Chapter 3

Clinical Interviews Embedded in the “Philosophy of Teaching Units”— A Means of Developing Teachers’ Attitudes and Skills

Those who like practice without theory are like seamen sailing without steering wheel and compass and never being sure where the voyage goes. Practice must always rest on good theory.
Leonardo da Vinci

Within the field of mathematics education there is at present a clearly increased interest in methodological issues. This fact cannot be explained only by internal motives but is also a reaction to pressures coming from well-established disciplines, which question the academic status of mathematics education, as well as from teachers' associations, which question the utility of mathematics education for practice. It is the relationship between theory and practice that lies at the very heart of the problem, and it is to be expected that first and foremost the elaboration of effective ways to relate theory and practice to each other will help to define the specific status of mathematics education, to prove its necessity, and thus to stabilize it, both internally and externally.

The theory-practice relationship is a problem that appears in more or less all applied fields of knowledge. So mathematics education can learn from the experiences of more advanced disciplines that support the following facts:

- (1) The delineation of theory from practice is a natural and necessary step of development in any applied field and, in principle, opens the way to a more effective practice.
- (2) The relationship between theory and practice cannot be fixed once and for all but must be continuously re-thought throughout the progressive development of the discipline in question.
- (3) Tensions between theory and practice are not bad as such, but can be used for mutual criticism and thus as a source of progress.

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- (4) There is always the tendency that theories will fix their own ends and develop independently of practice. This is no danger as long as they are related to a *significant core* which itself is related to practice in a vital way. If, however, theories develop in complete isolation from practice, they are bound to become useless and to degenerate.

At the present stage of mathematics education, the creation of such a *significant core* must be the primordial aim. I agree completely with the view expressed by Alan Bell (1985, 109):

One might ask the general question whether, in the present state of knowledge about mathematical education, we should progress faster by collecting “hard” data on small questions, or “soft” data on major questions. It seems to me that only results related to fairly important practitioner questions are likely to become part of an intelligible scheme of knowledge. The developing theory of mathematical learning and teaching must be a refinement, an extension and a deepening of practitioner knowledge, not a separate growth. Specific results unrelated to major themes do not become part of communal knowledge. On the other hand “soft” results on major themes if they seem interesting and provocative to practitioners, get tested in the myriad of tiny experiments which teachers perform every day when they “try something and see if it works.”

The present paper is based on an approach that tries to bridge the gap between theory and practice by means of teaching units (Wittmann 1984). While this approach is addressed to didactics as a whole, the perspective taken in this paper is that of pre-service teacher education. In the first part of the paper, John Dewey’s position on the relationship between theory and practice is reviewed. The second and essential part will show how clinical interviews can be used to develop teachers’ attitudes and skills within the “philosophy of teaching units.” The paper is based on the booklet Wittmann (1982), which is a kind of reflection on the sabbatical leave spent by the author in Switzerland in 1974 where he had a chance to collaborate with Jean Piaget on the clarification of the concept of “grouping” (Wittmann 1978).

1 Cooperation Between Theory and Practice Through “Intermediate Practice”

From the viewpoint of the practitioner, the theory-practice interaction can be described by the scheme in Fig. 1 that is adapted from the well-known theory-practice loop in science. It reads as follows:

Within his or her daily practice the teacher is continuously confronted with (more or less open) teaching situations. In order to manage a given situation he or she uses his or her theoretical repertoire, his or her experience and various means for developing a model which indicates what to look for, what to do, what to expect, and which also explains his or her observations, decisions and prognoses. The model is a model “in the making,” that is, it is being revised during the teaching process as indicated by the arrows.

Fig. 1 The theory-practice loop of teaching

In the long run, experience with teaching models will lead to strengthening, weakening, modifying and revising the theoretical repertoire. So this repertoire itself is undergoing continuous development. By its very nature it may be called a *subjective theory* (or perhaps better, a collection of subjective theories) of the teacher. It must be distinguished from the theories of teaching developed within the discipline of mathematics education.

Using Karl Popper’s conception of the three worlds (Popper 1972), it can be stated: The teachers’ field of activity belongs to world 1, his subjective theory of teaching to world 2, whereas didactical theories of learning and teaching are part of world 3.

The central issue of teacher education is addressed by the following question: What is the best way to build up an effective theoretical repertoire for teaching?

One answer that has been given for centuries and is shared by the vast majority of practitioners even today is the *apprenticeship-conception of teacher education* (cf. Egsgard 1978): Suppose the prospective teacher knows his or her subject matter. Then the necessary theoretical tools evolve best through practice itself under the guidance of experienced teachers.

In a second view, the *scientific conception of teacher education*, which is held by most mathematics educators, the best professional preparation of teachers is seen in a study of mathematical, educational and didactical theories accompanied or followed up by practical work.

The two positions can only be evaluated and compared by referring to basic normative assumptions on mathematics teaching. The author of the present paper is in favor of a “genetic” perspective which can be characterized as follows:

- (1) Mathematics is not just a collection of concepts, procedures and structures, but a living organism whose growth is stimulated by continuous attempts to solve big and small problems inside and outside of mathematics.

- (2) Knowledge cannot be simply transmitted from the teacher to the learner, but must be developed (“constructed”) through the learner’s own activity.
- (3) Social interaction is an essential component of learning and development.

Although the origins of the genetic view reach far back in history, this view has only received conscious attention since the beginning of the 20th century. Interestingly, a fundamental paper by John Dewey also elaborated on the relationship between theory and practice from this point of view at that early time (Dewey 1904/1977).

Dewey sees the essential task of a teacher in “directing the mental movement of students” and stimulating the “interaction of mind” (Dewey 1904/1977, 254):

As every teacher knows, children have an inner and outer attention. The inner attention is the giving of the mind without reserve or qualification to the subject in hand. It is the first-hand and personal play of mental powers. As such it is a fundamental condition of mental growth. To be able to keep track of this mental play, to recognize the signs of its presence or absence, to know how it is initiated and maintained, how to test it by results attained, and to test apparent results by it, is the supreme mark and criterion of a teacher. It means insight into soul-action, ability to discriminate the genuine from the sham, and capacity to further one and discourage the other.

Dewey rejects the assumption held by the proponents of the apprenticeship-type of teacher education that the attitudes and skills of a good teacher can be acquired best through practice. On the contrary, he even considers premature practice as detrimental, because it puts the attention of the student teacher in the wrong place, and tends to fix it in the wrong direction, namely towards controlling the external attention of children, towards keeping them fixed upon his or her own questions, suggestions, instructions and remarks and upon their “lessons.”

According to Dewey, a reasonable practical training of student teachers is only possible (Dewey 1904/1977, 256)

... where the would-be teacher has become fairly saturated with his subject matter, and with his psychological and ethical philosophy of education. Only when such things have become incorporated in mental habit, have become part of the working tendencies of observation, insight, and reflection, will these principles work automatically, unconsciously, and hence promptly and effectively. And this means that practical work should be pursued primarily with reference to its reaction upon the professional pupil in making him a thoughtful and alert student of education, rather than to help him get immediate proficiency.

Dewey’s approach, which he calls the “*laboratory point of view*,” consists in forming the prospective teacher through “vital theoretical instruction.” Of course Dewey is far from understanding “vital theoretical instruction” as a transmission of mathematical, educational or didactical theories. His position is characterized by a very subtle analysis of what academic disciplines might contribute to a teacher’s subjective theory of teaching. What is important to him, as far as the subjects are concerned, is not the bulk of ready-made structures but the processes of thinking inherent in subject matter (Dewey 1904/1977, 263–264):

There is therefore, method in subject matter itself – method indeed of the highest order which the human mind has yet evolved, scientific method. It cannot be too strongly emphasized that

this scientific method is the method of mind itself ... [It] reflect[s] the attitudes and workings of mind in its endeavor to bring raw material of experience to a point where it at once satisfies and stimulates the needs of active thought. Such being the case, there is something wrong in the “academic” side of professional training, if by means of it the student does not constantly get object-lessons of the finest type in the kind of mental activity which characterizes mental growth and, hence, educative process.

It is necessary to recognize the importance for the teacher’s equipment of his own habituation to superior types of method of mental operation. The more a teacher in the future is likely to have to do with elementary teaching, the more, rather than the less, necessary is such exercise. Otherwise, the current traditions of elementary work with their tendency to talk and write down to the supposed intellectual level of children will be likely to continue. Only a teacher thoroughly trained in the higher levels of intellectual method and who thus has constantly in his own mind a sense of what adequate and genuine intellectual activity means, will be likely, indeed, not in mere word, to respect the mental integrity and force of children.

As far as teacher education is concerned, Dewey arrives at a surprising conclusion (Dewey 1904/1977, 260, 262):

What the student [teacher] needs most at this stage of growth is ability to see what is going on in the minds of a group of persons who are in intellectual contact with one another. He needs to learn to observe psychologically – a very different thing from simply observing how a teacher gets “good results” in presenting any particular subject ... It is not too much to say that the most important thing for the teacher to consider, as regards his present relations to his pupils, is the attitudes and habits which his own modes of being, saying, and doing are fostering or discouraging in them. Now ... I think it will follow as a matter of course that only by beginning with the values and laws contained in the [student teacher’s] own experience of his mental growth, and by proceeding gradually to facts connected with other persons of whom he can know little, and by proceeding still more gradually to the attempt actually to influence the mental operations of others, can educational theory be made most effective.

Dewey’s position can be summarized with respect to mathematics teaching as follows: The main task of a teacher is to stimulate and to develop the mental activity and interaction of his or her pupils. The best way for a student teacher to acquire the necessary competence is to become familiar with mathematical thinking, to reflect upon these mathematical activities, to observe and analyze his or her own learning, in interaction with other student teachers, and to study the development of mathematical thinking in children and groups of children.

This kind of *doing mathematics* and *doing psychology* reflects the essential aspects of learning and teaching mathematics in the classroom. So it represents some sort of practice, which can be denoted as “*intermediate practice*.” The author of the present paper considers this kind of theory-based practice as the key to relating theory and practice in teacher education to each other.

From what has been said before it should go without saying that theoretical studies of mathematics, psychology and education in the sense of intermediate practice require an interdisciplinary approach and a re-organization of teacher education. This approach provides a real chance for mathematics education to fill a prominent place in teacher education programs.

2 Clinical Interviews as a Special Kind of Intermediate Practice

The importance of intermediate practice for prospective teachers would be greatly enhanced if doing mathematics and doing psychology could be linked to the school curriculum without, however, trivializing or distorting the requirements mentioned before. Wittmann (1984) suggested centering didactical research and development as well as teacher education around groups of teaching units which are sufficiently rich in order to allow for mathematical and psychological activities in the sense of intermediate practice and which are representative of the curriculum. This idea is not new. For example, it is developed to some extent in Fletcher (1965). Additional examples of this “philosophy of teaching units” for the primary level are provided by Müller and Wittmann (1984), Wittmann (1982). Clinical interviews fit in here in a quite natural way as will be shown in this section.

The clinical method and other protocol methods have been enjoying increased popularity as a research instrument among researchers in mathematics education (cf., for example, Easley 1977; Ginsburg 1983). Bergeron and Herscovics (1980) have also suggested using clinical interviews in teacher education.

At the university of Dortmund we started a “Development of Mathematical Thinking” course as part of our teacher education programs in 1975. In the first years this course was more or less an introduction into Piagetian psychology. Clinical interviews played an important but nevertheless subordinate role in the course. They were just used to illustrate Piaget’s theory. In this period the few interviews conducted by student teachers were just replications of experiments of the Genevan school.

Over the years the course has been revised considerably in several respects. As the pitfalls, inconsistencies and flaws of Piaget’s stage theory became more and more apparent (cf., for example, Brown and Desforges 1979; Groen and Kieran 1983) Piaget’s theory was pushed to the background in favor of his research method, the clinical interview.

As the time available for the course didn’t allow for a lengthy introduction into psychological theories anyway, we decided to concentrate the psychological-didactical training of our students on “*doing psychology*” in analogy to the emphasis we had put on “*doing mathematics*” within our mathematical courses. It seemed to us that clinical interviews are the easiest way of doing psychology.

Consequently, the course was split up into two parts:

- (1) An introduction into basic ideas of Piaget’s genetic epistemology and into the clinical method,
- (2) Clinical interviews with kindergarten or primary children conducted by the student teachers themselves.

The second part turned out to be extremely motivating for student teachers. It demonstrated that clinical interviews are a very valuable instrument for developing attitudes and skills of good teaching far beyond the psychological insights they may provide. Virtues of good teachers are: introducing children into a situation, making

them feel comfortable, following their work and observing them without interrupting them, showing interest, listening carefully, accepting the children's thinking, avoiding criticism or authoritarian evaluation of the children's ideas, stimulating their thinking by cautiously arousing cognitive conflicts or by pointing to facts and statements that seem to have been overlooked, etc. (Wittmann 1982, preface).

A third modification of the course concerned the contents of the interviews. As already mentioned before, we started by replicating Genevan studies. However, the themes of these studies are far from the mathematics curriculum, in particular with respect to mathematical processes. So we replaced them more and more with themes taken from teaching units. The following examples are described through the suggestions and questions that "define" the interviews.

(1) Even and Odd Numbers

Questions:

- Can you tell me an even and an odd number? Is 5 even or odd? Is 10 even or odd? Why?
- Given a set of counters: How can you find out if the number of these counters is even or odd?
- The child is told the parity of each of two given sets of counters, each set with more than 10 counters, but the exact numbers are not given. The child is then asked to predict if the union of the two sets will be even or odd and to justify his or her answer.

(2) The Robbers and the Treasure

Fig. 2 Plan for playing "The robbers and the treasure"

The children are told a story (Müller and Wittmann 1984, 42): Two robbers are wrestling for a treasure. After some time there is no winner and they are exhausted. So they agree to resolve the quarrel by playing a game: They number a set of stones between their caves with numbers from 1 to 20 (Fig. 2). The treasure is put on field 10. Now they take turns throwing the die. According to the results, the treasure is moved towards the corresponding *cave*. As soon as the treasure enters a cave the owner of the cave wins it.

Suggestions and questions:

- Play the game with your partner.
- Suppose the treasure is on number 11: Where might it be after each of the two robbers has thrown the die just once?
- Where will the treasure be if the “plus robber” throws a “5” and the “minus robber” a “4?”

(3) Only Nine Digits

The child is provided with digit cards for the numbers 1, 2, 3, 4, 5, 6, 7, 8, 9.

Suggestions and questions:

- Form two 3-digit numbers such that their sum is as big as possible.
- Why do you think your sum the maximum?
- Can you find other solutions?
- How can you make the sum as small as possible?

(4) A Word Problem

- In a class of 29 children there are three more girls than boys. How many girls and boys are there?

(5) The Ice Cream Problem

Suggestions and questions:

An ice cream seller offers four kinds of ice cream: chocolate, lemon, raspberry, pistachio. He sells cones with three scoops.

- How many different cones are possible?

(6) Northcott’s Nim

In this game of strategy, pairs of children are asked to play the game and to find out how to play as cleverly as possible (Wittmann 1982, 16–23).

In part, the themes for clinical interviews were inspired by theoretical considerations. We wanted to know how children of different ages would react to a given problem in order to use that knowledge for teaching. In many cases, however, the inspiration came from observing classes. One sees an interesting teaching episode, but the class moves on too quickly to the next activities. One wants to learn more about it and to understand the children’s thinking in more detail. For example, theme (3) was inspired by a lesson given by a primary teacher to third-graders.

For each year we have developed new sets of themes and offered them to pairs of student teachers for investigation. As a rule each pair selects a theme according to its taste and goes to a kindergarten or primary school, explains the tasks to the teachers

and asks for collaboration. Supported by the teachers, the interviews are conducted with some 15 children, then transcribed and analyzed. Finally a report is written, presented and discussed in the seminar.

Some of the student teachers extend their clinical study into a thesis as part of their final examination. To give an example: One student teacher is presently working on theme (2) in cooperation with two schools. The teachers of grade 1 have identified children who have difficulties in adding and subtracting numbers. The student teacher uses the game both as a diagnostic and a remedial instrument. An interesting theoretical question here is the transition from material-based to mental calculations. At the same time, the study will provide information about the use of the game as a context for practicing computational skills. This kind of cooperation with schools looks quite promising.

Our experiences with the course in its new format are positive in two respects. First, the course fully serves its purpose as a framework for intensive intermediate practice. Clinical interviews with individual children or small groups of children in kindergarten or primary school represent a protected atmosphere where student teachers can concentrate on “intellectual contact,” “interaction of mind” and “mental movement,” to use Dewey’s terms. The student teachers are also stimulated to reflect on their own behavior and its influence on children. With some student teachers this results in quite a dramatic change of awareness. Later in their practical phase of teacher education (which in Germany follows university education and lasts two years), student teachers who reflect on their university studies retrospectively rate the relevance of the course very highly. The course ranks far ahead of all other courses. In particular, the student teachers appreciate the close connection to actual teaching practice.

Our second experience is that the skills of student teachers in conducting clinical interviews are a very good indicator of their skills in teaching a class. This is not surprising. As has already been mentioned before, the attitudes and skills of good teaching coincide with good attitudes and skills in conducting clinical interviews. So the course is very useful with respect to the personal development of student teachers as prospective teachers.

3 Concluding Remarks

Mathematics educators, who are in favor of major themes, basic ideas, and great lines of mathematics education, might find the occupation with teaching units as suggested in this paper to be conceptually poor, not controlled enough, not “research-oriented,” and perhaps naive. However, there are substantial arguments in favor of the “philosophy of teaching units” as a basis for the discipline of mathematics education.

1. Teaching units are a natural way to provide teachers and student teachers with a holistic view of mathematical, psychological, pedagogical, and practical aspects of mathematics teaching. This view is a specific mark of mathematics education.

2. Teaching units must not be seen in isolation, but rather in their relationship with objectives, contents and principles of mathematics teaching which they fill with meaning. Themes (2) and (3) of Sect. 2 are examples of a new approach to practicing skills (cf., for example, Winter 1984; Wittmann 1984). Themes (1) and (6) are typical for studying and developing mathematical processes (cf. Bell 1979). Theme (5) belongs to a class of units that are important for the development of combinatorial thinking, and theme (4) fits into the research on word problems. All themes could also be used to study social interaction in the classroom.

3. For bridging the gap between theory and practice it is necessary to have realistic empirical tests of theoretical ideas. It is only natural to use teaching units for infusing theoretical ideas with “meaning.” Clinical interviews attached to teaching units offer excellent opportunities for intermediate practice and thus for shaping effective subjective theories of teaching (see Sect. 1).

4. The ability to do mathematics and to do psychology seems to be an essential prerequisite for making use of didactical theory in an intelligent way. Almost everything depends on self-reliant teachers equipped with heuristic strategies for selecting, modifying, rearranging, specializing, transferring, supplementing, and making practical what is offered to them. In order to be able to apply results of research in effective ways, teachers must to some extent be able to do research themselves. Preparing and conducting clinical interviews on fresh themes seems to be a good introduction.

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