The aim of this paper is twofold. On the one hand it is intended to develop a model of the activity ‘textbook use’ that is of particular interest for research in mathematics education. On the other hand it is supposed to make a contribution to activity theory striving for “transcending the boundary between theory and practice” (Engeström, 1990) by applying activity theory to a particular activity. It appears that in the case of textbook use the triad ‘subject – mediating artefact – object’ as the nucleus of the human activity system does not entirely represent the activity ‘textbook use’. This will raise issues according to the model of the human activity system as suggested by Engeström (1999b).

INTRODUCTION

As Even and Schwarz (2002) point out, “the focus of research in mathematics education has extended from the individual student's cognition and knowledge to contextual, socio-cultural and situated aspects of mathematics learning and knowing. From a socio-cultural perspective not merely the “practices and culture of the classroom community” (Even & Schwarz, 2002) are of particular interest, but the study of artefacts of the mathematics classroom and their use.

Howson (1995), who states that „despite the obvious powers of the new technology it must be accepted that its role in the vast majority of the world’s classrooms pales into insignificance when compared with that of textbooks and other written materials” underpins the particular interest in the textbook and its use for research in mathematics education. In fact the textbook is associated with most of the activities related to teaching and learning mathematics.

While textbooks and the comprehension of mathematical text (cf e.g. Österholm, 2004) have received some attention in research on mathematics education, several authors point out a dearth of research into the use of texts (Gilbert, 1989; Love & Pimm, 1996). One reason may be the difficulty of obtaining data on the use of textbooks (cf Love & Pimm, 1996). Another reason may be the lack of a theoretical framework for textbook use. An appropriate theoretical framework might in fact be regarded as a prerequisite to collect data on the use of textbooks.

Therefore, the first aim of this paper is to develop a model of the activity ‘textbook use in teaching and learning mathematics’.

From an activity-theoretical perspective this activity is striking because it is connected to a particular artefact by definition. If activity theory aims at being “a pathbreaker in studies that help humans gain control over their own artefacts” (Engeström, 1999a) it should be capable to provide a model for the activity ‘textbook use’. 
use’. It appears that in the case of textbook use the triad ‘subject – mediating artefact – object’ as the nucleus of the human activity system does not entirely represent the activity ‘textbook use’. This will raise issues according to the model of the human activity system as suggested by Engeström (1999b).

RATIONALE FOR A MODEL OF TEXTBOOK USE BASED ON ACTIVITY THEORY

Activity theory analyses “object-oriented, collective, and culturally mediated human activity” (Engeström et al., 1999). The use of a textbook is an activity that is situated in the context of institutional teaching and learning. Within that context the use of textbooks is object-oriented and collective. The educational system itself is a historically and culturally formed system.

The emphasis of activity theory is placed on “mediation of human action by cultural artefacts” (Engeström et al., 1999). As well as the educational system the textbook is a historically and culturally formed mediating artefact. The textbook is influenced by the educational system and by traditional concepts of teaching and learning.

Both, the historical development and the literature on textbooks are characterized by controversies. It seems that the textbook and its use are best described as a set of dichotomies. The following questions may give an impression of some important dichotomies:

- Is the textbook a pedagogical means or a marketed product?
  Mathematics textbooks as well as textbooks in general are developed to serve a pedagogical purpose. Nevertheless, “publishing is a business and must please its primary customers – teachers – to remain viable” (Chambliss & Calfee, 1998). Therefore the textbook is not merely a pedagogical means but also a marketed product. “The economics of publishing also imposes constraints” (Love & Pimm, 1996) on the development of textbooks as a pedagogical means.

- Is the textbook an instrument for learning or the object of learning?
  The textbook mediates knowledge. In this respect it is designed to be an instrument for teaching and learning. However, Engeström (1999b) argues, that the main aim of teaching has been to reproduce the text in the textbook. Therefore he concludes that the text must be regarded as the object of learning. Then again, some authors even call for considering textbooks as the object of learning in order to develop a critical attitude towards mass-media (cf Keitel et al., 1980; Stein, 1995).

- Is the textbook addressing the teacher or the student?
  On the one hand mathematics textbooks pretend to be addressed to the student. Consequently, teacher’s guides are offered in addition to textbooks (Keitel et al., 1980). On the other hand, most authors agree that mathematics textbooks are addressing both, the teacher and the learner (Griesel & Postel, 1983; Keitel et al., 1980; Love & Pimm, 1996; Stein, 1995). This dichotomy is associated to the issue of the nature of the knowledge that represented in
textbooks, i.e. the dichotomy between a mathematical and a didactical nature of the knowledge.

- Is the textbook supposed to be mediated by the teacher or is its intention to substitute the teacher?
Most authors agree that the textbook are not in general conceived to replace a teacher, but are written to be mediated by the teacher (cf e.g. Griesel & Postel, 1983; Love & Pimm, 1996; Newton, 1990). But nevertheless there is a tendency to create teacher-proof textbooks (cf Keitel et al., 1980).

These dichotomies already demonstrate that a model of textbook use must be capable of incorporating dichotomies. According to Engeström (1990) “activity systems are characterized by inner contradictions”. Therefore, activity theory appears to be especially suited to be a basis for a model of textbook use.

**TEXTBOOK USE FROM AN ACTIVITY-THEORETICAL PERSPECTIVE**

The fundamental interacting components of the activity system are the subject, the object and the mediating artefact. Vygotsky (1978) was the first to introduce the triangle with these components as vertices as a simplified model of mediated action.

![Fig. 1: Vygotsky’s simplified model of mediated action](image)

A first approach to describe the use of mathematics textbooks by students according to this model might be the following triangular representation:

![Fig. 2: 2-d-representation of the use of textbook by students (1)](image)

The activity described in this model is part of the learning activity as a whole. Within this activity the textbook serves as an instrument to acquire mathematical knowledge. However, this model disregards the widespread agreement that textbook use is usually mediated by the teacher (cf Griesel & Postel, 1983; Love & Pimm, 1996; Pepin & Haggarty, 2001).

Newton (1990) claims that “text use is usually perceived as a relationship between the teacher, the student and the text”. Keeping in mind that the teacher is regarded as
the mediator of the text, Newton suggests a different model of textbook use that is displayed in Fig. 3.

Fig. 3: 2-d-representation of textbook use with the teacher as mediator of the text

From an activity-theoretical perspective this model of textbook use has two remarkable implications:

1. In this model the role of the textbook has changed. It is no longer an instrument but the object of the activity.

2. From an activity-theoretical perspective the teacher adopts the position of the mediating artefact. This means, that either this model is no representation of an instrument mediated activity in the activity-theoretical sense of the term or that the idea of mediation can not be reduced to artefacts. These two alternatives try to explain the position of the teacher within the triangular structure of the activity system. Another way of dealing with the mediating role of the teacher is to expand the triangle in Fig. 2 to a quadrilateral. The new vertex stands for the mediation of the use of the artefact by a person or another artefact.

In the case of textbook use the triangular nucleus of the activity system will expand to the following quadrilateral:

Fig. 4: 2-d-representation of the use of textbook by students

From the student’s perspective this seems to be an appropriate model for textbook use. In this quadrilateral structure the student is the user of the textbook and the teacher is mediating the use of the textbook. But in this model it is not yet taken into consideration that the teacher himself is a user of the textbook. In fact, it was inherent in one of the major dichotomies, that the textbooks are even addressing teachers.

Compared to the student the teacher uses the textbook in a different way. For him it is not merely an instrument to acquire knowledge. Different studies substantiate that mathematics teachers use textbooks as a means to prepare their lessons (cf Bromme & Hömberg, 1981; Hopf, 1980; Stodolsky, 1989; Valverde et al., 2002; Woodward &
Elliott, 1990). Hence, for the teacher the textbook mediates didactical aspects of the presented knowledge.

The use of the textbook by the teacher may be either modelled as a separate activity system or it may be included in the model of textbook use depicted in Fig. 4. As a result, the complexity of the model of the activity ‘textbooks use’ will increase in a way that is best represented in the three dimensional shape of a tetrahedron.

![3-d-representation of the model of textbook use](image)

This model includes another major dichotomy of the textbook, namely the dichotomy with regard to the nature of the knowledge represented in textbooks. But this time it appears at one of the vertices. This conforms with Engeström (1999b) who describes dichotomies to be characteristic for all vertices of the activity model.

With regard to the two major subjects that are using textbooks – the teacher and the student – Fig. 5 in fact represents a more comprehensive model of textbook use. The tetrahedron represents the use of textbooks in class. Each of the triangular faces of the tetrahedron reveals another aspect of textbook use.

1. student – teacher – textbook

   The student is the acting subject in this triangle and the textbook is the object of his activity. The teacher mediates the use of the textbook.

2. student – textbook – mathematical knowledge

   The student in this triangle uses the textbook on his own initiative without mediation by the teacher. The object of his activity is mathematical knowledge in general. The textbook is regarded as the instrument to access the mathematical knowledge. It mediates between the mathematical knowledge and the student.

3. teacher – textbook – mathematical knowledge (didactical aspects)

   This triangle describes the teacher’s use of the textbook. While the teacher acts as a mediator of textbook use in the whole activity system he is the subject of
the activity in this subsystem. The object of his activity are the didactical aspects of the knowledge represented in the textbook.

(4) student – teacher – mathematical knowledge

The traditional didactical triangle or as Chevallard calls it ‘the didactical system in the narrow sense’ (cf Chevallard, 1991), that also appears in the tetrahedron-model of textbook use does not even include the textbook, but still must be considered as a subsystem of the activity ‘textbook use’. It can be seen as the complement of triangle (3). The teacher implements the knowledge that is represented in the textbook without using the textbook overtly in the lesson. He acts as a mediator of the knowledge. Several studies substantiate this way of using textbooks (cf Hopf, 1980; Stodolsky, 1989; Valverde et al., 2002; Woodward & Elliott, 1990).

CONCLUSION

Two conclusions of the preceding section may be drawn. On the one hand it was shown, that activity theory can be applied to create a suitable model for the activity ‘textbook use’. The suggested model includes all the major aspects of textbook use with regard to the two primary users. But as presented above it just focuses on the nucleus of the activity system, i.e. the triad subject – mediating artefact – object. This must be integrated into the whole activity system (cf Engeström, 1999b). Furthermore, the fundamental dichotomies in connection with the textbook need to be incorporated.

On the other hand the triad ‘subject – mediating artefact – object’ turned out to be unsatisfactory to describe the activity ‘textbook use’ entirely. This was due to the fact, that the use of the artefact itself was mediated by another subject. In addition, this mediating subject plays a double role, because it is not merely a mediator, but also a user of the artefact. This lead to an extension of the nucleus of the activity system at best modelled and represented as a tetrahedron. This modification is accompanied by a change of the focus of the nucleus of the activity system. Originally, the main focus of the triangular nucleus of the activity system is the subject (cf Engeström et al., 1999). Likewise, the tetrahedron was created coming from the subject. But the final model is not a description of the use of the artefact by merely one subject, it rather represents the use of an artefact by two subjects. Consequently the tetrahedron-model can be interpreted as the activity that surrounds a particular artefact. In this way the artefact is put in the centre of the activity system. Put differently, an activity-theoretical model of an activity that is linked to a particular artefact automatically situates the artefact in the centre of the activity system. If activity theory is intended “to be a pathbreaker in studies that help humans gain control over their own artefacts” (Engeström, 1999a) this might be a new worthwhile perspective. Further implications for activity theory of this change of focus need to be discussed.
References


