

“LET’S PRETEND THIS [ORANGE] IS YOU!” PRESCHOOL CHILDREN MAKING MEANING OF A MULTIMODAL ILLUSTRATION OFFERED AT A SWEDISH SCIENCE CENTER

ANNELI BERGNELL KARLSSON

Abstract

Science centers throughout Europe offer package deals to nearby schools and preschools in order to enhance scientific education through theme-related exhibits and activities. This article focuses on a group of preschool children as they visit such a center in Sweden, where they were presented with a multimodal illustration of a life jacket. By drawing on sociocultural and multimodal perspectives, the meaning that the children made of the illustration was studied as well as the illustration itself. The analysis builds upon Engebretsen’s (2012) concepts of multimodal cohesion and tension and his three interactional dimensions: material, semantic, and performative dimension. The results show that high levels of tension between and within modes in an illustration seem to obstruct the meaning-making processes for young children. The concluding reflection offers a discussion about the need for attention both to the content’s accuracy and to the ways in which illustrations are presented in science centers as well as in education elsewhere.

Keywords

multimodal illustrations, preschool children, science education, meaning making

Introduction

In Sweden and many other European countries, facilities like science centers offer preschools and schools a variety of theme-related package deals for educational purposes. When a preschool group visits such a center, facts and information about specific phenomena or processes are provided in playful ways through exhibits, illustrations such as images, models, and animations, and hands-on activities. In addition, guides at these centers often lead lecture-style discussions, in order to initiate or summarize experiences during the visit.

Some of the provided illustrations are ensembles of modes (combinations of images, texts, speech, or gestures), which presuppose that children can handle such various affordances more or less simultaneously when dealing with the content (Lemke, 1998). According to Kress (1997, p. 28) young children seem to naturally use whatever is at hand when creating, interacting, or making meaning, which could be a way to manage flows of verbal and non-verbal information. Even so, it should not be taken for granted that every combination of modes would be suitable in any situation.

Another often held presumption is that an illustration brings the same message to all individuals. However, researchers have stated that illustrations cannot be assumed to be universal or transparent. How an illustration is understood depends on the person doing the interpretation and the situation in which it is done (Kress, 2003; Ljung-Djårf, Åberg-Bengtsson, Ottosson, & Beach, 2015; Pintó & Ametller, 2002). Further, it has been indicated that different modes provide various meaning potentials and that individuals choose and orchestrate the ones they consider appropriate for a particular task (Jewitt, 2008). This adds to the complexity of meaning making and raises questions about the frequent use of multimodal illustrations in educational settings, so it seems important to be observant of what aspects of illustrations might support meaning making and what aspects could obstruct these processes (Ljung-Djårf et al., 2015). Remarkably, there seems to be a lack of research addressing these matters in general and very few studies focusing on younger children in particular.

This article presents a part of a study of four- and five-year-old preschool children interacting with and making meaning of multimodal illustrations offered by guides at a Swedish science center. The focus is on an illustration related to two themes presented at the science center (*The Swedish Royal Ship of Vasa* and *Air has the power to lift*) that includes hands-on activities, drama, and guided interaction. The study on the whole is conducted within a larger research project dealing with explanatory pictures and models in preschools and primary schools.

Rationale

This article is based on sociocultural and multimodal perspectives in which language is central when communicating with others and when trying to make sense of the world (e.g. Vygotsky, 1987). Symbols and artifacts such as illustrations also work in a communicative way, as mediators between humans and the world. However, the interpretation and use of such sign systems are not universal, but rather related to the cultural context of which we are a part (Engebretsen, 2012; Jewitt, 2008; Kress & van Leeuwen, 2006; Rogoff, 1990; 1995). In this article, the term “illustration” refers to explanations in the form of images, sketches, models, animations, or actions used to clarify a learning content. In line with Wartofsky’s (1979) view of representation, illustrating is something we *do* in a specific context; nothing is an illustration until we treat it as one. Then (almost) anything may in principle be an illustration of (almost) anything else, as long as we agree on it. Stated differently, the use of illustrations involves the negation of meaning, if the illustration is to be used as a resource for meaning making in learning situations. Meaning making may be understood as the iterative process between “the meaning potential of a material semiotic artifact, the meaning potential of the social and cultural environment it is encountered in, and the resources, intentions, and knowledge that people bring to that encounter” (Jewitt, 2013, p. 251). This implies that making meaning is something we *do* in a specific situation, by interacting with people and by using, for instance, symbols or artifacts (e.g. Kress & van Leeuwen, 2006; Vygotsky, 1987; Wartofsky, 1979). This article presents a study of young children interacting within an activity about a scientific phenomenon called *Air has the power to lift*.

Research in the Vygotskian tradition applies a cultural-historical and sociocultural view to science and scientific concepts as cultural artifacts within a community where individuals have to both *make* them and *make use* of them (Vygotsky, 1987; Wartofsky, 1979; Wells, 2008). Adapting these ideas implies that the children in the present study are regarded as participants in activities that offer to make meaning of basic scientific concepts. Vygotsky (1987) refers to two types of concepts: the “scientific” (academic concepts taught in schools) and the “spontaneous” (concepts used on a day-to-day basis). Vygotsky argues that teachers play a significant role in guiding children to link these types of concepts together. In other words, building learning activities around children’s everyday and maybe playful ways of experiencing our world is recommended for further deepening scientific meaning-making processes, according to Vygotsky.

When drawing on multimodal perspectives, focus is directed to the process of making meaning and the constant transformation of communicational recourses, or *modes*. Modes are the ways in which you “channel” your information when you communicate or illustrate, for example, by using images, animations, models, gestures, or pieces of music (Kress, 2014). Some modes are combined into multimodal ensembles in which the multimodal analytic interest turns to the combination of modes, as they appear and are used in a context, rather than to individually isolated (“static”) signs or resources (Jewitt, 2008; Kress & van Leeuwen, 2006). Further attention is paid to how participants choose, use, and orchestrate modes to make meaning. By adapting such a perspective, I will regard all modes, verbal as well as non-verbal (e.g. gestures), as equally important parts of a composition situated in the actual context, where, moreover, each mode offers various meaning potentials in the children’s meaning making. Coherence or lack of coherence in those modes could support or obstruct the meanings offered in illustrations (e.g. Kress, 2003; Jewitt, 2008).

Issues on textual cohesion are found in Halliday’s (1994) social functional grammar, which has also inspired researchers outside the literacy domain. Researchers adopting visual and multimodal perspectives (e.g. Engebretsen, 2012; Jewitt, 2008; Kress, 2003) have analyzed pictures, models, computer games, and so forth as Halliday analyzed text. Engebretsen (2012) provides a model analyzing the balance between what he labels *multimodal cohesion* and *tension*. In this model, cohesion relates to the symmetry and harmony between modes and tension to contrast and discontinuity. Do they “tell the same story”? It is true that Engebretsen regards cohesion as important for making meaning, but he also stresses the need for tension, because tension offers a challenge by forcing the reader to react, which is assumed to be beneficial for the meaning-making processes.

There is a relatively substantial body of research investigating students grappling with various types of visual illustrations. Some such studies have highlighted difficulties, for example, in elementary and high-school students attempting to make sense of diagrams, flowcharts, or cartograms (e.g. Åberg-Bengtsson, 2006; Åberg-Bengtsson & Ottosson, 2006; Ainley, 2000). Other studies have focused on students struggling with educational materials in which pictures were assumed to simplify the reading and the content. For example, Wennås Brante (2014) found that adults with dyslexia treated text as superior to the side-by-side pictures and did not adapt the pictures into the content at all. Instead, the pictures were found to stress or even disturb the readers. The design of book pages seems to be a decisive factor in supporting meaning making (or not). This was observed by Ferlin (2014). In a sample of Swedish biology textbooks, the majority of pages had a large amount of sketches and photos, while much less space was assigned

to the written text. Ferlin maintained that simplifying (and commercializing) textbooks in this way could be a quick way to interest a student in biology. At the same time, however, unexplained illustrations might obstruct the offered meaning, especially when children are left alone to make sense of them. The importance for teachers to guide children through the content and to choose appropriate modes when illustrating (scientific) concepts was emphasized in a study by Kress et al. (2001). They showed how different modes highlighted different aspects (colors, 3D-views) of a concept (a cell), which in turn radically affected how the students were able to make meaning of the illustrations.

The above studies, however important, focus on older children’s or even adults’ handling of illustration. One exception is presented in a recent article by Ljung-Djärf, Åberg-Bengtsson, Ottosson, and Beach (2015), who studied preschool children conducting a refuse-sorting task including illustrations from a computer game. Even though the interpretation of the (refuse-bin) symbols seemed to be given and uncomplicated, the four- and five-year-olds in that study had great difficulties figuring them out. The authors stressed the need to guide children in their attempts to make meaning of presented illustrations.

There has been little research into young children dealing with illustrations. In particular, multimodal educational materials where different modes are combined seem to be a neglected area. This article contributes to the domain of preschool children’s interaction with multimodal illustrations. Even though the present examples originate from Swedish data, the study certainly has a broader scope, as similar illustrations certainly might occur in educational settings or science centers in other countries as well.

Aims

The overall purpose of the entire research project has been to study meaning making related to illustrations used for educational purposes for preschool children. The specific focus for the present study was a multimodal illustration meant to demonstrate how a life jacket works in relation to the scientific idea that *air has the power to lift*. The illustration was multimodal in the sense that it included visual, verbal, and bodily-based actions. It was presented to a group of preschool children at a Swedish science center. In this context, I regard all utterances, hand-on activities, and participation in dialogs as different ways to “use” the illustration.

The study deals with issues such as: How were modes combined in order to illustrate the notion that *air has the power to lift*? Were the children invited to actively participate in the construing of the illustration? What kind of

meaning making did the children express when dealing with the illustration? Particular interest was directed towards the cohesion and tension between the used modes and to the extent to which the balance between them seemed to support or obstruct the meaning-making processes.

Conducting the study

This study was conducted with a Swedish preschool group of 14 children (ages four and five years; 8 girls, 6 boys) accompanied by two experienced preschool teachers when visiting a science center. The children came from the same preschool, located in a small town in southern Sweden. They regularly visited this science center twice a year.

The data mainly consist of 2.5 hours of observational video data. The use of video-recorded observations offered opportunities to capture the participants' body movements, language, and facial expressions, as well as the materials in use and the context of the activity. The camera was either placed on a tripod or hand held, depending on what the circumstances allowed. All verbal interaction was first transcribed in whole and thereafter complemented with relevant body movements, gestures, gazes, sounds, and so on, in order to meet the intentions of this study.

In addition, detailed field-notes were taken during all observations. Parts of the visit were only documented by such notations, as the center, for copyright reasons, did not allow the entire theme activity to be video recorded. My analytic interest for the entire study comprises all sequences in which illustrations of various kinds were presented to and handled by the children. Besides pictures, models, bodily-based dramas, the children were presented to some experiments, one of which illustrated the functions of life jackets. The present article deals with this life-jacket illustration.

The science center regularly offers theme-related visits to nearby schools and preschools. At the time of the study, one theme was about *Swedish Royal Ship of Vasa*. This famous ship sank on her maiden voyage in 1628. The theme addressed this and included the phenomenon that *air has the power to lift*. It was intended for children ages four to seven, and had been up and running for almost a year. Two guides were responsible for introducing the visiting children to the theme and guiding them throughout the activities. They started with a dramatization of an "eye-witness report" of the day when the *Vasa* was wrecked. This was followed by experiments and activities focusing on the floating capacity of different materials. For example, the children were asked to test whether some materials floated or sank and they were also asked to build "a boat more stable than the *Vasa*" was.

The illustration in focus in my analysis is related to the notion that *air has the power to lift*. The illustration was intended to show how a life jacket works. For this purpose, an orange was used. During this part of the session, which lasted for 20 minutes, the children were seated on a U-shaped bench in front of the two guides. One of the guides, dressed up as a mermaid, carried out an experiment where she let an orange illustrate how a life jacket works. She started the experiment by separating the orange into two parts; the peel [representing a life jacket] and the fruit segments [representing a child]. The experiment showed that without the peel surrounding the segments, the segments sank to the bottom of the glass bowl. If segments were put back into the peel, they floated. This experiment was followed by a conversation about air and life jackets. In upcoming sections, what took place will be returned to and further described.

For triangulating the data collected at the science center, a follow-up back at the preschool was video recorded and analyzed. This follow-up was designed as a boat-building activity, suggested by the guides at center, who had also provided the group with a box of materials for this experiment. A preschool teacher guided the children in this activity, which consisted of the boat building and a dialogue about what makes boats (and people) float. However, the children neither spontaneously referred to the life-jacket illustration nor entered the conversation when the guide talked about air and its power to lift.

Analysis

In accordance with the theoretical framework adopted, both the actual actions and the situation as such are of interest for the present analysis. My participation at the science center when collecting these data meant, in fact, that the analysis had already started. Thereafter it wound its way through numerous readings of the verbatim and non-verbal actions from transcripts and repeated scrutiny of the video-recorded material. In a first step, sections when the guides or the children were involved with illustrations of one kind or another were highlighted. Next were a few sections that promised to be fruitful for further analysis in terms of how the children responded to the presentation and interacted with the guide and the illustration. One episode of such interest is presented in this article. The chosen episodes were then further read and re-read to understand the children’s interactions with the guide, the other children, and the illustrations, in attempts to catch indications of their meaning making. In this phase, the analysis was guided by Vygotsky’s (1987) theory of how scientific concepts are formed and Wartofsky’s arguments that illustrations are situated in their cultural context, when construed and agreed upon by the participants.

However, at this point of the analysis, it became evident that the level of child participation and mutual negotiation in the “making” of the illustration was low. Consequently, it was decided that the illustration as such and how it functioned in context needed to be properly investigated. To accomplish this, I used Engebretsen’s (2012) model for analyzing cohesion and tension as well as the balance between them. The model includes three interactional dimensions: *material*, *semantic*, and *performative* dimensions. Engebretsen originally used them in analysis of user–text interaction. Nonetheless, Engebretsen’s model was also appropriate for a non-textual analysis. Using it implied that my analysis of the illustration was divided into three separate sections: the combination of modes used (materiality), the information that was given and in whose interest (semantics), and how it was presented to the children (performativity). Thus, it was possible to focus on one dimension at a time in order to find common themes, when trying to understand what combinations of modes were in use in the illustration, the degree to which these modes related to each other, and if/how they might enable meaning making.

In the next step, the analysis was directed towards whether there was interplay between these different dimensions of the illustration that offered coherent information to facilitate the children’s meaning-making processes or if contrasting modes created too much tension.

Results

Using Engebretsen’s model as described above rendered three categories that appeared to be central with regard to the material, semantic, and performative dimensions respectively. The Results section is organized in accordance with these three categories: *competing modes*, *within-mode tension*, and *an authoritative voice*.

Competing modes

Engebretsen’s *material dimension* concerns aspects of perception. In this case, it deals with issues such as what there was to see, feel, and hear in the life-jacket illustration, and what combinations of materials and modes were included. A question to be posed is whether there was a coherent interplay between these aspects of the illustration – did they “tell the same story” of how life jackets work. Excerpt 1 (below) presents the start of the illustration, when the children were seated in front of the two guides, with one guide dressed up as a mermaid wearing a long fishtail dress and a silver wig. The mermaid holds up an orange, which is pre-peeled into two pieces: fruit segments and a loop of peel.

EXCERPT 1

(The mermaid pulls the orange apart into two pieces: one with the loop of peel and one with the fruit segments. She holds up the segments in front of the children).

Guide: Let’s pretend. This is you!

(The children are quiet, looking intently at the guide and the orange).

Guide: *(Puts the fruit segments into a bowl of water. It sinks to the bottom).*

Child 1: Ouuu *(makes a squeaky sound).*

Guide: You weren’t able to float! Let’s bring you up again. *(Brings the fruit up and puts it back into the peel and holds the “whole” orange up).* So! Now you have a life jacket on! *(Puts the orange carefully into the bowl once more. Now, the orange floats).* Guide: Now you’re floating! But? How come? How come it’s floating now?

Child 2: It took in water! *(Eagerly).*

Guide: Well... but... how... what happened to the boats? The boats that you made [earlier]?
(Silence).

This excerpt shows a tension between modes in use for the illustration. Visually, the children see a mermaid performing a sort of a “magic trick,” when pulling apart an orange with just one twitch. Probably none of them had ever seen oranges being torn apart in that way, nor had they probably seen oranges floating or sinking. In my understanding, the surprise of the experiment itself provided enough tension to engage the children. Verbally, there is an initial invitation for make-believe in this experiment: “Let’s pretend, this [orange segments] is you”. Even though no one is responding to this invitation, the entire experiment continues with the assumption that now everyone regards the segments as illustrating themselves and the peel a life jacket. However, there are no signs that the children ever saw the intended metaphoric relation between the orange (peel and fruit segments) and themselves (life jacket and child). Further, the children are both invited to this imaginary play *and* expected to separate it from facts in order to actually learn about life jackets. In addition, a third mode is involved, as the room is filled with the distinctive scent of orange. Altogether, there seems to be a lot of things going on that clamor for attention. In order to make use of all the information provided, the children need to juggle at least three modes at the same time.

Within-mode tension

The *semantic dimension* balances the interpretation of the illustration and concerns what is and is not given by it. The fact that everything cannot be included or explained in an illustration might cause confusion for those trying

to make meaning of it. When presented with the life-jacket illustration, the children needed to fill in certain gaps to make it useable and meaningful. In the example below, the time issue seemed to be such a gap.

EXCERPT 2

Guide: But? How come? How come it's floating now?

Child 2: It took in water! (*Eagerly*).

Guide: Well... but... how... what happened to the boats? The boats that you made?

(*Silence*).

Guide: What could there be inside the fruit peel that can make it float?

(*Silence*). (*Some of the children are now turning their backs to the guide*).

Guide: (*In a louder voice*): Could it be AIR? Is there AIR in here (*she points to the inside of the peel*)?

(*Most of the children are, urged by their teachers, now facing the guides*).

Guide: What's inside my life jacket? (*points to her colleague who is holding a life jacket*).

(*Silence*).

Guide: And inside your arm floaties?

(*Silence*).

Child 2: (*Very slowly*): Aaaaair?

In order to grasp the hints about the role of air in this illustration, the children need to alternate between present and past experiences. They have to move in time from the floating orange, first to the boat-building activity during an earlier session at the center and then further on to a more recent, previous conversation about arm floaties (which also related to their use of such at the seaside or the swimming pool). Such a “time-leaping” conversation builds on the presumption that everyone actually refers to the same timeframe in order to make sense of the questions. The high level of tension caused by the vague connections between the different points in time for the referenced experiences might have been avoided with just a brief explanation of where the examples were taken from. It may be assumed that difficulties with bridging these time-gaps cause the non-responses or hesitant responses from the children, as the conversation is extremely asymmetric and carried out almost entirely by the guides.

An authoritative voice

The third of Engebretsen's dimensions, the *performative* dimension, relates to response and reaction. The focus is on whether the life-jacket illustration was open for negotiation or just “delivered” to the children by an authoritative voice (Engebretsen, 2012, p. 153).

EXCERPT 3:

Guide: What could there be inside the fruit peel that can make it float?

(Silence). (Some of the children are now turning their backs to the guide).

Guide: *(In a louder voice)*: Could it be AIR? Is there AIR in here *(she points to the inside of the peel)?*

(Most of the children are, urged by their teachers, now facing the guides).

Guide: What’s inside my life jacket? *(points to her colleague who is holding a life jacket).*

(Silence).

Guide: And inside your arm floaties?

(Silence).

Child 2: *(Very slowly)*: Aaaair?

(Fruit segments slips out of the peel and sinks to the bottom).

Children: *(Point at the bowl)*. It’s sinking!

Guide: Ok. You shouldn’t be sloppy about life jackets. It’s supposed to fit tightly on you, and even if you can swim, you should wear one. For example on a boat.

Child 1: *(Excited)*. I go to swimming classes!

Child 2: Me too! I can’t swim.

Child 3: I go on Sundays.

Child 2: I can’t swim.

Child 5: My granddad has a boat! I use a life jacket.

Guides: *(Look at each other)*.

Child6: *(Has been quiet. In a loud voice)*. I can smell the orange!

In this section, the guides are asking questions about the illustration, but there is little room for answers. Instead of waiting for the children to respond, the guide tries to steer them to the “right” answer by posing still another question or example. This frequent use of questions, as well as their complexity, causing high levels of tension in this illustration. A question like “What’s inside my life jacket?” is probably too complex for children of these ages to answer (and probably for some adults as well). Thus, the guide adds to the level of tension and leaves the children with no room for their own ideas or questions. Information is passed on to them in what seems to be a predetermined order. At the end of the excerpt, the children become more active. Here the guide could have taken a chance to join their discussion and to make their everyday experiences of air a point of departure, when wrapping up this session. This would have been an excellent opportunity to actually summarize what the experiment was meant to illustrate that air has the power to lift, for instance, someone who cannot swim but wears a life jacket.

Summary

The life-jacket illustration showed high levels of tension between modes, for example, when a strong visual mode obstructed the verbal information. Further, time issues and an overuse of complex questions tended to be stumbling blocks in the children's meaning-making processes. When the children had to switch between different modes and move back and forth in time, this added to the complexity of the illustrated content. Moreover, the children were left with little room to negotiate the meaning or to ask questions about the illustration, which seems to have made some of the information somewhat uninteresting and, it seems, also unusable.

In addition to the data collected at the science center, this study includes a video-recorded session back at preschool, in which the children and their preschool teacher built "best-floating boats" while talking about their experiences at the center. Among other things, they discussed what could make boats and people float. During this activity, none of the children spontaneously mentioned the life-jacket illustration. Only when prompted by the preschool teacher, the children talked about "air" (in floating devices like arm-floaties) but still not referring to the life-jacket illustration. As the children did not relate the life jacket and the best-floating boat illustrations to each other, no excerpts from the latter activity were selected for this article. However, this lack of coupling is presumably another indication that the life-jacket experiment did not support a meaning-making process for the notion that *air has the power to lift*.

Concluding discussion

The discussion of the results will mainly be based on the balance between multimodal cohesion and tension (Engebretsen, 2012) and on Wartofsky's (1979) notion about illustrations being *created* and *agreed upon* by participants. Despite the quite narrow scope of this study, the results raise new questions about the kind of educational package deals that science centers offer to preschools and schools. My analysis of preschool children encountering illustrations of the notion that *air has the power to lift* in a *life-jacket experiment* indicates that the intended meaning-making processes were most likely mapped out in advance. The guides of the center seemed to follow a strict plan with the aim of bringing the children detailed information about the focused content. Furthermore, the results show that there was little room to pause or change the plan or to use the children's everyday experiences as a starting point. All in all, this created high levels of tension in the illustration's *material, semantic, and performative* dimensions (Engebretsen, 2012).

The life-jacket experiment is an example of Wartofsky’s (1979) statement that just about everything can illustrate anything as long as people agree on the interpretation. Regrettably, in this study, it seemed to lose its illustrative function, because there was no real agreement or negotiated meaning. When the guide said: “Let’s pretend this [orange] is you”, she did not wait until the children seemed to have adapted this invitation before continuing her story. Even though silence sometimes *is* an agreement, the rest of the activity indicates that the silence in this case seemed to be caused by *not* agreeing on the imaginary play. Further, the guides moving in and out of the imaginary play might have caused confusion as the children had to distinguish between when to be imaginative and when it was time to learn something for real. In addition, in my understanding, too much tension was created between modes (Engebretsen, 2012) in that too many examples of various kinds were introduced at the same time. This seems not to have supported but rather to have hindered the intended meaning making. Perhaps that was why none of the children appeared to respond to or even register the vague invitations to negotiations.

In contrast to Engebretsen’s conclusion (where tension worked as a motivation for somewhat older readers) the tension in this illustration *did not* seem to engage the young children. Although the guide used a very amusing and seemingly age-appropriate way to illustrate a life jacket, the results indicated an overly ambitious combination of modes used in the illustration as something that seems to have obstructed the meaning-making processes. Adding to this, the allotted time for the visit might have led to the use of entertaining and eye-catching objects and actions in order to quickly make the children interested in the illustration (Ferlin, 2014).

Teaching sometimes calls for more or less dramatic measures, but educators certainly need to consider the way they combine different modes, in order to give the children a fair chance to make sense of an offered illustration in whole. For example, a simple embodied illustration of air, like “let’s blow on our hands”, could be a starting point for a further, deepening meaning-making processes (which actually was the case in another part of the larger study). As Vygotsky (1987) stated, the use of children’s everyday concepts is crucial for future meaning making of scientific concepts. This however, requires educators to understand the importance of linking the two kinds of concepts together.

I have tried to contribute to a weakly focused domain of educational research involving preschool children making sense of multimodal illustrations in (pre-) science education in Europe. My purpose when presenting and discussing the results of this study has not been to criticize the theme-related work at science centers or the use of entertaining experiments. Instead, my paper stresses that when using illustrations, guides and teachers for young

children need to pay attention not only to the content's accuracy, but also to the ways in which different modes of presenting this content are combined with respect to cohesion and tension. Such awareness might protect educators from the risk of being merely "entertainers."

References

- Åberg-Bengtsson, L. (2006). "Then you can take half...almost": Elementary students learning bar graphs and pie charts in a computer-based context. *Journal of Mathematical Behavior*, 25(2), 116–135.
- Åberg-Bengtsson, L., & Ottosson, T. (2006). What lies behind graphicacy? Students' results on a test of graphically represented quantitative information to formal academic achievement. *Journal of Research in Science Teaching*, 43(1), 43–62.
- Ainley, J. (2000). Transparency in graphs and graphing tasks: An iterative design process. *Journal of Mathematical Behavior*, 19(3), 365–384.
- Engebretsen, M. (2012). Balancing cohesion and tension in multimodal rhetoric. An interdisciplinary approach to the study of semiotic complexity. *Learning, Media and Technology*, 37(2), 145–162.
- Ferlin, M. (2014). *Biologisk mångfald i läroböcker i biologi* [Biodiversity in Textbooks in Biology]. Gothenburg: University of Gothenburg. Retrieved from <http://hdl.handle.net/2320/14251>.
- Halliday, M. A. K. (1994). *An introduction to functional grammar, 2nd edition*. London: Edward Arnold.
- Jewitt, C. (2008). Multimodality, media, learning and identity. *Medien Journal*, 32(1), 31–40.
- Jewitt, C. (2013). Multimodal methods for researching digital technologies. In S. Price, C. Jewitt, & B. Brown (Eds.). *SAGE Handbook of Digital Technology Research*. London: SAGE.
- Kress, G. (1997). *Before Writing: Rethinking the Paths to Literacy*. London: Routledge.
- Kress, G. (2003). *Literacy in the new Media Age*. London: Routledge.
- Kress, G. (2014). What is mode? In C. Jewitt (Ed.). *The Routledge Handbook of Multimodal Analysis. Second Edition*. London: Routledge.
- Kress, G., Jewitt, C., Ogborn, J., & Tsatsarelis, C. (2001). *Multimodal Teaching and Learning: The Rhetorics of the Science Classroom*. London: Continuum.
- Kress, G., & van Leeuwen, T. (2006). *Reading Images: The Grammar of Visual Design*. London: Routledge.
- Lemke, J. (1998). Multimedia Literacy of the science curriculum. *Linguistics and Education*, 10(3), 241–271.
- Ljung-Djårf, A., Åberg-Bengtsson, L., Ottosson, T., & Beach, D. (2015). Making sense of iconic symbols: A study of preschool children conducting a refuse-sorting task. *Environmental Education Research*, 21(2), 256–274.
- Pintó, R., & Ametler, J. (2002). Students' difficulties in reading images. *International Journal of Science Education*, 24(3), 333–341.
- Rogoff, B. (1990). *Apprenticeship in Thinking: Cognitive Development in Social Context*. New York: Oxford University Press.

- Rogoff, B. (1995). Observing sociocultural activity on three planes: Participatory appropriation, guided participatory, and apprenticeship. In J. V. Wertsch, V. R  o, P. del R  o, & A. Alvarez (Eds.). *Sociocultural studies of mind*. New York: Cambridge University Press.
- Vygotsky, L. S. (1987). Thinking and speech (N. Minick, Trans.). In R. W. Rieber & A. S. Carton (Eds.). *The collected works of L.S. Vygotsky, Vol. 1: Problems of general psychology* (p. 39–285). New York: Plenum.
- Wartofsky, M. W. (1979). *Models*. Dordrecht: Reidel.
- Wells, G. (2008). Learning to use scientific concepts. *Cultural Studies of Science Education*, 3(2), 329–350.
- Wenn  s Brante, E. (2014). *M  te med multimodalt material. Vilken roll spelar dyslexi f  r uppfattandet av text och bild?* [Encounter with Multimodal Material. The Role of Dyslexia for Perceiving Text and Picture]. Gothenburg: Acta Universitatis Gothoburgensis.

Corresponding author

Anneli Bergnell Karlsson

Department of Preschool Teacher Education, Faculty of Librarianship, Information, Education and IT, University of Bor  s, Sweden
E-mail: anneli.bergnell_karlsson@hb.se

