From percentage to prediction: University students meeting a parallel language of visuals and numerals

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Abstract

A less-frequently discussed parallel-linguistic issue is the parallel language of visuals and numerals: the diagrams, tables, models, mathematical signs and different symbols that students have to deal with in their reading and writing. Texts are multimodal, that is they are constructed with visual objects and different sign systems as well as writing. For new students, it can be difficult to grasp how visuals and numerals can have different meanings in different contexts, such as academic disciplines. For teachers, the disciplinary use of the visuals and numerals is often so ingrained that they may have difficulty seeing the problems that students face. Drawing on the theoretical framework of social semiotics and the neo-Vygotskian perspective, this article shows how new students of economics in Sweden encounter a multimodal academic literacy. The article also discusses some of the difficulties relating to this situation and argues for a raised awareness among teachers in order to scaffold students into academic, visual literacies.

Keywords: multimodality, visuals, numerals, disciplinary writing, scaffolding.

Resumen

Del porcentaje a la predicción: Estudiantes universitarios que se enfrentan a una lengua paralela de cifras y elementos visuales

Un asunto poco tratado y que guarda relación con el uso de una lengua paralela es el lenguaje paralelo de las cifras y los elementos visuales: los diagramas, las tablas, los modelos, los símbolos matemáticos y los distintos símbolos que deben utilizar los alumnos en sus tareas de lectura y escritura. Los textos son multimodales, es decir, se construyen mediante el uso combinado de texto escrito, elementos visuales y distintos sistemas de signos. Para los nuevos

estudiantes puede resultar complicado llegar a entender cómo es que los elementos visuales y las cifras pueden tener significados dispares en contextos tan diferentes como las distintas especialidades académicas. Para los profesores, el uso disciplinar de las cifras y los elementos visuales es una práctica tan arraigada que puede resultarles difícil entrever los problemas a los que se enfrentan los alumnos. Tomando como base el marco teórico de la semiótica social y la perspectiva neo-Vygotskiana, este artículo muestra cómo los estudiantes que inician la titulación de económicas en Suecia se enfrentan con un modo de lectura y escritura académica multimodal. En el artículo también se estudian algunas de las dificultades que guardan relación con esta situación y se apuesta por conseguir una mayor sensibilización por parte de los profesores de manera que puedan ir introduciendo a los alumnos gradualmente en una comprensión y escritura de textos académico-visual.

Palabras clave: multimodalidad, elementos visuales, cifras, escritura disciplinar, construcción del conocimiento por niveles.

Introduction

The LSP and genre approaches have made clear the importance of researching and teaching language as applied in different settings, discourse communities and genres rather than solely as a linguistic system. Recently, focus has also been directed toward the fact that language use and literacy involve not only verbal or written language, but also different resources such as images, sounds and colours (Kress & van Leeuwen, 2006; Lankshear & Knobel, 2006; Organisation for Economic Co-operation and Development, 2005). In academic settings, although the written mode is predominant, meaning has long been constructed by visual tools such as tables and diagrams. Students have gradually learnt how to make sense of these visuals and how to use them in their own writing. Nevertheless, it is perhaps fair to say that schools and higher education often lack a deeper awareness or pedagogical methodology to this end. When it comes to making sense of and applying visual representations, students are mostly left to their own devices and implicit learning.

This article aims to describe some of the complexity of languages or literacies that students encounter when they begin university and to discuss some of the difficulties related to this situation. The main research questions are as follows: what problems do new students encounter, how do teachers support the learning process, and how do students develop over a one-and-a-half-year course?

After an overview of the literature on multimodality and learning, I present a case study from an economics degree course in which students (taught in Swedish, using both English and Swedish literature) encounter graphs, models, and mathematical signs. The conclusions suggest that students might require more informed support or scaffolding in this process.

Previous research

Different modes and visual representations have been studied from aspects such as cognitive development (Erkens et al., 2010; Kolloffel, 2010), linguistic development (Johns, 1998), and disciplinary identity and development (Rowley-Jolivet, 2002 & 2004; Dressen-Hammouda, 2008; Airey & Linder, 2009). The cognitive aspects are often studied through experimental designs, comparing development with and without combined modes – for instance, do students learn more from written and visual material than from written material alone (e.g. Bauer & Johnson-Laird, 1993; Schneider, Rode & Stern, 2010)? Even if such studies can reveal certain general tendencies, they usually do not acknowledge the importance of situatedness and disciplinarity for learning.

Studies that include a disciplinary and/or linguistic aspect are, for example, Johns (1998), Rowley-Jolivet (2002 & 2004), and Dressen-Hammouda (2008). Generally, these scholars emphasize firstly the affordances of visuals for communication between native speakers and non-native speakers (NNS) and, secondly, the importance of awareness or a critical stance towards the representation of data in visuals. Concerning the affordances or possibilities of visuals, the basis is the potential to create meaning from different modes. It may be easier to understand a mathematical problem if it is visualized than if it is merely explained in words. Likewise, the use of visuals may contribute to the development of second language in NNS: visuals may serve as a transition between the first and second language, if used in a conscious manner by teachers (Johns, 1998). Concerning the awareness of the representations of data, scholars point out the importance of a critical discussion of how data are chosen and presented. There is no such thing as "naked data"; rather all data are socially constructed in some way (Johns, 1998). Students need to become aware of this, both for their reading and their own knowledge contributions.

In addition, research has highlighted the importance of understanding and applying the visuals in a certain manner for disciplinarity (Rowley-Jolivet,

2004). Every discipline has its own ways of constructing reality, and visuals may be one of these. For instance, Airey and Linder (2009) show how visual representations are used in physics to show electric and other phenomena.

Theoretical framework

Sociosemiotic theory of multimodality

Since the 1990s, the concept of multimodality has been increasingly applied in linguistics, discourse studies and pedagogy (Kress & van Leeuwen, 2006; Jewitt, 2009; Kress, 2010). The background is the rapid development of digital media, making it possible for large groups both to express themselves, and to encounter texts designed using a mix of techniques and technologies, such as the written word, video and sound. However, multimodality has always been present, as many traditional texts include pictures, and all texts have a visual and an auditory aspect (i.e. the text can be read aloud).

Drawing on the Systemic-Functional Linguistics work of M. A. K. Halliday (Halliday, 1978; Halliday & Martin, 1993), scholars within the framework of social semiotic theory, have pointed out how different modes or semiotic resources have different meaning potential. For instance, compared to verbal representations, visual representations have a greater potential to realize meaning on spatial conditions.

Another relevant aspect covered by sociosemiotics and Systemic-Functional Linguistics is to what extent information is "packed" (Martin, 1993; Ventola, 1996). Verbal language and visual modes allow content or a clause to be packed into more concentrated items. In verbal language, we often pack processes in the form of nominals: "to create" becomes "creation". In visual modes, a process can be represented by an arrow, for instance (Kress, 2010). The concentration of this type of representation allows information to be handled rapidly, which is often the case in LSP and academic texts.

However, different meanings can also be construed from the "same" sign. An arrow, the example mentioned above, can also mean location. Kress (2010) gives the example of a sketch of a garden: in a gardening book, it is likely to be interpreted by the reader as representing reality, but in a children's book it is not. Hence, the meaning of the drawing depends on the context. Moreover, the representation of meaning in different modes can be described as transduction (Kress, 2010): we might first describe something

verbally and then transduce it into a drawing. In academic writing, transduction is quite frequent, as writers have to shift between the written and visual modes, for instance when explaining the meaning of a specific table in writing.

Neo-Vygotskian theories of learning

According to neo-Vygotskian theories, all learning is situated within social practices and is dependent on sociohistorically developed tools (Wertsch, 1998; Wells, 2000; Säljö, 2003 & 2004; Barton, 2006). There is no entirely non-contextual knowledge or skill that is easily transferable between situations. For instance, Säljö (1991) showed how 12 to 13-year-old students had difficulties using a postage table in school, due to problems connecting the in-school applications of tables with the everyday experience of weight and costs. That is, the school domain and the everyday domain entail different types of knowledge. Even a student who can read and calculate a table in mathematics does not necessarily understand how to use a table in a non-mathematics situation, and vice versa.

Learning in social practices also means learning by doing things together. Novices learn by first imitating more experienced members (reproducing), then mastering and eventually appropriating actions (Vygotsky, 1978; Wertsch, 1998). Appropriation means making something one's own, integrating it in our personality. At the beginning of a career, we often imitate the words and actions of the profession, then we master them; but not until they are appropriated do they appear natural, part of our identity. Appropriated knowledge and actions are often unconscious and difficult to verbalize. This phenomenon may be related to the issue of "packing" mentioned above: eventually knowledge becomes so ingrained and "packed" that it becomes invisible to us.

The idea that humans learn by doing things together, often with someone with greater knowledge, is also the notion behind the concept of scaffolding.[1] A more experienced participant makes a temporary scaffold, a support, for the learner; when the learning process is complete, the learner can do without the scaffold. The type of learning relevant here is not the transfer of information or "facts", but how to perform a relatively complex task, such as writing a text or making a calculation (in Vygotsky's (1978: 40) words, "higher psychological processes"). The scaffolding metaphor implies that acting together is the crucial point for learning and that together with another the learner can perform more difficult assignments than alone.

Scaffolding is also a concept used in the Systemic-Functional Linguistics approach, or rather its pedagogical branch, known also as the Sydney School or genre pedagogy. A relevant contribution in that tradition is Macken-Horarik (Macken-Horarik, 1996; Macken-Horarik et al. 2006). This scholar describes teachers' scaffolding of younger students from an everyday knowledge domain, via a specialized domain with discipline knowledge into a reflexive knowledge domain. Each of these domains entails a certain type of language use and a certain worldview. According to Macken-Horarik and her colleagues, it is the role of the school to scaffold students to participate in knowledge domains other than the everyday.

Design of the case study

The study was conducted at Stockholm University over three semesters of an economics degree course. The teaching was conducted in Swedish, and the literature consisted of both Swedish and English items. For data collection, ethnographically inspired methods were used. I followed the same route as the students, from semester one to semester three. In total, I conducted 17 observations of lectures and seminars and 21 interviews with students and teachers. The observations were documented by notes and the interviews mainly by recordings. An extensive corpus of student and professional writing was gathered and analysed. For closer analyses, seven student texts from each semester were selected. Of these, about 50% were written by women and 50% by men, and about 50% were medium graded and 50% highly graded. In the presentation of the analyses below, I use fictional names of these and other students. I also studied literature on the discipline of economics (Henderson, Dudley-Evans & Backhouse, 1993; McCloskey, 1998; Smart, 2006).

The data were analysed using qualitative methods, thematizing both deductive categories determined by the research questions and literature (such as development and scaffolding) and categories induced from the data (Spradley, 1980; Ryan & Bernhard, 2003).

At Swedish universities, most students take a full-time degree course in one subject at a time. An economics student thus typically studies economics and nothing else for a full semester. She or he then chooses to continue with the course or not. There are two semesters a year, normally comprising one degree course each. In many subjects, students write a thesis at the end of

their second semester ("B thesis") and third semester (Bachelor thesis). The theses consist of empirical studies or literature reviews, and are similar to professional research papers or theses in their structure. They are typically presented, discussed and defended in a seminar with a peer as an opponent.

Results

Practices and problems

The study shows three major problems encountered by students: difficulties realizing what the visuals represent in economics, difficulties connecting the levels of societal processes and mathematical symbols, and difficulties integrating the visuals with their verbal, written presentations. These problems will be illustrated by a number of examples below.

Of the visual tools of economics, graphs were introduced from the very beginning, even in the introductory lecture. Typically, the lecturer drew or showed a graph and the students copied it into their notes. They quickly learnt to bring rulers, Tipp-Ex and coloured pens. The colours represent different aspects in the graphs. The graphs usually represent a hypothetical economic development, for instance, future unemployment or rates.

My observations indicate that in the first semester many students had difficulties grasping the significance of the graphs, what they represent, and how to handle them. During lectures, students did not ask many questions; however, additional seminars in smaller groups aimed to give students the opportunity to discuss and ask questions. Students tended to ask two types of questions: (i) on formal details and (ii) on general economic conditions, both everyday and on economic policy. When explaining a specific graph, teachers were asked questions both on the meaning of specific graphical objects and on the reasons for economic processes. The first type of question, on formal details, included "Does it matter if you use a lower case or an upper case Y?", "What's that cute little symbol of yours?" and "Should it really be R there?". Examples of the latter type of question, on economic conditions and national policy matters, included "But why is there bound to be inflation?", "Do you think that prices will rise now?" and "Why does the rate fall?" The tendency to ask these types of questions suggests that new students deal with the graphs on other levels than their teachers. While the teachers aimed to make the students apply the graphs as mathematical tools for theoretical processes, the students initially became entangled in details

and/or attempted to see the concrete societal conditions that the graphs are supposed to capture.

In one of the observed seminars, the teacher explained how to derive a certain graph on rates. However, several students kept asking questions, mainly about related actual policy issues such as the actions of the National Bank and difficulties in raising prices. The lecturer replied, "Now there is no issue of policy here, we are only trying to obtain the graph". As the policy questions kept coming, eventually one student turned to the others and stated, "This is only hypothetical, you know, it doesn't happen!". Many students laughed, but the lecturer replied, "Exactly". This situation is an example of how students have difficulties grasping the hypothetical property of the visual tools of economics. For students, the graphs constitute something that "is", something stable; for economists they represent a tool for hypothesizing about and calculating future events.

Other problems concern the mathematical traits of economics. A general notion among the students was that skills in mathematics were not supposed to be necessary to finish the first semester. Of course, mathematical skills from upper secondary school were required, but more advanced skills or knowledge were not. Nevertheless, the frequency that this notion was mentioned can be regarded as a sign of concern among the students. They often related to mathematics in the interviews; for example Magnus, after reading an earlier B thesis, stated: "It was really heavy, loads of mathematical calculations, I was thinking, like, uh-oh, is this the expected level?!".

Several of the details about which students asked questions included mathematical symbols and variables such as x, y and R. All of these can be replaced by different values, and some also represent a certain meaning, such as R=rate. That is, students have to differentiate and learn which symbols have a meaning as such and which do not (compare O'Halloran, 2005).

Even students with greater mathematical skills and experience using the visual tools could have difficulties adjusting them to the specific disciplinary setting. Sverker and Fredrik were students with several semesters' experience from a technical university. After their joint B thesis in economics had been approved, they said:

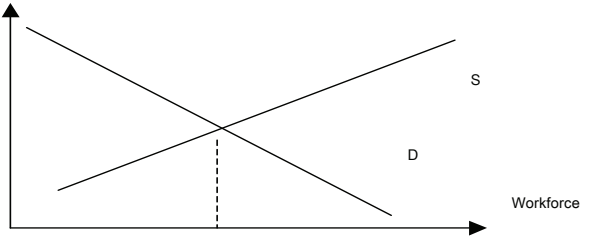
> Sverker: We got this comment on formulae, too, that in economics you are supposed to write in words after the formula what everything means. We're not used to that.

From their technical university, Sverker and Fredrik were used to handling formulae and mathematical figures as self-supporting entities. In this new context, they were supposed to present this kind of information in both mathematical and verbal form, that is to transduce it between two different modes. In addition, the lecturer remarked on the lack of a source for a table in their theses. However, they claimed to have merged two existing tables, and for that reason did not regard it as "stolen":

> Fredrik: And it's so general. You can find it in five other books.
> Sverker: It's like, "Who drew it first?"!

Quotation and paraphrasing often have different forms in different settings. In economics, the students must learn a new way of dealing with sources. Thus, although students may be skilled in visual tools such as tables and graphs, they have to learn a specific way of applying them in a new setting, in this case, a new discipline.

In the first semester, most numbers in students' assignments represented years and percentages. As could be expected, their texts did not look particularly "economic", rather they handled numbers in an everyday domain manner (Macken-Horarik, 1996). Years and percentages are notions of everyday knowledge, not specialized economics knowledge. Further, in these assignments and their B theses, students sometimes inserted a graph without any introduction. An example of this is where Juha and Niklas answered a question in the assignment as follows (they began by citing the question from the assignment):

> Describe the concept of equilibrium unemployment. Is the explanation for the fact that unemployment did not decrease between 1993 and 1997 that equilibrium unemployment had increased?
>
> 
>
>
> Equilibrium unemployment occurs when workforce demand equals workforce supply. At that point there is a certain level of unemployment, consisting of people who are between jobs, in competence-enhancing training or are simply not willing to work at the given wage level. (Juha & Niklas, B thesis)

Inserting a graph without any introduction or caption could be viewed as a non-disciplinary or non-academic practice, something that contravenes the rules. However, one could also regard it as imitating the lectures, where graphs are sometimes presented without any contextual information at all. For some reason, there were several instances of non-integrated visual tools in the data, especially from the first and second semesters. Even when more integrated, a majority of the graphs and tables in B theses were cited rather than created by students. There was no self-created table and only one self-created graph in the B thesis data.

Apart from graphs, a fundamental mathematical tool in economics is the model (Smart, 2006). Often models consist of a mathematical formula, and are used to insert certain variables to calculate different phenomena such as a rate or unemployment. All B theses in the study contained models, but only one was self-produced. Alex, Daniel and Göran created a model to calculate the benefit of paying the TV licence:

> First, we state the following assumption, namely that our TV owner is benefit maximizing, with the benefit function u=P. Another assumption is egoism, which means that the TV owner thinks only of his/her own benefit and has no moral qualms about not paying the fee.
>
> U (entertainment value) = the value of the television supply
> A= licence fee
> p = probability of getting caught, a number between 0 and 1
>
> This allows us to calculate the benefit of paying or not paying the licence fee. We can join the following benefit functions:
>
> $E\,\pi$ (pay) = U–A
> $E\,\pi$ (not pay) = U–pA
>
> (Alex, Daniel and Göran, B thesis)

Although this was a self-created model, which is a core element of economics, the thesis was not graded highly. Even as non-economists, we can see that the presentation of the tool is somewhat imprecise or non-academic, such as the formulation "getting caught". These students realized that models are important, and tried to imitate their use; however, they did not quite succeed. In their bachelor theses in the third semester, most students used self-created graphs, and several used self-produced tables. Most students included one or more mathematical models, though mostly from the literature. Some elaborated the models, but there were no self-produced models.

The main problem that students faced when they encountered the visuals in economics was realizing the meaning of graphs and other mathematical symbols. They also focused on the general level of the economy of the country and details such as single variables, while the lecturers focused on hypothetical predictions. In addition, it took time for students to learn to integrate the visuals in a manner accepted in their discipline.

Methods used by teachers

Teachers performed some scaffolding for the students. The main scaffolding act was that teachers drew and showed graphs that students copied or drew. Even when graphs were shown rather than drawn, teachers tried to get inside the graph, explaining how points move in relation to one another, how lines move, fall and so forth. A frequent wording was "We move …" in combination with pointing at a line in a graph. Hence, an aspect of dynamism or movement, as well as position, was implicitly emphasized in the teaching, and thereby a character of doing it together. Below are some excerpts from one lecturer's class:

> If we are situated at point d, the demand will be greater than the supply. To fix that, y must increase. You move to the right. Why? Well, for the reason I just mentioned. It's more profitable. And so we move along the AA graph down to point 1. (Lecture, second semester)

As elements in lectures such as these consist of joint activity – "we move" – the character of scaffolding was strong. That is, the students performed the act of drawing and following graphs together with the teacher. Moreover, this tendency in the lectures can be seen as a kind of transduction in the sense that the teacher brings the visual mode into the verbal mode.

In doing so, the teachers mainly "remained" within the visuals; they did not often relate them to societal phenomena or everyday knowledge, and the visuals were presented with quite limited context. However, occasionally teachers did relate to students' previous knowledge and experience of everyday and societal economic issues. Some examples are given below:

> You can easily see that when negotiating wages, it wouldn't be nice to have to say that the result was minus 0.5 percent.
>
> That's what we can see in Swedish policy today. The model that explains this is the endogenous growth model.

The most ambitious attempt to build a bridge to students' understanding was when a lecturer teaching probability theory arranged a lottery in his group. The lottery was intended to illustrate theories of consumer preferences and was accompanied by numerical calculations. The same teacher illustrated his examples with balls, eggs and dice. However, these specific ways of concretizing probability theory are relatively standard in any introductory textbook on probability. Also, this attempt and others were more an exception than the rule.

The general finding of my analysis is that teachers performed some scaffolding, but not enough to bridge the gap that new students faced concerning the use of visuals in economics. Moreover, the teachers related to everyday knowledge and concepts even less, which could also be regarded as a lack of integration of visuals, i.e. putting them into context.

Students' development

Although the scaffolding could be stronger, students did develop over the three semesters. After some time in the first semester, students learnt to "go straight to the diagrams" – as Susanne said, "If you get them, you get the rest". Jonas stated that "The function of the language is just to clarify an equation" (compare Johns, 1998). These two statements indicate that students learnt or realized the importance of the mathematical objects and regarded them as the focus of the discipline. When Inger and Hans wrote their B theses, they were relating to what they perceived to be a disciplinary norm: "It's good to have a lot of numbers and diagrams". Hans stated this as a well-known fact in an interview. Another indicator of this development is that students took notes more eagerly when the teacher showed figures, graphs and similar objects than when s/he merely spoke or showed verbal, written information. That is, students quickly learnt that numerals and visuals are important in economics.

The general tendency of development is shown in Figure 1. The students developed from an everyday understanding of economics as existing phenomena such as unemployment and actual numbers to a more disciplinary understanding of economics as predicting and constructing hypotheses about future processes. They also learnt how to produce mathematical models, how to integrate visuals in their texts, and how to develop and produce visuals and mathematical models. However, there are no real proofs of students reaching the critical knowledge domain (Macken-

Horarik, 1996; Macken-Horarik et al., 2006) or appropriation (Wertsch, 1998).

Semester 1	Semester 2	Semester 3
Mathematical signs used solely for percentages and years	Mathematical signs used in formulae and models	Mathematical signs used in formulae and models
Reproduced and weakly integrated graphs	Reproduced graphs, tables and models	Self-produced tables. Reproduced and self-developed models
Mathematical signs representing actual numbers and results		*Mathematical signs representing hypothetical processes*
Everyday domain →		*Specialized domain*

Figure 1. Students' development.

Discussion and conclusions

Students quickly realized that numerals and graphs are important in economics. They focused on these in the classroom and talked a lot about mathematics in the interviews. However, attaining the disciplinary practice of graphs and numerals took longer, often several semesters. The greatest problem for the students, as shown in my analysis, was to realize the hypothetical meaning of visuals and mathematical signs used in economics. Initially, they regarded the mathematical and visual tools as more substantial entities, related to an everyday knowledge domain, and only gradually reached the disciplinary domain (Macken-Horarik, 1996).

The case study suggests that teachers and new students use visuals and numerals at different levels or for different meaning potentials. For teachers, visuals and numerals function as an instrument, to get a job done. The tools are "packed" and ready for use. For new students, the visual tools need to be explored in their own right before they can be applied in a discipline-approved manner. Students need to learn about details within the visuals, such as what different variables mean, before they can "pack" and use them (see above, Ventola, 1996, and Blåsjö, 2009). More precisely, they have to encounter and learn the meaning of the specific variables and mathematical signs included in a graph or a model before they can handle it as a complete object. Although this may not be a completely novel result, taking it into full consideration can lead to a more informed teaching.

The case study also shows that teachers supported or scaffolded (Wood, Bruner & Ross, 1976; Macken-Horarik et al., 2006) their students by applying

the graphs together with the students in the classroom and to some extent relating them to the everyday domain. However, there were also lapses where students had to help each other understand the hypothetical character of economics and its visuals. This seems to be due to the "hidden propositions" (Dressen-Hammouda, 2008: 240) and implicit norms that all disciplines and discourse communities encompass. However, in my view, teachers could use scaffolding to a greater extent. They could thereby verbalize the as yet implicit notions of the visuals, such as the hypothetical character of the graphs, which is clearly not obvious to all new students.

Even if students are familiar with a certain visual tool, they need to practice using it within the new context before it can be applied in an appropriate way. They need to learn to handle the visuals in a disciplinary manner, such as integrating them in their texts in the way the discipline requires (Dressen-Hammouda, 2008). This conclusion agrees with a neo-Vygotskian view of learning as related to different social practices (Säljö, 2003). Knowledge and competencies are not context free: they have to be rooted in a new context when the individual shifts settings. As we have seen in the analysis, visuals like graphs are used and integrated in the text in different ways in different disciplines.

One explanation for the problems could be that the teachers have appropriated the use of the visuals to such an extent that they have difficulties verbalizing their knowledge about them. They take many aspects for granted, such as the hypothetical meaning of the visuals, and do not explain this explicitly to their students. Generally, it may be necessary for teachers to discuss and make explicit the "hidden norms" (Dressen-Hammouda, 2008: 240) of their discipline in order to make them visible to their students (compare Airey & Linder, 2009).

The students' problem of integrating the visuals in their own texts can also be discussed in the light of the concept of transduction (Kress, 2010). Initially, students had to focus on understanding the visuals as such, and had difficulties transducing them into written mode. They gradually learnt how to draw a graph; however, it took longer to learn to transduce it into a written presentation. This is revealed by the non-integrated visuals. As Kress (2010) states, the process of transduction is quite thoroughgoing, making it demanding for the learner. Although teaching certainly includes verbalizing of different objects and entities, teachers could scaffold students further in this complex process by making conscious transductions between modes.

These students encountered a parallel language situation in the sense that the teaching was in Swedish and the literature partly in English. Visuals and numerals constituted a parallel language in two additional senses: firstly, they made meaning parallel to verbal language, and secondly students had one way of perceiving and using visuals from their experience and must adopt a new parallel way. One could say that the visuals have a different meaning potential in a university discipline than in school or an everyday domain.

Even in disciplines that are less mathematical than economics, students encounter diagrams, tables and other modes of representing information. Although there has been "a visual turn" (Schultz, 2006: 368) in discourse and literacy studies, there is still a great need for research and pedagogical development on the parallel language situation of readers, writers and students in today's multimodal world.

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NOTES

[1] Originally introduced by Wood, Bruner & Ross (1976) and only later connected with neo-Vygotskianism.