Map competence: The pupils' perception of space is trained. The pupils learn how to deal with maps adequately and are able to create topographic overviews and simple maps themselves.

Another analysis tool is the **RGB Classifier**. With the RGB classifier, the pupils learn that digital images consist of raster cells (pixels) which all have characteristic colours. These colour information can be used for deriving a thematic map from a satellite image. To carry out classifications, three controls are available to the pupils. Through these controls they can choose percentages of the three primary colours red, green, and blue. All pixels with the corresponding colour components are selected automatically. When a class is sufficiently covered, the highlighted pixels are assigned to a class by clicking and coloured in a chosen colour. Now all residual pixels can be assigned to other classes.

If a pixel has been assigned to a class in the classification process, this pixel is not available in the further course of classification. Figure 2 shows all pixels in white which have been assigned to a class in the classification process. Correspondingly, in the next classification step, only black pixels can be classified. The graphic on the right of figure 3 shows the end of the classification process. All pixels have been assigned to a class.

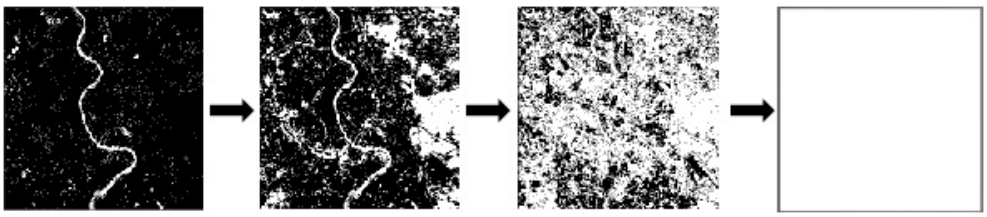

Fig. 2: Classified and non-classified pixels (Source: Author's design=

In addition to the three colour controls, the pupils can use a fourth control. Through this, they are able to define a range of tolerance. This is used to adjust the colour deviation of pixels, so that they are still assigned to the current class.

Remote sensing data offer the possibility to observe current processes. Often, access to up-to-date satellite images is not easy. Because of this, another tool has been developed – the **MeteoViewer**. It shows images of the Meteosat satellite on a daily basis, which are reloaded every 15 minutes automatically. The pupils have the option to watch the latest image or a 3- or 24-hour loop for the whole earth or for Europe to draw conclusions regarding present weather conditions.

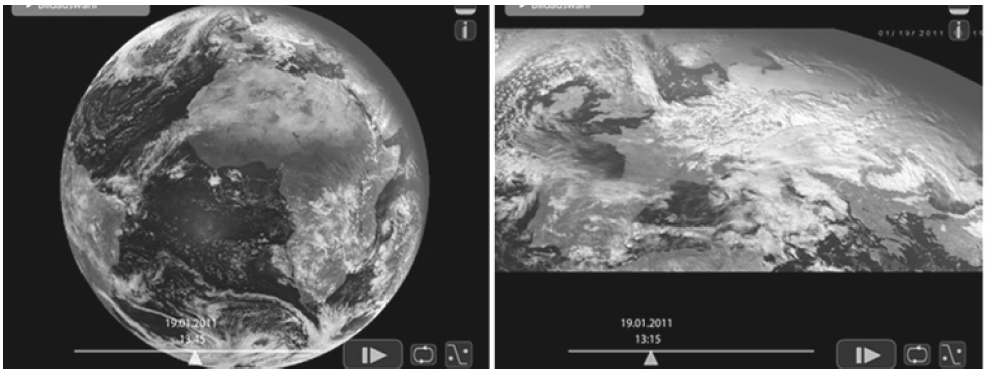

Fig. 3: MeteoSat Viewer (Source: Author‘s design)

To ease the introduction to a subject for teachers, to reduce preparation time and effort, and to provide direct access to the topic, all learning materials are complemented by didactic comments. They include thematic background information as well as suggestions how the teaching materials can be used and combined in the lessons.

4 Perspective

Modern school education requires pupils‘ individual learning. The developed learning portal creates a range of teaching material and tools, which put forward individual and discovery-based learning. Through combining learning modules, research and analysing tools, multiple ways for dealing with problem and exercises open up. Parallel to gaining specific geographic expertise, the pupils gain competences regarding information and communication techniques. Furthermore, the learning portal offers the possibility for teachers to accompany the learning process integratively. Moreover, the learning portal gives an easy introduction to remote sensing.

In the future, empirical surveys will support the theoretical concept. Thereby, the effects of single factors relevant for teaching shall be worked out systematically. The results will be used for evaluation and further configuration of the learning portal.

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