VISUAL LITERACY – ONE OF 21ST CENTURY LITERACIES FOR SCIENCE TEACHING AND LEARNING

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Abstract

For understanding information and explanation while learning about the nature (so: biology, chemistry, physics...) via ICT the student must have developed skills implied in the terminus 21st century literacy, which implies so called computer literacy, media literacy, information literacy and above all visual literacy. Visual literacy in needed for perception of visual data in the multimedia text, to understand them and to interpret them correctly. But that is not all, for reading longer texts where words and images have an (equal) important role the student needs metacognitive strategies and specific metacognitive strategies implied in the conception of new literacy's too. This new and old literacy and new and old metacognitive strategies must be taught in the 21st century school in the frame of mother tongue lessons and in the frame of science lessons.
Key words: *literacy, multiliteracy, metacognitive strategies, information literacy, media literacy.*

Introduction

Researchers and theorists have come to recognize the impact of the fast-changing global economy on our definition of literacy. The study of literacy has become the study of new literacy — the new skills, strategies and dispositions that are required for successful learning – also about science and nature. In this context the current didactic dialogue about using information and communication technologies in the process of science education somehow implies the question: *do students actually still have to read* in the old fashioned sense of word or is nowadays *knowledge presented via new media, internet, ICT* available without reading longer texts? Is reading remaining the way to learn about the world and the rules of *how it functions*? Is reading the way revealing secrets of physics, biology and chemistry? It seems obviously: books / textbooks, printed material are (are going to be) hardly needed any more. In future most likely ICT is going to overtake their function. Accepting this anticipation we are confronted with dilemma: shall reading still be taught with such effort as it is in our schools nowadays? Or do we have to consider some changes?

Multiliteracy - 21st century literacies

It is simply the fact that ICT changed the form of science information and science explanation in biology, chemistry, physics textbooks and e-textbooks. That consequently means that educational system needs a change in reading education - from literacy to multiliteracy (Lotherington, Chow 2006). In this context we do not speak of purely reading (words) any more: we speak of decoding and reading, because in the new ICT world, not many **information** are sent in a pure verbal language. Furthermore: the picture, pictogram, line, colors, shape are carrier of the message. What we need for our students is multiliteracy.

Terminus "multiliteracy" describes two important arguments we might have with the emerging cultural, institutional, and global order. The first argument engages with the multiplicity of communications channels and media; the second with the increasing salience of cultural and linguistic diversity (Cope & Kalantzis, 2000, p. 5)

Multiliteracy has been the topic of vivid research. Turbill (2002) hypothesized that we have entered "the age of multiliteracies" in which "[m]eaning making…involves being able to 'read' not only print text but also color, sound, movement, and visual representations."

Which literacies are implied in »multiliteracy« for 21st century?

Multiliteracy curriculum in the 21st century involves teaching both "traditional" literacy and how to read and produce the kinds of texts typical of the emerging information and multimedia age. Teachers and administrators are beginning to take interest in the new literacies of multimedia and first tries for integrating them into the school life has been established, although no consensus has been established, what does multiliteracy actually means and from which literacies it is structured. In recent years, labels for many new literacies -- including computer literacy, cultural literacy, diagrammatic literacy, document literacy, economic literacy, environmental literacy, film literacy, information literacy, mathematical literacy, media literacy, music literacy, political literacy, scientific literacy, technical literacy, television literacy, video literacy, and visual literacy - (Patersson, 1996) and several more have been mentioned, but not defined until recently.

Before deciding what to do in the framework of training multiliteracy in the school curriculum it is necessary to define new literacies and explore their place in school.

- First we must agree, that we use terminus "new literacies" for those literacies that have emerged in the post-typographic era, using the term "post-typographic" to mark an intellectual and cultural shift in the way information is designed, communicated, and retrieved. (Semali 2008).
- Than we must examine the **definitions** of a few of the most commonly mentioned **new literacies:**

Computer literacy

This refers to the competencies needed to perform a variety of tasks related to computer language and use. However, a person can be computer literate without being a programmer. Further, literate use of computers now includes competence with the visual representations, multimedia, interactivity, and linked hypertexts they present on screen.

Information literacy

The ability to create, disseminate, and retrieve information quickly is necessary in today's technological world. The American Association of School Librarians (1989) defines information literacy as having the ability to recognize when information is needed and...to locate, evaluate, and use effectively needed information. The expansion of information and data retrieval systems to include the World Wide Web has broadened the equation to include virtual libraries and virtual data systems. The emphasis today is that literacy can no longer be considered merely to be able to read and memorize a base of knowledge; instead, literacy must entail the ability **to acquire** and **evaluate information** that is needed in any situation.

Media literacy

Media literacy may be defined as the ability to access, experience, evaluate, and produce media products. Media are seen to represent actual events, but those representations are subjective and incomplete. Journalists and news producers select which stories to publish, what aspects to emphasize, and what language to use. Media literacy is necessary for media consumers to sift through the variety of

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presentations, including films, newspapers, Web sites, and video screens to arrive at meaning. (Semali 2008) **In short: we must not make the mistake and use the terminus media literacy for covering the whole field of needed skills to "read" (visual end verbal) texts we are exposed in new media, such as e-textbooks, www encyclopedia…!**

Visual literacy

Visual literacy is not new. Actually it is very old, even older than print literacy, though the term has not been used until recently. Visual literacy has been used as an interdisciplinary concept that includes theoretical perspectives, visual language perspectives, presentational perspectives, and technological development, including digitization. In an attempt to define visual literacy, scholars have often compared it to print literacy. Heinich, Molenda, and Russell (1982), for example, define it as the ability to interpret visual messages accurately and to create such messages (Semali, 2008)

After conceptualizing new literacies in the framework of multiliteracy for 21st century science teaching and learning, now we know what education systems must do. They must include new goals in their curricula: an explicit effort to enable students to acquire the ability to understand, how new, also visual media produce meanings. This effort would strive to develop literate people who are able to read, write, listen, talk, analyze, evaluate, learn and teach about nature while using e-textbooks, World Wide Web and other forms of multimedia.

A closer look to visual literacy

There is no doubt: the ability of perception, understanding and evaluation of visual data is the essential part of all needed new literacies. Consequently this means that visual literacy is not only one of the most important literacies but also a basic skill for other 21 century literacies and therefore deserves our extra attention:

What is actually visual literacy? What is it from? The International Visual Literacy Association (IVLA) suggests definition that it includes

- A group of competencies a human being can develop by seeing and at the same time having and integrating other sensory experiences.
- The learned ability to interpret the communication of visual symbols (images), and to create messages using visual symbols.
- The ability to translate visual images into verbal language and vice versa.
- The ability to search for and evaluate visual information in visual media. (IVLA, 1989).

This 30-year-old definition is because of the technologies now upon us, now inadequate or incomplete. What is missing is the **ability to evaluate**, to analyze or question the motive of the creator of the visual representation, relative to one's own experience. This involves a critical examination and analysis of content and point of view represented in the visual work. Basically, this means that viewers consciously engages in a systematic inquiry to

- Identify the symbols (which necessarily emanate from a particular culture and social context) and understand their meaning and functions,
- Analyze the structure and understand its power,
- Articulate the meaning as it communicates to us within our social context,
- Appreciate that we won't arrive at a definitive interpretation,
- Come to a deeper meaning that unpacks the contradictions and dilemmas furnished by the visual text (Semali, 2008).

For our use we need more critical approach to visual literacy, one that goes beyond the impact that visuals have on individuals. Thus visual literacy refers to multiple abilities to **read, view, understand, evaluate, and interpret visual texts** including artifacts, images, drawings, or paintings that represent an event, idea, or emotion, we must not forget, we are observing visual literacy in the concept of new literacy education. In this context visual literacy makes most sense when we define it **as knowing and understanding visual texts, one form of "mediated" texts that are part of the world of knowing**

and learning. Text simply goes beyond a verbal or written artifact to refer to any communication (Semali, 2008).

Visual literacy for reading natural science information and explanations in new "textbooks"

To understand, why visual literacy is so important for learning about natural science, for understanding natural science e-textbooks, we must explore **function of visual image in the multimedia text**.

A hallmark of the new literacies is the use graphics to explain, introduce a part of nature, demonstrate a theory, or support a definition. Graphics use pictorial representations, and can combine with animation, sound, and music to communicate meaning about ideas, content, and concepts. At their best, computer graphics can take the place of words to convey a message (Wepner, Coter, 2008).

Research supports the claim that (computer) graphics contribute to students' content area learning (Card, Mackinlay & Shneiderman, 1999). But at this point we want to explore, how these graphics function in relation to text. For this we need a functionality framework for understanding the value of (computer) graphics and tools for determining the value of CD-ROM software and websites. So we need to ask the question, what are the functions of (computer) graphics in the informational and explanation text and what are the characteristics of computer graphics**.** Wepner & Coter explored these questions (Wepner, Coter, 2008). In their research they used Taos model of classifiifation and classified functions of graphics in the text as **organic, supplemental and irrelevant** (Tao, 1998). All three types of graphics are used to capture the attention of the learner. Let us have a closer look:

Organic Graphics

Organic graphics provide meaning for the learner. They are intrinsic to the spoken and written text in that they allow the reader to construct an understanding of the ideas and words presented. Text that is potentially incomprehensible benefits from the use of organic graphics. For example, a graphical demonstration of the concept of gravity provides visual cues for forming mental images of this physical force. Other types of graphics cannot take the place of an organic graphic. For example, the only graphic that can be used for a cow is a picture of a cow. It cannot be a graphic of a pig, an elephant.

Supplemental Graphics

Supplemental graphics are those that augment but are not necessary for the comprehension process. Charts and graphs are examples of supplemental graphics because they are not essential for understanding the meaning, and are often considered secondary to the written text. A supplemental graphic can be substituted with another type of similar graphic.

Irrelevant Graphics

Irrelevant graphics have no real connection to the text and do not aid comprehension, but they can enhance the visual value of the screen. Any graphic can be used--an example would be an unrelated cartoon at the end of a section of text about a chemistry concept, or a picture of a calculator at the beach. However, sometimes the graphic actually can detract from the comprehension of the written or spoken text. Table 1 summarizes the three types of graphics.

Table 1. Description of Three Types of Graphics. The function of computer graphics for the illustration of content knowledge.

Organic	Supplemental	Irrelevant
The graphic gives text meaning.	The graphic augments the written or spoken text.	The graphic has no real connection to the written or spoken text.

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Organic	Supplemental	Irrelevant
The graphic is intrinsic to the written or spoken text.	The graphic is not necessary for the comprehension of written or spoken text.	The graphic could detract from comprehension of written or spoken text.
The graphic serves as a cue for comprehension.	The graphic serves as a cue for comprehension.	The graphic does not serve as a cue for comprehension.
No other type of graphic can take the place of the graphic used.	The graphic can be substituted for another similar graphic.	Any graphic could be used.
The graphic is used to capture attention.	The graphic is used to capture attention.	The graphic is used to capture attention.
The graphic alters the set up of a screen.	The graphic alters the set up of a screen.	The graphic alters the set up of a screen.

The computer graphics can shift from being organic and supplemental to being irrelevant and unrelated to the text, often taking away from student's ability to connect with the intended meaning. (Wepner, Coter, 2008).

There is no doubt: computer graphics contribute to the reader's ability to form mental images about written and spoken text. However, computer graphic's functional relationship to the text determines their real value. Graphics that give text meaning (organic) or augment the meaning of the text (supplemental), contribute to students meaning making. There is essential for "reading" and understanding such texts to be adequately literate, to be visual literate.

How to develop the visual literacy?

First we must clarify the question, why yisual literacy must be intentionally developed? In industrial societies, most people spend much of their time looking at television screens, Web graphics, print illustrations, and other types of visual displays. Because of this, many could argue that children/ young people nowadays have more than enough practice in visual literacy, since they regularly are consuming new media.

But we must be sceptical about the opinion that young people acquire significant visual skills through mere exposure to television or other visual media – a preference for visual entertainment is nailmy not necessarily accompanied by superior understanding of visual information. Actually **the consumption of visual images does not lead to any notable improvement in a person's creative abilities in the visual realm** (Messaris, 2001). The reason for that is the fact that visual literacy differs radically from competence in written language. Learning to read usually goes hand in hand with learning to write. But becoming fluent in the consumption of images typically takes place without any concomitant experience in their production. No matter how many thousands of hours a person may have logged in front of the TV screen, skill in the actual production of meaningful images does not come readily to the novice.

So, visual literacy is something learned. Actually we can start on the idea that visual images are a language. Consequently the aim of visual literacy curriculum is to develop the **ability to understand and produce visual-language messages** and, what we are mostly interested in, **to understand and produce visual langue in information and explications in natural science texts.**

The problem, which emerges in this context, is**: teachers are mostly not qualified for teaching visual literacy,** because in there (school) time it was not yet taught (and hardly needed) and because the didactic of new literacy (and visual literacy among them) was not the topic in their teachers training (university) programs. This problem can easily be solved. The new didactic market offers quite enough solutions which are of remarkable quality. One of the most interesting ones is 21st Century Literacies Homepage (www.kn.pacbell.com/wired/21stcent/sitemap. The team of literacy experts developed here lessons to raise teacher's ability to incorporate 21st century literacy skills into his teaching techniques. The tools presented there are based on a 21st Century Literacies Framework and seek to promote the skills, knowledge and attitudes to help students develop effective lifelong literacy awareness, seeking,

management and presentation strategies, among them also visual literacy in the framework of 21st century literacy. Let us have a closer look.

The visual literacy curriculum in the 21st Century Literacies Curriculum is structured of six lessons: locating images, scanning for visual details, structural comparisons, function of images in text and framing a point of view. It seems that the last five topics are essential for visual literacy itself and that lesson one is needed to enable the student to find images for its own production of visual texts. So let's have a closer look to the essential lessons of visual literacy curriculum. What shall the student learn first?

The first step is to learn to scan for Visual Details. The purpose of this lesson is for students to practice scanning images visually for details that can be seen. First lesson should focus on locating visual details and examining them within the overall context of an image. After the lesson students should be able to locate visual details within images. Students will be able to look at an image's larger context to gain insights into the meaning of visual details. Students will be able use captions to locate and identify the meaning of visual details. They will learn some strategies for searching for visual details: (read the image from left to right, create a grid on top of the image and then look carefully in each square, read the caption for clues, look within context).

At the end of the lesson students will understand that visual details can provide evidence as to meaning.

The second step of the visual literacy curriculum is focused to the structural comparisons. The purpose of this lesson is to teach students to scan images visually to look for structural elements within the picture's composition, such as foreground and background, symmetry and asymmetry, motion and tone. The lesson, "Scanning for Visual Details," focuses on looking more closely at an image's structure rather than its content. We can ask students to write the following "Glossary" of terms on a transparency, whiteboard, or a handout: foreground - the part of the picture that is nearest to the viewer; background - the scenery behind something (usually whatever is in the foreground); symmetry - an exact correspondence of form on two sides of a plane resulting in balance; asymmetry - lack of balance or symmetry; tone - the intensity of light and dark; shape - the basic geometric shapes, such as triangles, squares, and circles, that are apparent in a visual image's composition; motion - the illusion of motion within a visual image.

The third step is oriented to develop the ability of understanding the function of images in text, to show students that images can be used in a variety of ways in a text. The lesson shall be focused on three major ways that images can be used in a text. Students shall recognize this three major ways that images can be used in text. They are the following:

> ***Example*** - An image can be used to show what an idea might look like. The picture may be used to illustrate a concept that is being described within a text or strengthen a point of which the author is trying to persuade his or her audience.
>
> ***Evidence*** - An image can be used to add new information. The picture may be used to represent data that is being described within a text or highlight one aspect of an argument of which the author is trying to persuade his or her audience.
>
> ***Expression*** - An image can be used to express a feeling or attitude. The picture may be used to stylize information that is being described within a text or make an ironic or emotional comment on the point of which the author is trying to persuade his or her audience.

The aim of the fourth step of visual literacy curriculum is to teach students that there are three important types of camera shots - close-up, medium, and long. This lesson focuses on how those different types of shots affect meaning. Interpretation of an image may vary depending on what the viewer sees and doesn't see. These three different types of shots grant the viewer different points of view.

We shall explain students that three different types of shots defined by camera-subject distance are used primarily in television and film editing. They are:

Close-up - shows detail but none or little of the context.

Medium shot - shows the subject in relation to the immediate context.

Long shot - shows the subject in relation to the overall context.

We must also explain that close-ups focus in on details and facial expressions; that medium shots reveal relationships, be them person-to-person, person-to-thing, person-to-a space, etc.; that long shots

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unveil information about the overall context.

The last step of visual literacy curriculum should show how images are used as persuasion. The purpose of this lesson is to teach students that images can function as a means of persuasion. This lesson should focus on how images can be used to convey messages that may influence an audience. Students shell also learn that an image's message or meaning may depend on from what perspective it is coming and on how it is being framed, be it using captions, cropping the image to accentuate a certain part, etc.

What do we do, when we develop visual literacy? Intellectual consequences

As we see, visual literacy curriculum is oriented to develop student's ability to understand visual messages. But this is not all it happened. From the point of view of the natural science didactics, is essential that visually oriented curriculum gives even more. A visual oriented curriculum develops student's mental abilities, his cognitive development.

What would be the intellectual consequences of visual literacy education, and what are its broader implications for a student's cognitive development? Paul Messaris is mentioning three groups of cognitive benefits: thinking in pictures, spatial intelligence and analogical thinking (Mesaris 2008)

Thinking in Pictures

One of the most important things in learning visual literacy is to go beyond the literal content of images. The meaning of an image is not just a matter of the people or places that appear in it, or the action that it depicts. How those people or places or actions are portrayed -- in close-up or long shot, in balanced or asymmetrical compositions, in high-key or low-key lighting, etc. -- are essential ingredients of the creation of visual meaning.

Spatial Intelligence

Although the acquisition of visual literacy is valuable in and of itself, it is worth noting that the intellectual benefits of a visual education often extend beyond the realm of visual media as such. As students become more fluent in creating and combining images, they also develop certain broader mental aptitudes that these activities bring into play. This connection between visual creativity and general cognition has been explored extensively in the well-known work of Howard Gardner (1983), who used the term "spatial intelligence" as an encompassing label for the kinds of mental skills that are cultivated by working in visual media.

Spatial intelligence is the process of forming mental representations of three-dimensional reality as a basis for understanding one's environment and interacting with it effectively. It is a type of intelligence crucial for success in professions such as architecture or carpentry, but it is also a vital ingredient of any person's everyday physical activities. What role does it play in visual media?

Analogical Thinking

In his discussion of spatial intelligence, Gardner (1983) also makes reference to the intellectual activity of "analogical thinking," which he subsumes under spatial intelligence but which is, in certain respects, the broader of the terms. Analogical thinking is the ability to discern similarities between superficially disparate aspects of reality and to derive insight from those similarities. It is often claimed that analogical thinking is the basis of scientific creativity.

Analogical connections are also a pervasive feature of visual media. When a film maker uses a close-up to enhance the dramatic impact of an image, she or he is relying on an analogical connection between visual size and emotional significance. When an editor speeds up a scene's cutting rate to make it more exciting, she or he is drawing on an analogical connection between fast pace and visceral impact. Low versus high angles, dark versus bright lighting, slow versus fast camera movement -- these and many other visual conventions are examples of visual analogies (Mesaris, 2008).

Learning these skills can be considered as a core objective
of an actively oriented visual curriculum!

In other words, one could say that visual education should aim to enhance students' aptitudes for spatial and analogical thinking (as well as other cognitive abilities related to visual media), so as to make them better able to make active use of the conventions of visual communication. But there is also another side to this view of visual education. As noted earlier, there is evidence that important mental skills are acquired through such. In becoming "visually literate," a person may also become more adept at other cognitive tasks that are less directly related to visual media. Although visual literacy is surely valuable for its own sake, its potential broader ramifications lend additional urgency to the argument for visual education.

Is this enough? Have we solved all the problems connected with multiliteracy in 21st century?
Certainly not!

Visual literacy seems to be essential part of new multiliteracy, but we must not neglect the fact that moving from science information in the direction of **science explanation in the process of acquiring natural science knowledge,** we can observe increasing amount of verbal language usage. And even more: **the more detailed explanation, more words are used for it**, texts are longer and longer - and **special skills are needed for processing** them, skills, called simply reading comprehension. The consequence of this is the fact that classical (words) reading skill, **classical literacy remains a part of multliteracy - and is so one of needed 21 century literacies.**

Reading comprehension is a multifaceted process. In addition to decoding skills, students need vocabulary knowledge and metacognitive skills so they can monitor their understanding and reflect on what has been read. Competent readers learn these components simultaneously and fluently. In addition, if either component is inadequate, comprehension can be impeded. In other words, reading instruction does not end when students can decode the words. They continue to need instruction that will support their understanding of what they are reading.

In 21st century reading comprehension skill still must be taught through formal education. In this context metacognitive strategies are extremely important. Let us clarify: what is metacognition? For clarification purposes we can adopt the definition offered by Kuhn (2000). Kuhn defined metacognition as, "Enhancing (a) metacognitive awareness of what one believes and how one knows and (b) metastrategic control in application of the strategies that process new information" (p. 178). This awareness is developmental and lies on a continuum. Proficient readers use one or more metacognitive strategies to comprehend text. The use of such strategies has developed over time as the reader learns which ones are best suited to aid in comprehension. Students' comprehension is not enhanced by merely reading more text, while their understanding increases if they use even one of the strategies, for example summarizing, comprehension was improved - we se how important is classroom instruction for using metacognitive strategies. If students get a host of strategies that they could apply at their discretion, comprehension improves significantly.

Conclusion

For reading and "reading" information and explanation in the science class in the 21st-centuy we need a new 21st-century multiliteracy. The important part of 21st century multiliteracy is the so called visual literacy, which must be taught by the teacher as verbal literacy must be taught. Reading ICT text, students' must show great variety in comprehension strategies. They need to read and understand images, they need to read and understand the meaning of words and above all they need to read and to understand texts which are constructed from images and words. For all this they need metacognitive strategies and helpful categories of such strategies. Visual literacy and metacognitive strategies must be taught by mother tongue teacher and by science teacher. 21st-century literacy and metacognitive strategies for processing (and using them) are a challenge for the team of teachers: for mother tongue teacher and for all science teachers.

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