PRIMAPODCASTS – VOCAL REPRESENTATION IN MATHEMATICS

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After having investigated written and graphically-based communication I focus on vocal representations of mathematical contents. The so-called mathematical podcasts were made by primary level pupils and are called PriMaPodcasts. The relationship to written/graphical representations, the special setting to produce the podcasts with primary pupils and an example is depicted in this paper. The different steps of production of the PriMaPodcast are classified in reference to the special relation of vocal and written communication. It is a first classification according to the linguistic model of Koch & Oesterreicher. Furthermore some interests of investigation concerning the use of PriMaPodcasts, the acquisition of competences, semiotic analyses and the use of digital media in teacher education are briefly described.

MOTIVATION

Our special interest in vocal representations of mathematical contents aroused from the investigation of written and graphically based communication in the project 'Math-Chat' (Schreiber, 2010, 2012a, see next section). A first conception was developed (Schreiber, 2011) to create podcasts about mathematical contents with primary school pupils, which was modified later (Schreiber, 2012b). In this project only audiopodcasts are produced, so the use of written and graphical elements is not possible and this kind of representation must be 'replaced' in some way by the primary pupils. Three different aims are crucial:

- The learning can be fostered because of the requirement of not using any written/graphical representation but only vocal representation for the description of mathematical contents.

- The level of the pupils' skills in reference to their mathematical expression, both spontaneous and planned, can be identified by analysing all products during the production of the podcasts.

- This is very promising for the purpose of investigation because it is possible to see what is used to replace the written and graphical representation when only vocal representation is possible.

Not only the product but also all steps in the production of PriMaPodcasts are of interest. There are seven different steps and the written and vocal representations are interwoven permanently. The written and vocal parts of this process are classified by the two-dimensional model of medial and conceptual orality and writtenness (Koch & Oesterreicher, 1985).

ANCESTOR PROJECT

The ancestor project 'Math-Chat' [1] was about the genesis of 'mathematical inscriptions' (Latour, 1987; Latour & Woolgar, 1986) in primary education: In an experimental situation, an internet-chat setting, the communication between pupils solving together given word-problems depended on the use of written/graphical representations. This setting offered insights into the learning of mathematics because mathematics depends on written forms of communication (Pimm, 1987). Writing constitutes an integral part of mathematical communication. Fixing ideas in a written form changes their status and makes them more explicit and conveyable (s. Bruner's approach of the "externalization tenet" 1996, 22-25). The focus on the medial written form of language in problem-solving situations in mathematics was the special issue of 'Math-Chat' (see Schreiber, 2005). In the 'Math-Chat' project a semiotic instrument for analysing inscription-based mathematical problem-solving processes has been developed. These processes are described as "Semiotic Process-Cards" (Schreiber 2012a/ 2010).

PRODUCTION OF PRIMAPODCAST

According to the latest conception (Schreiber 2012b, 2012c) there are seven steps in the process of production of the so-called 'PriMaPodcast' (see Fig. 1):

1. Spontaneous Recording: The pupils have to answer a question or to react to a stimulus about mathematical terms like 'infinite', 'greater than', 'less than', or calculation methods like addition or subtraction or about geometrical objects like a circle or a cuboid. Their first spontaneous reaction is recorded with a voice recorder. This is like a brainstorming about the mathematical content and can be used in the further process because it is recorded and available for the pupils.

2. Manuscript I: The pupils have to plan an audio-podcast, which is to explain this content to others. For this they can and they should now take some notes and make a kind of manuscript for their recording. They are free to make it more or less detailed, to decide who is saying which part or to make more or less a rough draft.

3. Audio-podcast: The recorded audio-podcast should begin with the same question or stimulus as in the first step. It will be recorded based on the pupils' manuscript. Depending on this manuscript it can be read out or the pupils speak freely.

4. Editorial Meeting: Two different groups meet here together with the teacher to give one another feedback to the created audio-podcasts. The feedback can be about the content, formal aspects or the choreography of the whole audio-podcast. These two groups decide with the help of the teacher if the created audio-podcasts are ready to be published or if there are changes to be needed.

5. Manuscript II: In connection with the editorial meeting the manuscript has to be revised. This way, the final version is initiated.

6. PriMaPodcast: The pupils take a final recording of their audio-podcast. Afterwards, it is ready to be published.

7. Publication: After the release of the PriMaPodcast, an administrator publishes them in a blog on the internet. (in German: http://blog.studiumdigitale.uni-frankfurt.de/primapodcast/). The advantage of publishing the PriMaPodcasts in a blog is the categorising of the several podcasts in main-theme and sub-theme categories which makes it easy to manage for a group of researchers.

Fig. 1: Steps to produce a mathematical podcast with primary pupils - PriMaPodcast

Similar to the ‚Math-Chat-Project', in which there is a link between medial written/graphical but conceptually oral communication, there is a link between the two kinds of communication in PriMaPodcast production, too. As it is explained below, orality and writtenness are present in the different parts of the production of PriMaPodcasts in different manners and both are interwoven.

CONFLICTING FIELDS OF WRITTENNESS AND ORALITY

To explain more about the interwoven use of oral and written communication in a medial and conceptual manner, I use the linguistic model of orality and writtenness of Koch & Oesterreicher (1985), well explained by Fetzer (2007, p. 79) as the "two dimensions of orality and writtenness (translated by the author: „Zwei Dimensionen von Mündlichkeit und Schriftlichkeit").

Koch & Oesterreicher (1985) have developed a model of communication that distinguishes between medial phonic and medial graphic communication and between communicative immediacy and communicative distance. The medial phonic and the medial graphic realization of communication are dichotomous, whereas the conceptual realization can be placed on a scale between the communicative immediacy and the communicative distance (see fig. 2).

As an example a personal talk is not only medial phonic, there is an emotional closeness to the dialogue partner and thus conceptual oral. Writing in a diary is in a conceptual sense also oral, not formal and characterised by the 'closeness' to the reader, but it is medially graphic. An administrative directive in contrast is medially written and also conceptually an example for communicative distance. The language is strictly formalised in this case. If this administrative directive will be read aloud, it

will be medially phonic, but conceptually it continues to be written. The language is still the same and characterised by distance and formalism.
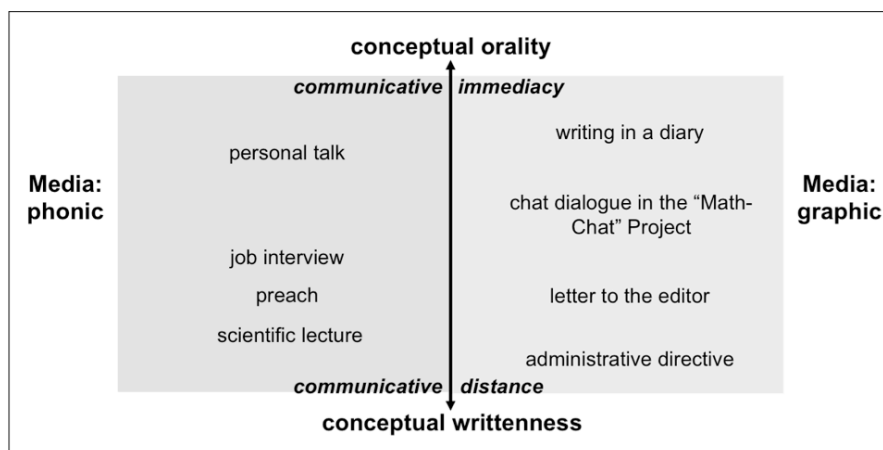

Fig. 2: Koch & Oesterreicher's model according to Fetzer (2007, p. 79; translation by the author)

EMPIRICAL EXAMPLE

A couple of PriMaPodcasts have been made in German and also a few in a bilingual German-Spanish class. The PriMaPodcasts in German language are available in this blog: http://blog.studiumdigitale.uni-frankfurt.de/primapodcast/, the examples in Spanish language are available here: http://blog.studiumdigitale.uni-frankfurt.de/primapodcast-es, but this blog is still in progress. Further examples will be added to these two blogs. A blog in Greek, in Turkish and one in English are planned.

In the PriMaPodcast which is presented here, the question was 'What is so special about a square in comparison to the other quadrangles?'. This PriMaPodcast was developed by one girl and two boys in grade four and the recordings were led by a teacher-student. At first the transcript of the spontaneous recording is given. [2] After that the manuscript is depicted, which is written by one of the pupils as agreed with the others. Then the audio-podcast, which is based on this manuscript, is exhibited as transcript. The improved recording, the PriMaPodcast, is also documented as a transcript. It conforms to the manuscript, even though there are some different intonations and it is not fluently read in all cases. For my analysis this is of interest. All citations of the transcript are marked in squared brackets <like this>.

Spontaneous Recording:

At first pupil 1 (the girl) asks 'What is so special about a square in comparison to the other quadrangles?' <sp1> and pupil 2 answers spontaneously <sp2>, that he knows an answer. But it is pupil 3, who explains that there is a difference in terms of spelling <sp3>. He remarks that the capital letters of the two words are different. This assumption is correct even though his spelling of the second word is wrong. Pupil 2 takes the turn and has a content-related point of view and claims that the sides of a

square are of equal length. To this he gives an example <sp4>. Pupil 3 adds another example to confirm the statement <sp5>.

sp1	00.00	p1	What is so special about a square in comparison to the other quadrangles
sp2	00.07	p2	Okay I know
sp3	00.10	p3	A square (*in German Quadrat*) is spelled with Q and the quadrangles (*in German Vierecke*) are spelled with F
sp4	00.14	p2	Squares have on each s. on each side a square is of equal length that means when one side is five centimetres the other sides of the square are five centimetres too
sp5	00.29	p3	And when it's one centimetre the other side is one centimetre too (*colloquial*)

You can see here that pupil 2 and pupil 3 both focus on the sides and on the shape of the square. With their utterances they do not actually compare the differences between a square and the other quadrangles. The pupils only describe the characteristics of a square. Other characteristics of a square, for example symmetry or angles, are not taken into consideration. Pupil 1 does not add another content-related argument either.
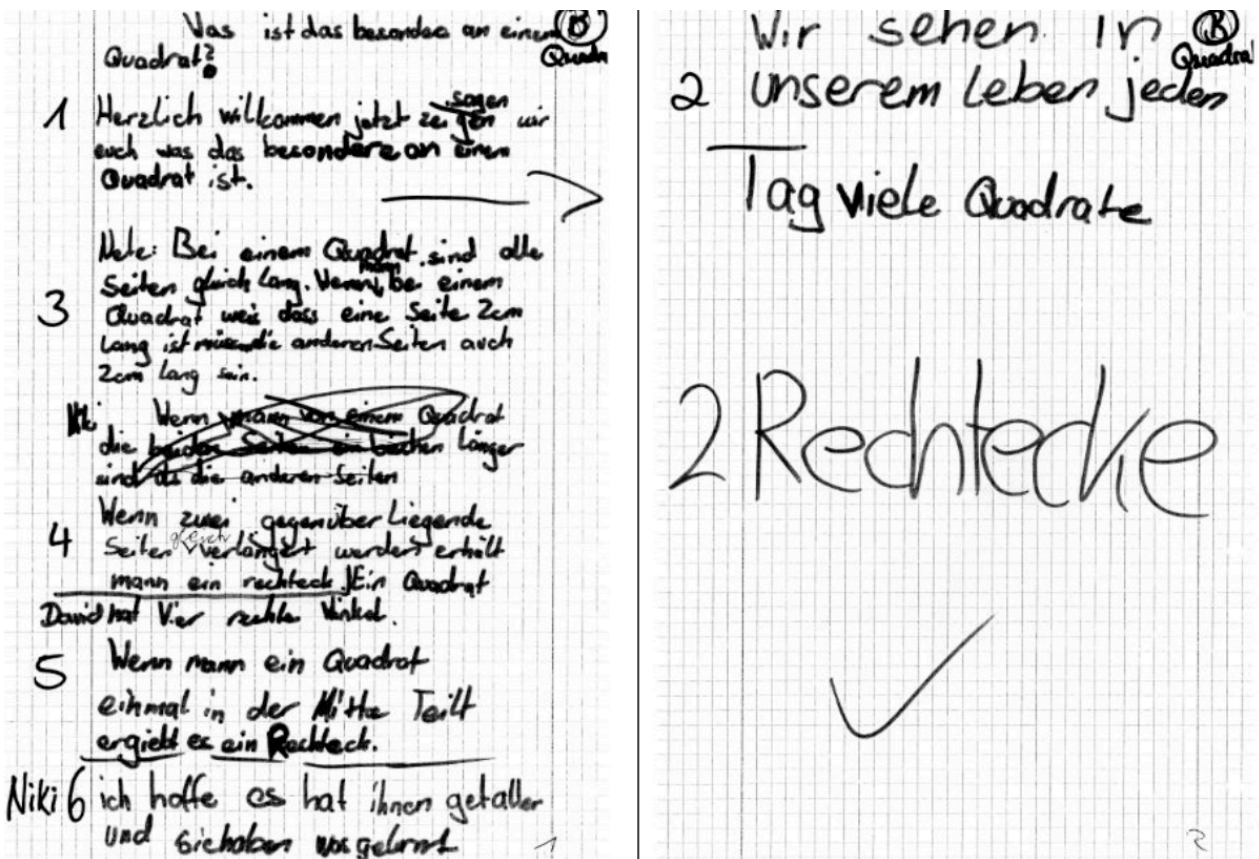
Manuscript:

Fig. 3: Manuscript of the PriMaPodcasts (original two pages in A4)

Here I give the translation of the manuscript (see fig. 3):

What is so special about a square?

1 Welcome now we are going to tell you what is so special about a square.

3 Nele: A square has got four sides of equal length. When you know that a square has one side of 2 cm all the other sides have to be of 2 cm, too.

~~When both sides of a square are a bit longer and the other sides~~

4 When two facing sides are lengthened equally you get a rectangle.

David 5 A square has got four right angles. When you split a square in the middle, you get two rectangles.

Niki 6 I hope you liked it and you have learnt something

2 Every day we see many squares around us

2 rectangles

Audio-Podcast:

At first they welcome the audience of their audio-Podcast by presenting their topic <a1>. Then they make clear, where you can find squares in the "every . day" <a2> world. After that, they take an utterance of the spontaneous recording and focus again on the length of the sides of a square <a3> with the help of an example. In utterance <a4> they explain how to transfer a square into a rectangle and utterance <a5> is another way of transformation. The right angles are mentioned in this context, too <a5>. With their statements in <a6> and <a7> they refer again to their audience.

a1	00.00 p1	Welcome now we are going to tell you what is so special about a square
a2	00.04 p3	Every . day we see many squares cede covers glazed tiles squared paper (*Hessian accent*) in our Maths school books around us .
a3	00.13 p1	A square has got four sides of equal length when you know that a square has one side of two centimetres all the other sides have to be of 2 centimetres too
a4	00.22 p2	When two facing sides are lengthened equally you get a rectangle
a5	00.28 p3	A square has got four right angles when you split it in the middle vertically or horizontally you get two .. rectangles (*Hessian accent*)
a6	00.37 p2	I hope you liked it and you have learnt something ..
a7	00.42 all p	By-yee

In this version, the pupils think of an audience of their work <a1>. This is different to the spontaneous recording and makes their work 'public'. So it changes the status of the spoken text, which bases on the manuscript. With the first content-related statement they make clear what the question means in their "every . day" life <a2>. This shows their personal interest of the question. By taking an utterance of the spontaneous recording they focus another time on the length of the sides <a3>. And this shows that they are still aware of their first ideas. They do not only take over this idea, but they are able to generalise it and to add an example. For the first time, in utterance <a4> they make a difference and also a connection between squares and other quadrangles. It is not any quadrangle but a special one, a rectangle. They show the connection and the difference by using two modifications of the square: In the first case, it is a modification by changing the length of "two facing sides" <a4> and in the second case by splitting into two equal parts <a5>. Moreover, the pupils mention one more detail of the square by focussing on the angles <a5> and they are able to use the terms 'vertically' and 'horizontally' to explain the directions <a5>. In utterance <a6> they emphasize that their aim was to let the audience learn something.

PriMaPodcast:

After the editorial meeting the PriMaPodcast is recorded. It still bases on the same manuscript. Mostly all parts of the audio-podcast are in this PriMaPodcast version. The pupils only change details like leaving out the examples from every day life <pr3> and adding their names <pr7>.

pr1	00.00 p1	Welcome . Now we are going to tell you what is so special about a square
pr2	00.04 p3	Every day we see many squares around us
pr3	00.08 p1	A square has got four sides of equal length if you know that a square has one side of two centimetres all the other sides have to be of 2 centimetres too
pr4	00.17 p2	If two facing sides are lengthened you get a rectangle
pr5	00.22 p3	A square has got four right angles when you split it in the middle vertically or horizontally you get two rectangles (*Hessian accent*)
pr6	00.29 p2	I hope you liked it and you have learnt a lot.
pr7	00.33 p3	This commentary was given by Nele Niklas und David ..
pr8	00.37 all p	By-yee

In the PriMaPodcast version the pupils are aware of the imaginary audience <pr1>. This is clear because this version is for publication in the blog and the children were told this before. So their recordings will be made 'public' indeed. In this version the pupils read it out louder and more fluently than in the audio-podcast version. Leaving out the examples from every day life is an important change. Up to now it was of great interest for the children and they put emphasis on it by mentioning it at the beginning of the audio-podcast. But from their point of view it is not so important for the imaginary audience. All the other arguments are repeated <pr3;pr4;pr5>, which shows that the pupils see their relevance for the audience. The children were not

asked to mention their names, but this seems of interest, too <pr7>. The pupils can identify with their PriMaPodcast and they finish it jointly.

CLASSIFYING IN THE CONFLICTING FIELDS

The communication in the 'Math-Chat' Project is medially graphical, but conceptually oral, because it is in a high range interactive, synchronous and little formal. The classification of the different phases of the development of PriMaPodcast consists of three parts: The spontaneous recording, which is medially phonic and conceptually oral too. The utterances are little formal and not very elaborated. The manuscript, which is the base for the later recording of the PriMaPodcast, is medially written but conceptually – depending on the kind of manuscript – it should be classified more to the vocal pole. The so developed PriMaPodcast is medially phonic and conceptually nearer on the oral pole than the manuscript.

The overlapping areas mean that, e.g., a manuscript for the PriMaPodcast can be conceptually more oral, than the medially written-graphical interaction in the Math-Chat project, which is in its part also conceptually oral. As well a PriMaPodcast can be conceptually nearer to oral than the spontaneous recording.
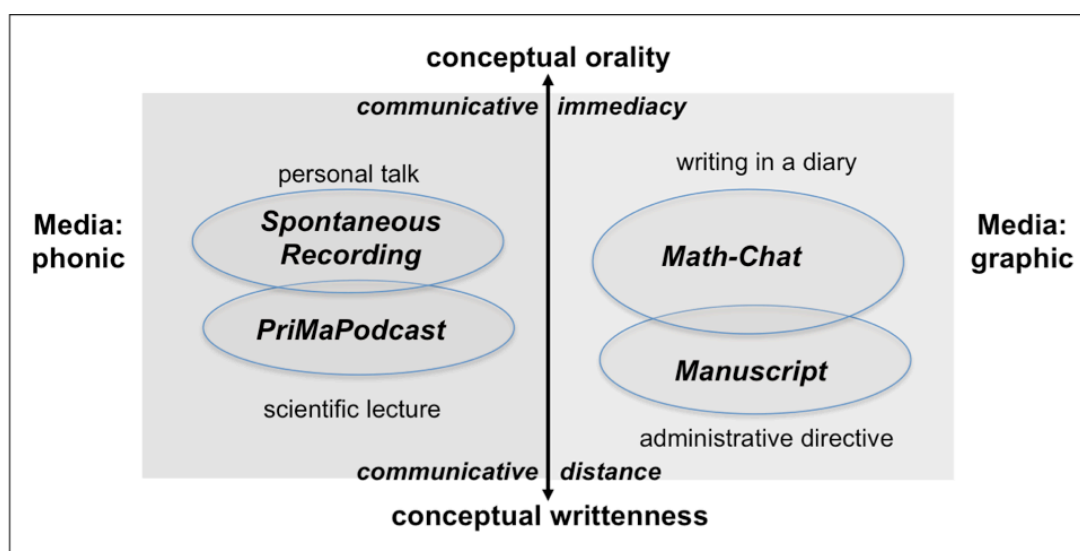

Fig. 4: Examples classified in the conflicting field of writing and speech (see also Schreiber 2012b)

FURTHER INTERESTS OF INVESTIGATION

Here I want to highlight three aspects of interests of investigation:

- The acquisition of competence in mathematical learning
- Semiotic analyses of vocal representation
- Digital resources in teacher-education and mathematical learning

Communication is one of the mathematical competencies. It is overlapping with representation and also with argumentation. If we want to foster the acquisition of

these competencies, we have to find a task in which they are required aligned and in variations. So for the empirical investigation there is a special requirement. I want to investigate this field by video analyses and explore, in what extent it is possible to foster this competencies acquirement. Especially the connection between written and vocal representation in the production of the PriMaPodcasts is of interest. This can help to identify the importance of the different models of communication.

As always in the field of reconstructive social investigation this investigative work should amplify the repertoire of methods: the vocal products in connection with the before created manuscript are subjected to a semiotic analysis. For this the analyses-method of the Semiotic Process-Cards is developed further to be used for vocal forms of communication. The goal of the more differentiated theory is to examine the semiotic aspects of interaction in mathematical classroom activities. Up to now they were limited to inscriptional aspects of mathematical communication (Schreiber 2010) and they are used for Gestures in this context (Huth 2011/ in press).

If it is true, that there is a deficit of use of digital media in primary mathematics classes (at least in Germany) like Mitzlaff (2008) and Ladel & Schreiber (2011) affirm, then we as educators in mathematics should close this gap. Especially for project-oriented mathematical education we have to create and to prove scenarios for all-day use in primary classes. This is what happens in the above described scenario of creating PriMaPodcasts. They can serve as a scenario to teach and learn mathematics and also as a possibility for investigative learning for the teacher students of primary education.

NOTES

[1] This study was supported by Müller-Reitz-Stiftung (T009 12245/02) entitled „Pilotstudie zur Chat-unterstützten Erstellung mathematischer Inskriptionen unter Grundschülern".

[2] The audiofiles are available here: http://blog.studiumdigitale.uni-frankfurt.de/primapodcast/

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