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Enjoying teaching
A Handbook of Practice - Oriented Teacher Education

By

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This handbook was reviewed by two educational experts under the supervision of Dr Tayseer Al Nahar and Dr. Hans-Peter Otto

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Contents

Preface

The present volume represents one part of the project "Improving Teacher Education at Jordanian Universities". The authors who contributed to this book come from different countries – Jordan, England, and Germany – each of them with practical experience of their own in schools in their own countries and/or experience in comparative studies in other places. Furthermore, all of them are or have been involved in teacher training. The authors from England and Germany frequently visited schools in Jordan and exchanged views with their Jordanian colleagues.

Direction in selecting contributions for the book was given by the Ministry of Education, which has set down goals for school reform in the Education Reform Program (ERP). Among the goals they state are "teaching children to be flexible and critical thinkers," "group work and communication skills," "discovery learning," "activity-oriented and student-oriented teaching methods," and "the ability to make decisions through self-organization of learning processes."

We know, of course, that not all the problems of practice-oriented teacher training can be addressed in this manual, but we still hope to present the reader with some stimulating ideas and, hence, to fulfil the main purpose of the project.

The chapter "Professional Qualifications of Teachers" by *Horst Hörner* is based on the results of an analysis of the professional teaching field. He presents a survey of the wide range of qualifications which teachers must have in order to competently handle all of the tasks he/she will be confronted with. Here we consider *what* makes a qualified teacher and what abilities and skills need to be learned for this profession. The question of how these qualifications can be conveyed during teacher training is dealt with in the following selected contributions.

Imfadi Abu-Hola and *Ibrahim AL-Momani* discuss in their contribution "Lesson Planning" the advantages and relevant aspects of lesson planning, giving suggestions for defining learning goals and presenting model examples of lesson plans.

In his chapter "Lesson Evaluation" *Horst Hörner* presents a structural model for conducting lessons as well as an evaluation form for the qualitative assessment of teaching behavior.

The chapter "Action Research/Classroom Research" by *Qaseem M. Alshannag* illustrates how action research/classroom research bridges the gap between theory and practice and improves the qualifications of students in teacher training.

Alan C. Mclean compares three different models of teacher training in his chapter "Action Research." The advantages of the "Teacher Development Models" are clearly elaborated. To what degree action research can be effectively implemented in teacher training, i.e., already in students, is shown is the second part of the chapter.

The different social forms of teaching and learning with respect to various forms of interaction and didactics in the learning process are described and discussed in "Social Forms of Learning – Interaction and Function" by *Horst Hörner*.

Finally, *Horst Hörner* discusses the teaching of creativity in the chapter "Teaching Creativity and Encouraging Creativity in School" from an anthropological point of view. Selected teaching examples and topic suggestions exemplify how the creative process can be initiated in the classroom.

Mathematics are the same all over the world. Using themes from mathematics, the didactics and methodology of this subject can be clearly elucidated. *Albrecht Abele* has done just this in his chapter using the phenomenon of problem solving. Creative readers will be able to apply this arrangement of problem situations to other subjects as well.

Constructing test problems and evaluating the results is the focus of the chapter by *Achmad Qudah*. He demonstrates this using a practice-oriented approach and provides analysis criteria for qualitative evaluation using quantitative data (curves).

In his contribution "The Impact of Computer Technology on Mathematics Education" *Joachim Engel* shows how the computer can be used effectively in mathematics lessons.

A large part of the discussion in this manual has been devoted to supervision. The results of a survey conducted in Spring 1999 among Jordanian students demonstrate the importance of this theme. The students who participated in the survey cited various problems which mainly pertained to the supervision.

The chapter by *Eberhard Jeuthe* is devoted to the psychological aspects of communication during supervision and outlines possibilities for developing a real dialog between the supervisor and the person being trained.

As the title "The Roles of Practice Teaching Educators" indicates, *Husean Abu Serdaneh*'s chapter describes the groups of individuals

involved in practice-oriented teacher training and allocates specific tasks to each group according to its function.

The teaching profession is a very interesting one. In dealing with young people a teacher is always being asked new questions and faced with new tasks. It requires the highest measure of sensitivity to the students whose education we have been entrusted with, to their needs, their problems, and their questions. Anyone who is interested in people will thoroughly enjoy this profession and will be surprised over and over again by how young people think about things. A person who enters this profession won't only give, but also receive.

Clearly, a certain kind of professional sophistication is needed. Then teaching can really be a joy, not only for the teacher but also for the students.

It doesn't happen very often that a team of authors in this combination writes a book. We are grateful to all the authors for their willingness to contribute to the project. Without the active negotiation work of Ms. *Asmaa Jarrar* and Mr. *Burghard Kehr* of the GTZ office in Amman and the advice of Mr. *Hubert Hartman* in the central office of the GTZ in Eschborn, Germany, this book never would have come to be. Thanks also go to *Sherryl Sundell* for the language editing of the chapters and to Ms. *Doris Schmitt* for her work in formatting the texts.

Horst Hörner

Professional Qualifications of Teachers

Practice-oriented teacher training must revolve around the professional field of teaching. Thus, to determine the abilities and skills which mark teachers as professionals, it is necessary to analyze the profession itself. This is the task we would like to undertake in this chapter, whereby we will restrict our discussion to general didactic or pedagogic competence. The didactics and science of specific subject areas are deliberately being left out as they will be dealt with in other chapters of the book, though not explicitly and in another context.

That which is required of a teacher in everyday school life is varied. Teaching, educating, and cultivating: The actual job involves working with others, for others, and in the service of others. The teaching profession is a social profession, i.e., it is always people-related, specifically speaking, it is related to students, who need their own room for maneuvering and making decisions and who cannot be treated as objects. Whether education, teaching, and school are successful doesn't only depend on the teacher, but largely also on whether a young person wants to be taught and educated or whether he wants to evade or even resist a teacher's teaching efforts. No matter how well a teacher is prepared, if the students do not accept him/her – for whatever reasons – his/her work will not be effective.

Teacher and student are fatefully bound up with one another. In reality, education is a field whose dynamic structure is determined both by external forces (school organization, curriculum, building architecture, etc.) and by the people who are working in it. The structure and quality of this field will vary from case to case and class to class. A person's behavior (B) is always a function (F) of the situation (S), $B = F(S)$, whereby S can be more closely defined than the society in which one lives or one's own environment. That a field changes from time to time is determined by its dynamic structure. Teaching is a very complicated field of social relations, and a great variety of factors affect it. Because of the complexity of the multidimensional factors of the field, it tends to be labile in the face of even the most minor disturbances. Any changes at one point of the field affect the character of the field as a whole. It would be convenient for many teachers – though perhaps not always desirable – if the structure of

the dynamic field was basically stationary, i.e., showing (pedagogically justified) regulation of the relationships between the individuals in the field, a permanence to the change in dynamic processes, comparable to the planets, which always circle in the same orbit. In reality, however, if the essential structure of the relationship is destroyed, the field collapses. New field structures develop which may differ structurally but also – teleologically speaking – qualitatively from the original ones. If this happens one does not know what is going to happen in the next moment.

For education to be successful, the teacher must know the field. He/she must be able to theoretically analyze and reflect upon the individual structures and mutual dependence of the given educational situation. This is not easy because the teacher himself is a decisive dynamic factor. To gain an objective and phenomological view of the situation, a teacher would have to leave the field and take the position of a neutral observer. Obviously, this is impossible during a lesson. However, it is possible to intensively and repeatedly observe and study the educational field by recording lessons with a videocamera or when a supervisor is present and takes notes, if only post festum. All over the world, education research relies on such documentation, i.e., mainly videotaped recordings of lessons being taught.

This has implications for teacher training and further education. At teacher training institutions television studios should be set up where teachers and students can be filmed while teaching. This gives trainees the the chance to observe and analyze the educational field on video and, above all, to observe themselves at work. It also provides material for supervisor consultation, if necessary. Furthermore, students can observe and analyze their own behavior in the educational field with some distance over and over. It is not a seldom occurrence that alternative solutions are developed from such analyses; this can impart new knowledge and also contribute to optimizing instruction.

In most countries teachers are government employees, often also civil servants, and as such are subject to the directives of the state administration. To what degree a teacher is able to achieve professional status as a government employee or work professionally is an issue which must at least be addressed here. If a teacher's autonomy is fundamentally restricted by the state and if he/she is merely an executor of administrative regulations, then we can't speak of professional autonomy anymore[1].

By virtue of his/her position, a teacher "plays" in two fields – his actual field of work and in the field of the school supervisory board, which in-

cludes the supervisors themselves, the laws, edicts, and administrative and organizational structures. How professionally a teacher can work will depend on how compatible the two field structures are.

The characterization of actual teaching as a field is necessary in considering teacher professionalism, since the teacher is only one of the players in the field, and the reactions of the students to his/her actions are not always predictable. Therefore, a teacher must try to anticipate possible reactions of the students and to orient his/her behavior on the patterns and learning activities of the students. This assumes a high degree of sensitivity to group dynamics and differentiated knowledge of the field structure.

The entire field of educational reality is always implicit to the discussion of the professional abilities and skills of a teacher, i.e., potential reactions on the part of students are, insofar as necessary, hypothetically considered, if not predictable.

Professional qualification is required of teachers, above all, in the following areas of activity and knowledge[2]:

I. Teaching

II. Knowledge of learning processes

III. Lesson planning

IV. Teaching evaluation

V. Performance evaluation

VI. Curriculum development

VII. Behavioral and organizational problems and areas of conflict in school

VIII. Guidance counselling for students and parents

IX. Knowledge about the school system and education politics

Each of the major areas can be broken down into partial problem areas and into a multitude of issues with which teachers may be faced. This breakdown represents a catalog of tasks and problems which, in turn, forms the basis for developing a differentiated curriculum for practice-oriented teacher training.

I. Teaching

1) Learning theory and motivational psychology are taken into account when introducing a new topic

Introducing the lesson, setting the stage. Knowledge of learning theory and the didactic implications for the course of the lesson: classical conditioning, operant learning, imitative learning, cognitive learning, learning by discovery. Being capable of choosing the respective learning theory for the topic in question. Knowledge of determining factors of learning motivation: extrinsic and intrinsic motivation variables and their relevance for the students' stage of development. Knowledge of the problems of manipulation through extrinsic motivating.

2) The criteria for choosing social forms of learning

Knowledge of the various social forms of learning: Working individually, working with a partner, working in groups, class discussion, classroom teaching. Applying the social form appropriate for the given task. Advantages and disadvantages of working individually in class. Principles of choosing partners, various roles of the partners.
Possibilities of forming a group, group leader, group pressure, forms of group teaching – dividing the work up/everyone does the same thing, creativity and the group.
Role of the teacher in a class discussion, leading a discussion, occasions for a discussion.

3) Initiating and supervising independent phases of learning by the the teacher

Advantages of independent learning. Forms of independent learning, e.g., learning by discovery. Possibilities of differentiation through independent learning as regards time, methods, degree of difficulty (mastery learning). Role of the teacher in independent learning. Providing various materials for independent learning which present a challenge to the students. Teaching techniques which encourage independent learning (how to use reference books, interview technique, evaluating tables and statstics, learning to use scientific apparatus and equipment, writing speeches and reports).

4) Providing appropriate, topic-related learning aids which do not restrict learning

Knowing how to guide lessons: direct and indirect measures. Guidance measures: clues, calling on students, suggestions, further inquiry, play back. Forms of questioning: simple question, open question, presenting a problem.

5) Function of learning and work materials

Didactic function of learning and work materials. Media to trigger learning processes, media as learning aids, media for testing.
Teacher and students construct media and work materials together. Developing games: quizzes, card games for practice and testing. Preparing slides or videotapes on selected themes such as "our town," "our school," or "our village." Organization of a photographic documentary and photo exhibition and writing a report or commentary.

6) Arranging problem-oriented learning situations and problem-solving strategies

Defining problems from the perspective of gestalt psychology. What are students interested in; what do they want to know? Strategies for determining the problems and questions students have.
Methods of discovering and identifying problems, for example, in activity-oriented lessons, on excursions or field trips.
Problem-solving strategies, through trial and error, restructuring, new definition, divergent thinking. Knowing the psychological phases of problem solving: preparation, incubation, intuition, and verification.

7) Optimizing information phases

Dosing information. Clarity and design of information units. Channels of perception (optic, acoustic, tactile, olfactorial perception) and information processing. Practicing the individual means of communication: one-way communication, pseudo-two-way communication, genuine two-way communication. Knowing common kinds of disturbances in the communication process (time, system of reference, definition of terms). Symmetric and asymmetric communication.

8) Designing practice phases

Knowing methods for training abilities and skills in the various subjects: physical education, language, foreign language, mathematics, or science. Developing practice excercises in learning, comprehension, and application. Using computer software and hardware for practice purposes: learning materials, computer software. Practicing in suitable social forms. Developing materials for practice purposes, learning games.

9) Organizing discussion groups and initiating discussions and conversations

Setting the stage for class discussion: Stimulation, food for thought, provocative question. Organizing debate groups: What is discussing, debating, active listening?

Summarizing: how is that done? Role of the teacher in a class discussion. Helplessness while speaking – the search for the right words – as a fruitful moment in the learning process. Knowing the connection between speaking and thinking.

II. Learning

1) How socialization at school and outside of school influences the learning process

Definition of terms, function and goal of socialization, enculturation and education. Basic personality structure, modal personality structure. Role and socialization. Learning norms and values. Primary socialization, secondary socialization. Agencies of socialization in society: religion, print media, television, and many more. Norm conflicts, value conflicts.

2) The significance of different mental processes on successful learning

What is reproducing, restructuring, transfer, interpretation and analysis? What is problem solving, convergent thinking, divergent thinking? What is comprehension? What is the difference between learning and thinking?

3) Connection between learning development and interest development

How do interests develop? Interests and what is offered in school. The development of interests in the course of human development. Study methods for assessing interest.

4) Independent learning and conditions for it

Knowing the forms of independent learning. Knowing the advantages of independent learning with regard to goals, methods, time. Pedagogic justification for independent learning. Examples of independent learning: activity-oriented lessons, projects, free working, circuit training.

5) The significance of anticipation for the learning process

What is anticipation? Underlying rationale of anticipation in terms of learning theory and motivational psychology. Knowing the conditions for the construction of an anticipation scheme. Knowing the connection between anticipation of the learning goal an the different stages of the learning process. What are the implications for organization of the learning processes?

6) Methodology consciousness and successful learning

Trial and error – learning by experience. What significance does knowing how something is being learned have on comprehension for students? Operations as internalization of actions. The significance of algorithms, formulas, and rules. What is objectivity, intersubjective verification? What function do the methods have in gaining objective knowledge? Outline how the development of new methods can lead to new understanding.

7) Causes of failure despite high learning activity of the students

Diagnostic possibilities for determining concentration weakness and its causes. The connection between emotional state and failure in school. Fear of school and failure in school.
Students' personal learning history and socialization in school, Pygmalion in the class, self-fulfilling prophecy.

8) Diagnosing learning disorders

Intelligence tests, dyslexia tests. Projective procedures in the diagnosis of psychological, social, family problems. Knowing reasons for learning disorders and failure in school which are related to school or to factors outside of school: socialization deficit. Somatic reasons, psychological causes in the student. School causes: too much performance pressure, discrimination, mobbing.

9) Teaching materials in the learning process

Being familiar with different kinds of teaching materials and understanding their function. What do we mean by "challenging teaching materials?" Ability to design materials for specific subjects, themes, and social forms of learning.

III. Lesson Planning

1) Lesson plan models

Being familiar with various planning models. How should free work be planned, projects, circuit training, programmed teaching? How can students be involved in planning?

2) Didactic analysis and objective analysis[3]

For which problems and problem areas is the planned topic exemplary? What previous experience do the students have with the topic? What significance does the topic have for the lives of the students? What significance might the topic have for

the students later in life? How is the content of the topic structured? What logical factual or functional connections should be discussed? Can the topic be approached from more than one perspective? How can the students be motivated for the topic and how can their curiosity be aroused? What approaches could be tried out? How can the topic be illustrated?

3) Choice of didactic variables in planning a lesson[4]

What goals should be achieved? How will the goals be presented? In which social form should the students work? Which activities are necessary to achieve the goals? Which learning aids should be made available?

4) Economical lesson planning and available concepts of planning

What planning aids are available? Lesson plan forms and structures of a lesson as the basis for lesson planning. What are the minimal requirements for lesson planning aids?

5) Construction of learning goals

How are learning goals constructed? How are aim, general goal, and specific goal related? The taxonomy of learning goals and its significance for constructing learning goals. Knowing the various learning goal taxonomies. What does "exemplary approach" in constructing learning goals mean? What is the significance of key qualifications in developing learning goals and to what extent can they be taken into consideration?

6) Structuring the lesson into learning phases

Can or should the lesson be subdivided into phases (solution situations)? Ability to subdivide the lesson logically and systematically with respect to the subject, based on learning theories. Knowing what is necessary to create an individual solution situation.

7) Methods and diagnosis of the prerequisites for student learning

What previous experience have the students had regarding the topic? Which abilities and skills are required to achieve the learning goal – which of these do the students already have? Which abilities and skills need to be developed or improved during the course of learning?

8) Function of written lesson preparation

To what extent does planning help structure the lesson? To what extent can a written lesson plan serve as a basis for an alternative plan?

9) When can/should/must a teacher deviate from the lesson plan?

An attitude of questioning should be developed and encouraged in the students. Whenever students' questions are taken into consideration or become learning goals, the students will identify themselves with the learning goals. Open planning offers optimal conditions for this. What is open planning?

IV. Teaching Evaluation

1) What data and norms should teaching evaluation be based on?

What advantages/disadvantages does a free form of evaluation/a structured form of evaluation offer? What is meant by supervision? What advantages/disadvantages could self-evaluation procedures/written evaluation procedures have?

2) Criteria for teaching evaluation

Judgments about teaching are not measurable values, but rather assessments. Some of the important aspects for evaluating teaching: objectively correct, organization of the partial learning goals, ways and means of initiating the learning process, choice of social forms , materials, guidance, means of guidance, enabling learning activities, testing. Problems of scoring. Evaluation of planning, on the one hand, and implementation, on the other.

3) To what extent can evaluation serve to improve teaching?

How are teaching evaluation and teaching research related? To what extent can the assessment of competence and deficit during actual practice teaching benefit teachers being trained at universities and teachers' colleges? To what extent can teaching evaluations help in revising the curriculum of teacher training? What significance does teaching evaluation feedback have? Advantages, disadvantages?

4) Methods of observation and documentation procedures in teaching evaluation

What is meant by free observation, structured observation? Advantages and disadvantages of the two approaches. What do observation aids such as videocameras, observation protocols, or analysis forms achieve?

5) Methods of interaction analysis

Knowing the approaches to quantitative and qualitative recording of interaction structures. What is meant by symmetric and asymmetric interaction? Knowing pos-

sible disturbances in interaction processes and conflicts. What is meant by punctuation in interaction processes?

6) Function of teaching evaluation and teaching observation for teaching theory

How are theory and practice related? Knowing possible approaches to developing theories: inductive approach, deductive approach, and their potential problems. Are there pedagogic, learning theoretical, and sociopsychological factors which are relevant to teaching theory?

7) Possibilities for teachers to correct their teaching errors

To what extent can videorecordings of teaching be helpful to teacher trainees? How should supervisor-trainee conferences be conducted? What teaching principles can be taken as reference norms in the analysis and discussion of teaching and would be of heuristic value?

8) Self-evaluation methods

Which methodological possibilities are given for self-evaluation? Methods for designing evaluation sheets with practice teachers as regards lesson planning, students, one's own well-being.

9) Methods of evaluation by others

How should evaluation sheets for student use be designed with regard to learning content, achievements, teaching methods, interaction, tests?

V. Performance Evaluation

1) School performance evaluation

Knowledge of observation methods and assessment methods to test performance. Which reference norms can be taken for the evaluation of performance? Which problems have reference norms? Which problems may be triggered by comprehensive standardized examinations? Which problems must be taken into consideration if normal distribution is the basis for giving grades?

2) Constructing learning achievement tests

How should achievement tests be designed? What problems and limitations of achievement tests should be borne in mind? How are standardized achievement tests

designed? What is their function? Where are the limits in their application? What problems are involved in objective performation evaluation?

3) Evaluation of oral student performance

What purpose do oral examinations serve? What can only be tested by oral examination? Knowledge of the objective and relationship levels in oral examinations. Being aware of how the examiner's verbal, mimic, and gesticulatory expression affects the examination candidate. Understanding the fear of oral examinations and possible causes thereof. What advantages and disadvantages do oral examinations have for the students, for the teacher?

4) Evaluation of written student performance

Knowledge of the criteria for evaluating written performance. What function and what value do written examinations have? What advantages and disadvantages do written examinations have for the students, for the teacher?

5) Problems of grading

What do grades mean? Communicative value of grades in school and society. Are there alternatives to grading? Grades are estimations – how could they be made more objective? What reference norm should be taken for grading: the class, the school, the age group, or the individual?

6) Measuring learning success

What forms of testing are there? Ability to arrange explicit and implicit tests on the lesson topics.

7) Errors in evaluation

Knowing the specific kinds of evaluation errors, such as stereotypical evaluation on the part of the teacher, halo effect, Pygmalion in the classroom. What is the evaluation usually based on in borderline cases?

8) Factors involved in the preparation of examination problems

How should the examination be set up: individual examination, group examination, oral examination, or written examination?

9) Evaluation data and pedagogic consequences

Knowing the forms of feedback. What role do the age of the students and the quality of the rapport between teacher and students play here? Being aware of relationship between individual performance level and performance motivation. Being pedagogi-

cally tactful in discussing performance; when does performance evaluation lead to discrimination? Self-fulfilling prophecy.

VI. Curriculum Development

1) Legitimed criteria for choosing learning goals

What key qualifications as regards competence in the subject area, methodology, and social skills should be conveyed in school and how can they be reflected in curriculum development?

2) Institutions and persons responsible for developing the curriculum

Who should develop the curricula? How are curriculum boards organized and who are they made up of? What leeway does the teacher have for decision-making?

3) What concrete information regarding the actual lesson should the curriculum contain?

What decision competence does the teacher have in teaching and educating and in choosing the methodology? Where is this decision restricted by guidelines? When and where is personal responsibility called for? Knowledge of adminstrative and school administrative laws and decrees.

4) Finding comprehensive school goals and justifying them

Are there education political, societal, ethical and religious guidelines which apply to all school forms in the country?

5) Basic education and additional subjects

What should all children learn? General education for everyone – what does that mean? What subject content does this involve? Are there key problems specific to a country or typical of an era? Knowledge of content streamlining in the various kinds of schooling and schools. Are there subjects which students can elect to learn? Are there additional course offerings?

6) Formal and material teaching goals

What is meant by teaching? What are formal and material teaching goals? What significance do they have on developing a curriculum?

7) Relationship between learning goals and tests

Can all learning goals be tested? What forms of tests are there? What is the difference between grading and observing? Awareness of types of questions: free questions, structured questions, multiple choice, etc.

8) Criteria for selecting subject matter–what does exemplary mean, determining exemplary teaching subject matter

Awareness of methods for finding exemplary learning goals. Accepting a gap in knowledge in favor of concentrating on what is essential – how is that done? What is exemplary teaching and learning: representative, transferable, fundamental? What is universally applicable in each individual example?

9) Establishing level of difficulty of the learning goals for students

Awareness of the differentiation possibilities as regards time, method, language, dividing of subject matter into modules of varying degrees of difficulty and levels of abstraction.

VII. General Behavior Problems

1) Reward and punishment

What is deviant behavior? Knowing forms of behavioral disorders. Being aware of possible causes of typical conflicts in school. Ability to categorize conflicts: central conflict/fringe conflict. Being aware of the relationship between frustration and aggression. Awareness of forms of reward and disciplinary measures. Establishing classroom and school rules.

2) Conflict-solving strategies in the classroom

Awareness of forms of conflict. Mastery of methods of conflict solving. Awareness of the significance of "I-messages" and "You-messages" in conflict solving. Ability to intervene and use behavioral therapeutic skills in school.

3) Generation conflict – teacher and student

Knowing possible causes of generation conflicts. Where do the differences between teacher and student lie? Knowing the difference between authority and authoritarian. What do students expect of teachers and teachers of students?

4) Rivalry in school

Knowing about conflicts and causes of conflict between students. Outsiders, mobbing, forming cliques.

5) Varying roles of teachers and the causes

Why teachers become teachers? On the psychology of the teaching profession. Teacher typing.

6) Cooperation among the teaching staff

How should teacher conferences be designed? How should team teaching be organized? How can further training events at school be organized? How can a school develop an educational profile?

7) Socialization at school and outside of school

Is there a connection between social status and educational career? How can socialization deficits in the areas of language, intellect, and social skills be diagnosed and what pedagogic measures can be taken to remedy them?

8) The influence of parents and students

What tasks can be taken over by the student representatives and what basic legal policies must be observed? How should parent representation be organized in school and what basic legal policies govern this? How should parent conferences be organized? Is it possible to further educate parents about school matters? How can parents be advised about education strategies and school matters? How can parents be involved in school work?

9) School rules

Who should participate in formulating school and classroom rules?

VIII. Guidance Counselling for Students and Parents

1) Schooling and education counselling

On what legal basis can/must counselling about a child's schooling be conducted? How should such a conference be conducted? Guidance counselling as an aid – how is that done? Knowing the limitations of teacher counselling.

2) Counselling of children with learning disabilities

What methods for diagnosing learning disability can be recommended? What methods of remedying learning disability are available to teachers, at school? Knowing about the possiblilites of remedial education and psychological counselling in and outside of school.

3) Behavioral disorders

Being aware of individual forms of behavioral disorders. Knowing about medical, psychological, and sociopsychological causes of behavioral disorders. Management at school. Knowing about therapeutic measures and psychological counselling services.

IX. Knowledge About the School System and Education Politics

1) School system

Knowing about education politics in one's own country. How can the existing school system be justified from the point of view of education politics?

2) Teacher education and further training for teachers

Knowing about reform efforts in schools and in teacher education and further training for teachers. Knowing about further training courses being offered to teachers. Knowing about educational agencies. Participation of teachers in research projects to improve practical training in school. Willingness to cooperate with the universities and schools in teaching research.

3) Involvement of external parties in school matters

Should outside interest groups have a say with regard to school matters; if so, who and with regard to what issues?

4) Parents' rights

In what areas should parents have a say, and where should this be regulated or be improved?

Even though the qualifications described above could be changed here and there, in principle, the teaching profession is distinguished from other professions through knowledge, abilities, and skills in these areas. Furthermore, this catalog could be extended and differentiated with no dif-

ficulty whatsoever. An entire semester can be spent with students working on and dealing with many of the themes which have been presented. For many of the topics numerous works have been published and are available on the international market. Unfortunately, dealing with these topics would go beyond the scope of this chapter. Furthermore, the topics listed in Sects. VIII, IX, and X would require knowledge of national administrative regulations and of concrete conditions and problems locally and can only be dealt with by colleagues from the respective country; outsiders can only discuss such issues from the perspective of their own country. However, compiling a list of professional qualifications does perhaps give us an impression of the wide range of tasks which a teacher is actually faced with in school.

Numerous tasks have been listed; however, many a reader may wonder how they should be carried out. For example, how should oral examinations and conferences be conducted, and which rules for communicating should be adhered to and why? Obviously, new information is to be presented, but how it should be introduced and why a teacher intrinsically attempts to motivate students have not been included in the list. In other words, the question of "what," i.e., what a teacher has to do, has been answered; the question of "how" hasn't nor can it be answered here in detail. Fundamentally speaking, the question of how something is taught and learned and how people interact in the classroom can only be resolved in terms of educational philosophy or anthropology.

Actual teaching takes place between people. The actions of the teacher are based consciously or unconsciously on particular ideas of how a person is or how he can or should be. The ways and means of teaching practice always refer to a human image. Hence, anthropological studies are fundamental to the education of responsible teachers. By thinking about and consciously accepting anthropological findings and knowledge of patterns of interaction, teachers will internalize basic pedagogic perspectives which determine and explain our actions to the last detail.

However, there are different anthropological theories. In addition to scientific and medical anthropological perspectives, there are theological, sociopolitical, and many more, all of which attempt to fathom the essence of man according to their own specific manner of scientific inquiry. We are then speaking of a political being – zoon politikon, a religious being – homo religiosus, and a social being – homo sociologicus. Educational anthropology differs from the other forms in that it not only tries to analyze "homo educandus" – the being to be educated, to address the issue of why

a human should be educated, but also provides pedagogic models for doing it. If education is understood as an approach to life, then it is meant initially as enabling young people to exist in the society and culture of their birth. Of course, we do know that there have been and still are societies and political systems which manipulate individuals for their own purposes, which are intolerant of those who think differently and persecute and terrorize them. The question here is whether education as a scientific discipline must present certain educational goals which are essential independently of state and society.

Let us attempt to define such universal goals according to the concept of education!

By education we mean here both the result of an educational process as well as the goal of eduation, the plan which a person has made for his life.

A person's education can be seen in his life's story by what he has been endowed with and that which he makes of it. We don't owe everything that we consider "our education" to someone else. Education is dependent on others but is not synonymous with being molded by others. On the contrary, the educational power of each individual plays an absolutely essential role. Awakening and developing this educational power does, however, depend on a number of preconditions:

- On being able and qualified to reasonably determine the course of one's own life
- On being able and qualified to decide something along with others
- On being able and qualified to show solidarity[5]
- On being able and qualified to freedom of thought and making one's own moral decisions
- On being able and qualified to exercise criticism

Being able to exercise criticism is not meant in the sense of being querulous and complaining but rather in the classical sense of the word, meaning exercising criticism as a decision-making ability, as the art of expert judgment. It is not the person who allows others to make his decisions or do his thinking that is educated but rather the person who is in a position to do it for himself.

According to this understanding of education an individual is, of course, the subject of his own norms and, hence, fully responsible for his own decisions. However, taking responsibility assumes that there is

someone towards whom one can take it, who asks a question and expects an answer and is interested in the answer, and who, if necessary, insists on an answer and doesn't stand by indifferently. It is not our job as teachers to determine decisions beforehand, but at school we can create situations which continuously behoove the students to make decisions.

Independence and the ability to participate in decision-making processes, to show solidarity, and to exercise criticism are key qualifications as well as leitmotifs in the "How" of our didactic actions. This determines how we communicate in the classroom and how well we function as educational advisors. If we as teachers want to reach these educational goals, we must make qualified methodological decisions.

Notes

1 Teachers in totalitarian states are in such a position. There, school is used to maintain the power of dictators.

2 Compare experimental model of the project group Hörner, H./Maier, H./Pfistner, H. J.: "Entwicklung von Kontaktstudiengänge für Lehrer. Gegenstandsbereich Unterricht und Schule."

3 Compare here: Klafki, Wolfgang (1969). Didaktische Analyse als Kern der Unterrichtsvorbereitung. In H. Roth & A. Blumenthal (eds), *Auswahl*, 10th edn.

4 The decision as to what extent students should be involved in the planning has to made from case to case.

5 Compare here: Klafki, Wolfgang (1991). *Neue Studien zur Bildungstheorie und Didaktik*, p. 52. Weinheim/Basel.

Imfadi Abu-Hola and Ibrahim AL-Momani

Lesson Planning

Introduction

Teachers today are fortunate because of the abundance of material he/she can use in the teaching of any subject. Daily events, the endless variety of natural phenomena, the growth of plants and animals, the passage of seasons, changes in life span, and individual needs are just some of the elements of an endless variety of materials which can help the teaching process to succeed. Rocks and minerals can be collected, mathematical projects finished, maps made, and training programs implemented. There are also numerous examples of curriculum devices that can be used as teaching aids in classrooms.

Alert and enthusiastic teachers will not want to miss any opportunity to use different materials in his/her lesson plans. Clever use of appropriate items and examples will inject interest and spontaneity into his/her classes which is unmatched by any other method. Students will respond by bringing items for discussion, newspaper clippings, models, living samples, and articles which are interesting from a scientific point of view. The spirit in such a classroom will be enthusiastic, exciting, and enjoyable for both students and teacher. Students will look forward with pleasant anticipation to come to this class the next day, and learning will be probably also be more productive and satisfying.

In this chapter, we address the issue of how to plan daily lessons for teaching in an organized and useful manner. Through successful planning of lessons, we hope to help our students develop skills such as questioning, defining the problem, hypothesizing, searching and planning the solution, observing, discovering, documenting, discussing, organizing and verifying, drawing conclusions, generalizing, and applying knowledge and relationships to a day-to-day kind of life experience. Basic concepts are further applied after students have verified and tested them. In this way, students are trained to use acceptable analogies and substitutions and to detect and analyze faulty procedures, tactics, and strategies.

The beginning steps in lesson planning require much thought before anything is put down on paper. Questions such as "what do I want to ac-

complish," "what do the students already know about this topic," "how can I utilize this previous knowledge?" and "how can I build on it," and "how can I illustrate the main points of the lesson?" must all be answered to the teacher's satisfaction before a lesson plan can be prepared. Students certainly vary in abilities and interests, and lesson plans must attempt to provide for these variations. Furthermore, a method of motivating individual students must also be identified. Only by knowing something about the background of each student can teachers be effective in this task.

A lesson plan should suit students' needs. One reason for planning effectively is so that students' topic-related misconceptions can be avoided or overcome. Effective strategies for overcoming the troublesome problem of students' misconceptions involves first determining where the students are and then building meaningful experiences starting from the level of the students. The overall process can be summarized in the following steps:[1]

1. Test students before you begin to teach a lesson to determine their prior experiences related to the given topic (different methods of testing can be used, not just paper and pencil).
2. Identify and address any misconceptions students have. Confront incorrect thinking with a correct explanation.
3. Begin with what students know and help them identify how new information and experiences are related to previous learning.
4. Begin with general, broad ideas and work your way down to the more specific details of the concept.
5. Help students see how concepts are related to one another and how all concepts may interrelate or be connected. Concept mapping is a good way of making this type of thinking more concrete.
6. After the lesson, try to determine how well your students have assimilated ideas by asking them to explain relationships and concepts. Capable students may be asked to make their own concept map.

Reasons for Planning Lessons

Lesson planning enables us to:

1. Present material in a more logical, systematic, and effective way. Keep the developmental level of those who we plan to teach in mind.

2. Obtain adequate samples of the subject matter to be taught and the instructional objectives to be achieved.
3. Try to save more time, effort, and even money.
4. Ensure better instruction especially in the first class session. This avoids frustrating and embarrassing situations.
5. Reveal a teacher's personality.
6. Provide teachers with a better opportunity to try out his/her own ideas.
7. Foster self-confidence, persistence, security, and individual pride in one's work. This further reduces fatigue, fear, and even stress.

What Is a Lesson Plan?

A lesson plan could be defined as "able print", a creative piece of art, a plan or guide for action in the near future, a systematic and elastic approach to the development of topic concepts and skills. It does not exist in a vacuum. It takes into consideration all major variables which influence the teaching-learning process, namely, school philosophy, the nature of the students, availability of rich educational experiences, capacity of the teacher to individualize instruction, especially in overcrowded classrooms, and to provide intelligent and well-informed supervision in a permissive atmosphere (not too exclusive). In a way, we can say that a lesson plan is a teacher's own guide to effectively handle the teaching-learning process under the given circumstances, which are unique to each individual teacher. It is no wonder then that there are as many lesson plans as there are teachers who teach a particular topic. It hardly matters whether these plans are short or long: that is to say, there is no such thing as an ideal lesson plan. Furthermore, a lesson plan is for the personal use of the teacher. Therefore, it is as good as he/she makes it.

Parts of a Unit and/or Lesson Plan

There is no list of various parts of a unit or a lesson plan which have been agreed upon. Consequently, selecting the parts for making unit and lesson plans is a matter of individual choice. Thus, individual choice is not

at all a haphazard matter because it is based upon the objectives as well as the kind of content to be presented and investigated by students. The various parts of the unit and lesson plan are as follows:

1. Basic Information:

   - Subject
   - Title
   - Class
   - Date
   - Total number of sessions or meetings
   - Time estimate of the unit and lessons

2. Resources:

   - Instructional and illustrative materials
   - Listing the community resources/off campus experiences
   - Visits and field trips

3. Purposes of lessons:

   - Listing general and specific (instructional) objectives for the unit and lesson plans
   - Use of behavioral terms in the statement of objectives

4. Introduction to the unit/lesson:

   - Preview as well as review
   - Use of pre-test/lesson/unit situation for testing the previous knowledge
   - Use of story, discrepant events, demonstration and problematic situation

5. Development of the unit/lesson:

- Steps in development
- Major activities/concepts to be developed
- Other brief activities
- Developing questions
- Asking and answering questions
- Waiting time for children to think out the answer
- Trying to meet individual needs
- Application

6. Closure:

- Testing questions/Obtaining feedback
- Self-evaluation
- References

Defining Instructional Objectives for the Unit (Goals and Objectives)

After spending a number of years preparing for the excitement of the teaching profession, as a new teacher you look forward with anticipation to meeting your first classes and to taking responsibility for what they are to learn. Why should you have goals?

Suppose an older teacher told you, "Forget all that teaching stuff you learned at the University. All that theory just doesn't fit the real world of teaching". Do you still need goals/objectives? What is the purpose of meeting with your classes? Why are students coming to you to be taught? What is your obligation toward them?

Goals provide guidance and direction. Effective teaching reguires clarification and understanding of your own goals and preparation of the objectives which are to be achieved. Plans for effective teaching have their roots in well thought out goals and objectives. Without them it is almost impossible to achieve systematic and measurable results. Many teachers become frustrated and disappointed because of the lack of direction accompanying poor or non-existent goals.

Often the words "goal" and "objective" are used synonymously. We prefer to make a distinction. Goals are "broad" general statements, sometimes vague in meaning, which generally shape the character of an educational program. Examples are:

1. To promote interest and appreciation for the role and contributions of scientists and pioneers in the past.
2. To develop the ability to solve problems in a systematic way.
3. To understand and use new ideas and scientific information to improve a student's life.
4. To teach students how to think critically, creatively, and rationally so that they can solve problems and promote lifelong learning processes.
5. To develop attitudes and skills necessary to become a responsible citizen.
6. To develop effective and positive work habits related to different fields of knowledge.
7. To develop psychomotor skills so that students can properly manipulate equipment and instruments.

According to this, it is important to start with unit goals, which will guide the teacher in stating the instructional objectives of the unit. Although these goals are broad, they fall short of providing the teacher with specific teaching objectives. For this reason, recent efforts in education have emphasized instructional objectives. These are stated in performance or behavioral terms. This means that they must state how a student is to act, think, or feel. For example, the students should be able to:

1. Explain the phenomenon of a rainbow.
2. State different types of triangles.
3. Draw the map of Jordan.
4. Analyze a piece of poetry.
5. Use the right procedure to brush his/her teeth.
6. Define the meaning of the word "miracle" after reading the story "The Miracle of Life".
7. Mention the characteristics of magnets.

8. Prove that the outside angle of any triangle is equal to the other two angles of the triangle but not the one beside it.
9. Use the problem-solving method in dealing with the desertation problem.
10. Write at least 200 words on the subject of the future of Jordan, without any help from the teacher.
11. Give his/her opinion about cloning.
12. Select the best poem from his/her poetry course.

Preparing Instructional Objectives Has Many Advantages, Including

1. They help the teacher become more precise in his/her teaching.
2. They clarify exactly what is expected.
3. The teacher plans more carefully because he/she knows what performance his/her students should display after finishing a lesson, unit, or course of study.
4. The teacher knows what materials are needed and is able to give more specific help to students in directing them to outside sources of information.

Steps in Writing Instructional Objectives

This task can be simplified by the following steps:

1. Have your overall goals in mind. What are your general aims for the lesson or unit you are going to teach? Is it to improve particular skills? Is it to develop better understanding of a concept? Is it to stimulate interests in a new area of knowledge? Or is it a combination of all these goals?
2. Select the appropriate content desired to achieve goals of the unit. It is important for the teacher not to let the mere presence of a topical outline dictate the teaching aims. Thinking of students' needs, abilities, and interests is very important. Also, the circumstances of the school should be taken into consideration.

3. Write tentative statements to describe how the student should act. Refine these into instructional objectives which are expressed in terms of performance criteria. Each objective should include a description of the behavior expected from the students, the conditions under which the students must exhibit the given behavior, and criteria to assess appropriate performance. As an example of this: "the student should be able, given a coded weather report, to put the information correctly on a station circle on a weather map".
4. The final step in writing instructional objectives is to analyze and evaluate them in terms of their overall contribution in achieving goals of the unit or the course. Without this evaluation, it would be easy to obtain an imbalance between various levels of objectives and areas of content.

Identifying "Big Ideas" of the Lesson

Keeping in mind the four steps in writing instructional objectives, it is very important for a teacher to be aware of the different big ideas (broad or general concepts) of the lesson. These big ideas reflect or represent the main parts or the backbone of each lesson. As mentioned above, teachers should follow the four steps to prepare instructional objectives. However, knowing these big ideas makes the job easier and more organized because any lesson plan depending on these big ideas will be balanced.

The job of deriving these ideas from the entire content could be done by giving definitions and some examples of these big ideas.

If "big idea" is defined as a general or broad concept, different ideas within the content make up the main parts of the content knowledge. "Respiration" represents such an example. The big idea (respiration) could be broken down to many sub-concepts, which together make up the general concept. Under the broad concept of respiration one can derive the following sub-concepts:

- Oxygen
- Carbon dioxide
- Inhaling
- Exhaling

- Gas exchange
- Enzyme
- Mitochondria
- Energy
- Lung
- Nose

In the light of these concepts, teachers could prepare many lesson plans covering the big idea (respiration). Teachers can find out the main (big ideas) concepts for each subject.

Examples:

1. Science
   - Nutrition
   - Growth
   - Photosynthesis
   - Reproduction
2. Math
   - Integration
   - Derivation
   - Differential geometry
   - Numbers
3. Languages
   - Grammar
   - Passive voice
   - Active voice
   - Punctuation
4. Social Sciences
   - Map
   - Scientific values
   - Common sense
   - Fasting
   - Zakat

It is important for teachers to concentrate on these big ideas and inform students about them in order for students to build up a balanced content body structure. It is also important for teachers to be aware that any lesson plan is more than just making sure there is something to do for the entire class period. Unless it is the very first lesson of the year, it is probable that assignments have been given and that the nature of the subject matter is understood. Thus, the basis for planning has already been established.

For the sake of conducting an interesting class period, it is important for the teachers to vary the methods from day to day and even within the class

period itself. It is deadly to fall into the same repetitive pattern of teaching day after day. Even an excellent method can suffer from overuse. With the great variety of methods to choose from and with the potential excitement of inventing a new technique or modifying one, the teacher is in an excellent position to plan a highly effective lesson.

Plans must provide for more time for questioning, for a greater variety of materials, and a willingness on the part of the teacher to allow individual variations to exist among students. Although lesson planning is a necessary facet of effective teaching, good teaching does not happen by accident. It is particularly important that a prospective teacher of any subject recognize the values and benefits to be derived from careful, inspired planning in the art of teaching.

Identification of Students' Preconceptions, Ideas, and Thoughts

The notion of students' preconceptions or alternative frameworks has become another important source of insight into possible educational differences among students. The idea of alternative frameworks has a strong theoretical base. A framework arises as students strive to construct their own meaning for, and understanding of, the experiences that they have. These personal, perhaps idiosyncratic, frameworks are then used by students to explain and predict phenomena they encounter. Furthermore, these frameworks, which may not be at all similar to accepted scientific explanations, nevertheless do work for the student who has constructed them. Finally, they work in the perhaps limited range of circumstances in which the student usually operates in.

Driver et al. (1985) offer some interesting general comments about such frameworks, which may well represent a more fundamental insight into children's thinking, and which may hold true across a range of teaching contexts in general and of science teaching contexts in particular. These general comments may be particularly helpful in guiding teachers' explorations of individual students' concepts and in planning responses to them. Moreover, teachers can recreate their knowledge about preconceptions or alternative frameworks in planning, implementing, and evaluating both their own work and their students. Driver and her colleagues reported that:

- Students tend to be dominated by the perceptual features of a situation rather than to emphasize underlying concepts (thus, sugar disappears in

water, rather than continuing to exist as dispersed particles too small to see).

- They tend to focus on one aspect of a situation rather than on all relevant changes (Paige's notion of centering).
- They tend to concentrate on characteristics of situations with change rather than on aspects which remain fixed and may fail to apply ideas one derived in changing situations to steady state (forces may be recognized in connection with motion but be ignored in static problems).
- They tend to think in terms of linear change and may find it difficult to think of two-way or multi-way interactions (e.g., energy input to cause melting is much more readily accepted than energy release during freezing; reversible chemical change and equilibrium are more difficult to understand than one-way processes).
- They tend to use a single concept which includes elements from a range of scientific concepts and to use it in a rather undifferentiated way (e.g., electrical power is used with a meaning which includes parts of the concepts of current, charge, and potential difference).
- They sometimes use different ideas to explain essentially the same phenomenon if that phenomenon is presented in rather different contexts, but they also have some favorite ideas which influence the nature of their thinking in a range of situations.

For our present purposes of lesson planning the two most important points which emerge from this field are: first, that there are insights available into pupils' alternative frameworks, and second, that these frameworks will necessarily affect pupils' learning, as once frameworks are formed, they can be quite resistant to change.

Teachers may use different approaches to diagnose students' preconception to enable them to plan correctly and efficiently. Interviews, direct observations, open discussion, paper and pencil tests, and students' self-reports could be used as tools in those diagnostic approaches. Finally, investigations of pupils' thinking can be valuable, especially if we have some clear ideas on how we might bring about change in their thinking.

Designing Classroom Instruction

Teachers can design their classroom instruction in different ways, depending on their capabilities, their students' abilities, and their school's readiness for such a design. The main two designs teachers can use are cooperative and individual learning strategies.

Designing classroom activities that use cooperative strategies will help students develop their creative thinking, their abilities to become better problems solvers, and their social competence and encourage them to be more productive.

This strategy of learning reflects a kind of classroom instruction which has changed from being teacher-centered to student-centered. This approach aims to let students learn together and use each other as a source of information and support.

Students are grouped heterogeneously. Many advantages have been gained from this approach, social development being one of the most important.

In this approach, teachers should address the following:

- *Interaction.* The communication skills of the individuals and procedures or guidelines for their participation in the group are often defined by the role or objective of the cooperative task.
- *Process.* The steps or sequences which control the interaction.
- *Structure.* The external components, possibly the school, or, at least the classroom, which has rules and expectations which cannot be ignored by the group or its procedures.
- *Role.* In different small group methods (cooperative) participants must assume different types of roles or responsibilities for themselves or the group. Some responsibilities are to choose or be assigned task roles, to assume responsibility for maintenance of the group, or possibly to take on self-serving roles which are detrimental to the group goals or objectives.
- *Coordinating.* A special role in the small-cooperative group method is that of group coordinator. Sometimes this is an assigned role, which would be identified as the status coordinator, while there is generally another role for the actual group coordinator – the functional coordinator – who provides the initiative and energy to see that the group reaches its objectives. However, it is recommended that this role be changeable from one task to the next. This changing

of the coordinator's role will stimulate different group members to react and fight to get the best results compared with other students. Note, however, that there is no competition force inherent in this strategy.

The second way is designing classroom instruction and activities by using the individualized learning strategies. In this kind of classroom instruction, students need to be directed to become more creative and self-reliant. The initial impression of such a classroom might seem to be one of chaos, but upon closer observation it would become apparent that students were working, but in a way very different from the traditional class situation. The activities of the class will have been organized by the teacher so that each student could progress at his/her own pace. The classroom organization portrayed above is somewhat idealized as to the extent to which instruction has been adapted to individual differences. It is difficult in that teachers need to prepare carefully when using this strategy in order to meet students' individual differences, but it gives very fruitful results as each student will find what is suitable for his or her abilities and attitudes. Teachers should have thorough training to cope with this strategy due to two main challenges:

- *Individuals come* to the classroom with varied backgrounds and experiences and are probably, as Piaget has pointed out, at different cognitive levels because their experiences vary and their genes, too. This is not to say, however, that each individual student learns and processes new knowledge in a completely different way. Therefore, teachers have to offer different learning strategies, resources, and materials for students to learn at their own pace.
- *Individuals vary* in the rate of concept attainment. Some students must have a relatively prolonged contact with concepts before they grasp them.

Using this method of learning students work at their own individual rate and when they finish, they are required to remain in the same class. They will eventually need new activities and material to progress. This will be a challenge and may be a demanding process for teachers to apply, but it will eliminate the scheduling problems found in the other kinds of plans in which students are allowed to pass from subject to subject during the school year. Furthermore, in this strategy a student is not held back by a class average. The fast learners find new materials and/or activities, and

the slow learner is not frustrated by trying to attain something developmentally inappropriate. This way might also help to shift student emphasis from extrinsic to intrinsic reinforcement. A student doing an assignment at his/her own rate receives self-confidence and a sense of competence which may not manifest itself as easily in group instruction.

Emphasizing the use of activities that challenge students preconceptions and/or misconceptions will help them understand the content at hand, become interested in learning new content-knowledge, and to be self-reliant and creative. (Further information about this topic has been given in previous sections of this chapter).

Models for Unit and Lesson Plans

It may be helpful to give some examples of unit and lesson plans for different subjects. These are just suggestions; however, teachers should be creative and work hard to prepare useful plans which suit their purposes. The following are examples of this:

Example 1:

A unit planning format

Example 2:

A lesson planning format (Biology)

Example 3:

A lesson planning format (Social Science)

Example 4:

A lesson planning format (Social science)

A Unit Planning Format[2]

Unit Title: The Human Body

Science Program Goals	Science Unit Goals	Student Objectives	Learning Activities	Evaluation
1.1 The children will understand and use new ideas and scientific information to improve their lives.	The children will understand the importance of maintaining a clean body to prevent disease.	The children will: 1. communicate why they should wash daily. 2. infer how keeping a clean body can prevent disease. 3. demonstrate proper dental care.	1. Wash hands before eating. 2. Dentist or hygienist to demonstrate and discuss proper dental care. 3. Match vocabulary words to hygiene.	Practical hand washing and tooth-brushing test. Attitude and process skills observation checklists. Match pictures and words on worksheet.
2.4 The children will recognize how the advancement of science and technology has changed the lives of people in local, national, and global communities.	The children will understand the effects of unsanitary conditions on the health of a community.	The children will: 1. infer how diseases are transmitted. 2. observe proper hygiene in public facilities. 3. describe the reasons for and demonstrate the correct way to use a public facility.	1. Discuss how disease is transmitted. 2. Discuss how to prevent disease. 3. Experiment with soap, oil, and dirt. 4. Collect pictures or objects used to clean kitchen, bathroom, etc.	Student interviews. Observation in washrooms. Attitude and process skills observation checklists.
3.1 The children will develop a knowledge and understanding of sientific principles and concepts.	The children will understand the general framework of the human body and how it can be kept healthy and strong.	The children will: 1. describe the function of the human skeleton. 2. discuss ways to care for and maintain a healthy body. 3. describe the functions of basic human organs.	1. Construct layed model of body with skin, organs, skeleton, etc. 2. Discuss skeleton and organs. 3. Survey class to find out whose relatives have had organs removed. 4. Discuss how broken bones heal.	Human body project. Student presentations of projects and descriptions of good health practices. Attitude and process skills observation checklists.
4.6 The children will become informed about the contributions scientists make to society.	The children will learn about the health professions.	The children will: 1. identify and name major occupations related to health care. 2. decribe specific health care services received by individuals in the class or family.	1. Construct collage of health care professionals. 2. Provide hats of health care uniforms for students to wear while they discuss the activities of the professional.	Attitude and observations checklists. Observe wearing hats. Discuss sex-role stereotypes. Practical test over collage via student inverviews re: occupation.

Notes

1 These steps are adapted from the strategies provided by Steven Rakow in „six steps to more learning", Science scope, October, 1992, PP. 18-19.

2 Martin, Jr. and others, p. 99.

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Horst Hörner

Lesson Evaluation

Lesson evaluation is a central task in teacher training. Independently of who is evaluating a lesson – the supervisor, the methodology teacher, the cooperating teacher, or the trainee himself – lesson evaluation is necessary. The first step in this evaluation is analyzing the lesson, which means identifying the didactic variables by describing them phenomenologically. The didactic variables achieved by this method are constitutive to every lesson. You will find them in every lesson which has been analyzed, and anyone who is planning a lesson must reflect upon them and respect them. Such didactic variables are *social forms of learning*, *learning activities*, *arrangements at the beginning of learning processes* (for example tasks, instructions), *goals,* and possibly *help, aid, and assistance and support during the learning process.*

Using the following STRUCTURE-CONCEPT FOR PREPARING AND ANALYZING LESSONS we can identify the variables very economically.

The form used for evaluating a lesson is divided into two parts. On the left side the variables which can be observed among the students are listed. It is easy to identify which social forms of learning they are working in: *class teaching, individual learning, learning with a partner, group discussion or in small groups.* According to your observation you may mark the one you identified with a cross in the square.

Relevant activities are neccessary to achieve the goals. It is possible to use the taxonomy of Bloom to categorize the activities. However, after these have been formulated for a relative abstract level, it is much more effective to recognize what the students are doing concretely. Are they listening, planning, discussing, or constructing something, copying a text from their books into their notebooks, writing an essay, painting, and so on? Such activities can be categorized into three groups: productive, reproductive, and receptive categories.

STRUCTURE-CONCEPT FOR PREPARING AND ANALYZING LESSONS

LEARNING POSITION	TEACHING POSITION

THE SOCIAL FORMS OF LEARNING

CLASS TEACHING ☐ INDIVIDUAL LEARNING ☐ LEARNING WITH A PARTNER ☐

GROUP DISCUSSION ☐ LEARNING IN SMALL GROUPS ☐

ARRANGEMENTS AT BEGINNING OF A LEARNING PROCESS

(FORMULATE CONCRETE INSTRUCTIONS)

RELEVANT ACTIVITIES

	productive	reproductive	receptive

HELP, AID, ASSISTANCE, SUPPORT DURING THE LEARNING PROCESS

ACHIEVED GOAL

INTENDED GOAL

On the left side you will see what the students have accomplished and whether they have achieved the intended goal.

On the right side, the didactic categories for the relevant activities of the teacher are provided. First, the *arrangements at the beginning of a learning process*, such as tasks, instructions, exhibiting of films, pictures, or paintings (to motivate the students to interprete them), are presented.

In these arrangements the intended goals should become transparent. Here, the students should be informed of what's going on, what they have to do, and what the goal of the lesson is. Students and those observing the lessons should be able to anticipate the learning objectives. If this is not possible, more work will be required while teaching the actual lesson.

In student-oriented lessons it is also necessary that the students formulate their goals, and that they decide which methods they will use, and in which social form they will learn.

This structure-concept has the advantage of showing the interdependent relation between the didactic variables. If the students don't achieve the intended goals we have to find out whether it was caused by unsatisfactory instruction, an incorrectly chosen social form, or because they didn't know how to work.

The goal of a lesson is, in many cases, achieved by going through different learning phases. We call these phases solution situations. Figure 1 illustrates this.

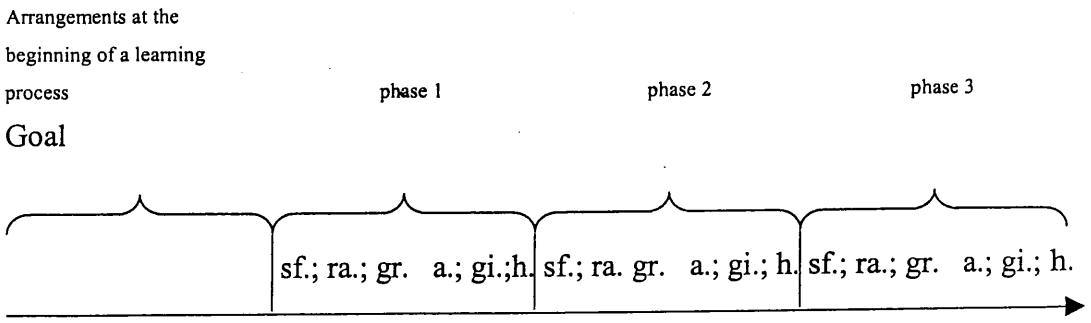


Fig. 1: Model of a lesson with several learning phases

Depending on the complexity of the subject matter, the goals may not be able to be achieved in one step. It is often necessary to deal with different aspects along the way and so the lesson must be divided into more phases. Each phase has its own objective/goal (g), its particular social forms of learning (sf.), particular relevant activities (ra.), and particular intermediate goals. Every phase is initiated by specific arrangements (a), or a certain kind of instruction at the beginning, each phase has its own in-

tended goal (gi.) and a particular kind of help or aids which are necessary. Every phase has its own didactic structure. So if we, for example, are dealing with a fable, one aspect might be the content, another the particular kind of text (animals are speaking), another the origin of the fable, and yet another the "lesson to be learned". All these aspects are important for understanding fables.

Because each learning phase (solution situation) has an individual structure, we need a separate evaluation form for analyzing and describing each individual learning phase of the structure-concept.

After describing and analyzing the lesson, we can try to evaluate it. Clearly, evaluation is very important for teacher training. However, if two or more persons evaluate one and the same lesson there is no guarantee that the results will be the same, because lesson evaluation is not an actual measurement, but rather a scoring. There is no unit of measurement we can use. Therefore, lesson evaluation is always subjective. The only way to make it as objective as possible is to define the aspects of the evaluation process.

We have attempted to develop a lesson evaluation form, which is presented in the following.

LESSON EVALUATION FORM

Lesson content
correct and specific (1) – correct (3,5) –
incorrect (6) 1 2 3 4 5 6

core topics
are at the focus (1) – play a minor role (3,5) –
are not dealt with (6) 1 2 3 4 5 6

Objectives are organized as learning
sequence (1) not organized (6) 1 2 3 4 5 6

Objectives are explained (1) – not
explained (6) 1 2 3 4 5 6

Opening measures are adequate(1) –
inadequate (6) 1 2 3 4 5 6

Helping students in performing their tasks
is related to the learning situation (1) –
not related to the learning situation (6) 1 2 3 4 5 6

Social forms of learning/teaching methods
are pupil centered and suitable for the topic (1)
only suitable for the topic (3,5) unsuitable (6) 1 2 3 4 5 6

Teaching /learning media are effective
concerning learning achievement (1) - ineffective (6) 1 2 3 4 5 6

Lesson conducted by the teacher
with different learning/teaching methods (1)
– not with different methods (6) 1 2 3 4 5 6

Learning /teaching methods have a positive
impact on the students' achievement (1) –
not a positive impact (6) 1 2 3 4 5 6

Learning activities are used in a meaningful
way (1) – unnecessarily restricted (6) 1 2 3 4 5 6

Achievement of learning objectives
is assessed (1) not assessed (6) 1 2 3 4 5 6

Social behavior is satisfactory (1)
unsatisfactory (6) 1 2 3 4 5 6

On the left sight of the form the different aspects are listed. On the right sight you will find the rating scales, beginning with 1 (best) to 6 (unsatisfactory).

In an empirical study[1] we found that these aspects are relatively discriminating. They give us the perspectives for lesson evaluation. On the rating scale we have to rank the feature according to the specific aspects by marking a number.

Thus, ultimately, we get a profile of the lessons we evaluated. The profile shows us the relation between the specific aspects and provides a basis for discussing the lessons with the trainees.

In the selection of these aspects professional teaching behaviors was the only concern. Hence, numerous aspects were deliberately left out of this evaluation form, for example, conflicts in the classroom.

Now to the comments of the aspects!

Lesson Content

The concepts correct and specific complement each other. The correctness of content also depends on its specification. If you plan a lesson about Amman, for example, it is not enough to say that Amman is the capital of Jordan; its history, its monuments, its geographical situation, its industry, and, last but not least, its inhabitants and much more are neccesary to understand this city.

Naturally, the kind of specfication must be oriented to the age of the students.

Core Topics

How can students be made aware of the core topics? Have the students had enough time for learning and processing important information? Was the content for practicing selected well? Was there enough time to practice? Contents and forms of testing.

Objectives Are Organized as a Learning Sequence

Every lesson is goal oriented[2]. In manys cases the goals of a lesson are achieved in different learning phases. If the students can anticipate the

goals of the lessons, they will comprehend the sequences of the learning phases. If not, they won't understand what the teacher is doing.

Ojectives Are Explained

In manys cases students don't understand why they should study a particular topic. In the following lesson the teacher should then explain the motives and the purpose the objectives will serve. This will make things easier for both teacher and students.

Opening Measures

How the lesson is introduced is very important for the course of the learning process. In many cases the students don't understand the task or the problem because it has not been clearly formulated. Adequate time should be taken to inform the students of what they will be learning (content and goal), in which social form of learning they should work (individual learning, partner work, group work, discussion group), how they should learn – what methods, or what kind of activities are necessary to achieve the goal or whether they should find out the methods by themselves, what kind of learning aids or media they can use, and why they should learn about a particular topic.

Helping Students To Perform Their Tasks

Was the teacher able to anticipate learning difficulties of the students. Did he/she take the chance to check or to test the learning process of the students.

Social Forms of Learning/Teaching Methods

Depending on the goal of the lesson or on the different phases of the learning process, the social form of learning might change. The justification for a particular social form depends on the content, the goal, the methods, the relevant activities, and the social development of the students. Finally, we have to find out whether the students have achieved

the goals which were set and whether they also were able to improve other key qualifications such as communication skills.

Teaching/Learning Media

There are two categories of learning media: those which are not made especially for specific lessons, for example, maps, atlases, literature, or cubes – they take on the function of learning materials by serving a subjective didactic purpose – and those which are made for didactic purposes, such as learning programs, models for science topics, and illustrative material for teaching mathematics.

Are learning media necessary to achieve the goal, and are they necessary for independent learning phases? Do they enhance goal-relevant activities? Are the media appropriate for the students' level of ability?

Lesson Conducted by the Teacher

By "conducting" we mean all verbal and nonverbal measures which a teacher uses to direct the learning process to the intended goal. These measures include questions, simple or open stimulation of ideas, assignments, learning programs, summaries, suggestions, playback, confrontations with different hypotheses, and learning aids. The "conducting" measure can be divided into two categories, rigid and open. A rigid measure prescribes the learning process of the students in a restricted way, not allowing for creativity or own activities.

Conducting Measures Have a Positive Impact on the Students´Achievement

This aspect corresponds with different categories of conducting measures, both rigid and open measures. We may also achieve results if we use rigid conducting measures, but they may be different from the results achieved by open ones. (Cf. the following aspect!).

Are Learning Activities Used in a Meaningful Way or Unnecessarily Restricted ?

There are three categories of learning activities: receptive, reproductive, and productive. Are the students permitted to decide on the goals, the methods, and the learning aids. Are they allowed to decide spontaneously or are all activities dictated? What is the emotional situation like? Are they motivated, timid?

Achievement of Learning Objectives Is Assessed or Not Assessed

It is necessary to assess whether the students have achieved the goals. Apart from the diagnostic interest, it is a kind of feedback for the teacher to learn whether the applied methods were effective. The assessment can be explicit or implicit. An example of explicit assessment could be a questionnaire, of implicit assessment a classroom discussion.

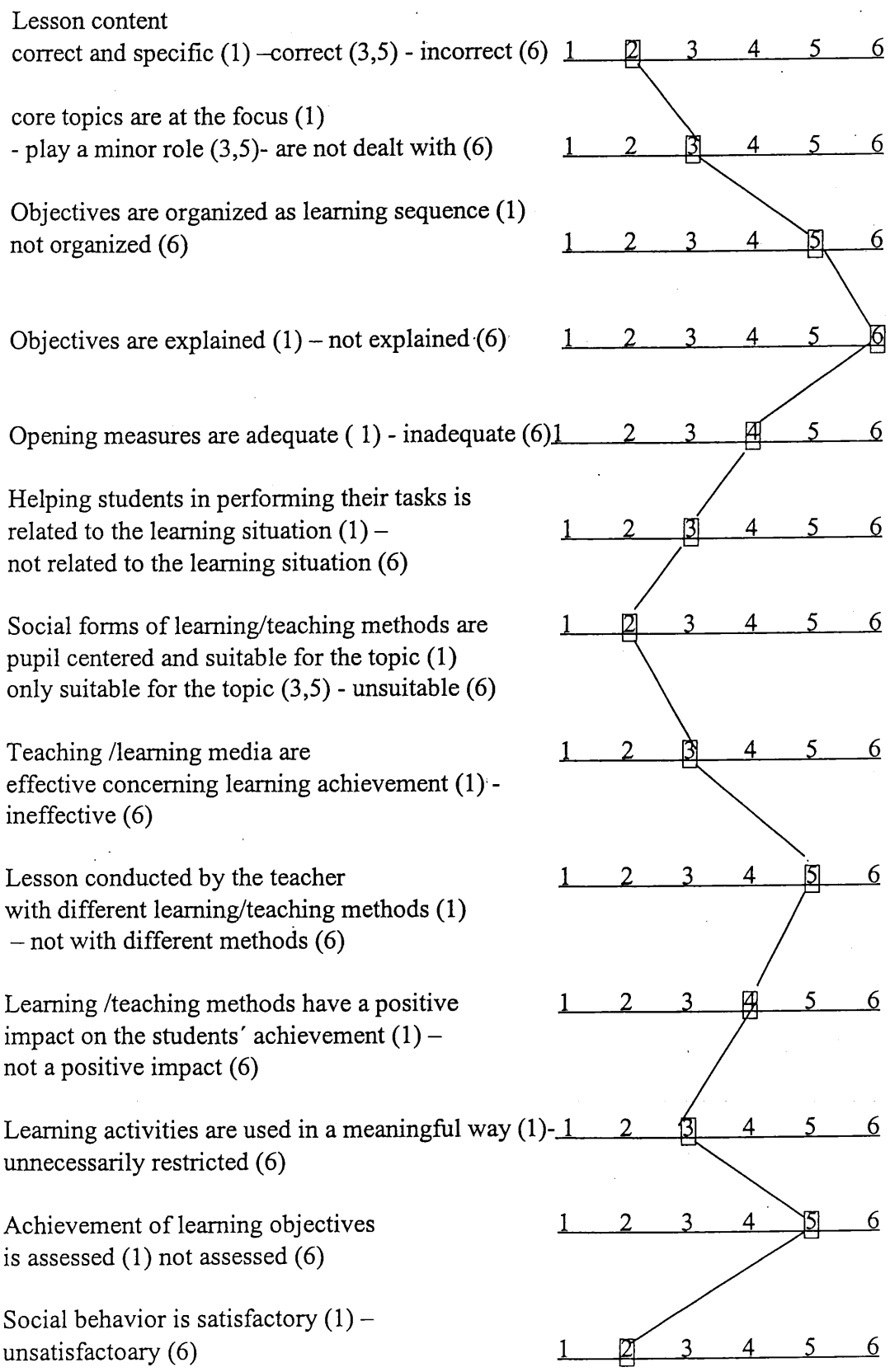
Social Behavior Is Satisfactory/Unsatisfactory

Teacher and student communicate on two levels in the classroom, on the subject level and on the relationship level. The quality of communication depends primarily on how they communicate on the relationship level. If the communication process from the teacher to the students is reversible, communication will be symmetric; if it is irreversible, communication processes are asymmetric. The students expect the teacher to be able to listen, avoid double-bind effects, and cooperate.

In ranking this apsect we have to observe the relationship level.

By connecting the marked points on the rating scale we can get a profile of the lesson.

LESSON EVALUATION FORM



It is obvious that the quality of a certain aspect impacts the others. If the content is not correct, the learning objectives will not be achieved, or if the objectives are not organized as a learning sequence, the lesson will not usually be conducted by the teacher with different methods.
If the social form of learning is not satisfactory or not pupil centered, learning activities are restricted in most cases. If the opening measures of a lesson are not adequate, it will not be apparent to the students that the learning objectives are organized as a learning sequence, and so on. Thus, the profile serves as a basis for supervising or analyzing the lesson.

Notes

[1] Hörner, H./Maier, H./Pfistner, H.-J. (1981). *Beurteilung von Unterricht*, 2. Aufl. Rheinstetten.

[2] Even if the students define the goals.

Qaseem M. Alshannag

Conducting Classroom Research to Improve Teaching

Introduction

Recent research in the field of education has been directed towards bridging the gap between theory and practice. Bassey (1995, p. 6) distinguishes three types of research: theoretical research, evaluative research, and action research. She defines theoretical researchers as researchers who try to describe, interpret, and explain events without making any judgment about them; evaluative researchers as those who describe, interpret, and explain events so they or others can make judgments about these events; and action researchers as those who attempt to describe, interpret, and explain events in order to change them for the better.

McNiff et al., (1996, p. 7-9) view action research as "a form of practitioner research that can be used to help you improve your professional practices in many different type of workplaces. Practitioner research simply means that the research is done by individuals themselves into their own practices." Thus, according to this definition, teachers can become action researchers. They can conduct research regarding their own practical work (i.e., teaching), and the outcome of it should aim to improve practice rather than to produce knowledge (Elliott, 1991). Both qualitative and quantitative research techniques are used in conducting action research.

The Main Features of Action Research

McNiff et al. (1996) summarize the main features of the action research process as follows:

- A commitment to educational improvement
- A special kind of research question
- Putting the 'I' at the center of the research
- A special kind of action that is informed, committed, and intentional

- Systematic monitoring to generate valid data
- Authentic descriptions of the action
- Explanations of the action
- New ways of representing research
- Validating claims made as a result of the research
- Making the action research public

A Commitment to Educational Improvement

Action research is shaped by the educational values that guide how we practice our profession. It is a practical form of research which recognizes that the world is not perfect and also that professional values have to be negotiated. The most significant value of action research, which is accepted by most researchers, is respect of others. This means that the views, perspectives, and values of others must be respected and accommodated. Hence, the role of each individual involved in action research is a central concern and needs to be given careful thought.

A Special Kind of Research Question

Action research begins with a special kind of question :
How can I improve...

...my own teaching?
...my understanding of this?
...the wider educational situation?

Questions of the kind stated above differentiate between action research and other kinds of research. The questions are centered around practitioners (i.e., teachers). As we know, certain types of questions and hypotheses lead to particular research designs, many of which are not suitable for action research. In other words, the right research design is one that focuses on your own actions, not on the actions of others.

Putting the 'I' at the Center of the Research

In action research you, i.e., the teacher, are at the center of the research. It is a good idea to use the personal pronoun "I" when it is needed, for it is important in action research and must be used with great care.

How do "I" fit into the research?

- I am the subject and object of the research.
- I take the responsibility for my own actions.
- I own my claims and judgments.
- I am the author of my own research account.

How do 'I' fit into the action?

- By seeing my own practice as the central focus of my research through critical reflection and self-study.
- By encouraging others to participate in a negotiated definition of shared practice.
- By showing respect for other ways of doing things.
- By showing tolerance and exposing my disadvantages.
- By being open to argument.
- By being willing to accept that I could be wrong.
- By owning up to my mistakes.
- By standing my ground when my principles are at stake.

What Kind of Action?

Generally speaking, there are three different kinds of actions in action research: informed action, committed action, and intentional action:

a) Informed Action

Action inquiry is in itself a method of ensuring that an action is an informed action. It implies that you need to investigate your own actions and motives systematically, treating findings and interpretations critically, and being open to alternative viewpoints in order to reduce personal biases. For an action to be informed, you need to be "proactive," by pointing out the personal values that the act was based on. You need to be open to different strategies of action and more than one explana-

tion of its outcome. One way to do this is by opening your research to the public, so that others can give input to your research. Another way is to read other research findings and see how they match with your results.

b) Committed Action
Action research should be committed. In other words, an action researchers should have a strong personal commitment to bringing about the improvements that he/she is looking for. Moreover, he/she needs to commit his or her personal values to the research project.

c) Intentional Action
Action research must be intentional. This means that action researchers need to make and implement plans, monitor the action, and evaluate the essential aspects of the process. However, in the course of this some unplanned events might occur, which then must be integrated into the future cycles of action. In doing this, action researchers act with intention: the intention to improve practice, to be systematic, to invite criticism, and so on.

Systematic Monitoring to Generate Valid Data

The most important outcome of action research is to understand the changes which have come about in your own professional practice. You need to be able to show how this happened by describing how your thinking changed over time and explaining how your own investigation affected your own action. Being systematic about collecting data is important for many different aspects of the research process. Furthermore, collecting data may require making some critical decisions in predicting which data will be important later on.

Providing Authentic Descriptions of the Action

Monitoring action research should generate data that can be used to provide authentic descriptions of the action. Many action researchers reduce the accuracy of their accounts by mixing up the explanation of the data with a description. In general, there are three kinds of accounts (data sources):

1) Factual Account

Most of the descriptions are factual accounts based on transcripts of conversations and meetings or summaries of data from questionnaires and interviews. Video and tape recording are also ways of documenting the data. Statistical data are often used to show patterns of individual contributions or changes over time, for example, frequency to show the level of students' participation in one class period.

2) Subjective Account

Other descriptions may be based on more subjective accounts taken from personal diaries, reflections, and observations. These are subjective because they represent one person's viewpoint.

3) Fictionalized Account

Many action researchers have experimented with fictionalized accounts so as to preserve the anonymity of participants. These fictionalized accounts can be written such that the context is changed or the real identity of the characters is masked.

Explaining the Action

In action research, explaining the action requires a careful description of the action and also involves the following aspects:

- Identifying possible meanings
- Theorizing
- Constructing models
- Linking with other work
- Making the description critical

There is more than one strategy to explain the action. One of them, reading the literature, helps in identifying possible interpretations of the action. Being open to others, another strategy, can help you in the analysis and research processes by sharing the action with someone else. For example, videorecordings of the classroom are useful in this respect. Linking the action to different educational theories or the philosophy of the discipline at the school in which the action took place provides the basis for a critical description.

Representing the Action Research

Scholars have agreed upon some exciting new ways of representing action research. These are:

- Self-reflection
- Dialogue and conversation
- Narrative and story
- Drawings
- Experiential techniques
- Action research cycles and spirals

Researchers have described the process of action research in different ways. As demonstrated in figures 1 and 2, action research operates in cycles or spirals. These cycles or spirals include planning, acting, observing, doing, monitoring, evaluating, and long-term reflection.

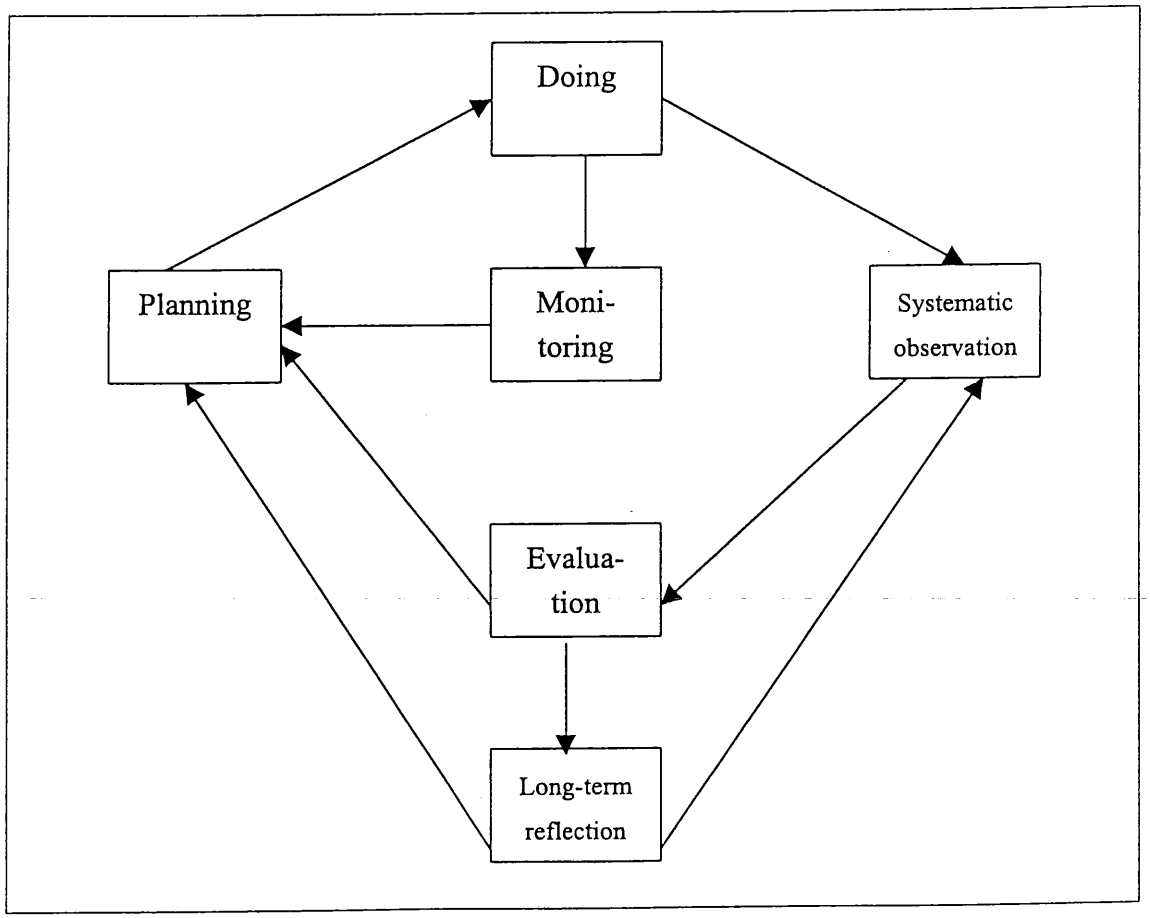


Fig. 1: Cycles of action research

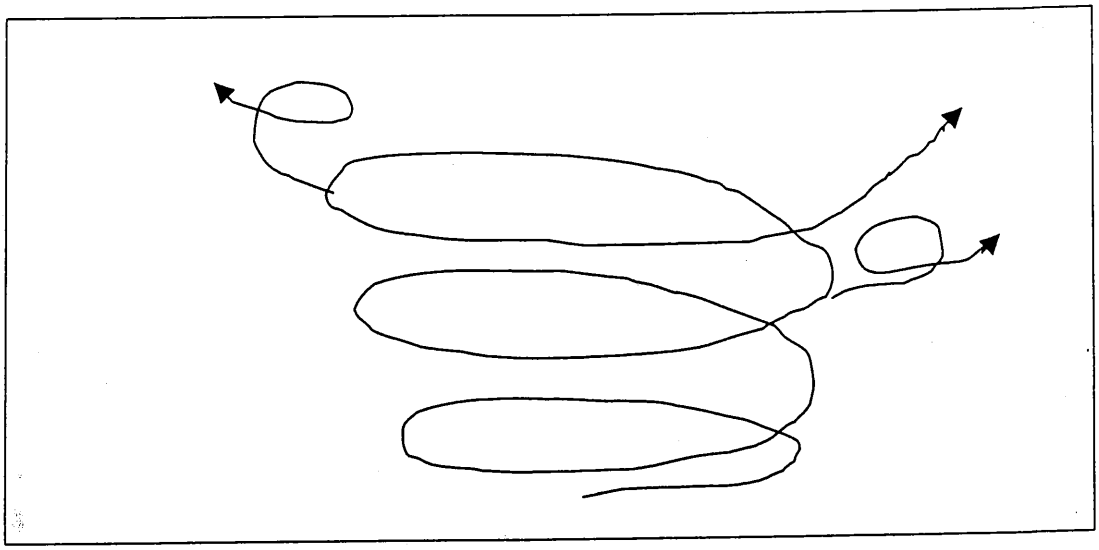


Fig. 2: Spirals of action research process

Validating Action Research Claims

Validating action research claims involves:

- Making claims
- Critically examining the claims against the evidence
- Involving others in making judgments.

Action research interpretations can be validated through different levels: self-validation, co-practitioners, and other persons who may be blinded to the truth of your own interpretations.

Making the Action Research Public

Making the research public is the best way to validate it. You can make your research public by:

- Sharing the findings with other people, particularly colleagues (i.e., teachers within the same school).
- Presenting your research results at a conference or any annual meetings of professional organizations (i.e., local, national, or international meetings).
- Publishing in a journal (for example, *Journal of Research in Science Teaching*)

Conducting Cassroom Rsearch

Scholars refer to classroom research as one kind of action research. Hopkins (1993, p. 1) describes classroom research as an "act undertaken by teachers to enhance their own or a colleague's teaching, to test the assumptions of educational theory in practice, or as a means of evaluating and implementing whole school priorities" (p. 1). According to Hopkins' view, teachers who conduct research liberate themselves from the control position they so often find themselves in to the leader position where they can criticize their own teaching practice.

The main focus of this article is to help student teachers (pre-service teachers) to improve their teaching practice through classroom research. More precisely, this paper offers a concrete example of a student teacher in science by the name of Adalia. Adalia used classroom research to improve her teaching of science to the 8th grade students in one of the public schools in the north west of the Jordanian capital Amman. She was teaching general science and physics courses to 8th, 9th, and 10th grade students at Alfajer School, a school for girls. The total number of students in this school was about 850. In general, the economic status of the students was average. Most of the students came from families of the middle and lower social classes. On average there were 35 students in each class.

After careful consideration, Adalia decided that doing research in her 8th grade science class might help her students to understand science concepts better and to be able to apply this scientific knowledge in their everyday lives.

At the beginning of her teaching experience, Adalia noticed that her 8th grade students had difficulties in understanding science concepts. Moreover, they could not apply this knowledge to their lives. Most of her students memorized facts, laws, definitions of concepts, and theories as separate fragments of knowledge without making any connection between them. Her students' attitudes toward science topics were not very positive, their motivation about learning science was low, and there was only little participation in science class discussions. The kind of science classroom environment described by Adalia has been confirmed by many science educators. For example, Bennett (1999) argues that learning in science classes can be a frustrating process if students are asked to accept what they are told about how the world works without considering how the new information may fit into their knowledge and experiences.

During her science practicum seminar, Adalia had a chance to talk with her colleagues about the educational needs that derived from their own teaching practice. Adalia talked to her science education instructor about the low interest level of her students for learning science. He advised her to do classroom research in this group and to try to apply different teaching strategies. He also volunteered to work with her as a research partner.

After that meeting, Adalia went a step further and began thinking about how she could improve her teaching of science. How could she help her students understand scientific concepts and be able to apply them in their everyday lives? How could she stimulate her students to participate actively in science class?

In response to these research questions, Adalia decided to switch from a teacher-centered to a student-centered approach in her class of 8th grade students (Salish, 1997). As the first step in implementing the new approach, she decided to let her students work in groups. Alexo (1996) suggests that small group discussion in physics classes is more productive in groups of four rather than groups of two. Most of the time, however, Adalia divided her students into groups of five, ending up with eight groups. Her teaching strategies focused on the inquiry approach which involved the students in scientific activities that helped them construct their own ideas and develop their own understanding of scientific concepts.

To collect data, Adalia asked one of her fellow students to help her as an observer and critical participant in her classroom research. Moreover, one of the teaching staff members videotaped three consecutive science lessons of her teaching the 8th grade students about chemical bonds. These videos were analyzed according to the Secondary Teachers Analysis Matrix -- Science Version (STAM) (Alshannag, 1999). Other sources of data were students' notebooks, students' journals, Adalia's notebook, and unit and lessons plans.

The result of analyzing the three lesson videos according to the STAM is summarized in this short report. From 28-30.11.1999 Adalia taught three laboratory classes to her 8th grade students. She usually began her lessons by saying "Alsalamu Alaykium" (Islamic words of praise). She then divided her students into groups of four and five. These groups were heterogeneous according to each student's achievement in science. Adalia started the science lesson itself by asking students to give examples related to the topic of the lesson. For example, she asked them to think about how someone can live in the desert without other people? She often made a connection between previous and current class topics. The content of

science and any related activities were presented using didactic, conceptual, and early constructivist approaches. For example, the structure of the content of her science classes was mostly explanatory, where students and teacher negotiated understanding. One major activity in the third lesson was for the students to present ideas about their understanding of covalent bonds by making drawings on the blackboard. The students' activities in the classroom were mostly designed according to early constructivist and conceptual theories. For example, there was much discussion among students about the concept of the covalent bond. The students played different roles within their groups. Adalia moved from one group to another to guide, help, and answer students' questions, which were focused mostly on clarification of the meaning of the concept of chemical bonds. There were many activities in which students could offer ideas and examples. The use of resources was mostly discussed between teacher and students. The dominant modes of interaction in the three science lessons were student-student, student-teacher, and student-teacher-student.

By the end of the semester, Adalia noticed that the students' motivation toward learning science was much better than it had been. For example, they were self-motivated to work in groups and discussed their understanding of scientific concepts with their classmates. Adalia noticed through her teaching and the students' notebooks that the students were often able to use the language of science (Lemke, 1993). The students learned to observe, describe, compare, analyze, conclude, and generalize.

Throughout this period, Adalia, her fellow students, filed instructors, and cooperating teacher for the science practicum had many conversations about how to guide and help Adalia and her colleagues to improve their teaching practice. Finally, Adalia had many opportunities to talk with her colleagues about the learning process which took place as a result of the action research, being a classroom researcher, learner, and student teacher at the same time. She valued this process greatly, "really, it is a great opportunity to learn from" Adalia said.

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Alan C. Mclean

Action Research: Its place in Teacher Development

"Teacher development is becoming the best kind of teacher that I can personally be"
Adrian Underhill

"Better is one's own law, though imperfectly carried out, than the law of another carried out perfectly. "
Bhagahavad Gita

"In these matters, my inclination is to admire and do otherwise."
Gerard Manley Hopkins

1. Teacher Taining and Teacher Development

We can distinguish three distinct models of teacher education: the transmission model, characteristic of much traditional pre-service training; the experiential model, which is found in more progressive approaches to teacher education; and the developmental model, which extends the notion of training into a lifelong concern for self-improvement.

1.1 The Transmission Model

Behind many of the best-known theoretical approaches to language teaching of the past three decades (e.g., the Silent Way, Suggestopedia, TPR) lies the assumption that there is one set of pedagogical principles which apply to all teachers in all learning situations. For followers of these approaches, it is the job of the teacher to match his/her teaching style to the principles of the method rather than for the method to be flexible enough to adjust itself to the distinct teaching styles and personalities of individual teachers.

A similar misconception underlies research which seeks to define what makes for effective teaching, namely that "somewhere or other there exists a way of teaching which results in effective learning for all learners in all contexts" (Richards, 1987).

Traditional teacher-training is characterised by the adoption of a transmission model of learning. Typically, 'experts' from outside bodies such as universities or international educational agencies bring ideas to the aspiring classroom teacher. These ideas tend not to be carried out in practice because of their lack of perceived relevance to actual classroom situations, problems, and issues.

The transmission model of training works on the assumption that the trainer is the source of all useful knowledge and the role of the trainee is largely receptive. Other features of this model of teacher education include the following:

- A top-down approach not derived from classroom practice
- Inadequate follow-up to verify the effectiveness of the method as used in classroom practice
- Minimal trainee input into the training process

1.2 The Experiential Model

This model arises out of dissatisfaction with the transmission model. It offers a more practical and involving approach to pre-service teacher education and is characterised by the following distinctive features:

- School-based: an awareness of the culture and characteristics of the school environment is essential to this approach to teacher education. The need to establish strong links between the training body and schools used for practice teaching is recognised. Similarly, appropriate school personnel must be actively involved at all stages of the training process.
- Experiential: teacher education results from close observation and analysis of what happens in the specific classroom environment rather than on general theories about teaching and learning. The trainee thus becomes an active participant in the training process.
- Problem-centred: training is based on identifying and resolving actual classroom issues. Investigation of these problems by trainees is seen as part of the teacher education process.
- Individualised: training should be tailored to the needs of individual teachers. Effective teacher education cannot be based on a "one-size-fits-all" model.

1.3 The Developmental Model

This differs from the previous two models of teacher education in that it extends the concept of teacher education beyond pre-service training into the development of the qualified teacher as a practitioner and an individual. Teacher education is seen as open-ended and is not considered complete when the pre-service training course ends. It should lead to a lifelong concern with developing and improving the teacher's professional skills and self-awareness.

The aim of teacher development is to encourage teachers to reflect on their teaching and become more aware of their strengths and weaknesses. The reflective practitioner is a teacher who wishes to discover more about his/her own teaching in order to facilitate personal and professional growth. Teacher development is an active process, initiated by the teacher, not imposed by others.

Just as the learner is encouraged to be self-motivating, someone who participates in setting the learning agenda, so should the teacher/trainee seek to engage with the process of learning how to teach. The aim of training should be teacher autonomy.

1.4. Teacher Training and Teacher Development

The differences between teacher development and teacher training can be summed up in the following table:

TT	TD
Compulsory	Voluntary
One-off	Ongoing
External agenda	Internal agenda
Skills/techniques	Awareness/personal growth
Done with experts	Done with peers
Top-down	Bottom-up

Although teacher development usually arises from issues faced by individual teachers, it often leads to group action. Teachers' groups can be formed with the aim of developing skills and knowledge and tackling common teaching problems. An example of how such a teachers' group can operate successfully is shown in the following case study:

TD case study: ELT teachers' group in Cambridge
Group of teachers meets informally once a week to discuss use of humanistic techniques and provide support and encouragement to each other. Group was voluntary. Object was to try out new ideas in practice and report back to group. Around eight members.
After one year the group had worked on these topics:

- Co-counselling
- Teaching pronunciation
- Introductory course activities
- Assertiveness in and out of class
- Improving classroom environment
- Reasons for success: Group was voluntary, by and for teachers. Not led by outside 'experts'. Everyone respected each other's ideas and listened to them openly. No leaders or led.

1.5 Can Teacher Development Be Incorporated into Pre-service Teacher Training?

The motivation for teacher development normally comes from a teacher's sense of dissatisfaction over some aspect of his/her teaching. The teacher may feel that his/her teaching is in a rut or he/she may be frustrated by some aspect of the teaching environment. Trainee teachers do not normally experience such feelings on a regular basis. Nevertheless, some of the features of teacher development can be usefully included in a pre-service training programme, e.g.:

- Allow plenty of time for trainees to give feedback on practice teaching
- Encourage trainees to suggest the content of lessons and the procedures to be followed
- Discuss ways of continuing training after course finishes via support groups, teacher diaries, etc.
- Reverse trainer/trainee roles: let trainers teach lesson while trainees observe and give feedback
- Ask trainees to assess themselves and their peers

- Encourage trainees to keep a diary of their experience of practice teaching.

2. Action Research

There has been a substantial growth of interest in the notion of action research in recent years. Its popularity arises from the perceived failure of academic research to address the day-to-day problems faced by classroom teachers. Action research allows teachers to become participants in research and shapers of language-teaching theory.

A major change in thinking rejects the notion that the principles of language teaching should be imposed from outside the classroom. It is now generally felt that it is an advantage for educational research to start from within the classroom with the teacher as researcher. This form of teacher-initiated research is known as action research. Its benefits include the following:

- It begins with teacher's own knowledge and experience
- It is process-oriented (i.e., it is concerned more with the how? and why? of teaching and learning than the what?
- Self-monitoring sharpens teachers critical awareness by observation, recording and analysis of classroom events

2.1 Action Research: Principles and Problems

Action research is recursive. That is, you start with a problem, act, and then consider the effect of the action on the problem. A typical procedure for carrying out an action research programme would include the following phases:

Phase 1 – define the problem you wish to investigate
Phase 2 – develop a plan of action to solve the problem
Phase 3 – act to implement the plan of action
Phase 4 – observe the effects of the plan of action
Phase 5 – reflect on the effects of the plan of action

The motivation for action research is a desire for change: something is not working (well) and you want to make it work (better). It is problem-focused and solution-oriented.

2.2 Action Research: Tools

A number of tools can be used to initiate a programme of action research. These include:

- Peer observation
- Teacher's diary
- Audio/video recording of lesson segment (self or others)
- Analyse audio/video lesson segment (self or others)

2.3 Topics for Investigation: Some Examples

Action research can be instituted in a variety of areas of teaching and learning. Here are some of the most interesting areas in which to pursue research, with specific examples of topics suitable for investigation by action research.

Methodology	What materials do learners respond to? Which approach is best for teaching grammar: inductive or deductive?
Management	Effective instruction giving Dealing with unruly students – how can I change my behaviour?
Professional development	How to set up and run a teacher's support group.
Implementation	Relationship between lesson plans and actual lessons.
Talk	How much do I talk? How often do students initiate talk? What's the most effective method of correcting errors?

2.4 How to Start an Action Research Project

The following questions can be asked before choosing an area of research:

- Are there any specific problems in my classroom now? if so, what can I do about them?
- What are my students learning? Is it what I am teaching?
- How can colleagues (supervisors, fellow subject-teachers) be involved?
- How do others (colleagues/students) see me as a teacher? Do their impressions correspond to my own view of myself?

2.6 Collaborative Research: Guidelines

Collaborative research is often more fruitful and rewarding than research by individual teachers working on their own. Teachers working together in groups improve the developmental element in research. A major aim of action research projects is to increase self-awareness and develop critical reflection for individual teachers and teachers' groups.

The following guidelines for starting collaborative research projects are suggested:

- Organise research groups. Make sure you participate yourself.
- Make sure all group members are committed to project. For example, insist on regular meetings, proper minute-taking, and punctuality.
- Start small. Establish consensus on what is to be investigated. Begin by investigating specific problems. Be wary of taking too much on – too wide a focus can lead to vagueness and lack of specificity.
- Allow adequate time for the research process: data collection, for example, is not always as easy as you might think and may be delayed by logistical problems. Allow time for things going wrong.
- Create a supportive environment so that discussions can be open and honest. There should be no question of group members sitting in judgement on each other. Tolerance is essential.
- Be persistent in drawing research results to the attention of authorities. Remember that change is always problematic and will not be achieved

quickly. Remember that "change is a process, not an event" (Nunan, 1989).

- Keep the school community informed of the progress of the project. It's important not to alienate those who may be sceptical of the benefits of action research.
- Write up the research as it develops. You need to keep an accurate account of progress.
- Evaluate the project as it is proceeds. Formative evaluation is an important aspect of keeping the investigation on track or, where necessary, changing direction.

2.7 Collaborative Research: Practicalities

In order for a collaborative research project to be successful, there are certain logistical needs, viz.:

- Teachers need to be trained in the skills of action research.
- Teachers need time off to carry out and write up research.
- Teachers need the ongoing support of advisers and supervisors ("critical friends"). These must also be allocated time to work on project. (Therefore, education authorities must support the project and be kept informed of its development.)

2.8 Collaborative Research: Reporting

Think of ways you can report on research – attending a conference, writing an academic paper, or producing an end-of-semester report. If the research is not written up appropriately, its usefulness will be limited. An aim of action research is to feed back to and influence language teaching methodology and padagogical theory. There are a variety of possible ways of disseminating research results, viz.:

- A written account, e.g., paper for journal, newsletter
- A seminar report
- A poster display
- A workshop discussion

3. Conclusion

Given that a major aim of teacher education is the development of a reflective practitioner who seeks to develop both as a professional teacher and an individual, action research is an important component in achieving this goal. The inclusion of an action research element within an in-service training programme can make a significant contribution to the developmental aspect of in-service teacher education.

Suggestions for Further Reading

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Horst Hörner

Social Forms of Learning – Interaction and Function

When planning any kind of lesson, a teacher must decide how the students will learn it best. There are five different social forms of classroom instruction, and learning:

- Working individually
- Working with a partner
- Working in a group
- Group discussion
- Class teaching

These forms can be distinguished from each other by the different possibilities they present for interaction and, furthermore, they serve different teaching goals, i.e., the decision for one of the social forms depends on the given task.

Patterns of Interaction

If a student works alone, there is usually no interaction with other persons present in the classroom. Each student learns and works by himself unless he encounters difficulties and asks the teacher for help. This social form is called "working individually."

Working Individually

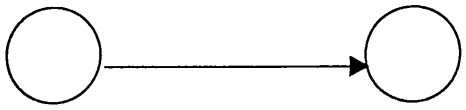

Fig. 1: Interaction with the teacher only if necessary

Working with a Partner

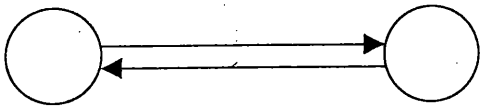

Fig. 2: When working with a partner, two students learn together. There is mutual interaction and the two students are dependent on each other for solving the given problem.

Working in a Group

For group work, ideally, four students should work together. If there are more than four students in a group, each individual has fewer chances to interact with each of the others. Organization of the desks is also more difficult, and the seating problems could hinder participation in the communication process in many cases.

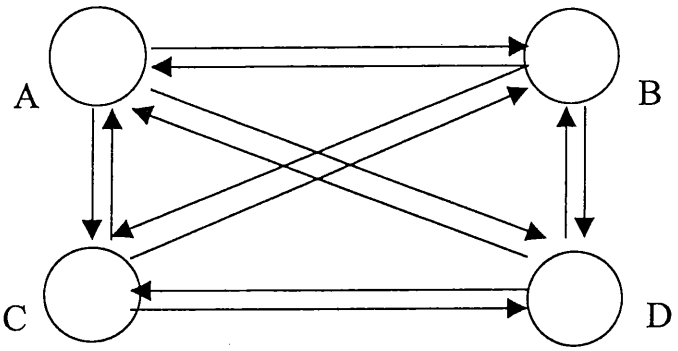

Fig. 3: All the students (A, B, C, and D) can interact with each other.

Group Discussion

The teacher also participates in a group discussion. He is one of the group: he can ask questions, but also be asked. He can make suggestions and stimulate certain patterns of thought, but he does not necessarily have to lead the discussion. Each student can ask questions, and everyone can make suggestions, offer solutions, and participate in determining the course of the discussion. Everyone can interact with everyone -- of course in accordance with the rules which have been established.

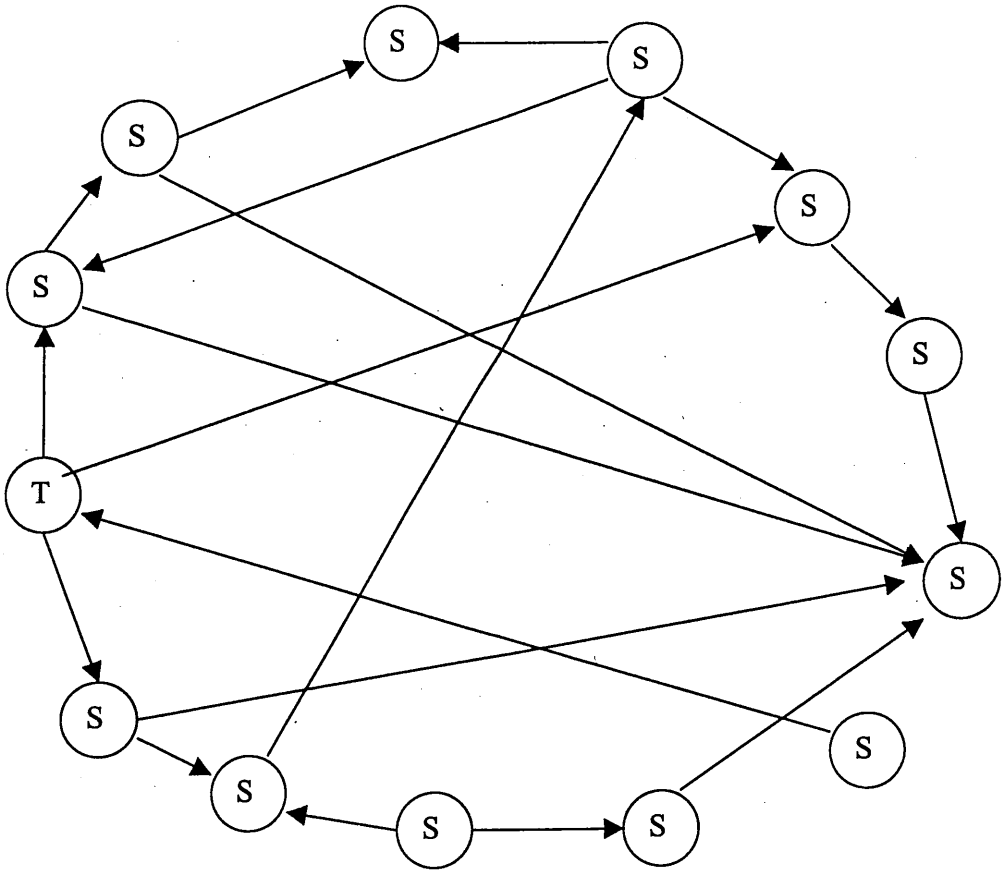

Fig. 4: Everyone can interact with everyone, in accordance with the discussion rules.

Class Teaching

In the standard form of teaching, the teacher is at the front of the classroom. It is usually only possible for the teacher to interact with one student, most often upon the initiative of the teacher. Any possibility of interaction between individual students is ruled out.

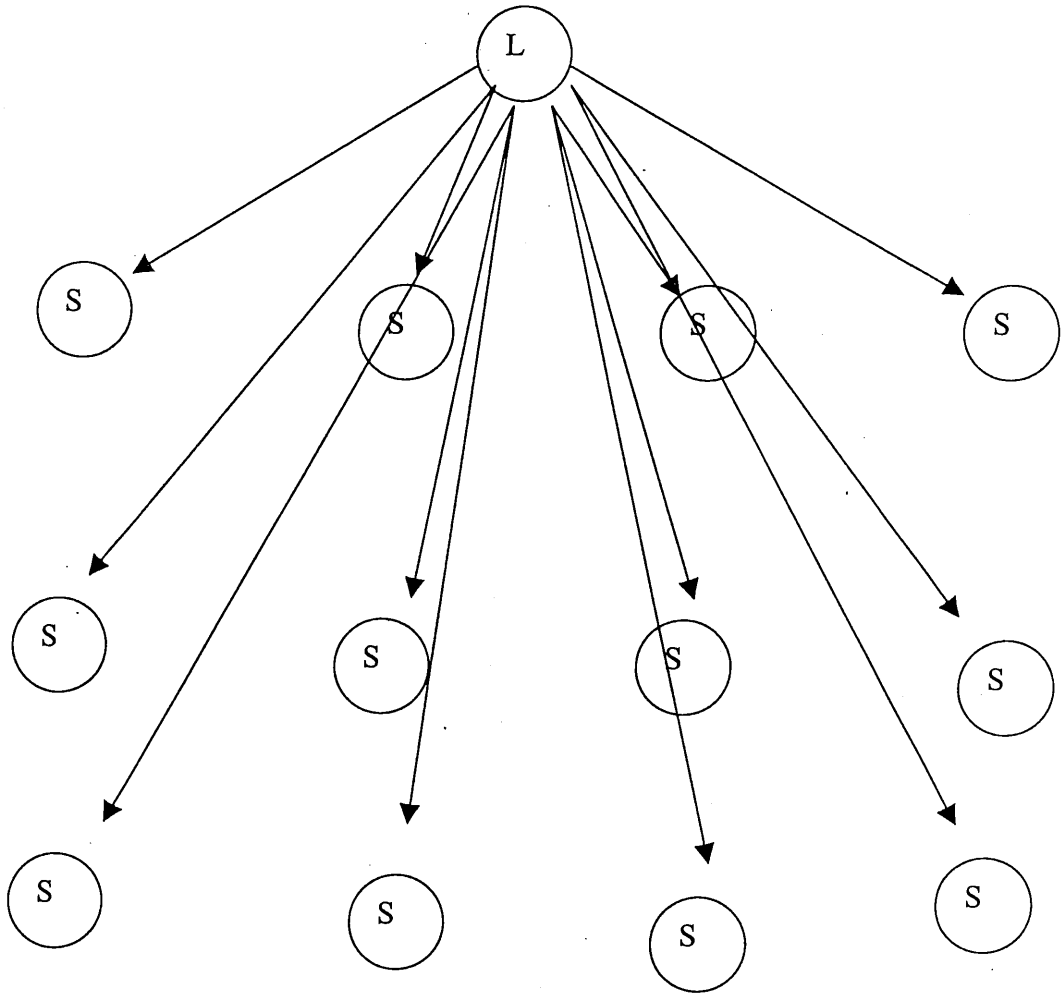

Fig. 5: The arrows indicate the one way communication in class teaching

Teaching Goal and Choice of Form

If a learning process is to be effective, a teacher cannot just choose a form of instruction at random. This choice depends on the goal to be achieved.

Working Individually

Our first task, then, is to clarify which form of instruction is best suited for the individual teaching goals.

When is it better to work alone; when are others likely to be a disturbance? Individual work, for example, is appropriate for penmanship lessons, for learning to write. As soon as the individual letters have been presented by the teacher, each child must develop his own motor skills. Learning penmanship, making letters and syllables, and constructing words require that the students use their senses. Coordination of movement and perception is an individual experience and each student is best able to correct himself.

Reading is also suited for individual work. It is, of course, sensible and perhaps even necessary to discuss a text with the others afterwards, but each student should have developed his own idea of what a text says first.

Individual work is also recommended for tasks which are meant to develop creativity, such as writing a theme or working on an art project – in short, whenever individual expression is called for.

Working with a Partner

It is common knowledge that we all like to do things with others and with friends: we are social beings and, hence, dependent on other humans. Working with a partner, however, implies "work". It requires that a student work with a classmate to solve a problem.

What might possibly motivate a student to cooperate with another student? How does it help student "A" to work with student "B"? But also, how does it help student "B" to work with student "A"? What do they each gain from cooperating?

This aspect may seem very pragmatic, but it should be taken into consideration, because ultimately, such reasoning provides rational and comprehensible arguments for choosing partner work.

The example presented in Fig. 6 from SEARS, R.R[1] schematically illustrates what motivates students in partner work and how partner work functions.

Situation: Person "A" is hungry (motivating stimulus: S_d), sees an apple tree (external stimulus: S_{ext}), and knows that apples can be eaten (cognitive stimulus: S_{cog}). This constellation of stimuli triggers an instrumental act (instrument. act): he shakes the tree, but none of the apples fall down. The trunk is too slippery and too high. "A" cannot climb the tree. "A" asks "B," who also wants an apple, to stand under the tree. "A" climbs on to "B's" shoulders, picks two apples, and gives one to "B". In this dyadic sequence,

it is important that neither of the partners can achieve the goal reaction (R_g) without the instrumental act of the other. Without cooperating, neither of the of two would achieve anything.[2]

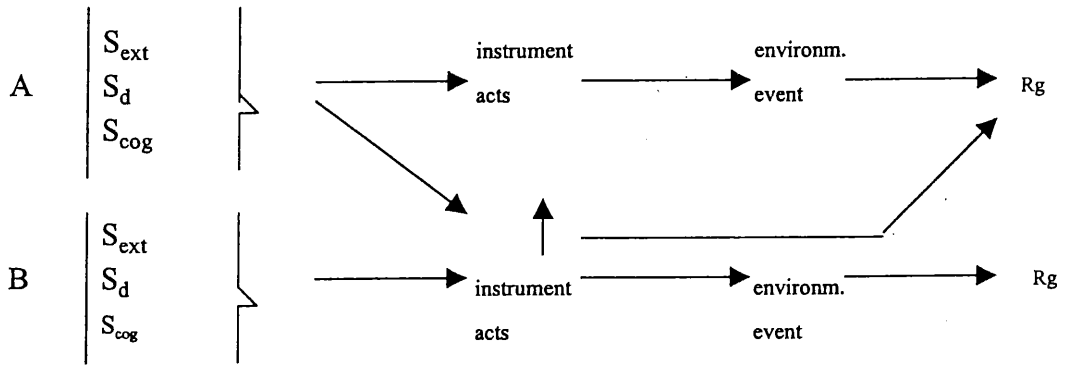

Fig. 6: Function and model of partner work.

In addition to the rational reasons for partner work, there are numerous other social motivation variables which make working with a partner an attractive option for children. The interdependency of these variables may be very complex.

Everyone needs to feel accepted by his peers, and so for partner work to be effective the respective partners must be valued such that it is a positive experience to be accepted by him. To ensure this, a certain degree of display behavior or exhibitionism may have to be tolerated and a certain amount of social give and take will be evident in the fulfillment of these social needs.

Communication occurs at three levels:

- Factual level (we give and receive factual information)
- Pragmatic level (we work with a partner because we have advantages from it)
- Relationship level (we communicate so as to establish our social position or fulfill our social needs)

We can assume that priorities will be different or that one or the other level of communication will predominate from situation to situation and from partner to partner.

Teachers should consider the following with respect to partner work:

- What facts (task, problem) are involved?
- What will each student gain from partner work?

- How far can social needs be fulfilled through working with a partner? Which social skills does each of the students need?

The last question is particularly important if the students are required to take on a certain role: in a partner dictation, for example, one student dictates, takes on the role of the teacher, and the other writes, takes on the classical role of a student. How does the "teacher" correct the "student"? Undiplomatic social behavior may cause emotional irritation at the relationship level.

Suitable tasks for partner work are principally those through which the learning goal can only be achieved or is facilitated by working with the partner.

Working in a Group

Why and when do we choose group work? There are three main lines of reasoning:

- Sociopolitical reasoning
- Anthropological reasoning
- Epistemological reasoning

Sociopolitical Reasoning

In today's workplaces in industry, finance, and administration, in banks, drafting shops, and hospitals we find teams, assembly groups, serving groups, and work groups. To master the tasks of today in large companies and corporations and to carry out projects in science and research, it is clear that specialists and experts must cooperate with each other. No one can maintain in this day and age that they have an overview of the entire field. Universal scholars and universals geniuses have disappeared from our complex world. Technology has become more refined: Specialists and experts have even evolved within the individual professions and must cooperate closely to reach a common goal.

Where rationalization and automation have made the work itself seem senseless to the worker, more effort has been invested in the consideration of human social needs, by respecting the social nature of man and by remodeling the workplace to make it a more convenient environment (Loesl, 1961)[3]. Finally, we have discovered that work morale and productivity can

be promoted by establishing more informal relationships (Stirn, 1961)[4], (Weiss, 1961)[5]. The introduction of group work for sociopolitical and economic reasons became an "Archimedean point of work organization" (Loesl, 1961)[6].

However, states and political groups are only as good as their members. Responsibility for the community, solidarity, and ability to participate are human qualities which guarantee that such communities will function.

These qualities must be acquired in school. In concrete terms, this means:

- Draw students out of their lethargy and train them to be observant, active young people; show them to what extent they can contribute to, be responsible for, or blamed for certain developments. This assumes that they participate with all consequence in discussions and decisions involving school.
- Give them the feeling that their opinion is not only desirable, but necessary and required and will be accepted and teach them that everyone must listen to everyone else.
- Develop and promote their communicative and intellectual skills through dialogue.
- Teach them how to critically examine their own opinions and to correct and even discard them, if necessary, in the interest of the present facts.

As a method, group work helps to solve these sociopolitical problems. In contrast to class teaching, activity is delegated by the teacher to the students. They are the active ones; they carry the major load of responsibility for what happens. They do the work, discuss the problem, and make the decisions but they also have to reckon with criticism of anything they do or say from their classmates and include this in their thinking and learn to express themselves in a comprehensible way. Classmates also represent a critical factor against which their behavior and statements must measure up. This awareness can motivate the students to think harder and to present more differentiated arguments. We must not forget that training young people to majority means teaching them to speak and think independently. For this, they must be taught to use language well and be encouraged to think for themselves.

Anthropological Reasoning[7]

What does working in a group, working together with others, mean for the development, anthropogenesis, and ego identity of an individual?

We cannot exist without others. As infants we are dependent on our fellow humans and from then on we are tied to each other through a multitude of interactions. The first cry a newborn makes to announce its existence calls upon those in its surroundings to take care of it. Its very being is founded on the existence of the others.

When we are born, we only have reflexes; we humans have not developed any behavioral patterns yet. We have to learn to find our way, to orient ourselves. Orientation is a necessity in life. Education offers such an orientation and, hence, represents a tool for life. It gives us the grammar to master our lives and teaches us how to survive. Even though societies differ in their structure and composition, what they offer, and how caring for each other is expressed, it is still generally true that we live from, through, and for others. We are tied to others through destiny and anyone can be the destiny of another.

With respect to social integration, the question arises as to whether an individual can be considered alone, whether you or I can be addressed as independent entities. We may have to abandon any idea of independence of the individual in nature and society which has been passed on to us. Emancipation, independence, and self-consciousness are not innate characteristics. Our concept of self develops from the dialectic confrontation with our environment and the people in it. Becoming and being a person is a life-long process of exchange. This "dialogue" is the pulse of human life and establishes the foundation for our existence: The "I" needs "You" to become "Self." Through dialogue with "You," "I" find "Self". When the "I" addresses the "You" and the "You" responds to the "I," both step outside of themselves, and they exist. Life is demonstrated by this stepping outside of oneself. Existence is the expression of life. If we want to live, we must express ourselves. Further, the right to exist implies the right to communicate and enter into dialogue with others. Life means living together.

Why, though, should students communicate with their peers?

Each "I" enters into numerous "You" relationships throughout the course of life. The "You" can be the parents, the teacher, a classmate, or a friend. However, the various "You" relationships differ from one another in content and quality. They may be perceived as pleasant or disturbing, liberating or restricting, or stimulating or boring. The variety in our human

relationships corresponds to the diversification in our relationship to the world. Polyvalent relationships and different discussion partners are necessary for our human development.

Meeting others of the same age is particularly valuable from a learning psychological and developmental psychological perspective. For most students it is a new experience to be confronted with the subjects presented in school. In contrast to adults, they have not formed any specific opinions, do not have any recipes for life, or have not issued any ultimate interpretations of the world. As members of a group, children set out together on the path to realization. Everyone must contribute to the goal of finding the answer. The fear of making a fool of oneself, of saying something wrong, or of not knowing the answer is not ever an issue. The sense of having the same chance as everyone else is motivating and stimulating. Everyone can articulate his own relationship to a particular theme. Group members will ask questions, correct themselves or the others, agree, and offer suggestions for change out of an elementary need to discover a clear answer for themselves. The common struggle for knowledge takes time: Observing childrens' attempts at formulating a statement and the effort which is invested in expressing in words a connection which has been understood or is sensed so that they understand themselves and are understood by the others shows just how much time this struggle takes. The endeavor of thinking the world through, discovering it, and putting it into words together with others of the same age demonstrates directly to a young person what he is capable of. He experiences that he has learned something and can be pleased about it. If he only has adults as partners, he will always sense their superiority and competence and may become resigned and not dare to allow his own intellectual and creative powers to unfold.

Epistemological Reasoning

In the cognitive process we differentiate between the subject who is seeking to comprehend, the object to be comprehended, and the relevant cognition thereof. Cognition is defined as what the subject seeking to learn has understood with respect to the object. Comprehension is always subjective by nature and depends on individual ability. Comprehension is also object related. In situations in which more than one person is attempting to comprehend one and the same object, the understanding of the object will vary, reflecting the differences in the subject-object relationships. This in-

dicates how well an individual is equipped to grasp the object and the results are correspondingly different in quality. How can this phenomenon be explained and how can subjective perceptions of the world be made objective?

Any object or any fact can be viewed from various standpoints. By changing our standpoint, in the act of giving up one position and taking on a new position (P), we also change our view. Hence, new aspects of the object are also presented.

Let us take the Hercules temple on the citadel in Amman as an example. From the Roman theater, it is viewed as rising above the horizon from the observation point. It seems nearly insignificantly small. We can just distinguish the columns. However, if we are sitting directly in front of the columns and look up, the Herculean power of the temple ruins becomes evident. When the colossal structure is right before our eyes, we directly experience its proportions. From the museum we can see the ground plan of the temple, which is still dominated by the columns but which then can be perceived in perspective. If we approach the temple grounds from the Amayaden palace in the evening, the reflection of the columns in the evening light and the view of the city between them are fascinating; the columns resemble massive picture frames, and looking through them opens yet further dimensions.

Up to now we have been speaking of spatial perspectives. Besides these, however, a number of meaning-related perspectives are determined by differences in intellectual interests. Hence, we can look at the temple as a historian, art historian, photographer, restorer, archeologist, security authority, tour guide, or director of a temple theater festival. The individual cognitive goal determines our perception. We focus our attention on what interests us; anything else more or less fades out.

This can be presented schematically:

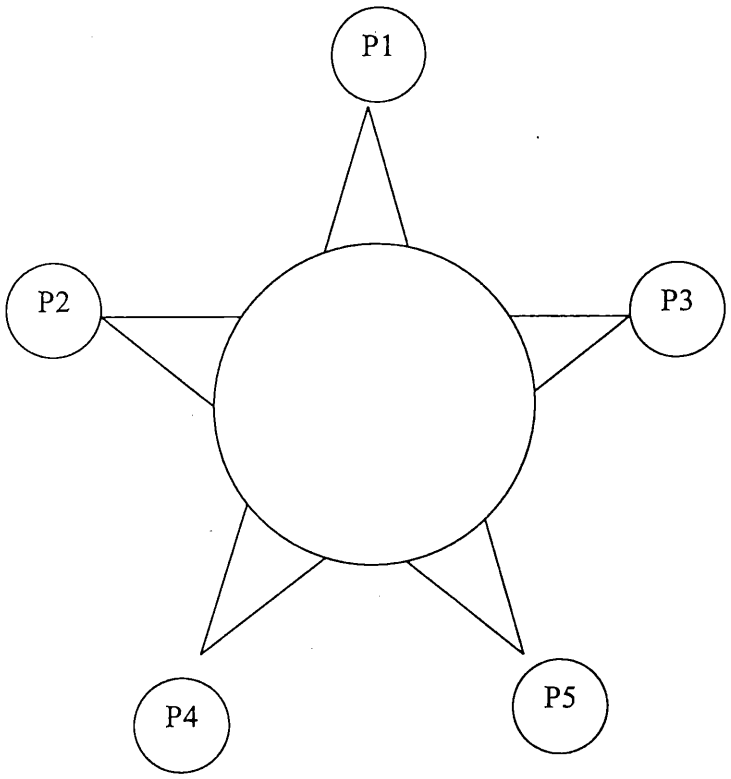

Fig. 7: P1-P5 identifiy the possible standpoints from which an object can be viewed.

In perceiving an object, there are a number of conceivable spatial and intellectual perspectives. Being tied to a certain place at a certain time as well as individual skill prevent us from seeing them all. An individual cannot be everywhere at once nor can he immediately process all intellectual perspectives. However, if we only view an object from one perspective, we do not do justice to the whole of it. Anyone who considers their own view as the whole one exemplifies the six blind men in the Indian tale, each touching one part of an elephant and puzzling about the shape of the animal. The first one, holding the tusk, says it must be like a spear; the second one, feeling the high, flat flank of the animal, thinks it must be like a wall; the third, hanging on to a leg, believes it to be like a tree; the fourth, touching the trunk, is convinced it is like a snake; the fifth felt the ear and thought it must be a fan; and the sixth grabbed the tail and thought it was a rope.[8]

One must grasp the whole object to comprehend it. Not until we have perceived the whole does our judgment do justice to the object and thus become more objective and appropriate. The object is more than a subjec-

tively perceived idea; it is the "geometral point of all perspectives" (Merleau Ponty).[9]

The examples show that we can develop a variety of relationships to something, which means that a "thing" can become meaningful to us in a variety of ways. The value and significance can only be discovered, however, by dealing with it in a variety of ways. Understanding something means discovering the potential relationships. This also applies to teaching subjects to texts, technical concepts, plants, animals, physical and chemical phenomena, questions, and problems. It applies to anything that we can learn. Learning means we enter into a new relationship with a fact, establish new relationships in the world, and develop and refine those we have already established.

In a traditional classroom, the intellectual perspective of the teacher is set down in the form of tasks, questions, and instructions. For example, the teacher determines what is to happen with a text. The student does that which the teacher considers meaningful. Since "meaning" is a subjective category, the student will never be able to develop a relationship to a classroom subject if his own intellectual perspective cannot unfold or if he cannot follow the teacher's line of thinking.

To give something meaning or significance means understanding it. We understand something when we have comprehended its significance. The comprehensive process, attributing meaning to something, is a creative act, and the center of activity can be found in the person learning – the student.

Group work makes it possible for students to develop their own relationship to an object; here they are required to struggle for comprehension and to interpret their own understanding, and not to take on anyone else's – usually the teacher's – interpretation. At the same time they learn how differently an object can be approached and the variety of ways it can be interpreted and examined by interacting with their classmates. Their own relationship is often corrected and refined and the opinions of the others reflected upon. In working with others, there are more opportunities to discover the variety of an object than there are in individual work or class teaching. Working in a group encourages a more differentiated perspective and, hence, more meaningful and appropriate cognition.

Not all teaching goals can be achieved in group work, but those which encourage children to look into and investigate something, those which require creative construction, and in part those involving the training and practicing of certain skills are. Looking into something, investigating something, and creatively constructing something all assume that

"something" does not yet exist or has not yet been discovered, or that a certain skill is not yet available or is still to be developed. In other words, at the beginning of a learning process, students should be presented with a problem that makes them curious, mobilizes their creative powers, and provokes them to solve it.

The practical implementation of group work requires certain organizational measures.

In many classrooms in the western industrialized countries, group tables have become standard classroom equipment. Figure 8 shows one possible arrangement of the tables which is not only suitable for group work but also for other social forms of learning and teaching, including even class teaching, since the students can all still see the board and follow the teacher's lecture. Even if the desks are arranged facing the front of the classroom (Fig. 9), they can quickly be moved around to set up groups of four simply by turning the chairs which are towards the front around and forming a group with the children behind them.

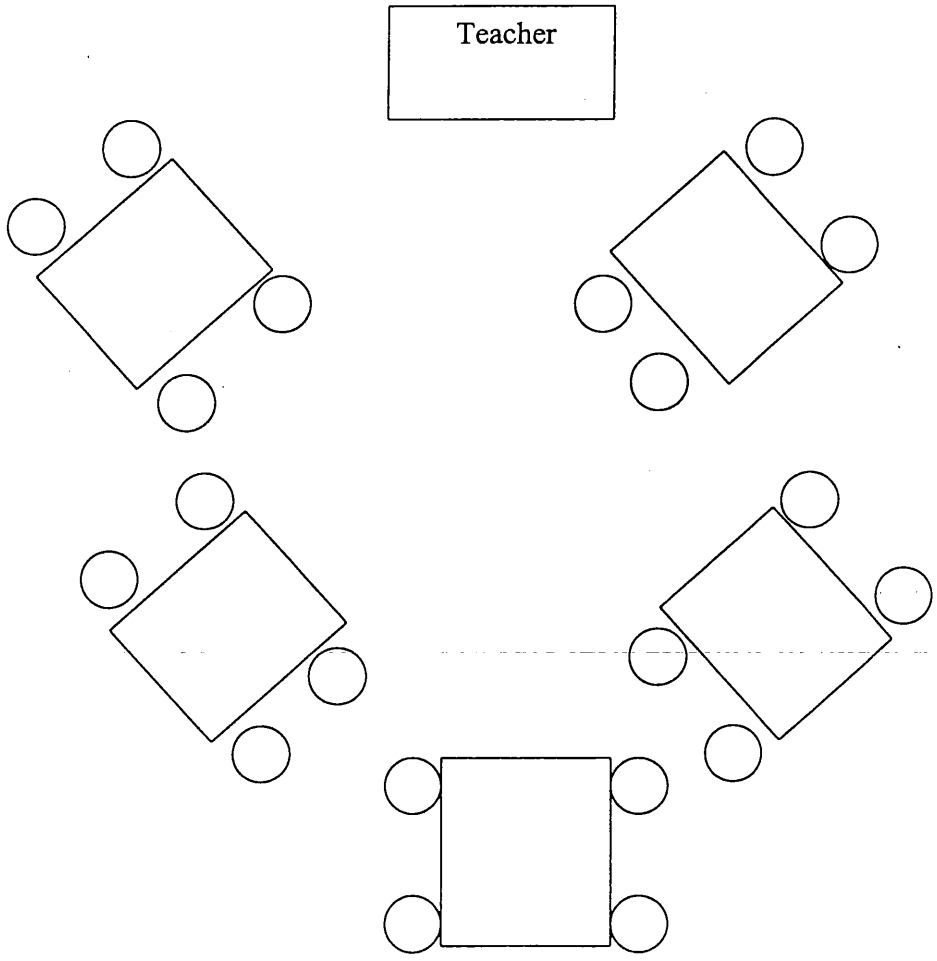

Fig. 8: Arrangement of group tables suitable for both group work and class teaching.

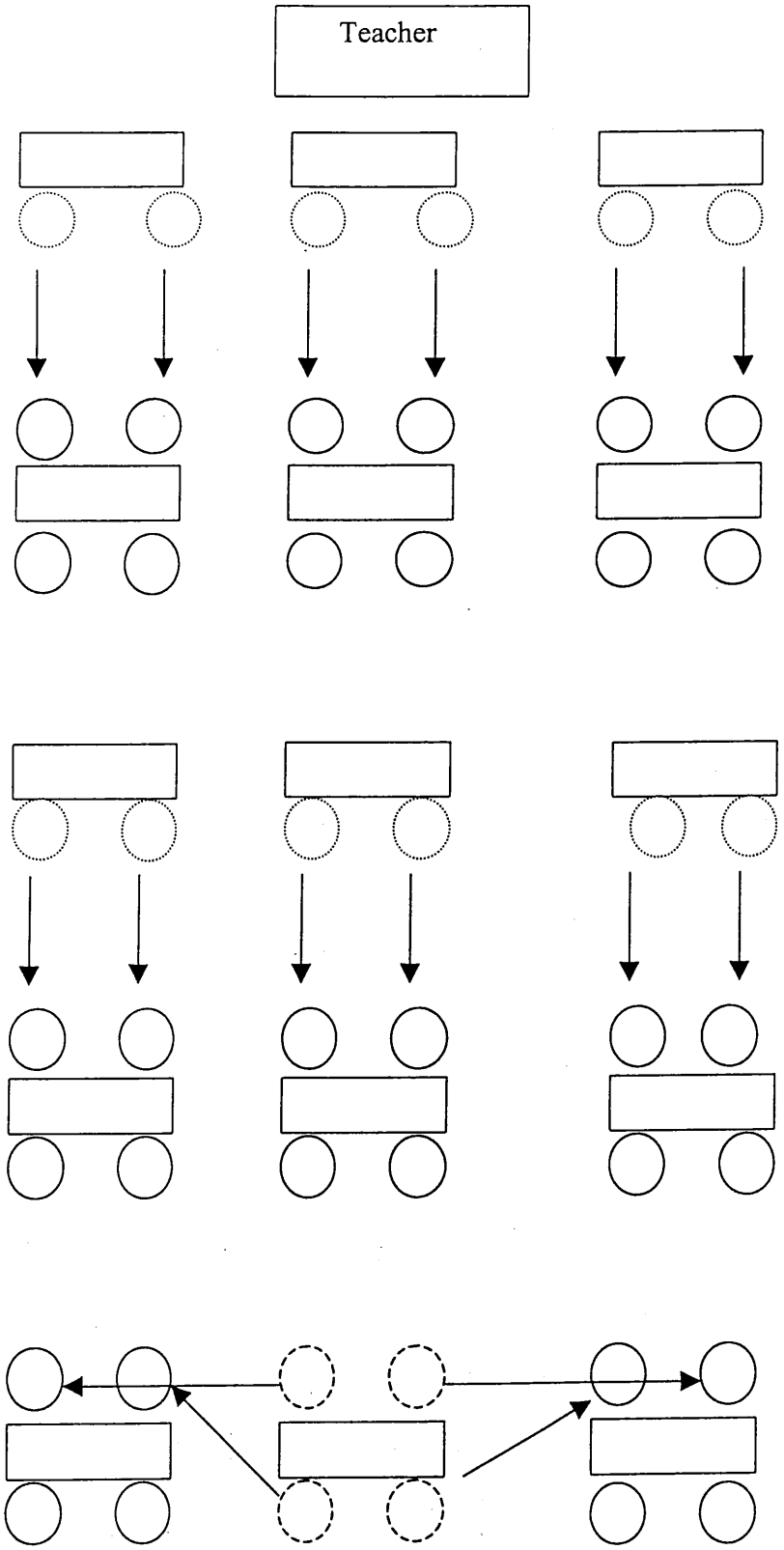

Fig. 9: Forming groups if desks are facing the front of the classroom.

Group Discussion

Discussion is always sensible when there is something to talk about or when there is something which still has to be decided. The openness and undecidedness of an issue represent the actual reasons for discussion.

Presentation of an open issue – whether through questions or arangements – can be initiated either by a student or the teacher.

As we have already seen (Fig. 4), the teacher is also one of the discussion partners. How can the teacher be a real partner? Hasn't he already found his own answers to all the questions which could be put up for discussion? As any other member of the group, the teacher can pose questions for discussion. He can also responds to the students' questions – which doesn't mean answering them! That would certainly end the discussion quickly. No, what is meant is listening to the students' questions and motivating them to search for their own answers, listening to their arguments, and allowing them to develop hypotheses – in other words, paying attention to what and how they think.

How can a teacher know what the students are thinking and what is going on inside them if he doesn't give them the chance to develop and formulate their thoughts? Thinking is dependent on speaking: if I don't allow students to speak, their thoughts cannot be expressed through words and are not accessible to those in their surroundings. The teacher's primary role in a discussion is to be interested and curious about the thoughts of the students. Herein lies the openness of a discussion situation.

The beginning of an open discussion can be developed in many cases by asking questions. It is not decisive who asks the question, teacher or student or both, but rather that the question is of mutual interest to the discussion participants. Nor is it important whether the question was expressed verbally or otherwise but rather that everyone involved is aware of what is to be discussed. The following example helps to illustrate how a discussion could begin:

The teacher places two glass receptacles at different levels and fills the one higher up with water. Then he holds one end of a glass tube which is bent on one end in the water and sucks on the other end until the tube is filled with water. He covers the end briefly and then lets go: the water flows until the receptacle on top is empty.[10]

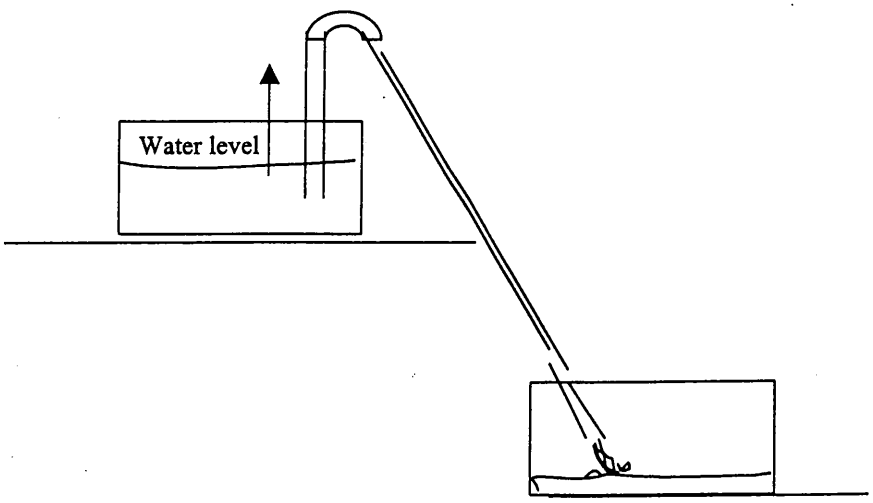

Fig. 10: Model of an experimental setup in a science lesson as the beginning of a discussion

The experiment shows that under certain conditions water can flow upwards. Until the students have discovered the laws of physics, they must formulate hypotheses and scrutinize them.

In this case no extensive verbal explanation of the problem is required. The arrangement of the physics experiment was perfectly adequate.

The written protocol of the discussion shows how familiar the students are with physical phenomena from their daily lives. It also demonstrates how they struggle to express themselves well but also their inability to find the words to make themselves understood.

Recognizing a problem, thinking it through, and then offering suggestions to solve it as well as clarifying the language for oneself are the central features of a good discussion.

Class Teaching

Class teaching can also be justified. It is useful when the teacher has to give information, explanations, and assignments to everyone. It is legitimate when everyone in the class is expected to have access to the same information. Some may argue that this goal is then best fulfilled if all les-

sons are conducted from the front of the classroom. However, student activity is reduced to listening during class teaching. Listening is important, being able to do so a virtue in a certain sense; however, being able to listen is not the only intellectual skill which guarantees successful learning. On the contrary, it is known that the art of listening is limited by time and that other learning activities, such as analyzing, constructing, experimenting, and many more, are more likely to ensure that the students have understood and to provide them with long-term learning success.

The choice for one or the other teaching form will always depend on the teaching goal. A teacher can perform an experiment in a science lesson and explain what happened to the students. On the other hand, he can stimulate the students to make up their own experiments and to observe what happens and then to develop hypotheses about the scientific laws which are governing them. The art of teaching is to design tasks which encourage and motivate the students to be active themselves. Learning goals can only be reached through the activity of the person learning.

During training, future teachers should learn how to decide what task is suitable for individual work, group work, discussion, or class teaching and to design specific activities for each form of instruction.

Notes

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Horst Hörner

Teaching Creativity and Encouraging Creativity in School

"A father didn't want his son to leave the trodden path or wander cross country to learn about the world, so he gave him a horse and wagon. 'Now you don't have to walk anymore' were his words. 'Now you may not walk anymore' was the implication; 'now you can't walk anymore' was the effect."

(After Günther Anders)

Two questions will be addressed in this chapter:

1. Why should children be taught to be creative?
2. How can creativity be encouraged in school?

The first question can best be answered by comparing humans and animals, i.e., from a philosophical–anthropological perspective. To answer the second question, didactic considerations are required.

1. Why Should Children Be Taught To Be Creative?

The necessity of teaching children to be creative is implicit in human existence. Philosophically speaking, animals have a natural environment and are a part of creation, but human beings create their own world[1]. Animals are born into their environment. They live there and only there. Furthermore, they are restricted to the environment of their species. What they perceive and do is, for the most part, established and determined. No animal species lives and behaves like any other, not even if their environments are identical. An animal understands whatever is required for the survival of its kind and whatever serves to fulfill the vital, species-specific needs. Instinct tells an animal what the species requires. It is inborn and hereditary. Anything that does not attract the animal drive and instinct does not exist – and if it exists, only represents an obstacle to satisfying animal craving. To have an environment means that an animal lives in a small, defined habitat according to established patterns of behavior.

In contrast to animals, humans have their own world. They are open to the world. Being open to the world implies both opportunity and risk. The risk lies in being vulnerable when facing the world as a biologically deficient being and taking the chances offered by necessity and opportunity to create one's own world. Except for hereditary motoric behaviors, humans are not born with a behavioral program. They have to learn to live in the world. The human being is cast into existence and has a dynamic, dialectic relationship to the world which molds his individual development and determines his life. Noncommittedness opens up a wealth of possibilities in life and for individual, varying relationships to the world. Open-mindedness, however, continually presents a human being with a series of tasks. He has to reorient himself repeatedly in the world: he must re-establish himself, build his nest, take care of himself, sow the fields, and create – that is, cultivate – the world which he has been born into.[2]

Cultivating something, however, presupposes creative powers in human beings. Indeed, these creative powers are creativity. Being open-minded requires creativity, and so without creativity, humans would be lost. Creativity is virtually a "family trait," humanness per se.[3] Open-mindedness and creativity make us individuals and make it possible to develop a culture. Animals are natural beings, humans largely cultural beings. Open-mindedness is specifically human, and developing a culture is the mission of humanity.

The human race could never have developed without creativity, and any further development depends to a large degree on the exploitation of creative potential in solving technical, ecological, economic, political, and ethical problems.

Teaching creativity, or better said, encouraging creativity is imperative for the development of young people. In theory, this may be self-evident to every teacher, but students are often hindered in their creative development.

Humans, called upon to create the world, do not do it just for themselves but rather for their contemporaries and offspring. Their works affect others. In a certain sense, this is good. However, we often consider our fellow human beings as part of the world which is to be created – as objects which are at our beck and call and which we can manipulate and decide for – and not as independent beings with their own creative potential. "Homo creator" does not stop at members of his own species in the drive to create his own world. It only seems meaningful when the others behave and function as he imagines they should – when they take on his way of

thinking. His world is not right until the others have fulfilled his expectations and ideas. That the development of another person is being hindered or that another person is being prevented from leading his life in a way which is meaningful to him is either not perceived or is consciously staged by dominating people. In such a situation one person becomes the downfall of another, estranged from his actual being and original destiny. Such situations are the cause of many conflicts in education, professional life, and politics.

Only an understanding of the actual essence of a human being – of all humanity – and a consciousness derived from this knowledge can prevent abusive and paternalistic treatment of others and can guarantee that each individual has room to develop. The call to create the world applies to everyone. It loses legitimacy for one person, however, at the point when another is hindered to an unacceptable extent.

In today's world the space allotted to each individual is getting smaller and new areas of our lives are being programmed. One speaks of perfecting one thing and actually wants relief from something else. Relief, however, can become a burden! A person who has been relieved of something senses his impotence more in the attempt to create his own life. Such a development is comparable to a classical tragedy because the human being, without knowledge of his real self, holds the blame for this development.

There are many examples of how external factors determine the course of our lives. An architect plans uniform housing for hundreds of families. In hundreds of apartments, the television stands in the same corner; the arrangement of the rooms is programmed by this uniform plan to the extent that the living space is planned up to the last square meter, depending on the number of family members. Through rationalization measures and assembly line work in administration and in factories, a person's work is programmed down to the most minor procedure. Vertical and horizontal division of labor in modern industrial society requires specialization in our occupations such that work for many of us no longer shows any resemblance to creativity.

The horizontal division of labor includes assembly line work, in which workers usually are required to carry out stereotypical hand movements. Often the work is repetitive and there is no room for making decisions or for any individual structuring.

Predetermined conditions and planning without consulting those who are affected can also be encountered in the educational setting. That which is learned and read differs from country to country and nation to nation.

There is no consensus among experts regarding lesson content; there is agreement to a large extent, however, that students never have any say about what they are to learn. By using didactically prepared school books, i.e., materials with central questions, mnemonic phrases, and algorithms, not only the content but also the thematic aspects thereof are given. Instead of presenting the students with problems to solve – or even better – having them bring their own problems into the lesson, solutions are supplied before the student has grasped the problem itself, let alone actively participated in solving it.

Lessons which are based on such teaching materials really only present the world through the eyes of a few adults, instead of helping a child to learn to interpret it for himself. Many people think that illustrations and schematic drawings in books make primary experience superfluous since they show students what they actually should see.

The words of a physics teacher serve as an example of such a practice: "If I draw electromagnetic waves on the board for my students, an experiment is superfluous. They believe what I write on the board."

True education is not possible without creativity. Education and creativity are mutually implicit. The verb that goes with education is educate. One educates oneself; one is educated by educating the world. The educated experience themselves in their work. It would be wrong, however, to think that education is restricted to a privileged few or creativity to artists, scholars, or leading members of industry and politics.

Creativity is also required in daily life in the creation of our own living space, in communicating with others verbally and in writing, in planning our personal and professional futures, in solving technical problems, and in answering aesthetic questions whenever the thought and solution schemes we have been taught do not suffice or convince us anymore.[4] Scientific progress is unthinkable without creativity. As the history of science has shown, research has mainly been spurred on by the development of new methods.

Schools need to be aware of this if they are to be entrusted with generations of young people. Creativity is an approach to life, the ability per se for mastering life. However, creativity is not only a personal approach, it is a means of survival of every society.

Tomorrow's society is as good as today's school. School is responsible for the future of society. Predetermined lesson content and tasks pertaining to these lessons may seem more efficient from the point of view of the adults, and it may be more time effective to protect students from making

mistakes from the very beginning and to tell them right away what the object of a lesson is; it may even stem from genuine solicitude and precaution. However, what is meant as precaution can degenerate to overprotection and ultimately incapacitate a person. What precaution is to an adult may be perceived as patronization to a young person.

If adolescents do not accept the world of the adults, and if they do not agree with their precautions and interpretations of the world, they are considered ungrateful. The reaction of the adults is often incomprehension or resignation, or even to impose sanctions. These adults have not yet grasped that young people must have the right to assert their own intellectual existence. For them the Arabic poet Kahlil Gibran wrote in his masterpiece "The Prophet"[5]:

"Your children are not your children.
They are the sons and daughters of Life's longing for itself.
They come through you but not from you,
And though they are with you yet they belong not to you.

You may given them your love but not your thoughts,
For they have their own thoughts.
You may house their bodies but not their souls,
For their souls dwell in the house of tomorrow, which you cannot visit, not even in your dreams.
You may strive to be like them, but seek not to make them like you.
For life goes not backward nor tarries with yesterday."

Many have tried to define creativity. A wealth of examples can be found in the literature. Interestingly, all the definitions sound like the Latin root "creare," meaning produce, cultivate, be creative, and form.

Creativity reaches its limits at the point at which fellow beings and the unified community would be harmed. It is a tool for life and serves to enhance quality of life in many areas: Take the fields of medicine, technology, and transportation. On the other hand, it can also destroy life, as the atomic bombing of Hiroshima showed us. Creativity can be very useful for humane goals, but there is also such a thing as criminal creativity.

Thus, teaching children to be creative always means teaching responsibility.

2. How Can Creativity Be Encouraged in School?

To answer this question, a number of other questions must be answered first.

The study of the phenomenon of creativity clearly shows that it is person specific and that creativity also yields products. Such a product is the result of creative acts and creative processes. Correspondingly, in the literature a differentiation is made between the creative personality and the creative process and the creative product. It is certainly practical to distinguish between these three things; however, we should always be aware that we are talking about three elements of creativity which are structurally and interdependently related. In more concrete terms: without a creative personality, there would be no creative process or no creative product (see Fig. 1).

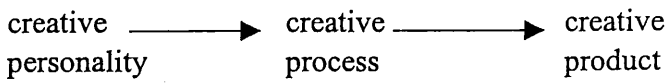


Fig. 1: Structural elements of creativity

This can be formulated in yet another way: a creative product indicates that a creative process has taken place and points to a creative personality (Fig. 2).

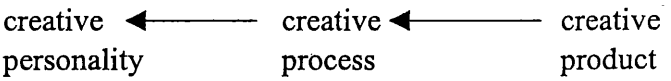


Fig. 2: A creative product indicates a creative process and a creative personality

A lack of creative products in some situations – and school is unfortunately often one such situation – does not necessarily mean that the students do not have creative abilities. The birth of creative processes and producing creative products are largely dependent of the conditions in our surroundings. Whether someone is creative depends on whether that person is allowed to be creative (Fig. 3).

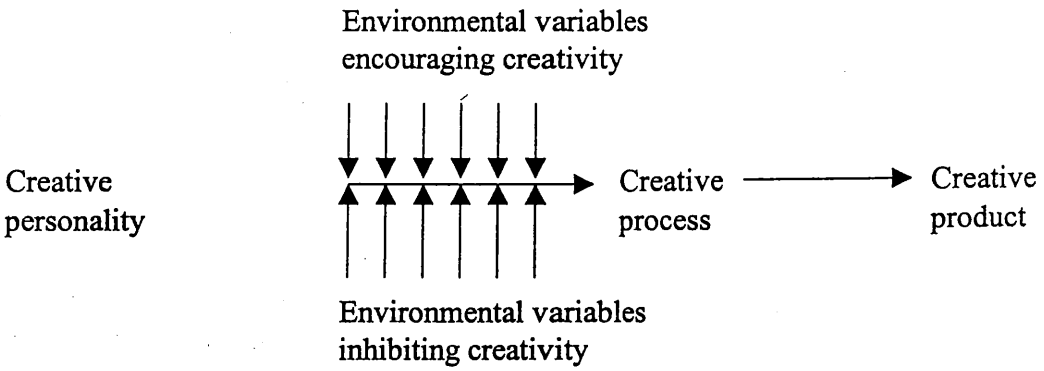


Fig. 3: Environmental variables determine the development of creative processes

Features of a Creative Personality

Creative personalities are distinguished, as research results from the field of differential psychology have shown[6], by the following features in particular:

- Consciousness or sensitivity to problems
- Ideational fluency, word fluency
- Flexibility

What do we mean *by sensitivity to problems* or *problem consciousness*?

Consciousness is defined as the knowledge, perception, and imagination of circumstances that are consciously experienced. Anything can be an object of consciousness: an impression and our own actions. In terms of language history, the word "problem," which has made its way into many, many different languages, comes from the Greek "problema" and originally meant "ledge," "foothills," and "cliff," and then finally "obstacle." Hence, problem consciousness or sensitivity implies knowledge of obstacles and difficulties. Using Gestalt psychological terminology, it means the awareness of "bad gestalten."

Those things become a problem which deviate from internalized norms (moral/ethical, political, and aesthetic norms and standards of knowledge). Since we learn norms from our families and through social processes, problem consciousness is also determined within the context of our family and society. Differing biographies and developments determine interindividual differences in problem sensitivity. Like consciousness in general, problem consciousness varies individually and is subjective. Whether

something is a problem depends on the degree of differentiation in the world of norms and values which a person has developed throughout the course of his life. If a young person is exposed to many different and pluralistic norms and values, it can be expected that his problem sensitivity will be distinct.

As a characteristic of creative behavior, problem consciousness is learned through socialization and differs among individuals.

Since nothing is so good that it couldn't and shouldn't be improved upon, society – and particularly schools – have the task of making it possible to recognize paradoxes, and, hence, of encouraging sensitivity to problems. Even offering students the chance to present their problems or ask questions in lessons can represent the beginning of developing sensitivity to problems. Teaching reforms such as those of Freinet[7], the American Free Street School movement[8], and Danilo Dolci[9] with his work in the Centro Studi e Iniziative in Sicily have shown that student-oriented teaching is possible. All three concepts have in common that students are given the opportunity of gaining primary experience. They are taken out into nature and to actual workshops and allowed to observe what is happening, making it possible for questions to arise on the spot.

If a person doesn't have a question, he can't try to answer it. If a person doesn't see any problems, he can't solve any. Students need to be encouraged to ask questions and to articulate their cognitive interests, no matter how absurd they may sound. Danilo Dolci quotes numerous questions which have been formulated by students – and which often cannot be answered[10]. Of course, students' questions and problems can disturb teaching, and students who ask a lot of questions are often considered troublemakers. If their questions aren't answered, they are frustrated. They isolate themselves and are hardly interested in the teacher's questions anymore.

By *word fluency* and *ideational fluency* we mean the ability to produce as many ideas as possible with regard to given concepts and tasks. Testing this ability is not only of diagnostic value, it opens the door to a multitude of associations and ideas for the person being tested. The freedom of thought which is experienced encourages students to take unusual paths to solve difficult problems later on in life. If they have experienced in school that "anything goes,"[11] then they will work on the solution to problems until they have tried everything. Teachers can devise tests or tasks which stimulate the quick production of words and thoughts. For example, give only the initial letter of each word in a four-word sentence and ask the test

subject to construct as many sentences as he or she can with the beginning letters:

W..... c..... e..... n.....

(for example "We can eat nuts." "We come every night.")

The more paths of association there are that can be taken, the more success a person has in producing words and thoughts. Here, radial thinking rather than linear thinking is called for.

By *flexibility* we mean the ability to free oneself from traditional ideas and thought patterns and from solution schemes. Flexibility makes it possible to form a new perspective or re-arrange our field of perception. It helps in restructuring problem situations, if required, and hence in finding solutions. The dotted square test of Maier demonstrates this ability particularly impressively.

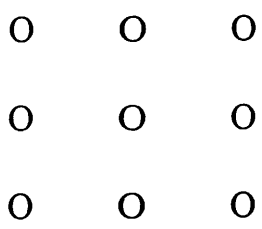


Fig. 4: The dotted square according to Maier

All the dots in the square can be joined with four lines, without lifting the pencil. In order to solve this problem, you first must recognize that connecting the dots within the configuration does not produce a satisfactory result. You must extend the line outside the dotted square to find the answer (see Fig. 5). The problem can only be solved by restructuring the given field of perception.

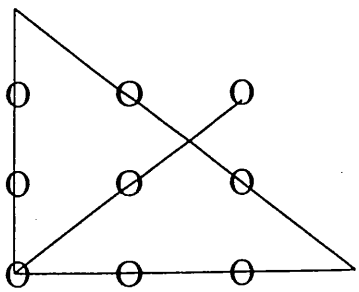


Fig. 5: You must go outstide the original field and gain a new perspective.

Those who cannot free themselves from traditional solution schemes will have great difficulty solving such problems. Here, flexibility is evident in the ability to re-organize or restructure fields of perception, to free oneself from ingrained patterns, and to try something new.

Whether flexibility is inherited or learned behavior[12] is less important in this context than the obligation not to require students to solve problems and think according to specific patterns but instead to encourage them to develop new problem-solving strategies. A person who experiences a pluralistic perspective is less likely to be intolerant of variation[13].

A number of tests for determining the aforementioned personality factors are available in which problem consciousness, word and ideational fluency, and flexibility are operationalized and which show concretely how this should be interpreted. It is difficult to say whether a person is predisposed to these abilities or whether they are learned abilities. As expected, test subjects react differently in these tests just as in other tests, and so the question "why" still has not been answered.

The Creative Process

Creativity only becomes evident through the creative process. Productivity becomes apparent in a human being through the act of making something. A person can experience his own power when creating something or his powerlessness if he cannot create anything. Creativity has existential significance.

Not all productivity is creative, however. What distinguishes the creative process from other activities a person may undertake, for example, from what we understand as "work"? Of course, the creative process may yield a creative product, but it is not only a means to an end; like a game, it has a purpose in itself.

If we observe children at play or the activities of young people, we can see that being busy and being active is sometimes more motivating than the object of the activity. Often the object (for example, a sand castle at the beach) is destroyed as soon as it is finished and the activity starts anew. The transient "happenings" in modern art demonstrate most impressively the self-fulfilling purpose of creating and acting. The creative purpose has its own value insofar as a person is aware of his own abilities and can discover himself during the process. He can experience that he can achieve,

create, and change something and that life is creativity and creativity is life.

Creative thinking, which accompanies each and every creative process, has also been termed "divergent thinking" by Guilford[14]. Today, creative thinking and divergent thinking are sometimes used synonymously. By divergent thinking, Guilford[15] means the kind of thinking that develops in different directions. Getzel and Jackson define "diverging" as "deviating from the social norm"[16]. In their view, divergent thinking would be a kind of abnormal thinking.

There are various possibilites of demonstrating the thought processes that develop in various directions:

1. Using different problem-solving strategies (for example, in mathematics to find a surface area (Fig. 7), one and the same result is found in solving a given problem (Fig. 6).

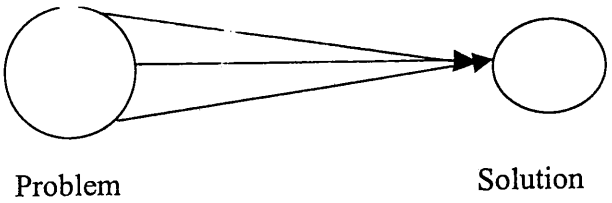


Fig. 6: Various possibilites of solving a problem lead to the same solution

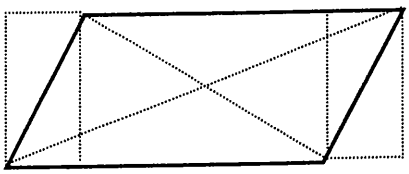


Fig. 7: How many different ways of finding the area of a parallelogram are there? Some of these are presented[17].

2. There are various ways of solving a given problem and various solutions to it which may differ qualitatively, aesthetically, or economically. For example, students conduct a campaign against smoking using pictures, texts, and interviews.

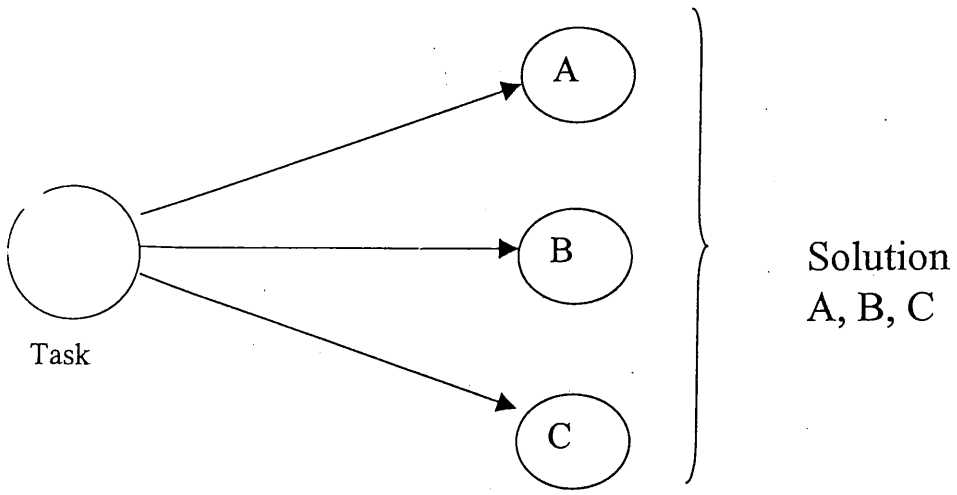


Fig. 8: There are different solutions to a task, all of which serve the same purpose (a campaign against smoking)

3. During the problem-solving process thought patterns have to be changed more than once. Familiar schemes of thinking have to be given up and new ones developed. The fact that students are allowed to make mistakes is implicit from the start. It is common knowledge that people learn from their mistakes and gain new experience and new insight (Fig 9-16).

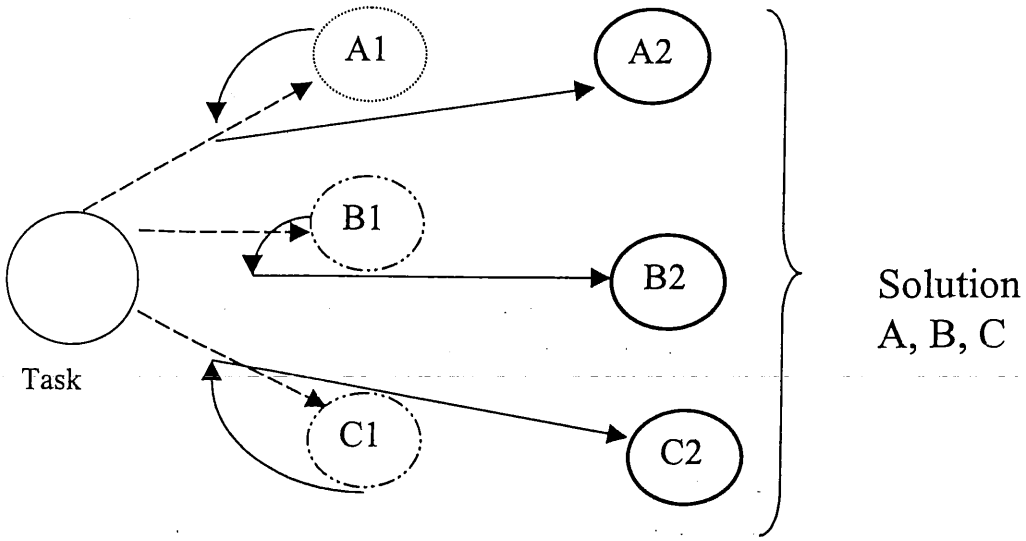


Fig. 9: After realizing there are unsurmountable obstacles in the first attempt (A1-C1) ways of switching to another track along the thought process path can be sought.

In an attempt to stabilize a road on a bridge in science or engineering lessons[18] (Fig. 10), the student discovers that the solutions were wrong after the first load test (Figs. 11-13). The problem must be reconsidered and the load distribution of the bridge analyzed (Figs. 14-16).

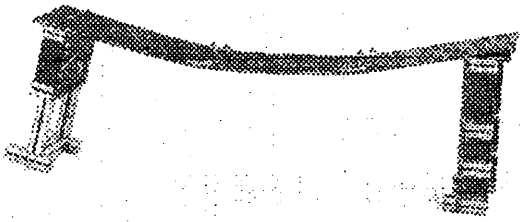


Fig.10: The road on the bridge must be stabilized.

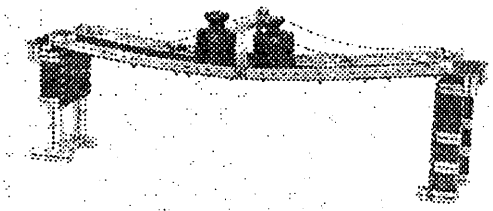


Fig. 11: First attempt at stabilizing a girder bridge.

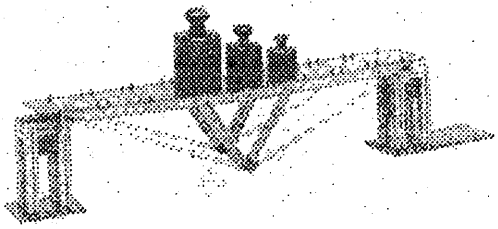


Fig. 14: Successful attempt at stabilizing the bridge.

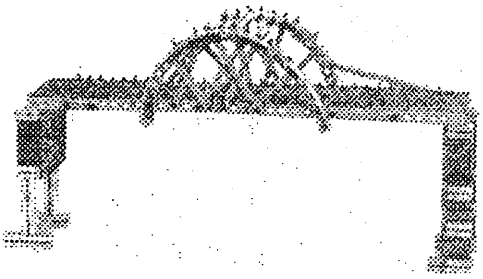


Fig. 12: First attempt at stabilizing an arched bridge.

Fig. 15. Successful stabilization of an arched bridge.

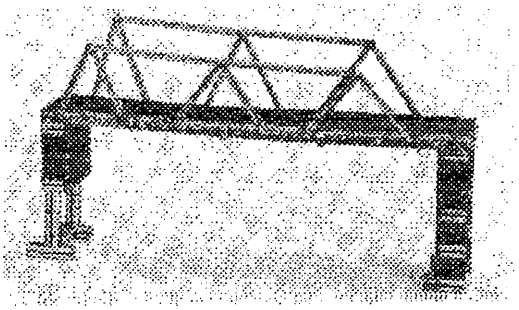


Fig. 13: First attempt at stabilizing a truss bridge.

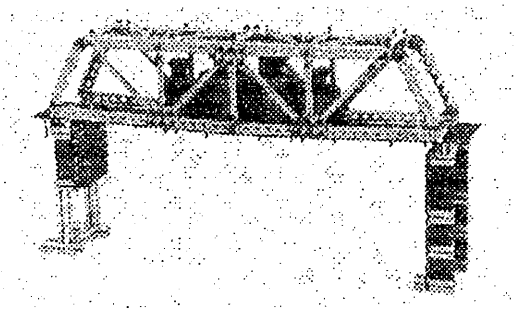


Fig. 16. Successful stabilization of a truss bridge..

The examples depicted here demonstrate different solutions and solution or construction methods. Furthermore, they show how new insight can be gained through construction mistakes.

The Creative Product

Originality is said to mark a creative product. Originality, understood as a rarity or unique thing, is usually statistically determined in creativity tests. Products are classified as original and less original according to a norm from which the creative product significantly deviates. Accordingly, statistical rarity is taken as the measure of originality of a product. Norms can originate from different systems of reference, however. A student's drawing can only be sensibly compared with drawings of other students or his own earlier drawings and not with the works of the masters. Any claims pertaining to originality are always relative and only sensible within their respective reference system. In school it is recommended that the performance f each individual student be taken as the system of reference.

Aspects of Creativity Training and Tasks for Creativity-Oriented Teaching

Whether students can be creative essentially depends on how a task or problem is presented. A task that is intended to initiate creative behavior should be able to be solved in more than one way or there should be more than one solution, or both, and consciously encourage creativity. Additionally, such a task should stimulate individual and independent thinking.

The times are gone in which Galilei was threatened with torture for thinking differently than comtemporary Christian thought allowed; however, divergent thinking is scarce in our schools even today, and some-

times even undesired. There are many explanations for this. Torrance writes, for example: "The goal of teaching is that all students learn as much as possible at the same time. Those children who are always curious delay the course of the lesson and may embarrass the teacher with questions he cannot answer or answers he did not expect. The teacher must try to coordinate the activities of the students and is hindered by those children who follow their own interests, have their own work rhythm, are not afraid of the teacher, and are self-assured."[19]

It is not a seldom occurrence that a teacher's vanity is wounded or that he feels his authority is not respected if a child looks for other ways of solving a problem and finds other solutions. Creative children are intellectual nonconformists and function outside of the norms of thinking and behavior which have been set by teachers and such children are often written off as troublemakers and outsiders.

Creative students need creative teachers in order to develop, teachers who are tolerant of those who think differently, and whose pedagogical creativity lies in helping their students to develop their aptitudes creatively and who measure their own success in terms of the independence, originality, and individuality of their students. They find pleasure in the variety of thoughts and ideas offered by their students. Amonaschwilli, a fellow teacher from the country of Georgia, compared creative teaching to a "tree in bloom in the spring which is full of singing birds". Some see pure chaos in this picture. We don't want chaos, of course, but we do want intellectual vivacity!

In creativity-oriented teaching, divergent processes of thinking will be observed. It is our job, then, to develop tasks which stimulate the processes we schematically presented in Figs. 6-9. Such tasks can be formulated for many topics in our curriculum. In preparing a lesson the teacher can decide:

- Whether he will dictate the questions or whether the students should be encouraged to formulate questions.
- Whether he will demonstrate something to the students or whether he allows them to discover something.
- Whether he presents finished ways of solving a problem or allows his students to find solutions.
- Whether he only allows one answer to a problem or expects more than one.

Some tasks which can stimulate divergent thinking are presented in the following:

1. The theme "sink or swim" is in the science curriculum. This is usually taught by the teacher in the following way: he brings a glass container filled with water to class and puts various objects into the container. Some of them sink immediately and some of them float on the surface. The task of the students is often just to categorize objects into those which float and those which sink.
   An alternative to this would be for the teacher to think together with the students about how to prevent a heavy stone from sinking. The question would then be:

"What can we do to stop the stone from sinking?"

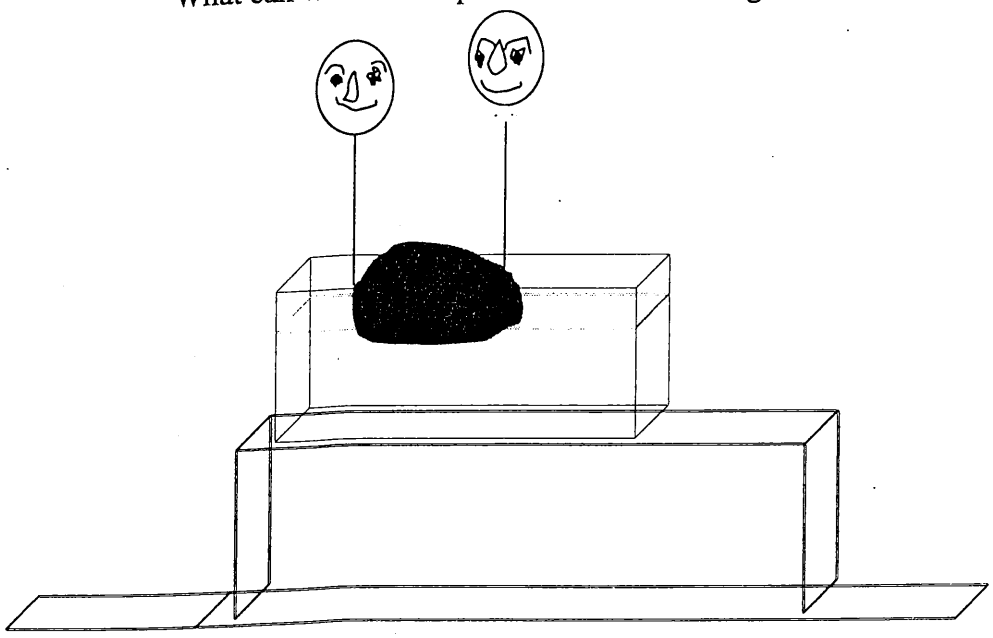


Fig. 17: How to prevent a stone from sinking

A class of third graders first thought about what materials would be necessary to keep the stone from sinking to the bottom. The next day they brought balloons, styrofoam, wood, wire, and empty containers and experimented with them. Some of the children tied the stone to balloons which they had blown up (Fig. 17), others put the stone into metal containers, and yet others tied the stone to small pieces of wood with wire. All of the constructions prevented the stone from sinking. In asking "why" afterwards, elementary scientific phenomena and princi-

ples such as specific weight and buoyancy could be recognized and explained to the students with respect to the various solutions they had come up with.
Creativity and divergent thought processes can be encouraged in the teaching of any subject. It is the teacher's task to formulate the topics given in the curriculum so that the students are motivated to search for many possible solutions and to produce different results.

2. "How can we experience air and/or make it visible?"
Fourth graders are certainly capable of coming up with experiments on this theme. The teacher can help by bringing certain materials to class (straws, water containers, wind instruments, ventilators, etc.) to challenge the children.
3. "Next week a boy/girl from Saudi Arabia is coming to visit. He/she would like to become acquainted with my city or village. I will draw a map with explanations of all the sights."
4. "We would like to renovate our school grounds or re-arrange our classroom."
5. "Write a funny story using the words camel, tourist, policeman, and water."
6. "We would like to make a new obstacle course in physical education to test our speed and skill."
7. Let's write a script and make a videofilm about our school.
8. We could have a project on the subject "protecting the environment in our village." Identify sources of danger and report about pollution. Conduct interviews with adults and other students. Have a photo exhibit.
9. Our country. In art class we make a collage presenting the attractions and sights in our country.
10. We could write a poem about the fabel "The Lion and the Mouse."

These are only suggestions for themes, some of which could even be used in combinations of subjects. They illustrate the structure of the kinds of tasks which are suitable for initiating a creative process.

If this seems too time consuming, you can start on a smaller scale, for example, by assigning the students to come up with questions which they could pose to their classmates for reviewing their lessons with a partner in language or mathematics lessons.

Schools need creative teachers who plan creativity-oriented lessons, teachers who are able to develop tasks which stimulate divergent processes. The noise level is higher in schools where children work like this than in schools where listening and memorizing are the only forms of student activity. On the other hand, boredom with school, disinterest, and even complete lack of interest in school are greater in schools where the students are not allowed to do anything. Those students with a creative potential are the ones who are bored most when forced to be passive and inactive. The discrepancy which is observed over and over again between school performance and professional success later in life should not have to persist. If spontaneity, improvisation, and abundance of ideas[20] are qualities which play a central role in professional life, then these skills should be cultivated in school.

Notes

1 Compare Scheler, Max (1962). *Die Stellung des Menschen im Komsom.* 6th edition, p. 38. Bern/Munich,

2 The manifold use of the term cultivate reflects the diversity of human connection in the world. The concept is used in agriculture, politics (political culture), and in laboratories (bacterial cultures). One speaks of language cultivation and intellectual cultivation, to name just a few of these areas.

3 Roth, Heinrich (1976). Kreativität lernen? In: *Die Deutsche Schule*, 68. Jg., p. 146.

4 Roth, Heinrich (1971). *Pädagogische Anthropologie*, Vol II, p. 154. Hannover.

5 Kahlil, Gibran (1970). *The Prophet*, p. 17. New York.

6 Guilford, J. P. (1964). *Persönlichkeit*, pp. 353 ff. Weinheim.

7 Freinet, D. (1965). *Die moderne französische Schule.* Paderborn.

8 Dennison, G. (1971). *Lernen in Freiheit. Aus der Praxis der First Street School.* Frankfurt.

9 Dolci, D. (1969). *Die Zukunft gewinnen.* Bellnhausen.

10 "Why am I on this planet?" "Why aren't I a horse?". In Dolci, D. (1969), ebd., p. 30.

11 The motto in Feyerabend, Paul (1977) *Wider den Methodenzwang*, p. 35. Frankfurt.

12 The numerous training programs for teaching creativity all assume that flexibility can be developed. We can recommend De Bono (1971). *Laterales Denken.* Reinbek bei Hamburg. – Michael Luther & Jutta Gründonner (1998). *Königsweg Kreativität.* Paderborn.

13 Bergius, R. (1964). Produktives Denken. In R. Bergius. (eds.), *Handbuch der Psychologie*, Vol. 1. Part 2, Lernen und Denken, p. 527. Göttingen.

14 Guilford, J. P. (1964). *Persönlichkeit,* p. 353. Weinheim.

[15] Op cit., ebd., p. 353.

[16] Op cit., ebd.

[17] This solution is certainly more complicated than the simple use of the formula g x h/2.

[18] Numerous examples can be found in Hörner, H./Kaufmann, F. (1975). *Statische Problems bei Brücken, Türmen und Masten*. Handbuch III, Sekundarstufe I. fischertechnik - Schulprogramm. Braunschweig.

[19] Ulmann, G. (1968). *Kreativität*, p. 114. Weinheim/Berlin.

[20] Serve, H. J. (1995). *Förderung der Kreativitätsentfaltung als implizite Bildungsaufgabe der Schule*, p. 235, 2nd edn. Munich.

Albrecht Abele

The Problem–Solving Approach to Learning Mathematics

There are several proposals under discussion as to how to introduce mathematical concepts and relations to young children. With regard to some of the results of these discussions five main questions must be addressed:

- Question 1: Why should we use the "problem–solving" approach?
- Question 2: What characteristic features must a task have to be called a "problem"?
- Question 3: How can problem–solving help students learn mathematics?
- Question 4: How should problems be designed?
- Question 5: How can (other) teachers make use of given examples?

1. Why Should We Use the "Problem–Solving" Approach?

Who is responsible for the failure of pupils in mathematics: the teacher who "hasn't explained it well"; the "method" which the teacher has used to teach the lesson; the social environment in which the pupils are growing up or the family who doesn't think mathematics is important? Or is it the pupil who doesn't understand what the teacher has explained, or who doesn't pay attention, who simply daydreams during the lesson because he isn't interested in the subject? Should the teacher then take special effort to motivate the pupil or is it even an inevitable destiny that some pupils don't have an "aptitude" for mathematics? Most of these questions are based on a model of teaching mathematics which proceeds from the assumption that there are those who are good at mathematics – adults, in particular the mathematics teachers who are responsible for the learning process of the pupils – and those to whom this knowledge must be "taught" – the pupils. Mathematics is understood as a ready construct which must be passed on

as a "cultural feature" to the next generation. Mathematics lessons then are a diphasic matter: "teaching" is the task of the teacher who *explains* known facts – "learning" the task of the pupil. The pupil is required to follow and *understand* the explanations of the teacher. Then he is expected to know how to use what he has understood, i.e., do arithmetic. This conception of mathematics, which is still very widespread, overlooks the results of numerous, productive attempts which have developed in schools in past decades and which clearly stressed self-supporting pupil activity in the learning process. Moreover, this conception disregards learning psychology research findings of the last 50 years.

The history of the theory and practice of learning and teaching mathematics is characterized by this controversy of two principally different positions, *passivity* and *activity*. The first standpoint philosophically assumes that learners imitate what they see and hear but are otherwise passive – as for instance in the *behavioristic method*. The "active" position is based on the results of *cognitive psychology* and *genetic psychology* (e.g., Jean Piaget). Here, the learner has to construct his knowledge using his own (mental) activity. This position is reflected by the terminology:

Not taught by someone who already knows, *but* acquired by the pupil; *not* explained by the teacher, *but* worked out by the pupil. The pupil is not receiving the knowledge from outside but he is constructing the knowledge by his own activities, and the teacher has the responsibility to organize the pupils' activities.

Therefore, teachers and researchers from many countries called for schemes for learning mathematics by discovery and by inventing mathematical relations and concepts, by solving problems over and over, starting in primary school by "learning by doing" using concrete objects. From this we present thesis 1:

Thesis 1

Mathematics lessons must consist of situations in which the pupils can gain their own experience with mathematical concepts.

The requirement stated in thesis 1 is independent of the age of the students. In the primary grades, problem-solving strategies should involve concrete didactic materials. The concept of "experience with mathematics" has to be seen more generally in the secondary schools. However, individual exploration on the part of the pupils always forms the basis for

learning to solve mathematical problems and to answer mathematical questions.

Many investigations have been conducted in the United States and Europe in which the emphasis was shifted from rote learning of facts and skills to understanding conceptual structures, through problem-solving and investigational work and encouraging activities through which the pupils can learn to create their own mathematical strategies and, based on these, develop their arithmetic skills.

Example

Start with any number and make a chain.
The rules are:

- If the number is even, divide it by 2.
- If it is odd, multiply it by 3 and add 1

$22 \Rightarrow 11 \Rightarrow 34 \Rightarrow 17 \Rightarrow 52 \Rightarrow 26 \Rightarrow 13 \Rightarrow 40 \Rightarrow 20 \Rightarrow$
$10 \Rightarrow 5 \Rightarrow 16 \Rightarrow 8 \Rightarrow 4 \Rightarrow 2 \Rightarrow 1 \Rightarrow 4 \Rightarrow 2 \Rightarrow 1 \Rightarrow \ldots$

Start with another number, and try it several times. What did you find out?

This exercise is presented as a problem – doing things in a specific order or sometimes asking a question leads to the solution. However, it is not necessary that the problem be as specific as this. Pirie (1987) suggests four different methods of presenting a problem:

(I) As an explicit question or activity with examples

(II) As a question to answer with directions on how to start

(III) As a vague question which leaves the examples wide open

(IV) As a bald statement which needs to be translated into a problem

The characteristics and the potential of an investigation can also be identified by asking four questions (q1–q4):

(q1) Is it easy to start playing with the situation?

(q2) Does it leave scope for inventing individual strategies? Or: Can the problem be solved in more than one way?

(q3) Is there a specific answer to the problem as worded – or an answer which can be generalized?

(q4) Does the problem suggest other related questions?

According to these results we can formulate thesis 2:

Thesis 2

Instructional programs for mathematics should focus on solving problems *as part of understanding mathematics so that all pupils*

- *Build new mathematical knowledge through working with problems*
- *Develop a disposition to formulate, represent, abstract, and generalize both mathematical and other kinds of concepts*
- *Apply a wide variety of strategies to solve problems and adapt the strategies to new situations*
- *Monitor and reflect on their mathematical thinking in solving problems*

2. What Characteristic Features Must a Task Have To Be Called a Problem?

The word "problem" or "investigation" is not used here in the sense of a verbalized task ("story problem" or "word problem") but rather to describe a whole range of more or less open activities in which the strategies for working out a solution are not prescribed. Perhaps it would be simpler to define what a problem is not:

Not every difficult task is a "problem", nor is a problem a task with a prescribed route (e.g., according to a well-known algorithm) to a single solution. It is not an exercise with the overt intention of repetitiously practicing a mathematical skill. In problem solving the pupils gain from practice – and improve their arithmetic skills – by searching for several routes to the solution and varying the numbers, creating a task like the aforementioned number chain. The emphasis is on exploring, and the exploration is more important than the answer.

What are the characteristic features of a problem? Some of these are:

- The task offers the pupils the possibility to make decisions.
- The task offers the possibility to discover something.
- The solution method is not known in advance.
- The task has a complex structure.
- The task can be solved by a difficult calculation.

- The text of the task describes a new or unknown situation.
- The task is presented by a more or less "open" representation.

Thesis 3
Almost any mathematical exercise or task can be called a problem if it is presented in the right way.

3. How Can Problem Solving Help Students Learn Mathematics?

In order to find a solution to a problem, students must use their knowledge *in different ways* and through this process – and not through the instruction of the teacher – they may learn something new. When a solution to a problem is not readily available, students will benefit from having a repertoire of strategies to help them make progress. Therefore, students should be asked to search for *more than one way* to approach a problem so that they can make new connections and see new components, which will reveal different aspects of mathematics. Problem solving is an integral part of mathematics as a whole, not an isolated exercise in the subject of mathematics.

To return to our question: how can problem solving help students learn mathematics? *Appropriately designed problem situations* provide a context within which students can solidify and expand what they know. Problem solving can and should be used to help students *develop fluency in specific skills*.

There have been many descriptions of various problem-solving strategies; they include *using pictures, diagrams, or other representations, looking for patterns, listing all possibilities, trying special values or cases, working backwards, guessing and checking, creating an equivalent problem, or creating a simpler problem.* Solving individual, partial tasks serves the problem solution as a whole. Strategies are learned over time and become increasingly complex as they are used in increasingly complex situations.

The teacher plays an important role in helping his/her pupils to develop the disposition needed for problem–solving by creating an environment in which students are encouraged to explore, take risks, share failures and successes, and question one another. For children to engage in true prob-

lem solving, teachers need to identify and utilize situations that are both problematic and attainable for a wide range of students.

According to these helpful ideas we can formulate the four phases of problem solving in thesis 4:

Thesis 4: Four phases of problem solving

1. *Analysis of a provocative situation, exploration, and development of a problem definition*
2. *Simulation and reconstruction with available material, development of new conceptualizations or procedures, and perhaps solution to the problem*
3. *Embedding the new information in the existing system; arranging of various relations*
4. *Re-evaluation of the new contents and the method of its acquisition; actual conscious trials of the transfer*

4. How Should Problems Be Designed?

We would like to present an example, including solutions, and show some possible strategies for solving the problem

4.1 Problem: The Young Shepherd

A young shepherd put 1008 sheep out to graze in a field. In the evening he led them back into the stable again. He formed 12 groups such that each group had two sheep more than the previous group. How many sheep were in the first group and in every other?

4.2 Solutions

Solution 1 (guess and check)

We make an *estimation,* say: the first group has 50 sheep. Then we calculate the number of sheep in the 2nd, 3rd, etc group. Then we can improve the estimation, followed by a new test calculation and so on. In consequence an *approximation method* develops: Estimation – test calculation / improved estimation – test calculation / improved estimation – test calculation / etc.

For example:

1st estimation:	50 sheep
Test calculation:	50+52+54+56+58+60+62+64+66+68+70+72=732
Result:	The sum is 732 instead of 1008; the starting number of 50 is too low.
2nd estimation	60 sheep
Test calculation:	60+62+64+66+68+70+72+74+76+78+80+82=852
Result:	Too low
3rd estimation:	70 sheep
Test calculation:	70+72+74+76+78+80+82+84+86+88+90+92=972
Result:	Too low

The number is still too low; there are still 36 sheep left over. Therefore 3 sheep must be added to every group. The first group has 73 sheep.

We can discover from this:

- At steps of 10, the sum value which comes from the estimation (let us say: the "estimated sum") always increases by 120 from one estimated sum value to the next.
- Every estimated sum can be written as a sum with the number 132.

  $732 = 132 + (12 \times 50)$ // $852 = 132 + (12 \times 60)$ // etc.
- The sum of all the differences from each group to group one is

  $2 + 4 + 6 + 8 + 10 + 12 + 14 + 16 + 18 + 20 + 22 = 132$

Help for finding a solution: Table

gr 1	gr 2	gr 3	gr 4	gr 5	gr 6	gr 7	gr 8	gr 9	gr 10	gr 11	gr 12	sum
50	52	54	56	58	60	62	64	66	68	70	72	732
60	62	64	66	68	70	72	74	76	78	80	82	852
70	72	74	76	78	80	82	84	86	88	90	92	972

Commentary

Strategy: "Neighbor Task"

Find an easy start by introducing a *"neighbor task"* (e.g., the first group has 50 sheep) which is much easier than the original task and is the key to solving the problem.

Solution 2 (constructive approach)

By making a game (role-playing) or from the imagination the following table can be derived which describes all the additional terms of the 2nd and the following groups in comparison to group 1.

2nd group	+2
3rd group	+4
4th group	+6
5th group	+8
6th group	+10
7th group	+22
8th group	+14
9th group	+16
10th group	+18
11th group	+20
12th group	+22
Altogether	132

If we subtract the sum of all these additional terms from 1008 then 876 are left over. These 876 sheep are divided into 12 groups. The result represents the number of sheep of the first group.

$876 \div 12 = 73$

The 2nd group has +2, thus 75 sheep
the 3rd group has +4, thus 77 sheep
etc.

Commentary

Strategy "Induction"

The idea for solving the problem is to think about the *additional terms* and see what consequences could be drawn from them.

Solution 3 (with uniform distribution)

By means of task variation we create simpler problems and construct a task series, which leads to the solution of the 1st problem.

Variation 1

The same task with 50 sheep, 5 groups
If each group had the same number of sheep, we would have

	gr 1	gr 2	gr 3	gr 4	gr 5
50 ÷ 5 = 10	10	10	*10*	10	10

Uniform distribution doesn't fulfill the conditions of the task. Only the central (middle) position (group 3) gets 10 sheep; the two neighboring positions have to be changed, 2 less and 2 more, respectively.

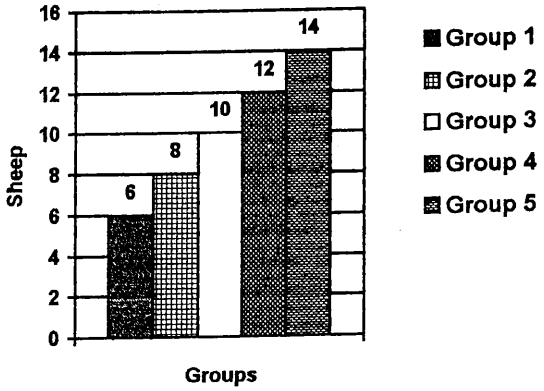
Correction

gr 1	gr 2	gr 3	gr 4	gr 5
6	8	*10*	12	14

Help for finding solution: histogram

The central group 3 reaches the line of the mean 10.

The sum of numbers of the groups immediately to the right and to the left of the central group is 20 (12+8), and the sum of the numbers of the following groups to the right and to the left is also 20, (14+6).



Variation 2

The same task with 60 sheep, 5 groups
Uniform distribution gives

	gr 1	gr 2	gr 3	gr 4	gr 5
60 ÷ 5 = 12	12	12	*12*	12	12

Correction

gr 1	gr 2	gr 3	gr 4	gr 5
8	10	*12*	14	16

Variation 3

The same task with 60 sheep, 6 groups

The problem is more difficult with an even number of groups since there is no middle group. But we try the same strategy first.
Uniform distribution

	gr 1	gr 2	gr 3	gr 4	gr 5	gr 6
60 ÷ 6 = 10	10	10	*10*	*10*	10	10

A central number doesn't exist. Then we try it, starting with the *middle pair 9 / 11*. The sum of the numbers is 20:

Correction

gr 1	gr 2	gr 3	gr 4	gr 5	gr 6
5	7	*9*	*11*	13	15

Check calculation: (5+15) + (7+13) + (9+11) = 60

Through further variations 4, 5, and 6 we reach increasing numbers of all sheep up to 1008 with the following steps: first using an odd number of groups, and then with an even number of groups, until we reach the goal which was the problem posed at the beginning: 1008 sheep and 12 groups.

Variation 4 (further transfer: higher number, odd number of groups)

The same task with 108 sheep, 9 groups
Uniform distribution

	gr 1	gr 2	gr 3	gr 4	*gr 5*	gr 6	gr 7	gr 8	gr 9
108 ÷ 9 = 12:	12	12	12	12	*12*	12	12	12	12

Correction starting with the central group 5

gr 1	gr 2	gr 3	gr 4	*gr 5*	gr 6	gr 7	gr 8	gr 9
4	6	8	10	*12*	14	16	18	20

Variation 5 (further transfer: higher number, odd number of groups)

The same task with 1008 sheep, 9 groups
Uniform distribution

	gr 1	gr 2	gr 3	gr 4	*gr 5*	gr 6	gr 7	gr 8	gr 9
1008 ÷ 9 = 112	112	112	112	112	*112*	112	112	112	112

Correction starting with the central middle group 5

gr 1	gr 2	gr 3	gr 4	*gr 5*	gr 6	gr 7	gr 8	gr 9
104	106	108	110	*112*	114	116	118	120

Variation 6 (further transfer: higher number, 1008 even number of groups, 12, solution to problem)

The same task with 1008 sheep, 12 groups
Uniform distribution

	gr 1	gr 2	gr 3	gr 4	*gr 5*	gr 6	*gr 7*	gr 8	gr 9	gr 10	gr 11	gr 12
1008 ÷ 12 = 84	84	84	84	84	84	*84*	*84*	84	84	84	84	84

Correction starting with the *central middle pair 83 / 85*

gr 1	gr 2	gr 3	gr 4	*gr 5*	*gr 6*	*gr 7*	gr 8	gr 9	gr 10	gr 11	gr 12
73	75	77	79	81	*83*	*85*	87	89	91	93	95

Solution 4 (Algebra)

Assume: The first group has y sheep. Then we have

$$\begin{aligned} y + (y+2) + (y+4) + (y+6) + (y+8) + (y+10) + (y+12) + (y+14) + (y+16) + \\ (y+18) + (y+20) + (y+22) &= 1008 \\ 12y + (0+2+4+6+8+10+12+14+16+18+20+22) &= 1008 \\ 12y + 2(1+2+3+4+5+6+7+8+9+10+11) &= 1008 \\ 12y + 2 \cdot \tfrac{1}{2} \cdot 12 \cdot 11 &= 1008 \\ y + 11 &= 84 \\ y &= 73 \end{aligned}$$

Result: The first group has 73 sheep, the 2nd group 75, etc.

Conclusion

1. The problem can be solved at *different levels of representation:* Concrete level: solution 2 (role playing); iconographic level: solution 1 (table), solution 3 (histogram); symbolic level: solution 4 (algebra)
2. The problem can be solved with *different depths of previous knowledge*
3. The problem can be solved using *different strategies*

   or according to Pirie (see above)
4. The problem is posed as a question to be answered, with variations and directions on how to start: solution 1, 2, 3.
5. The problem is posed as a question which leaves the path of solution or any other examples open: initial problem.

5. How Could Other Teachers Make Use of Given Examples?

In summary we could say, a good mathematical problem generally has three features:

Thesis 5

1. *It is problematic. There is something to make sense of and the route to a solution is not readily apparent.*
2. *It connects with knowledge the student already has so that current knowledge and skills can be adapted and applied to complete the task.*
3. *It is challenging and interesting from a mathematical perspective.*

There are plenty of books and other sources with an enormous collection of good ideas for investigations. Inevitably, teachers will find some of these more appealing than others. They can use them all (or adapt them for special use) with any age group or at any level of ability. The form of presentation needs to be considered and modified to suit the particular situation: sometimes more precise instructions will be appropriate, but in some cases teachers may choose to provide greater openness by deliberately making their instructions less precise.

There are several strategies for adapting or varying a task. We cite the three most commonly used strategies in thesis 6.

Thesis 6

1. *Reverse the problem (principle of reversion).*
2. *Decrease or increase the difficulty of the problem by taking elements out or adding elements to it (principle of composing).*
3. *Use a planned variation with a specific objective.*

The examples which now follow offers some possibilities for the reader's orientation.

Example 1:

Adaptation of the number series

$$22 \Rightarrow 11 \Rightarrow 34 \Rightarrow 17 \Rightarrow 52 \Rightarrow 26 \ldots \text{(see Section 1)}$$

There are many ways of modifying the example in section 1:

We choose a rule fitting for the second grade of the type "Find the rule and use it".
Assume: the students can practice – more or less – skills of addition and subtraction between 0 and 100.

Variation 1

Continue the following series as far as you can:

2, 5, 10, 17, ___, ___, ___, ___, ___, ...

[Rule: Add the next odd number, the first was +3.]

Variation 2

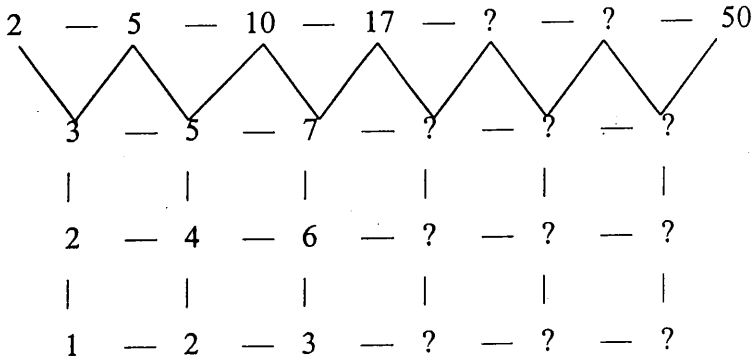
What are the missing numbers?

2, 5, 10, ___, 26, 37, ___, ___, 82, ___,

[Rule: Add the next odd number. The number 82 is given as a "control number".]

Variation 3

How do these numbers fit together



[Rules: 1st line: Add the next odd number
2nd line: Difference between two neighboring numbers in the 1st line
3rd line: Next smaller even number
4th line: Half of the above number (divide by 2)
Or: Start with the bottom line, which is the number series 1, 2, 3, 4, 5, 6 etc]

Variation 4

What are the missing numbers?

1, 4, 9, ___, ___, ___, ___, ___, 81, ___

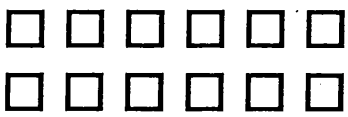
Variation 4 has the same rule ("add the next odd number") and another starting number. So you get the series of square numbers.

Commentary

These variations all have a similar structure: The pupil first has to *find* the rule, then he has to *apply* this rule. In the problem cited in section 1 the rule is given and the pupil just has to apply it. We used a planned variation with a question to answer, leaving the path of solution open.

Example 2: Rectangles and squares (2nd grade)

How many rectangles can you make with 12 cubes (or square plates)?



Variation 1

How many rectangles can you make with 4 // 6 // 8 // 9 // 10 // 11 cubes?

Variation 2

How many rectangles can you make with 36 // 72 cubes?

Variation 3

Use the cubes (or square plates), as many as you want, and make larger squares. Calculate the differences between each two squares.

Commentary

Variation 1 is a "planned variation" with a question to be answered. We used all numbers up to 10, which can be represented as a product. Then a prime number (11) follows, which only allows the product 1×11.

Variation 2 is a more complex problem; there are more possibilities for finding products.

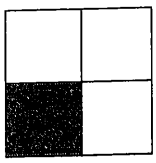
Variation 3 is constructed by reversion, with the objective to find square numbers.

Example 3: Square numbers or addition of odd numbers (3rd grade)

Complete the following calculations and make an appropriate mapping

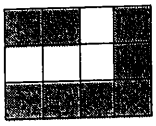
1 =
1+3 =
1+3+5 =
1+3+5+7 =
1+3+5+7+9 =
...
1+3+5+7+9+ ... +55 =

1 + 3



Variation 1

Complete the following calculations and the mapping



2
2+4
2+4+6
2+4+6+8
2+4+6+8+10
...
2+4+6+8+10+ ... +22
Which products are represented by the rectangles?

Variation 2

Start with 3, too, and represent similar rectangles.

3 =
3+5 =
...

Variation 3

Try this starting with the numbers 4, 5, ... What do you find?

Commentary

Example 3 is a continuation of example 2, variation 3, and is a reversion of that problem. This can be varied once more.

Variation 1 changes from squares to rectangles; each rectangle represents a product.

Variation 2 has a number variation, a question to answer, and a specific objective. Directions on how to start are given.

Variation 3 gives directions on how to start, but the objective is left open.

Example 4: Multiplication and addition (3rd grade)

We have two numbers. Their sum is 20 and their product is 96. Which numbers are these?

Variation 1

We have two numbers. Their sum is 7 and their product is 12. Which numbers are these?

Variation 2

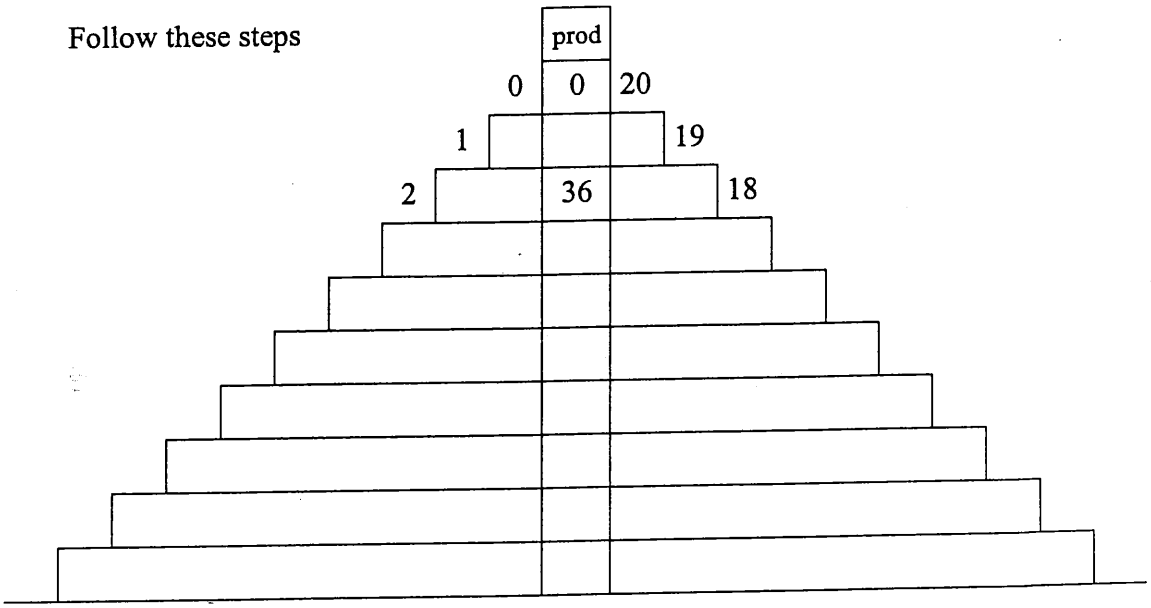
We have two numbers. Their sum is 20 and their product is 96. Which numbers are these?

Make use of a table	number 1	0	1	2								10
	number 2	20	19									
	product	0	19									

Variation 3

We have two numbers. Their sum is 20 and their product is 96. Which numbers are these?

Follow these steps

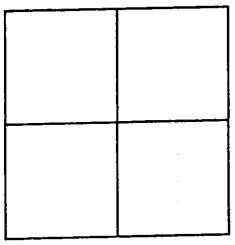


Commentary

Variation 1 uses a simpler "neighbor problem".
For variations 2 and 3 an appropriate description or representation is recommended.

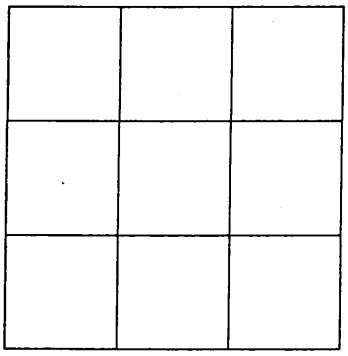
Example 5: Squares

How many squares are in this figure?



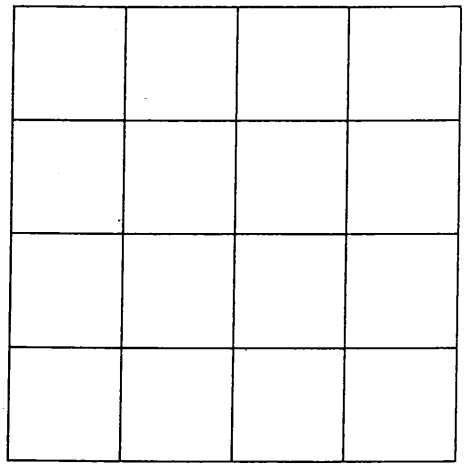
Variation 1

How many squares are in this figure?



Variation 2

How many squares are in this figure?



Commentary

The question is the same for all the variations, but no directions are given on how to start. The strategy could be solving the problem by induction from one figure to the next.

Example 6: Fractions

Make a decreasing series of these fractions (it is not necessary to use the common denominator!)

$$\frac{1}{4}, \frac{1}{10}, \frac{1}{8}, \frac{1}{2}, \frac{1}{3}$$

Variation 1

Make a decreasing series of these fractions (it is not necessary to use the common denominator!)

$$\frac{3}{4}, \frac{3}{6}, \frac{3}{2}, \frac{3}{10}, \frac{3}{8}$$

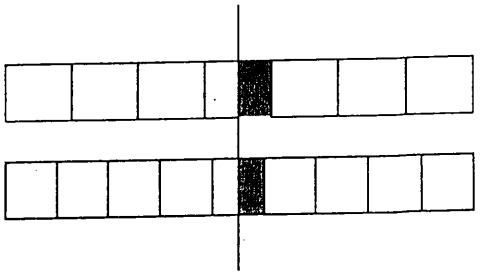
Variation 2

Make a decreasing series of these fractions. It is not necessary to use the common denominator of two or more fractions, but make use of an appropriate representation!

$$\frac{2}{4}, \frac{2}{5}, \frac{3}{5}, \frac{3}{6}, \frac{3}{7}, \frac{4}{7}, \frac{4}{8}, \frac{4}{9}, \frac{5}{9}, \frac{5}{10}$$

Commentary

The iconographic representation in circles or rectangles helps to find and demonstrate correct assumptions. For instance is $\frac{4}{7}$ bigger than $\frac{4}{8}$ because $\frac{1}{7}$ is bigger than $\frac{1}{8}$. The pieces are bigger if you partition a circle or rectangle into 7 pieces than if you partition it into 8 pieces! Or: $\frac{3}{7}$ is smaller than $\frac{4}{9}$, because $\frac{3}{7}$ is one half of a seventh part smaller than one half and $\frac{4}{9}$ is one half of a ninth part smaller than one half, and one seventh is bigger than one ninth.



Example 7: Pythagoras (9th grade)

You know the Pythagorean theorem about a triangle with one right angle. Would this theorem still be valid if you were to draw semicircles over the sides of the triangle instead of squares?

Variation 1

Draw a triangle with the sides 3 cm, 4 cm, 5 cm, and semicircles over the sides.
Draw a triangle with the sides 1,5 cm, 2 cm, 2,5 cm, and semicircles over the sides

Commentary

The variation introduces special numbers. Therefore, the answer to the original problem as a *general statement* could be reached by induction, calculating the two – or more – examples of the variation. The variation opens the door to the *process of generalization* for the pupil. At the end of this process, the static statement of the initial problem is reached.

To encourage all readers of this book to use the examples introduced in this chapter and to create their own examples and problems, a final remark is formulated as thesis 7:

Thesis 7

Learning by problem solving and discovery on the part of the pupils requires teachers to be open, and teachers then also become learners in the field of teaching mathematics.

For further reading

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Pirie, S. (1987). *Mathematics Investigations in Your Classroom*. London.

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Ahmad Qudah

Preparing Examinations and Analyzing the Results

Introduction

This chapter discusses the main phases of evaluation in school, which includes constructing, implementing, scoring, and analyzing examinations.

A very important in teaching is: where is the pupil now? To find the answer to this question, a teacher gives an examination, which at the same time achieves some further objectives:

- Gives the pupil a positive feeling toward the subject matter
- Builds confidence in the pupil that he/she can do the work by his/her own activities
- Encourages a questioning attitude in response to a pupil's curiosity regarding subject-matter problems

It is important to consider the objectives of each question in a test paper and even more important to relate those objectives to the class activities and the type of homework done before the exam. Teachers should state their questions very clearly in a test paper, using terminology appropriate to the pupils' level of understanding.

The training program for student teachers in grades 5 to 10 is a combination of content and methodology. Teachers focus their attention on content, lesson planning, questioning, homework, and testing and must become proficient in these essential areas in order to give effective instruction. In the area of testing it is important to have knowledge of what to test as well as how to test.

In many cases the results of examinations can be utilized for different purposes: (1) for classifying students into instructional groups, (2) for assigning levels of performance mastery in assessment, (3) for diagnosing specific weaknesses.

Exam results should be analyzed so that the teachers are aware of the type of errors that have been made so that emphasis can be placed on the particulars in their future teaching. This information is used to guide the next steps in teaching.

1. Constructing the Exams

Exams should be planned in advance in connection with planning the teaching process. It is even worthwhile to make up the next exam as soon as the previous one is given and after the homework assignments have been planned.

The teacher should begin to construct the exam by listing the topics with respect to the homework assigned and class work; he/she should also consider the objectives of each question.

The type of questions that can be asked are single-concept questions, multi-concept questions, multiple choice questions, and essay questions. The exam should begin with easy questions and then proceed with progressively more difficult ones. Topics covered on the last three days before the exam should not be included since students would need to practice these topics through homework first. Students should be informed as to the number of points per question on the test and the directions to be followed so that they can budget their time accordingly.

Exam question papers should be neat and legible and the pages not crowded. We suggest writing a draft of the actual exam first, and then making changes if necessary.

Finally, when you construct the exam the following questions should be considered:

- When should the exam be given?
- What is to be tested?
- What types of questions should be asked?
- How long should the exam be?
- How difficult should the exam be?
- What should be looked at while making the exam?
- How should the exam results be used?
- Should the exam be reviewed in class after it is marked? When? How? How do future tasks relate to the exam results?

1.1 Identifying Main Ideas

The teacher should be able to identify the main ideas that are included in a topic, and a student teacher should have read a great deal about the

topic and have discussed any topics or activities utilized in the textbook before he/she classifies anything as a main idea.

In many cases the textbook itself is designed such that the topic consists of many headlines or tasks. In this case the role of the teacher should be to identify the main ideas as this is very important for testing and in planning lessons in a subject area.

1.2 The Objectives of Exams

The teacher should derive the main objectives of a topic just as he/she identified the main ideas, perhaps by referring to detailed lesson plans for each topic.

The objectives should be stated clearly and simply and written in a form such that the answers are measurable. Some objectives should ultimately be elicited from the pupils. It need not, however, be elicited at the very beginning of the period.

Examples of objectives:

- To factor a quadratic trinomial.
- To compare two rational numbers with unlike denominators.
- To find the product of two binomials.
- To to solve problems involving areas of complex figures.
- To find the relationship.
- To solve new puzzles based on the geometry.

1.3 Content Analyses

The topic should consist of various elements such as concepts, facts, generalization, vocabulary, exploring, and others.

The student teacher should learn to categorize the knowledge into parts insofar as possible.

This means the content will be divided into small tasks or into small parts such that each one has a main feature.

For example: A mathematics lesson should consist of four main elements of mathematics:

1. Concepts and symbols
2. Skills
3. Generalizations and formulas
4. Problem-solving approach

At this point it is important to remember that not even practice will make you a perfect planner or a perfect teacher; there is no such person. What it will do, however, is make you an interested teacher, an inquiring teacher, and therefore a better teacher. The secret of your success will lie in your own efforts toward self-improvement.

1.4 Specification Table

A specification table is a major part of processing or constructing an exam. Such a table describes the content and confronts the topics of content with Bloom´s levels of performance for each question.

In table 1, vertically, each cell represents the content of the question and, horizontally, expresses the levels of Bloom.

Table 1 Percentage of levels of Bloom (example)

Levels of Bloom **Content Analysis**	**Gaining Knowledge**	**Applica-tion**	**Analy-sis**	**Synthesis**	**Evaluation**	**Percent of each part of Content Analyses**
Concept of fraction	**Q1**	**Q2**				**20%**
Addition on fraction		**Q3**		**Q4**		**25%**
Subtraction on fraction		**Q5**	**Q6**			**20%**
Division on fraction		**Q7**	**Q8**	**Q9**	**Q10**	**35%**
Percent of each level	**10%**	**40%**	**20%**	**20%**	**10%**	**100%**

Table 1 shows the percentage of each part of content analysis which, in the last column and also in the last row, clearly gives an idea of the percentage of levels of Bloom. The teacher has to determine these percentages. The objectives and main ideas written in previous steps can be translated into the cells of the table which are denoted Q1, Q2, ...,Q10.

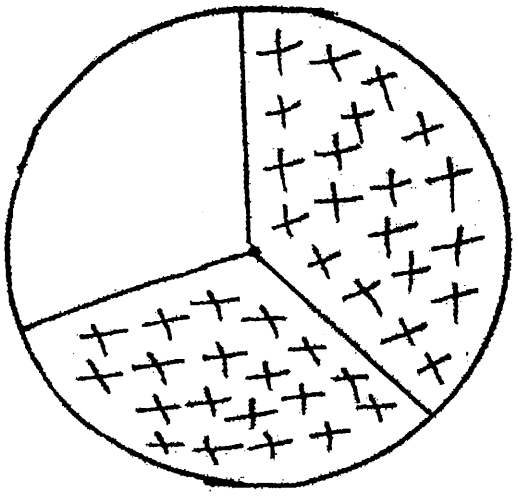
1.5 Writing Questions

The step of writing questions involves a transformation from the specification table to the final form of the questions. It is as follows:

Q1: the content is: the concept of a fraction
Bloom's level is gaining knowledge

So, Q1 will be in many cases (there is a margin of freedom for the teacher):

Case 1: Express the shape of the region in the following figure using a fraction:



Case 2: Suppose that you eat 5 sweets from a box which contains 18 sweets. What fraction describes the portion still in the box?

Case 3: Design a representation (shape) for the fraction:

3/4, 1/5, 2, 1/6

Other questions can be developed in the same way. Then the questions should be written in a form which is comfortable for the pupils.
You can change the order of the questions as follows:

Q1	Q2	Q6	Q4	Q10
	Q3	Q8	Q9	
	Q5			
	Q7			

This classification is derived from specification table such that the questions progress from easy to difficult and then to more difficult questions.

2. Holding the Examination

A test is conducted in an atmosphere which is relaxing for both the students and the teacher; therefore, no tension or stress can be detected during the test period.

It is preferable that the teacher remains at a distance from the students during the test period so that other students and observers will not misunderstand the movement.

Clear instructions must be written on the first page so that there is no need for questions during the test. This will also prevent the teacher from being required to answer any question.

The test questions must be clear, legible, and self-explanatory and not require the intervention of the teacher.

The points for each question must be explicitly specified in the appropriate position.

The test papers must be distributed as quickly as possible so that no time is wasted. After the test period, the test papers should be delivered to the teacher all at once in a systematic manner.

3. Scoring Exams

When scoring exams, the teacher should mark one question on all papers and then proceed to the next question on each paper, etc. In this way the marking will be consistent in all students' tests. If an answer is wrong, an "x" should be put through the answer so that it cannot be changed without being noticed.

Besides putting the grade on the test, whenever possible, a teacher should try to write a comment that will encourage better performance or give credit to the the pupils' work.

Try to have the test marked by the day after it is given so that the most can be gained in learning from mistakes, which are still fresh in the pupils' minds.

It is not necessary to inform the pupils of the number who have failed. This type of discussion should be avoided since it usually causes more problems rather than helping to improve instruction.

If test papers are returned the very next day after the test has been given, it is still fresh in the pupils' minds. It also shows the pupils that the teacher is concerned about the improvement in learning in an individual subject.

A discussion should take place with the pupils as to the purpose of going over a test, e.g., looking for points of error and looking for alternative methods.

Ultimately, the pupils must feel that they have something to gain from this experience and that understanding what they got wrong has value for the future, especially in subjects which are learned in sequence.

4. Tabulating Marks

The teacher should grade each question individually because it shows the pupils' performance on each part of the exam. Furthermore, the teacher should focus on the response of the pupil on each part of the task, so that the mark will be a good indicator of knowledge of the content of the task.

Formerly, teachers gave marks for the entire exam. However, in current practice a partial mark is given for each question. The following table shows the distribution of the partial marks with regard to the final mark.

Table 2: Distribution of partail marks with regard to the final mark

Name	Q1	Q2	Q3	Q4	Q5	Final mark
Ahmad	7	4	10	10	10	41
Ali	0	6	5	7	8	26
Ibraheem	1	0	7	6	6	20
Eman	9	7	8	9	19	42
Sanna	5	6	8	7	10	36
Mysoon	0	4	4	6	7	21
Ead	8	7	7	6	9	37
Kaled	4	6	7	5	5	27
Fareed	3	4	5	6	7	25
Salem	5	4	3	7	9	28
Samya	6	7	2	3	4	22

Note the situation of Ahmad, who got 41/50 points, which is very good, but the partial mark of question 2 reflects his weak performance here.

5. Calculating the Following Indicators

5.1 Discrimination Index (di)

The discrimination index is an indication of how a given item can discriminate between the high-scoring and low-scoring groups, but it does not lend itself to providing a direct comparison of the degree of discriminating power of the individual items in a test. It fails in this respect because the magnitude is, in part, dependent on the number of cases in the high-scoring and low-scoring groups.

In 1939, Kelley demonstrated that the lowest and highest 27% of a sample are optimal when item analysis data are to be obtained for items of 50% difficulty level and low reliability that are scored in graduated amounts. These groups are, as he pointed out, ordinarily the most practical for use in item analysis even though the items are scored only as "satisfactory" (passed) or "unsatisfactory" (failed).

If the discrimination index for a question equals zero or is a negative value, then a question does not discriminate between pupils, which is bad, and the question must be dropped or improved. We consider the following cases:

Case 1: If the discrimination index for a question shows an interval of 0 to 20%, then the discrimination index for a question is weak.

Case 2: If the discrimination index for a question shows an interval of 20% to 40%, then the discrimination index for a question is intermediate (midpoint).

Case 3: If the discrimination index is more than 40%, then the discrimination index for the question is high, regardless.

In general, when the discrimination index approaches the high level, the question is good.

5.2 Difficulty Index (pi)

The difficulty of an item can be defined as the proportion of sample of tested pupils who marked the item correctly an all tested pupils.

For example:

The following marks are taken from the results of a mathematics exam in the 9th grade.

Table 3: Example for the difficulty index (pi)

Name	Q1	Q2	Q3	Q4	Q5	Total Mark
A	1	1	1	1	1	**9/10**
B	1	1	1	1	0	**8.5**
C	1	1	0	1	1	**8**
D	0	1	1	1	0	**6**
E	1	1	1	0	1	**7.5**
F	0	1	1	1	1	**8**
G	0	0	0	1	1	**4.5**
H	1	1	1	0	0	**5**
I	1	0	1	0	1	**4.5**
J	0	1	0	1	0	**4**
K	1	1	1	0	1	**7.5**
L	1	1	1	0	1	**6.5**

1: Pupils' performance is satisfactory;
0: Performance is unsatisfactory.
To find the difficulty index (pi) for 5 questions one would proceed as follows:
p1: We find 12 positions and 8 ones in the column of Q1, therefore we have:

p1 = 8/12 = 0.67 p2 = 10/12 = 0.83 p3 = 9/12 = 0.75
p4 = 7/12 = 0.58 p5 = 8/12 = 0.67

To find the discrimination index (di) for these questions, we apply the following:

(a) Reorder the table with respect to total marks from top to bottom:

(b) Compute 27% of the group (i.e; 27% ×12=3.24: 3 pupils).

(c) The highest 3 and the lowest 3 total marks of the group.

Table 4 illustrates this:

Table 4: Example for the discrimination index (di)

Name	Q1	Q2	Q3	Q4	Q5	Total Mark
A	1	1	1	1	1	9
B	1	1	1	1	0	8.5
C	1	1	0	1	1	8
. . .						
G	0	0	0	1	1	4.5
I	1	0	1	0	1	4.5
J	0	1	0	1	0	4

Now it is easy to compute the *(di)* as follows:

1st step: Divide the number of ones of A, B, C by 3 (highest group) and divide the number of ones of G, I, J by 3 (lowest group).
2nd step: Subtract the fraction of lowest group from the fraction of highest group.
d1= 3/3-1/3=2/3=0.67
d2= 3/3-1/3=0.67
d3= 2/3-1/3=1/3=0.33
d4= 3/3-2/3=1/3=0.33
d5= 2/3-2/3=0

The question is more difficult when the difficulty index approaches 0. The question is easier when the difficulty index approaches to 1. The question is acceptable and very suitable when the difficulty index lies between 30% and 70%.

5.3 The Mean

The most commonly used indicator of the central tendency is the mean. The mean is nothing more than the arithmetic average of the scores in a distribution, calculated by adding the scores and dividing this number by the number of cases in the distribution. Thus, the mean should give us an idea about the level of the total group performance. At the same time we can use this indicator (mean) to compare the performance of an individual pupil, as follows:

$\bar{X}$: mean; xi: score of the pupil

If xi = $\bar{X}$, the performance of pupil is equivalent to moderat.

If xi > $\bar{X}$, the higher the mean the better the pupil's performance.

If xi < $\bar{X}$, the lower the mean the poorer the pupil's performance.

5.4 Standard Deviation

Standard deviation is the square root of an average of the differences (deviations) between the scores of a distribution and its mean. The standard deviation computation is straightforward, with one twist. First, the mean of the distribution is calculated and then it is subtracted from the value of each score, thus yielding a series of deviation scores. To illustrate this: if the mean of a distribution were 10, that number would be subtracted from all scores in the distribution, for example, 12-10=2; 16-10=6. But, of course, there will be scores lower than the mean, for example, 8-10=-2; 7-10=-3. Subtracting the mean from these scores yields negative deviation scores.

If we were simply to add all these deviation scores, the result would be 0. So, before trying to compute an average of these deviations, we first square each deviation because that operation gets rid of the minus signs (a negative number times itself yields a positive product: (-5)×(-5)=+25.)

These squared deviations are first added and then divided by the number of scores in the distribution, just as in computing the mean. Finally, to get back to the number size we were working with originally, we take the square root of the summed squared deviations.

The computation procedure for the standard deviation SD can thus be represented as follows:

$$SD = \sqrt{\frac{\text{Sum of squared deviation scores}}{\text{Number of scores in the distribution}}}$$

If you think for a moment about the procedure involved in computing the SD, you will realize that the more distant the scores of a distribution are from its mean (i.e., the farther they are spread out), the larger the standard deviation will be. Thus, in describing two sets of pupil scores on the same test, we indicated that the SD of group x was 10.4 and the SD of group z was 6.7. We would know that the scores in x were much more variable (i.e., spread out from the mean) than scores in group z. Used in

combination with the mean, SD is an extremely useful way of reflecting group variability and is undoubtedly the most widely employed index of variability that evaluators will encounter.

5.5 Consistency

Internal consistency is a method of estimating a test's reliability. Suppose we construct a test containing ten items and administer the test to 20 pupils. The number of items and subjects taking a test are important in measuring consistency.

Kuder and Richardson developed two formulas for measuring consistency that can only be scored as right or wrong. There are two major considerations in the use of internal consistency estimates. First, this method should not be used for speed tests or tests that are not completed by all those being tested. Second, it provides no estimate of stability over time.

The KU-RI21 (Kuder and Richardson-21) formula is somewhat less accurate than the KU-RI20 formula, but it is so simple to compute that it is probably the most frequently employed estimate of internal consistency.

$$KU-RI21=\frac{K}{K-1}\left(1-\frac{M(K-M)}{KS^2}\right)$$

Where K is the number of items in the test, M is the mean of the set of test scores, and S the standard deviation of the set of test scores.

$$KU-RI20=\frac{K}{K-1}\left(1-\frac{\sum_{i=1}^{K}pi(1-pi)}{S^2}\right)$$

Where K: numer of items pi: difficulty index
S^2: variance of the set of test scores

Like other internal consistency approaches to reliability, the Kuder – Richardson method focuses on the degree to which the items in the test function in a homogeneous fashion.

Thus, the coefficient will be larger (closer to 1.00) when the test items are intercorrelated. This is the meaning of internal consistency reliability.

6. Graphic Representation of the Indicators

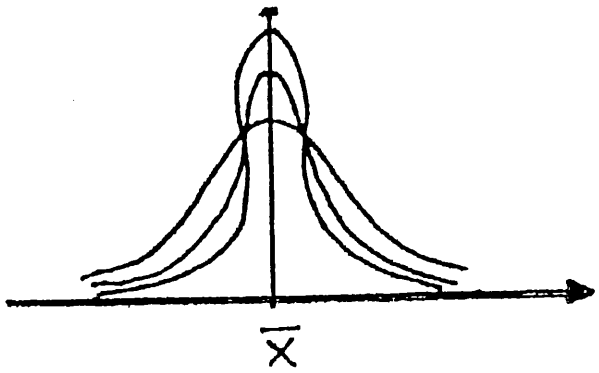
The mean is the arithmetic average of the scores and represents the balance point of the distribution. The standard deviation describes the spread or clustering of scores in a distribution.

Interestingly, there are only two things we need to know about the normal curve in order to draw it: its mean and its standard deviation. In other words, the equation giving the height of the curve (y) for any particular point on the horizontal axis (x) can be solved, provided we know the values of the mean and the standard deviation.

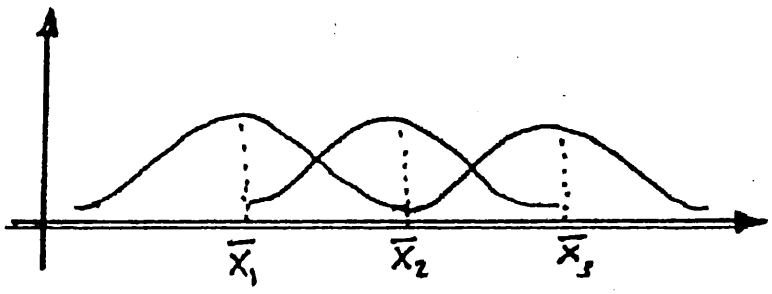
The practical significance of this point is that once we know that a variable is distributed normally, with a particular mean and standard deviation, we have a perfect description of the entire distribution. We can, in effect, specify precisely what proportion of the observations will fall between any two values we care to specify.

To be more specific, all normal distributions have the following property: if we draw a vertical line to indicate a fixed number of standard deviations above the mean, we cut off a constant proportion of the distribution of scores. For any number of standard deviations above the mean it is possible to specify what proportion of scores falls above this value and what proportion falls below it (since the total area covers 100 percent of the scores). Furthermore, since the curve is symmetrical, a line drawn a given distance below the mean will cut off the same proportion of scores as one drawn that distance above the mean.

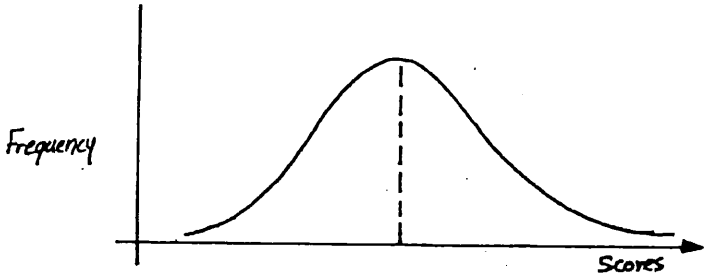
The following distributions illustrate the situations of tests in general without focussing on the items of a test.



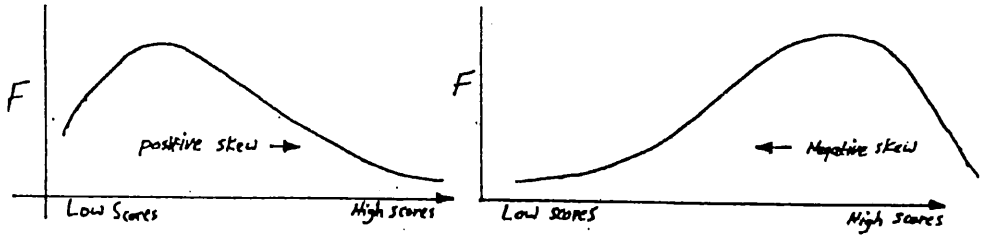
One mean $\overline{X}$ of 3 different standard deviations



One standard deviation of 3 different means



Distribution of scores for the very best test



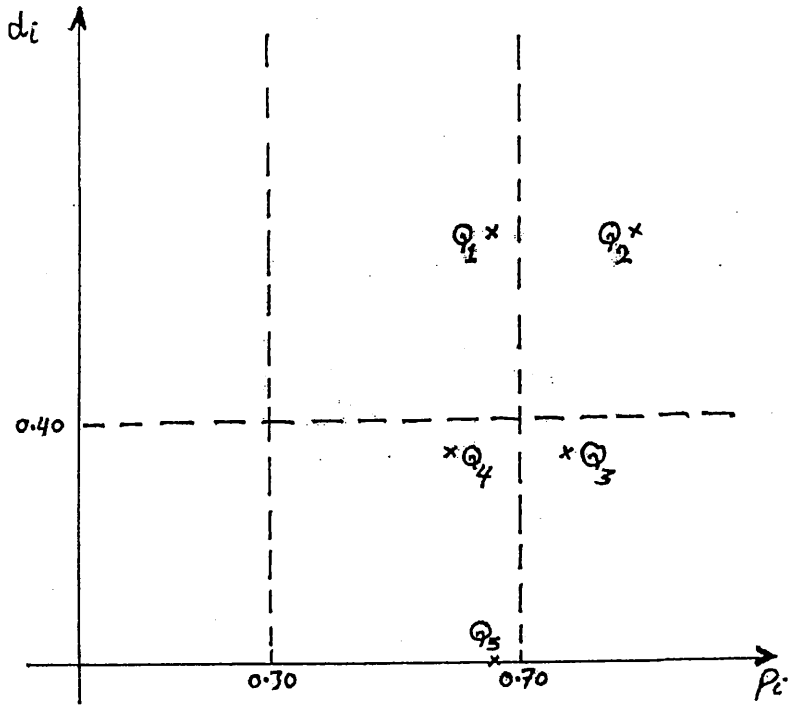
Distribution of scores on a hard test Distribution of scores on an easy test

The following table (table 5) illustrates the item-analysis data for the exam presented in table 3:

Table 5: Item-Analysis Data

Questions	Difficulty Index	Discrimination Index
Q1	0.67	0.67
Q2	0.83	0.67
Q3	0.75	0.33
Q4	0.58	0.33
Q5	0.67	0

We can represent these data graphically as follows:



A best question that: $0.3 \leq pi \leq 0.7$ and $di \geq 0.4$
An excellent question is shown by: $0.3 < pi < 0.7$ and $di > 0.4$.

For locating the region of accepted or rejected questions, we consider the previous graphic, and focus on two considerations: First, the intervals of an accepted difficulty index between 0.3 and 0.7; second, the accepted level of discrimination index – there is no cut-off score or level but it is better to be over 0.40. Accordingly, we can only accept question number 1 and must reject the others.

In many cases we need questions such as demonstrated by question number 2, which discriminates among pupils and seems easy.

7. Modifying the Marks

If questions are rejected on the above graphic, then the teacher should subtract the marks of rejected questions from the total marks so that the new total marks appear. The new marks are more valid than the previous marks. The following example illustrates this procedure. If Q3 is rejected:

Before Modifying	
Q1	10/10
Q2	10/10
Q3	5/10
Q4	7/10
Total	32/40

After Modifying	
Q1	10
Q2	10
Q3	R
Q4	7
Total	27/30

You should know that 27/30 better reflects the pupils' performance on the exam than 32/40, because question 3 is not suitable for statistical evaluation.

8. Describing the Performance of the Pupils (Horizontal Treatment)

After modifying the marks, we can consider the matrix of student achievement. All these processes depend on the indicators and their graphic representations. At the end of the processes we have a collection of marks and names which fully signify pupils' performance. We are then able to focus on each case and describe the weak and strong performance for each individual pupil.

A matrix gives the full description of each pupil for each task:

Achievement Matrix

Name	Q1 out of 5	Q2 out of 10	Q3 out of 4	Q4 out of 9	Q5 out of7	Total Marks out of 35
A	3	9	4	6	7	29
B	4	4	4	4	4	20
C	5	5	4	8	6	28

Consider pupil B: his performance is below the usual standard in tasks Q2, Q4 and Q5 but is satisfactory in others.

The teacher could be more specific when describing the content and level of each task for which B has performed poorly.

9. Describing the Total Achievement of Pupils (Vertical Treatment)

The total achievement of pupils is very clear if viewed vertically to the achievement matrix. If you focus on the first two items and compare the total marks that the pupils received, the result is 12 and 18, respectively.

So, 12/15= 0.80 represents very good achievement for the class and 18/30 = 0.60 weak achievement for the class.

If you calculate this for the 3rd question, you get

12/12 = 1.00, which represents excellent achievement for the class.

Try to compute the total achievement for the 4th and 5th question in the same way.

10. Calculating the Percentage of the Problem for Each Task

We can calculate the percentage of difficulty for any question according to the total achievement for the same question by taking the complement as follows:

Suppose that the total achievement of a question is 0.64. This implies that the percentage of the difficultyis 0.36 (0.64 + 0.36 = 1.00).

If we have five tasks and their achievement is represented by 0.73, 0.60, 0.65, 0.77, 0.85, then their percentage difficulty sizes are 0.27, 0.40, 0.35, 0.23, 0.15, respectively. Therefore, the teacher should solve the problems by considering the percentage difficulty sizes. The order will be 0.40, 0.35, 0.27, 0.23, 0.15, from a difficult task to the easier one that appears in the 5th task.

This sequence of percentages should show the teacher how to deal with the content of the questions that were given in the exam. It is important to start from the content of the more difficult tasks and proceed to the content of the less difficult ones.

In fact, the teacher should refer to the specification table to note the content and level of each task that was presented as a problem. He/she should take this into consideration when designing future tasks related to these contents.

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Joachim Engel

The Impact of Computer Technology on Mathematics Education

Advances in technology can profoundly affect education. What we learn, how we learn, and how we interact to extend our knowledge and communicate with others – be it our peers or our instructors – depends to a good degree on the technological resources available to us. Yet, not all new technologies fulfill the expectations some enthusiasts would lead us to believe. With the promise of transforming instruction, moving pictures, educational television, and programmed textbooks were welcomed by many educationalists, and yet a few years later these innovations were almost forgotten as relevant educational media.

With the advances in modern communication and information technology the last two decades have witnessed a powerful trend towards using computers in public administration, business, and industry and in our private lives. The issue now is do we really need computers in our schools? Are computer programs superior to compassionate human teachers made of flesh and blood? Is software better than books? Are computer screens more supportive to learning than chalk boards and posters? Should vast amounts of public money, sorely needed for improved and increased teacher education, textbooks, and new school buildings, be spent on electronics and high tech equipment?

1. Computers and Mathematics Learning

The advent of modern computers is one of the most fundamental factors affecting education today. This holds for the teaching of basically any subject in the school curriculum and applies in particular - but by far not exclusively - to the subject of mathematics. Computers offer potential for students to become engaged significantly with mathematical ideas. Technology can make mathematics and its applications accessible in ways impossible in the days when every graphical representation of a curve had to be drawn by hand and every computation be done with pencil and paper.

The availability of hand-held calculators and computers has stirred up a fierce debate about the goals and objectives of mathematics education. All of the algorithms, numeric procedures, and computations students learn from grammar school to high school graduation can be taught much faster and more reliably by common, widespread and even inexpensive software and computer algebra systems.

The impact of computer technology on instructional programs in mathematics is twofold: as regards content and improved learning. One issue is how the availability of this technology implies shifts in mathematical content and the way students perceive and think about mathematics. Another aspect addresses how technology might best support learning mathematics. An improved quality of learning is often achieved by encouraging students to adopt an investigative approach towards learning and the acquisition of new knowledge with the aid of mathematical software and structured worksheets. It has been shown that the use of appropriate computer software carefully integrated into the curriculum results in more emphasis being placed on investigative and experimental work, more mathematical discussion, and better student understanding of mathematical concepts.

In the past, it was necessary to teach the traditional (paper-and-pencil) symbolic manipulative skills of algebra because they were the *only* procedures available for "solving" algebraic problems. Today this is no longer true. Symbolic computer algorithms can now perform algebraic and arithmetic calculations much faster and with far greater accuracy than is possible with the "traditional" paper-and-pencil methods. What is needed in the future is a curriculum that takes advantage of computer technology to assist students in gaining mathematical understanding and in becoming powerful and careful thinkers, communicators, and problem solvers. In the future there will still be a need for mental mathematical skills (perhaps even more so than in the past), some paper-and-pencil manipulative skills, and certainly symbolic, computer-assisted algebra and calculus manipulative skills (Waits and Demana, 1997). In the following we illustrate, along with some examples, how the computer can assist learning in some basic areas of mathematics: iteration and algorithms, the notion of numbers, handling algebraic terms and equations, and geometric discoveries.

2. The Concept of Iteration and Subroutine

At virtually every grade level and relating to almost any content of the school curriculum, computers offer opportunities for students to experience mathematical concepts at a qualitatively deeper and more substantial level than without computers. An elementary school student can discover the possibility to "count" with a calculator by pressing "+1". After counting from 1 to 100 that way, it would be natural to count by 2's next. Trying to count by 3's leads to the discovery that it is impossible to arrive exactly at 100 and could give rise to interesting mathematical explorations.

In order to automate the systematic and tiring search for solutions, computers are used for what they can do best: carrying out computations and algorithms and performing systematic searches. In order to do this, the problem at hand has to be analyzed and phrased in the very precise language a computer understands. Algorithms that automate calculations have to be devised, as a relief from tiring calculations. Active programming supports conceptual learning. A computer program, an algorithm translated into machine language, requires a precise logical analysis of the underlying problem. The educational value of programming is not the technical acquisition of skills about particular programming languages (which will be outdated a few years later anyway) but its support of conceptual learning. For that very reason many educators prefer an environment such as LOGO over many easy-to-use software packages and computer algebra systems. The fact that children have to tell the computer what to do, and that the machine does precisely what they tell it to do, specifies the idea of an algorithm in a concrete way (Pappert, 1980). Commands such as

```
repeat 4 [forward 100 right 90]
```

rather than

```
forward 100 right 90 forward 100 right 90
forward 100 right 90 forward 100 right 90
```

introduces the concept of *iteration*. Replacing "100" by "n" in the definition of a subroutine called "square " creates a mathematical function which makes it possible to produce squares of differing sizes and presents the notion of a *subroutine*.

```
to square :side
        repeat 4 [forward :side right 90]
    end
```

A command of square 60, square 80, square 100, square 120 creates four differently sized squares (see Figure 1).

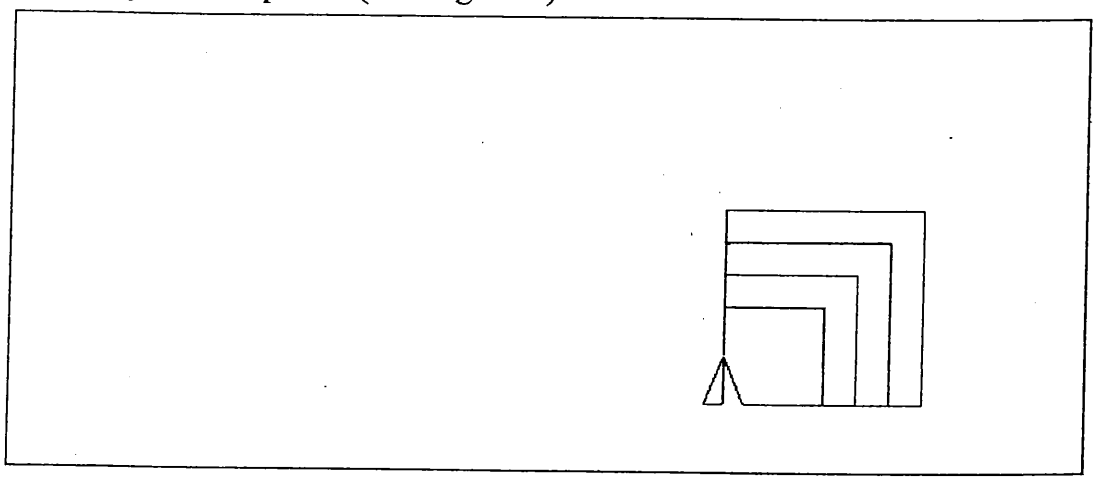


Figure 1: Four squares of differing size, created with a subroutine

3. What Computers Can Teach Us About the Properties of Numbers

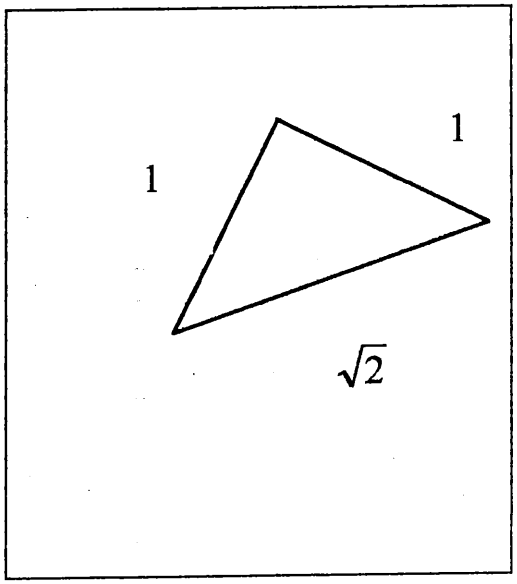
Numbers are constitutive mathematical objects. Using integers, students are introduced to fractions through successive extension, followed by whole numbers, rational, irrational and, possibly, even complex numbers. Comprehending a mathematical concept implies a whole host of ideas, comprising

- Intuitive knowledge
- Content knowledge
- Integrated knowledge
- Formal knowledge.

Part of comprehending the concept "number" is knowing the properties of numbers such as primes, divisor of an integer, different representations for one and the same rational number through a fraction, or decimals. How are various domains related to each other?

Example 1: Representing numbers graphically, numerically, and symbolically

What does $\sqrt{2}$ stand for? The number associated with this expression can be represented graphically as the hypotenuse of a rectangular isosceles triangle with side length 1, numerically through an approximation of 1.414213562 and symbolically as that number representing the positive solution of $x^2 = 2$.



Students can increasingly enhance their knowledge of numbers by learning about different representations. he computer can support earning y making it possible to switch back and forth between various forms of representation.

Figure 2: Representing a square root as the hypotenuse of an isosceles triangle

Example 2: Heron procedure: an algorithm for computing $\sqrt{2}$

A spreadsheet provides a suitable environment for implementing many basic mathematical procedures that highlight the properties of numbers. In ancient Greece it was already known that the square root of 2 cannot be represented by a rational number. Heron devised a method of approximating $x = \sqrt{n}$ through an iterative algorithm based on the formula

$$x_{new} = \frac{1}{2}\left(x_{old} + \frac{n}{x_{old}}\right).$$

Figure 3 shows an implementation of that formula with a spreadsheet.

A procedure for approximating square roots

Named after Heron of Alexandria (about.75 b.C.)

Compute square root of: 2

1	1,00000000000	1,00000000000
2	1,50000000000	2,25000000000
3	1,41666666667	2,00694444444
4	1,41421568627	2,00000600730
5	1,41421356237	2,00000000000

Figure 3: Heron procedure for computing square roots

Example 3: Terminal zeros of factorials

When introducing factorials of integers, i.e.,

$$n! = n \times (n-1) \times \ldots \times 3 \times 2 \times 1,$$

students discover how to compute a factorial from its predecessor according to the formula

$$n! = \begin{cases} n \times (n-1)!, & \text{if } n > 1 \\ 1, & \text{if } n = 1 \end{cases}$$

This representation introduces the concept and notion of a recursion. efining a v lue assigned to a number through the value of its predecessor can also naturally be implemented by a spreadsheet. When students compute factorials of the first 30 integers, they discover ery ast rowing sequence of numbers, hich nvites iscoveries and hypotheses that can be checked by calculating further factorials.

Factorials and their terminal zeros

n	n!
1	1
2	2
3	6
4	24
5	120
6	720
7	5040
8	40320
9	362880
10	3628800
11	39916800
12	479001600
13	6227020800
14	87178291200
15	1307674368000
16	20922789888000
17	355687428096000
18	6402373705728000
19	121645100408832000
20	2432902008176640000
21	51090942171709400000
22	1124000727777610000000
23	25852016738885000000000
24	620448401733239000000000
25	15511210043331000000000000
26	403291461126606000000000000

Figure 4: Factorial from 1 to 25 and their terminal zeros

One striking feature of the rapidly growing sequence of factorials is their number of terminal zeros. Natural questions to ask would be:

- Does the number of terminal zeros always increase?
- At which point does the number of terminal zeros increase?
- Why does the number of terminal zeros increase by two when passing from 24! to 25! ?
- How can we compute the number of terminal zeros of n! ?

After some experimenting, these discoveries could lead to a mathematical analysis: a terminal zero means that the number is divisible by $10 = 2\times5$, i.e., the number has 2 and 5 as divisors. To find out about the terminal zeros of 17! we start with a prime factorization: $17! = 2^{15} \times 3^6 \times 5^3 \times 7^2 \times 11 \times 13 \times 17$. From here we conclude that 17! is divisible by $1000=2^3\times 5^3$, i.e., it has 3 terminal zeros. Therefore, the number of terminal zeros is governed by the multiplicity of the factor 5, since the multiplicity of the factor 2 outnumbers the 5 by far, as every second factor in $n!= n\times(n-1)\times\ldots\times3\times2\times1$ is even.

Why does the number of terminal zeros increase by 2 when going from 24! to 25! ? Now the answer is obvious: $25! = 25 \times 24! = 5^2 \times 24!$, implying two additional 5's. For the same reason 125! has three more terminal zeros than 124!
because $125! = 125 \times 124! = 5^3 \times 124!$

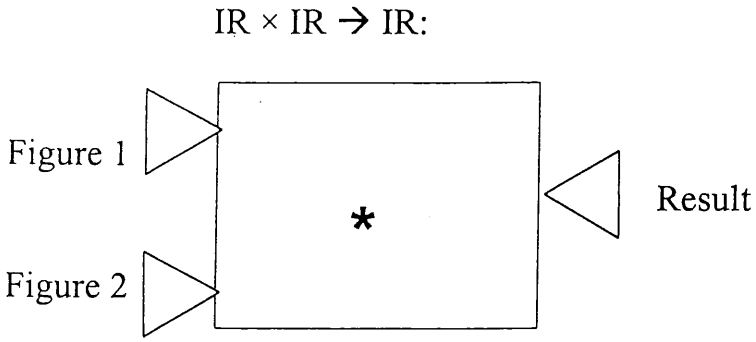
These three examples demonstrate a key feature for computer-assisted learning in mathematics class. Whereas in the traditional classroom the teacher derived new results or introduced a new algorithm to his or her students, with computers in the classroom a more active, investigative working style is possible that follows the sequence:

Experiment - Discover – Verify – Reason – Question – Generalize - Proof

Proceeding from specific phenomena or concrete discoveries, the instructional blueprint is inductive: beginning with the examination of a number of special cases, students suspect and hypothesize what will happen in general. Here a more thorough mathematical analysis should address the question of why the suspected generalization holds and where it will fail. During the analysis new questions are posed that may be addressed by further experiments, followed by new reasoning.

When dealing with numbers in mathematics class, the computer has a dual role. On the one hand, the computer calculates at high speed. This fact, however, has an impact on mental concepts as our attention shifts more and more away from algorithmic considerations and computational work towards formulating, investigating, and analyzing the qualitative structure of the examined problem, the interpretation of our results, and

how it applies to similar situations. Mathematical operations are perceived with a functional interpretation, e.g., multiplication of two numbers:



Details of a computational procedure can be obscured in a "black box", freeing students' minds to focus on structural properties and problem-solving strategies. However, students should be able to understand the fundamentals of what happens in that box. Once understood how and why a procedure works, students can delegate the future computational work to the "black box", thus freeing their minds to focus on other aspects of the new problem.

Moreover, the computer is a tool to create representations that are otherwise very cumbersome to obtain (which is why some of these representations are omitted in traditional mathematics teaching). New representations of mathematical objects reveal new properties of these objects. The computer becomes a tool to discover new properties.

The computer is a powerful calculator and gives practical and concrete calculations. But it also enables new forms of representation and the discovery of new properties of numbers.

What consequences will these new possibilities have for the classroom?

Algorithmic procedures such as finding square roots or multiplication by adding logarithms already became obsolete thanks to hand-held calculators. Applied and realistic problems, problems requiring the processing of larger sets of real data, are now feasible.

The emphasis of instructional programs on mastering a compendium of algorithmic procedures will decrease. Estimating, rounding, rough calculations, and structural knowledge about the relationship among domains of

numbers will receive more attention and emphasis. However, prototypical computations with pencil and paper shouldn't be neglected.

4. Algebraic Terms and Equations

Students can encounter equations at any grade level. Already in the elementary grades they will be presented with problems such as "7 + ? = 19" ; in around 6th grade they are challenged with the problem of solving "2 × x = 7", which introduces the notion of a fraction. Finally, equations such as "x^2 =2" introduce irrational numbers. The concepts of equations and numbers are closely interwoven. More sophisticated equations involving exponential or trigonometric expressions or terms to the degree of 3 or more are usually beyond the scope of school mathematics. Students usually proceed very schematically, applying algorithms which they have been taught without bothering about the underlying meaning. Besides applying computational procedures and algorithms to solve equations, an important skill is to derive an equation from an applied problem. Translating certain aspects of a problem into mathematical language is a key qualification for applying mathematics. Quite often the notion of a function plays a key role, emphasizing how closely functions and terms are related. The use of a computer enables more diverse approaches, which serves to broaden the comprehension of underlying concepts:

Example 4: Solve the equation $x^2 + 3x - 5 = 0$ in as many different ways as possible.

- Symbolically by paper and pencil, perhaps by applying familiar formulas
- Using a hand-held calculator: experiment with several values for x
- Graphically by drawing a parabola $y = x^2 + 3x - 5$
- Graphically by the intersection of $y = x^2$ and the straight line $y = 3x - 5$
- Symbolically with a computer algebra system such as Derive or Maple.

Factoring algebraic expressions is an important topic in algebra. After all, the *fundamental theorem of algebra* is a *factoring* theorem, stating that

any polynomial expression can be represented as a product of factors. This theorem is basic to good mathematical understanding, as are the important connections between the factors, x-intercepts of the graph of functions, zeros of functions, and the behavior of functions. Figure 5 shows the results f applying the `factor`-command in a common computer algebra system (CAS) to the given polynomial. The real mathematical significance of this result is not the actual factoring procedure. In some sense, we really don't care *how* it is done as long as it is done correctly. What matters is that the factors give us the solutions to the equation "expression" = 0 *and* reveal more information about the behavior of the polynomial function than in non-factored form. Consider the third degree polynomial $3x^3 + 8x^2 - 5x - 6$. The non-factored form gives us some global understanding (the cubic polynomial behaves like $y = 3x^3$ for x large) and the y-intercept. However, the factored form gives us a great deal of information about local ehavior x-intercepts and some idea of the existence and location of extremes). We can also explore the connections between the factors, zeros, and the graph of the polynomial as shown in Figure 5.

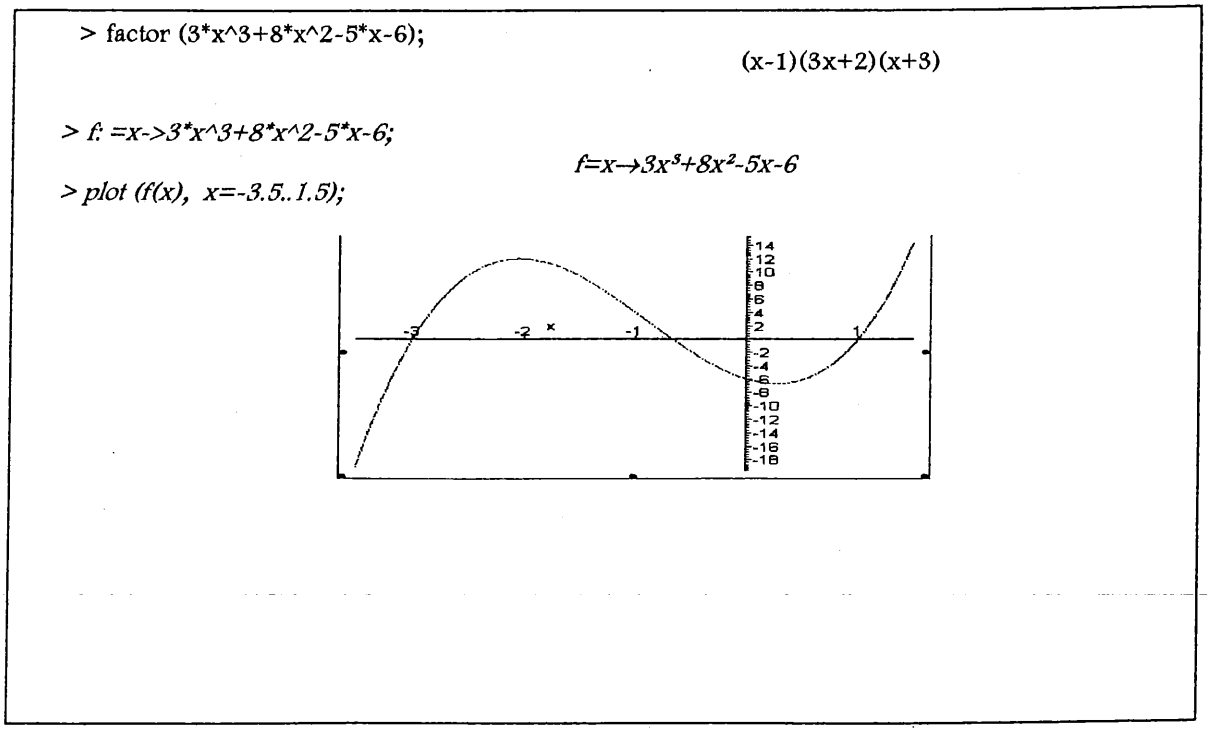


Figure 5: Factoring an algebraic term and graphing the associated function with a CAS

It is clear that widely available and inexpensive CAS technology will change the nature of the current style of "computing" in the teaching and learning of mathematics from an exclusively paper-and-pencil symbol manipulation approach to an approach that emphasizes more qualitative considerations, the process of establishing algebraic terms from an applied problem, and a focus on interpreting and conceptual understanding. This implies that in the future we will still need to do the appropriate mental work, some paper-and-pencil symbolic manipulations, *and* a great deal of computer-assisted symbolic manipulations. For example, in the past it was common practice in algebra to require all computations such as

"perform the indicated operation and simplify:
$(2x - 3) / (x - 5) - (2 - x) / (x - 7)$"

to be done with paper and pencil. In the future it will become commonly recognized that CAS software will provide the appropriate method of computation just as computing *sin* 20.125° using paper-and-pencil table interpolation was replaced by a scientific calculator tool.

All equations and inequalities of school mathematics can be solved by CAS. However, as the above examples indicate, understanding on a level deeper than applying algorithms is required as regards the number and the location of solutions in order to solve equations. More important is the interplay between the various forms of representation, the possibility to represent solutions symbolically, numerically, or graphically. With CAS a variety of representational forms can be studied by switching back and forth between numerical, symbolic, and graphical solutions. This will contribute to a more comprehensive and deeper level of understanding. Thus, the graph of a function associated with an equation gives an immediate survey about the number and location of the roots and enables a numeric approximation of its solutions. Using computers students are able to focus on the interplay between the symbolic, numeric, and graphical level of equations and functions – the so-called *rule of the three* – by quickly shifting from one level to the other.

The impact of computers on mathematics instruction is at least twofold: when interested "only" in the explicit solution of an equation, i.e., when the focus is on obtaining a numeric solution to a problem, then the student has to decide which method of solving and what type of representation is most appropriate for the problem at hand - whether the exactness of a graphical solution suffices, whether the level of precision of a numeric solution can be enhanced, or whether an equation should be solved sym-

bolically by the computer. Here it is important to be aware of various forms of representation and switching between representational forms at the same time.

A matter of general relevance is the role of symbolic solutions, i.e., why when dealing with an equation such as $x^2 + 6x - 5 = 0$ we are at all interested in solutions of the form $x_{1,2} = -3 \pm \sqrt{9+5} = -3 \pm \sqrt{14}$ and why $x_1 = 6.74166$ and $x_2 = 0.74166$ may not suffice. While numeric solutions are completely sufficient for most applied problems, exact, i.e., symbolic, solutions provide insight into how things are related to each other, for example, considerations of symmetry, locations of local peaks in relation to the roots of an equation, or *why* the two solutions have – except for the leading figure - the same decimal representation.

A second important aspect refers to the concept of an equation and comprehending it. How can the computer aid the learner in gaining a deeper understanding? Here divergent problems are often more helpful, i.e., exercises which allow for more creativity and openness in solving them versus problems that converge to a single, correct solution which can be obtained by one and only one algorithm. Examples of this are problems which call for the number of solutions depending on certain parameters or require equations with given solutions to be obtained. Establishing equations and interpreting solutions are gaining relevance in computer-assisted mathematics classes while computational matters such as carrying out algorithms are losing significance.

5. Geometry

Dynamic geometry systems such as CINDERELLA, CABRI GÉOMÈTRE (CAhier de BRoullion Interactif), GEOMETER's SKETCHPAD or EUKLID have been developed according to the principles of classical Euclidean geometry in which constructions are based on the use of compass and ruler only. These programs offer a range of possibilities as basic functions that make them superior to geometric construction on paper. In the *draw mode* the basic points can be changed dynamically. Several constructions can be combined to a *macro*. As a third feature traces of single objects can be recorded while basic points are being dragged by the mouse. Dynamic geometry programs can enhance a student's experience of two-dimensional and three-dimensional geometry.

Such programs make it easy to generate a large set of instances and to make conjectures, for example, *"the median of a triangle all intersect"*.

Example: Trisecting the Sides of a Triangle

If we construct lines which trisect the sides of a triangle (see Figure 6), we notice that, in general, none of the three trisecting lines intersect – as in the case of the bisecting median. In the draw mode of the dynamic geometry software the position and shape of the original triangle can be changed, i.e., we can move any of the triangle points A, B, or C around with the mouse and observe what happens to the trisecting lines. Is there a particular type of triangle where three trisecting lines intersect? Adding the bisecting median we notice that a pair of trisecting lines and a median intersect at one point R (this, in fact, happens six times). Does this property hold for any triangle? How does R divide the median into two parts? We discover that $A\,R : R\,MA = 1 : 1 = 1$, i.e., the median is divided by t_1 into two equal parts. How is the trisecting line t_1 divided by the median? The calculator button of the dynamic geometry system Euklid allows us to discover that

$$C\,R : R\,T_1 = 3 : 1 = 3.$$

Using the draw mode these discoveries can be confirmed by dragging point A, B, or C to new positions while the computed ratios remain unchanged. The question which then arises pertains to how the other trisecting line t_2 divides the median. Is there also a "universal" constant?

This complex example indicates how exploration and conjecturing can be a central part of geometry in a classroom enhanced with modern technology. Students can work on proving conjectures which they have generated themselves in addition to proving known results (NCTM, 1998).

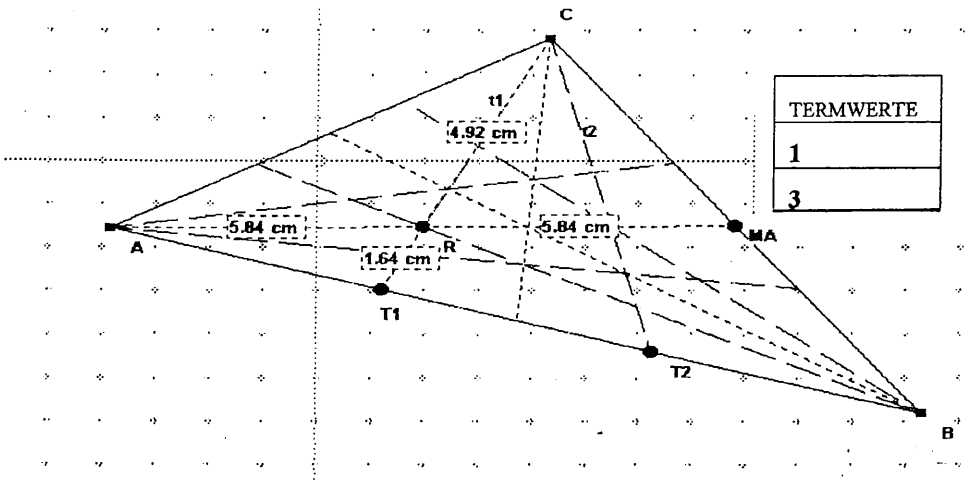
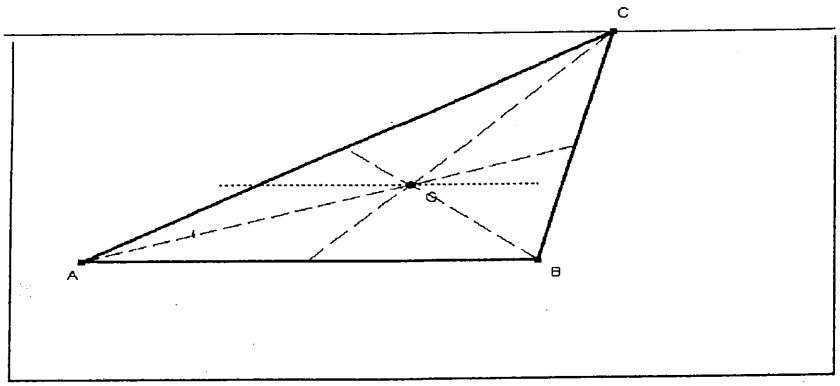


Figure 6: Triangle with median (dotted line) and lines trisecting each side (dashed). The figure in the window shows the ratio of
$A\,R : R\,MA = 5.84 : 5.84 = 1$ and $C\,R : R\,T_1 = 4.92 = 1.64 = 3$

Example: Trace of the Center of Gravity

The three medians intersect in the triangle's center of gravity. Now consider a triangle ABC and move point C on a line parallel to AB. What happens to the intersection of the medians? Along which type of geometric figure does the gravity center move when the location of C is changing along the circumference of the triangle ABC (See Figure 7)?

An enriched understanding as described in these examples can be gained, provided computer technology is used appropriately. However, one possible concern presented by a computer-enhanced classroom is that students ay lose the need to subject their assumptions and observed phenomena o proper mathematical proof. Dynamic geometry programs that can "test" conjectures with ease may give students the impression that proof is no longer necessary and that empirical confirmation guarantees the correctness of a conjecture. Computers should be used to generate conjectures, but teachers need to emphasize both *why* the conjecture holds with generality and the importance of proofs.



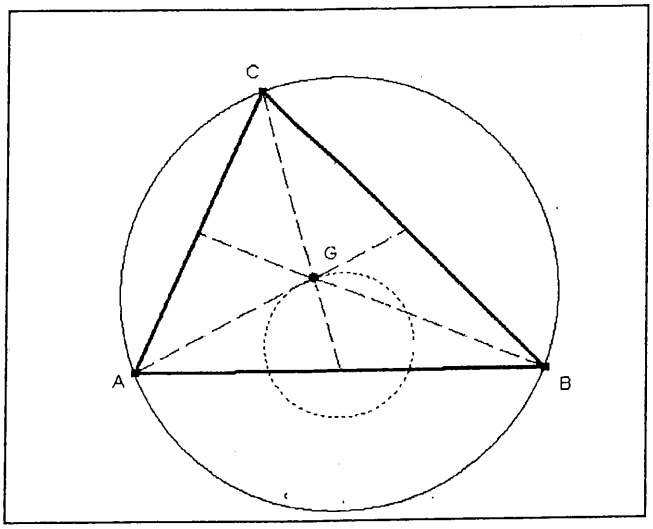


Figure 7: Trace of a triangle's center of gravity with A, B fixed when C is moved on a line parallel to AB (above) respectively on the circumference.

6. Conclusions

A prerequisite for employing new technologies in mathematics instruction is that students have basic knowledge, at least at some elementary level, of mathematical concepts and intuition. On the other hand, computer technology can be very useful in assisting students in gaining and extending their basic understanding of mathematical concepts. There is an interaction between promoting learning and understanding, using technologies, and also employing a more creative and investigative style of working. Proceeding from phenomena or isolated "discoveries," the process of acquiring new knowledge is inductive, by focusing on the investigation of further special cases. A mathematical analysis then explains – at least partially – the observations, but new "research questions" warranting further investigation are also posed which extend to new, special cases but which also require more general answers. Here the computer is an important tool, carrying out the greater portion of computational work.

For "brain jogging" as well as for obtaining a critical view of the tool, computer problems involving estimations and rounding have become an important addition to the subject of mathematics. During the learning process, it is up to the teacher to decide about the appropriateness of working with a computer in the classroom. Paper-and-pencil problem-solving skills will not become obsolete. Instead, they will form the basis for prototypical student exercises. Whether mental arithmetic, paper-and-pencil problems, hand-held calculators, graphics calculators, spreadsheets or computer algebra systems, it is still the responsibility of the teacher to make the decisions about which tools to employ for a given problem or topic.

Mathematics instructional programs that use new technology can help all students understand mathematics and prepare them to use mathematics in an increasingly technological world. Computer technology can make mathematics and its applications accessible in ways that were impossible in the past. Students can learn more about mathematics better with the appropriate use of technological tools. However, like any tools, technology can be used well or poorly. It should not be used to replace basic understanding and intuition; rather it should and can be used to foster understanding and intuition. In the field of mathematics education, technology should be used responsibly, with the goal of enriching our students' learning of mathematics. Although mathematics is flourishing as a discipline, students all too often experience it as a dead subject. Assisted by

modern technology, geometric visualization is an expanding field. Exploratory data analysis of large data sets and simulation studies are becoming feasible (NCTM, 1998). Interactive strategies and the employment of an experimental work style make it possible for students to discover principles and to reach deeper levels of understanding by experimenting with a virtual world, which in turn produces higher-level research skills and the discovery of how to learn. Simulations, for example, focus on structural elements which shape human experience beyond textbook descriptions and make it possible to explore situations under changing parameters. After all, knowledge is not a product, but rather a process (Bruner, 1974).

For the mathematics curriculum, the relief from tiring routine makes it possible to focus on more applied and problem-solving approaches, to foster more process-oriented qualities, and to promote key qualifications such as reasoning, communicating, interpreting, and discovering connections with what a person already knows. More complex and realistic problems based on real data from real life can be investigated. Processing and concluding with complex problems can be taken to a much more satisfactory end.

The new technological tools can also be used to *better* illustrate important concepts and applications of mathematics. We must redefine "basic skills" to include those paper-and-pencil manipulative tasks which are necessary to understand algebra as a language of representation. Some traditional paper-and-pencil skill will continue to be necessary for mathematical activities as will traditional mental skills. However, one of the greatest challenges in mathematics education today is to identify obsolete paper-and-pencil algebra and calculus manipulation skills and distinguish them from essential paper-and-pencil computation skills (Waits and Demana, 1997).

The analysis and comprehension of problems is enhanced when parameters are varied and the resulting numeric, algebraic, or graphical effects can be observed and studied. When describing a real situation using a mathematical model (such as the impact of a bottleneck-type narrowing of the road due to road construction on traffic flow), instructions can focus on the translation of the real situation into mathematics (a task no computer can do) while computations and drawings are done by the computer.

Problems that are too demanding from a theoretical perspective can be solved via computer simulation. Completely new possibilities become available in simulating population growth in biology, ecology, and popu-

lation studies with dynamic modeling. The availability of such a powerful tool not only has an impact on methods but also requires a new interpretation of goals and content. For the future, this means:

1. Routine skills, e.g., for computing solutions, will be devalued in favor of problem-solving skills such as applying, creating, and interpreting mathematical models. More importance and relevance are attributed to experimenting and simulation.
2. New categories of content that are closer to real-life situations will be much more accessible, such as dynamic modeling of populations in biology and populations studies, data analysis, and statistics.
3. It is now feasible and – considering the increasing relevance of applications – imperative to include more applied problems requiring the use of computers.
4. Another important aspect of computers as a teaching tool is the eased possibility to carry work on more complex problems to an end.

However, the use of computer also poses special risks and dangers for the learning process:

1. Arithmetic and geometric skills may be diminished or weakened, despite the fact that they are indispensable for applied problem solving.
2. Routine skills have helped many students to make it through school, by passing tests and exams. The devaluation of these skills make school more challenging for all and too difficult for some students.
3. The use of prefabricated software in applied problems may encourage an emphasis on using recipe-like mechanisms and techniques. In such cases the aspired activities of reflecting on the meaning and appropriateness of models and the interpretation of obtained results and conclusions may be neglected. The employment of ready-made software may lead to the degeneration of instruction to watching movies and animated multimedia shows instead of stimulating provocative and creative thinking. In consequence, shallow and superficial learning is fostered. Intellectual efforts and the fostering of genuinely creative activities are in danger of being brushed aside by the fascination for technically impressive graphics.

4. Fascination for technology must not lead us to emphasize technological problems instead of reflecting on and analyzing the original, applied problem.

Teachers should be aware of all these dangers, which could be very counterproductive to applied instruction. Awareness of these risks should serve to encourage a reasonable utilization of computers in school. The problems mentioned hint at research questions that have not sufficiently been addressed by applied educational research. If the use of computers and the integration of elements of computer science are embraced by the school curriculum, mathematics instruction will become more demanding for all involved, students as well as teachers. Analysis of the subject matter is becoming increasingly difficult, because algorithmic solutions to problems will by necessity lead to more precise and more abstract approaches than semi-intuitive procedures without the computer will.

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Eberhard Jeuthe

Modes of Supervision or How to Become a Critical Friend

I. Supervision in Teacher Education and Teacher Development

The expectations placed on fully qualified teachers are high. Teachers must demonstrate that they:

a) Have a secure knowledge and understanding of the concepts and skills in their specialist subjects

b) Can plan activities which take account of pupils' needs and their developing physical, intellectual, emotional, and social abilities and which engage their interest

c) Provide structured learning opportunities which promote pupils':
   - Personal and social development
   - Communication skills
   - Knowledge and understanding of the world
   - Physical development
   - Creative development

d) Use teaching approaches and activities which develop pupils' language skills and provide the foundation for literacy

e) Can use teaching approaches and activities which develop pupils'mathematical and scientific understanding and provide the foundations for numeracy

f) Encourage pupils to think and talk about what they are learning and to develop self-control and become independent

g) Can encourage pupils to concentrate and persevere in their learning for prolonged periods, to listen attentively, and to talk about their experiences in small and large groups

h) Are able to use teaching approaches and activities which offer opportunities for first-hand experience and cooperation and which use play and talk as a vehicle for learning

i) Can manage, with support from an experienced specialist teacher if necessary, to involve parents and other adults in the classroom to enhance learning opportunities for pupils.[1]

With these expectations in view, teacher education or teacher development[2] presents a great challenge to anyone who is involved in it. In order to obtain feedback regarding the effectiveness of the many aspects of good teacher education, certain *periods of supervised teaching practice* must always be included in the respective courses[3]. These periods are needed in order to

- Find out whether a particular student teacher or teacher in inservice training has made progress in acquiring certain teaching skills[4]
- Give the student advice regarding his future professional development
- Obtain feedback about the quality of education provided at the university

So, in a way, supervision is a life-line for educating teachers and for their further professional development.

Supervision comprises a number of skills and strategies which, combined and well applied, are an art that makes the supervisor an important contributor to teacher education. Foremost among these skills are the ones that ensure adequate observation and analysis of the student teacher's activities, in particular those in the classroom. Of no less importance are the skills and strategies required to communicate the findings from monitoring to the person being supervised in such a way that his or her professional development is effectively furthered. If supervision is well organized, sooner or later a constant dialog will ensue between the supervisor and the person being supervised. In this dialog both parties will speak the same language and it will provide the necessary structure for *give and take* in the communication process.

In order to be implemented effectively, this concept of supervision requires the kind of person who is not only a good teacher and who is well informed about the problems in our schools, but also someone who is informed about what the student teachers are being taught at their respective seminars. In other words, supervision, if it deserves its name must never be reduced to a one-to-one encounter in the classroom and afterwards in the staff-room, but rather be a situation of of extensive cooperation between the various providers of teacher education.[5]

Successful supervision, therefore, not only depends on the personality and qualifications of an individual supervisor, which makes his or her recruitment a matter of highest importance, but also on a well-organized communication network between the universities, the schools, and all other institutions that are involved in the education of teachers or in their in-service training. For the universities as providers of initial teacher education, the feedback which is obtained from the area of inservice training should be of particular interest, because more so than the teaching practice of students it represents *the proof of the pudding*.

Last but not least, a few more remarks are necessary regarding the topic that was touched upon in the previous paragraph, *the recruitment of supervisors*. Wherever supervisors are employed in teacher education, the majority proves to be dedicated and highly professional personalities. There is, however, never a totally reliable safeguard against recruiting people who sooner or later turn out to be low achievers and unsuitable for the task they have been selected for. Experience of that kind – although it certainly will be the exception to the rule – suggests a caveat in two respects. In the first place, the criteria by which supervisors are selected or appointed should not be defined by only one of the institutions involved in teacher education, namely, not only by the universities or only by a ministry of education or its regional branch office. On the contrary, the criteria for the recruitment of supervisors should be drafted and agreed upon by all involved in a kind of committee work. Secondly, the position of supervisor should not always have the character of a life-long tenure. If an individual teacher proves to be incapable of properly performing the task of supervisor he/she can be removed from this position more easily if it has not been bestowed for life. Further, a limited "term of office," at least for some supervisors, may provide a means to fend off burn-out syndromes that some of them may display. Notwithstanding these demands, it may be appropriate at this point to remind those who are responsible for the recruitment of supervisors of the other side of the coin, namely, that an incentive always facilitates the recruitment of good people.

II. Observing and Assessing Student Teachers´ and Fully Qualified Teachers´Activities

There is ample opportunity for monitoring and assessing student teacher and teacher activities: being present while a teacher is teaching in the classroom or talking with the parents or when he/she is addressing colleagues at a conference. In addition to this traditional procedure *videotaping* on occasion and with some restrictions has also become a means to monitor and assess a teacher´s performance in the course of the last two decades.

Whether a supervisor reverts to the traditional way of attending in person or whether he makes use of a videotape, he must always be aware of the perspective that is being used to monitor what is taking place. There are a variety of options for this, e.g., the supervisor or the videocamera is next to the teacher and facing the pupils or the other way around, with the supervisor ´s view or the videocamera directed towards the teacher and the blackboard and so on and so forth. Each of these options will provide a different set of data.

The same will be the case if a supervisor intentionally focusses on a particular performance indicator, for example, the quality of the teaching process or the quality of pupils' learning. In the first case the data will be more or less exclusively concerned with the following themes:

- Range and appropriateness of teaching approaches, including the use of homework
- Clarity and purposefulness of the teacher's expositions and explanations
- Quality of teacher-pupil dialogue

In the second case the majority of the data gained will be related to:

- The extent to which pupils are motivated by their learning experience
- Progress in learning
- Personal responsibility for learning, independent thinking, and active involvement in learning
- Interaction with others.

Whatever data are obtained from monitoring and assessment, a supervisor must always be able to describe them adequately and derive a message

that can be effectively conveyed to the person being supervised and which he/she will understand.

As far as the monitoring process itself is concerned, clearly, one supervisor alone or a videocamera has a limited capacity. Neither can register everything that is going on at the same time. Those who consider this to be a dilemma argue that the supervisor should be accompanied by colleagues or students to whom special monitoring tasks can be assigned. Whether this is a remedy remains to be seen, as a greater number of monitors at the back of a classroom may at times negatively affect the atmosphere of the learning process. This fact gives support to the notion that it is better to focus the monitoring and likewise the advice given to the person being supervised on one or two aspects of teaching performance only.

III. In What Way Is the Evaluation Form Important for Supervision?

Generally speaking, an assessment or evaluation form is a kind of guideline used by many supervisors for monitoring and assesssing of student teachers and fully qualified teachers. The layout of the form may vary from university to university or among institutions dedicated to teacher education or teacher development. As a rule the form covers a wide range of supervisory activities regarding one student teacher or teacher in inservice training. In order to give an idea of how vast the number of areas to be monitored and assessed may be, the following draft proposal[6] for a general format is presented here.

Evaluation FORM
for the supervision of student teacher activities

1. Assessment

Elements of the planning
(objectives, didactics, methods and evaluation)

Performance /Introductory Stage
How do the pupils react to the subject matter? Are they, for example, able to understand what is going on or what they are expected to do?

Performance /Main Stage
How many and what kind of activities are the students engaged in?
How many of them are participating? What kind of interactions can

be observed ? What are their achievements like? Are they below or above standard?

Performance /Evaluation Stage
In what areas of learning have the pupils achieved progress? Has their understanding of the subject matter been increased? Is the assignment given to them at the end of the lesson a result of their previous activities?

2. Follow-up Interview

General strategy of approach (indirect, situational, traditional, etc.)

Which aspects of the assessment are discussed?

Is the person being supervised asked to name aspects of what he or she wants a comment about or support in?

How does the person being supervised react to the supervisor's statements and advice?

Does the person being supervised take notes during the interview and does the supervisor receive feedback concerning the interview ?

The underlying concept of such a form or any other with a different layout will certainly be misinterpreted if a supervisor who has attended a lesson of a student teacher or a teacher in inservice training uses it as a sort of checklist for providing a statement or a comment about all of the aspects listed in this form.

As has been said before, forms are first and foremost a kind of guide-line that suggests a range of items to be monitored and assessed, however, not all at the same time. The form can be used to establish a common ground for dialog between the supervisor and the person being supervised, which should be the mainstay of any type of supervision. If the form is used to inform the person being supervised what the criteria are by which his teaching practice is evaluated, if this procedure is used to illustrate the targets that are to be pursued while developing his teaching practice, then the first step towards a profitable cooperation between supervisor and the person being supervised has been taken.

IV. The Importance of the Follow-up Interview and General Strategies for Making It Successful

It seems to be taken for granted that if a supervisor has attended a class and filled out an evaluation form with the results of monitoring a lesson, what comes next is simplicity itself: the supervisor has only to inform the

student teacher or the teacher of his observations by referring to the notes he has taken or the form he may have filled out very copiously. But can the supervisor be sure that the message conveyed this way will be understood or even accepted? Will the supervisor be seen by the person being supervised as a critical friend or as a superior, a kind of inspector whose advice is actually covert criticism, which is mainly used as a back door to proficiency assessment and finally resulting in ranking by grades?

In view of this it seems wise to single out a few essential aspects of communication between the supervisor and the student teacher or teacher being supervised after the supervisor has attended the classroom or other activities conducted by the teacher.

A prerequisite of any successful interview on teachers' performance is the basic understanding that critical or rather self-critical analysis of one's activities is vital for the development of professionalism. There are many ways of laying the foundation for this type of understanding. Seminars and lectures may, of course, be helpful. One of the most effective ways, however, is certainly to ask a student teacher or a teacher to watch a video made during one of his/her lessons alone and to monitor his/her own behavior in the classroom and to answer questions such as how much time of the lesson is taken up by explanations and how much time is left for questions, answers, and comments by the pupils? This approach to self-criticism without any interference by a supervisor will, sooner or later, always have an effect.

Another important prerequisite for a successful interview with a student teacher or teacher is that from the very beginning the supervisor and the person being supervised try to find a common language. Therefore, it seems advisable that the supervisor explains the criteria he is applying for the evaluation of classroom performance. A feasible way of doing this could be for the supervisor to discuss with the person being supervised the semantics of the monitoring and assessment items on his evaluation form in the presence of fellow students or colleagues.

Another prerequisite for a successful interview is that it is scheduled at a time which is convenient to the person being supervised. Some individuals like to have some time elapse before they feel they are able to discuss the observations with the person who has monitored them. Not everyone is in the mood to do it right away. Thus, from a psychological point of view, the timing of the follow-up interview requires some sensitivity. There are few occasions where the conventional wisdom: *fools rush in, where angels fear to tread* is such an appropriate caveat.

Apart from these conditions, the supervisor must be aware that, during such an interview, someone who is being supervised can never completely dispel the apprehension of being assessed. In other words, the supervisor must be conscious of the fact that the person being supervised might always bear in mind that his supervisor must fulfill two tasks at once, namely, counselling and appraising. Any willingness to seek expert advice during the interview will be marred or even reduced to nothing if the person being supervised thinks that the supervisor has to identify strengths and weaknesses in order to give a fair assessment. Due to this ambiguity of the supervisor's role or to the difficulties that have been mentioned at the opening of this section, there is the danger that the aim of the follow-up interview is totally misunderstood by the person being supervised. A worst-case scenario may even find the person being supervised suspecting the interview is a confrontation to highlight his faults and to voice complaints about what has not been achieved yet.

What can be done to avoid such an undesirable outcome of a follow-up interview? What can the supervisor do so that he will be seen as a critical friend worthy of trust and confidence? A review of possible strategies on how to organize and conduct such follow-up interviews may answer this question.

To begin with, the supervisor has to find suitable surroundings for the interview. The threat of interruption can undermine confidence and, therefore, a secluded and comfortable room where both partners can relax is a good choice. First and foremost, the supervisor has to bear in mind that his attidude must be one of understanding and reassurance throughout the interview. If the supervisor does not invite the person being supervised to name the problems he wants to discuss, then the supervisor must begin with *open questions* in order to encourage his interview partner to start talking – specific questions should only be used to eliminate misunderstandings. The supervisor should allow the person being supervised to talk freely, without interruption, until the problem that is on his mind is apparent. The supervisor must give more than usual attention to *active listening*, remembering that it is important to be seen to be listening and that a pause in the narration may lead to further revelation, if not interrupted. Thus, the supervisor must respect silence but also be prepared to restart the flow of information by direct questioning. He must show an understanding of the supervised person's position, while considering possible alternative interpretations of the problems that have been revealed during the interview at the same time. If the supervisor gives advice during the interview,

it must be given with discretion and preferably only when it is explicity asked for. When counselling, the supervisor should avoid giving the impression that he is thrusting unasked or unwanted help at his interview partner. If at the end of an interview the person being supervised is able to determine, at least in part, his own training needs for further professional development, then the interview has indeed been successful.

Everything mentioned in the previous paragraphs on how to conduct a follow-up interview can be effective, regardless of what particular themes are discussed in the interview. Generally speaking, it does not seem to matter whether the supervisor and the person being supervised discuss the quality of the teaching process or the quality of the pupils' learning. However, since a direct analysis and discussion of the teacher's performance may provoke too much emotion on the part of the teacher and, in turn, prove to be a barrier to a true understanding of what has been going on in the classroom, we recommend as a rule to try an indirect approach to analysis and assessment. In other words, the supervisor should take care that the topical focus is on the pupils' progress in learning throughout the interview. This strategy could be called *a situational approach*[7] and creates for both the supervisor and the person being supervised the feeling that they are partners in a joint venture, namely, the task of promoting pupils' learning efforts and thereby improving their chances for a successful career in the professional world. In order to illustrate how such a situational approach may be implemented based on respective monitoring notes of a supervisor the following two examples are given[8]. The first set of notes (text A) refers to a student teacher whose level of performance is basic. The second set of notes (text B) refers to a student teacher whose level of performance seems to be advanced.

Text A

- Pupils respond conscientiously to the tasks set by the teacher, but the classroom work is characterized by a lack of enthusiasm and pupils have only little opportunity to exercise initiative.
- The majority of pupils are making some progress in their learning.
- Pupils occasionally take responsibility for and are active in their learning. They do not always work well in the absence of direct supervision.
- Pupils rarely cooperate in their work and teams are only formed at the teacher's request.

Text B

- A learning environment which encourages pupils to produce work of high quality has been established. Due to praise and other encouragement pupils are motivated to work well and enthusiastically.
- Almost all pupils are making good progress in their learning and in line with their prior attainments and abilities.
- Pupils take responsibility for and are active in their own learning. They are frequently required to think for themselves and reflect on ideas, issues, and experiences.
- Pupils cooperate in a variety of circumstances involving groups of different composition and size.

Notes

1 The qualifications described under *a* to *i* are based on UK standards; cf. particularly *Circular Number 10/97, Department for Education and Employment (DfEE)*, London, July 1997; similar descriptions will also be found in the respective regulations issued by Educational Ministries of the Laender in the Federal Republic of Germany, cf.e.eg. *Pläne für die Pädagogische Ausbildung vom 31. August 1995*, Hrsg.: Hess. Kultusministerium.

2 By will the author of this treatise refrains from using the term *teacher training*, as the professional qualification of a teacher goes far beyond the adoption of skills and implies a development of personality. The use of the term *development,* furthermore, is to denote that professionalism in the world of teaching means a life-long process of learning.

3 In many member states of the EEC regulations regarding the academic education of teachers require that within the framework of the respective courses periods of supervised teaching practice are provided. Cf.e.g. a) Statutes of the Instituts Universitaires de Formation des Maîtres (IUFM), France; b) Requirements for Courses of Initial Teacher Training / Circular Number 10/97 (DfEE), Britain; c) Articulo 24 de la Ley Orgánica de Ordenación General del Sistema Educativo, Centro de Publicaciones MEC, Madrid 1999, Spain; Rahmenvereinbarung über die Ausbildung und Prüfung für ein Lehramt der Sekundarstufe II (berufliche Schulen) oder für die beruflichen Schulen – Beschluss der KMK vom 12. Mai 1995, Germany.

4 Inservice training of teachers is provided by many member states of the EEC. In addition to that there exists in the Federal Republic of Germany a so-called *preparatory service (Referendariat)* for a period of 18 or 24 months.This preparatory service can only be taken up after having passed the *First State Examination.* At the

end of the preparatory service there is a *Second State Examination* which is the final qualification for occupying a teaching position with the status of a civil servant.

5 Regarding this subject the respective literature is very extensive. Therefore only a few publications are cited. They may illustrate the wide range of aspects to be touched upon when writing on this subject. Heron, John (1989). *The Facilitator's Handbook.* London: Cogan Page/New York: Nicol's Publishing. Evison, Rose & Horobin, Richard (1990). *How to change Yourself and your world.* Sheffield: Phoenix. The same authors (1987). *Co-Counselling as Therapy.* Sheffield: Phoenix. Sauter, Werner (1994). *Vom Vorgesetzten zum Coach der Mitarbeiter. Handlungsorientierte Entwicklung von Führungskräften.* Weinheim: Dt. Studienverlag. Cohn, Ruth (1975). *Von der Psychoanlayse zur themenzentrierten Interaktion.* Stuttgart: Klett. Boettcher, Wolfgang & Bremerich–Vos, Albert (1987). *Kollegiale Beratung in Schule, Schulaufsicht und Referendarausbildung.* Frankfurt/Bern/New York/Paris: Lang. Gaude, P. (1989). Selbstbewertung und Beratung in der Lehrerausbildung (SBL)- ein angewandtes Forschungsprojekt. *Unterrichtswissenschaft* 17/1, S. 47-59. Jeuthe, Eberhard (1998). Praxissemester in der 1. Phase der Lehrerbildung. *Pädagogik* 50/9. S. 52.

6 This draft proposal has been developed and discussed at workshops in Jordan, organized by the author within the framework of the ITEJU-Project in April, May and October 1999.

7 The situational approach is one of the supervisional strategies based on: Pläne für die Pädagogische Ausbildung für die Lehrämter vom 31. August 1995, Hessisches Kultusministerium (Hrsg.).

8 The examples given represent modified versions of respective UK - performance indicators.

Husean Abu Serdaneh

The Roles of Practice Teaching Educators

The Role of the University Supervisor

Introduction

The role of a university supervisor is complex and multi-faceted. He serves as a liaison between the university, represented by the Faculty of Educational Sciences, and the cooperating schools. He interprets the program to the cooperating teachers and the cooperating principals at the cooperating schools. He guides the practice teaching of the student teachers in his specialization and evaluates their work during and at the end of their practice teaching. The purpose of practice, as with all aspects of teachers training, is to work toward improved teaching behavior from the current standpoint of a novice (Perrodon, A. F. 1966). As there are no straightforward recipes for successful teaching that can be applied in all situations, the university supervisor has to exercise his own good judgment in the given situation (Cọhen, L., Manion, L. and Morrison, K. 1966). Only through actual teaching experience can a prospective teacher fully realize the challenges and responsibilities of teaching (Perrodon, A. F. 1966). An important tenet of supervision has long been that the best supervision serves to help the person being supervised to become increasingly more independent. A good supervisor helps teachers to learn to help themselves (Neagley, R. and Dean, Eran N. 1980). Nevertheless, teaching is a complex process that can be conceptualized in many different ways, using alternative models, metaphors, and analogies (Moon, B. and Mayes, A. S. 1995). Let it suffice here to say that a university supervisor has to bridge the imaginary chasm between theory and practice and must set the tone for mutual trust and respect with all persons concerned, student teachers and the cooperating teachers and principals at the cooperating schools alike.

In the following the various facets of the role of a supervisor will be elucubrated.

1. Training Student Teachers in Classroom Management

The university supervisor, through observing the performance of the student teachers, should cater to their predominant concern of how to survive in real classroom settings and how to manage the class successfully.

The classroom environment clearly places a heavy burden upon student teachers to attend to and process a large volume of information (Moon, B. and Mayes, A. S. 1995).The supervisor should thus have deep insight into each student's teaching personality and whether he/she has the appropriate interpersonal skills and disposition for working in the pupils' best interest.

Individuals vary greatly in their talent for teaching and in their readiness to adapt their behavior in the appropriate directions (Perrodon, A. F. 1966). Therefore, the university supervisor should confer with each student teacher about his/her work and suggest possible solutions to any problems he/she may encounter, perhaps in collaboration with the cooperating teacher. A general rule for classroom management might be to stimulate pupils to become active learners in their own right, and to generate interest in the classroom the student teacher should play on the intellectual curiosity of the pupils through puzzles, problems, and questions (Brown, G. and Atkins, M. 1988).The assumption that learning and class discipline can be optimized through perspicuity in student teachers' speaking in classroom settings likely has implications for presentation of what is to be taught as well as for classroom management. Teaching is art, not technology. Detailed study and analysis, however careful, cannot generate comprehensive and situationally specific procedural rules which a teacher can learn and then apply in order to consistently achieve a desired outcome. There is no single route to classroom effectiveness (Moon, B. and Mayes, A. S. 1995). A good way to give student teachers an idea of classroom management at the beginning of his/her student teaching might be to first have her/him observe lessons of the teaching staff in the cooperating school in different specializations, followed by observing the lessons of his/her cooperating teacher for a certain period of time and then to teach part of each lesson of the cooperating teacher in a collaborative manner for at least 1 month before teaching complete lessons. Furthermore, all of this should be monitored closely by the university supervisor, who gives the student teacher comprehensive feedback and encouragement so as to help orient him/her in the best possible way.

2. Pedagogical Training: Content and Methods

Student teachers who enter the Practicum have already acquired a broad background of general knowledge, have specialized in a subject or in elementary education, and have studied education science, including social and psychological foundations of education, the curriculum, and appropriate methods of teaching (Perrodon, A. F. 1966). The knowledge basis for teaching has been conceptualized as comprising knowledge of subject matter, pedagogical concepts, and curriculum (Soled, S. W. 1995). Classroom practice is not content free; there is always some thing which is taught and learned (Elliot, J. 1993). Our model of learning has profound implications for how we teach (Elliot, J. 1993).

A university supervisor should help student teachers to become proficient thinkers in their subject area as well as to attain the skills, learn the techniques, and perform the behaviors that make them technically capable teachers (Soled, S. W. 1995).

It is not difficult to envisage the role of the teacher changing from a deliverer of fixed knowledge to a facilitator and supporter of student-centered learning (Cohen, L., Manion, L. and Morrison, K. 1996).

Pedagogical training must be geared to knowing and respecting the multiple aspects of human personalities (Aggarwal, J. C. 1995). The job of the university supervisor is both a challenge and an opportunity to prepare good teachers (ICET, 1997). The guidance offered by him to student teachers must be relatively specific and comprehensible, so that it can be related to the activity in question: likewise, the feedback needs to be direct and immediate (Francis, H. 1985).

The supervisor has to promote an awareness in student teachers of how children learn, how children differ in intelligence or learning potential, and the patterns of physical, social, and emotional development in children and young people. He should also help student teachers to employ a range of teaching strategies appropriate to the ages, abilities, and attainment levels of pupils and to clearly present subject content in a stimulating manner (Bourne, J. 1994). He has to train student teachers to specify lesson objectives, measure progress towards these objectives, and to consider alternative courses of action to reach the same ends (Elliot, J. 1993).

The main concern of a university supervisor should be to improve student teachers' skills and keep them abreast of the latest educational trends, and not just to criticize and admonish them (Neagley, R. and Dean, Eran N. 1980). There is little argument among theorists that learning involves

the construction of knowledge through experience: there is controversy, however, about the conditions under which such learning is optimized. A constructivist view of learning perceives children as intellectually active learners already holding ideas or schemes which they use to make sense of their everyday experiences. Learning in the classroom involves the extension, elaboration, or modification of their schemata (Moon, B. and Mayes, A. S. 1995). Thus, the student teacher's job is to find effective ways of modifying, extending, or elaborating the children's schemata (Moon, B. and Mayes, A. S. 1995). Another view holds that learning in the classroom is optimized in settings where social interactions, particularly between a learner and more knowledgeable others, is encouraged and where cooperatively achieved success is a major aim (Moon, B. and Mayes, A. S. 1995). Finally, good teaching must be oriented not towards the yesterday of development but towards its tomorrow (Moon, B. and Mayes, A. S. 1995).

3. Training Student Teachers to Manage Pupils Behavior and Conformity

Acceptance of student teachers' authority and manageability.

Children are formally required to attend school whether they wish to or not; they are required to submit to the authority of an adult other than their parents (Cohen, L. and Manion, L. 1977). No one can teach someone who does not want to learn; hence, first, a student teacher must stimulate the children's desire to learn (Perrodon, A. F. 1966). Children do not, by any means, lack in the ability to exert influence on adults, and most of them have clear expectations about what a teacher should do and how he/she should behave (Cohen, L. and Manion, L. 1977).

In most cases students welcome a change (a new teacher) and are most cooperative. They expect the knowledge, ability, patience, and understanding of a veteran from the student teacher. They are tolerant of errors or lack of information for the first few days but expect more than adequate preparation; they expect him to take interest in them as participants; and they want to be friends, not pals (Perrodon, A. F. 1966).

Oral presentation and interactions with students are a large and important part of teaching (Soled, S. W. 1995). However, the concept of what is good and what should happen is very difficult to pin down (Moon, B. and Mayes, A. S. 1995).

Thus, the university supervisor has to diagnose the causes of the problems the student teachers encounter and suggest workable solutions to

every one of them on an individual basis. Legally, the student teacher has no authority in the classroom: he may not punish a child or promote or fail pupils; he has, however, the responsibility of a teacher, within the area of his competence, without the authority or professional status (Perrodon, A. F. 1966). Research has indicated how important student teachers' previously acquired images of teaching are. Experience during their own school days appears to shape how novices see themselves as beginning teachers (Moon, B. and Mayes, A. S. 1995). Pupils are more likely to listen to the trainee and accept his/her suggestions if he/she is perceived as being credible and trustworthy and to have expertise (Brown, G. and Atkins, M. 1988). The university supervisor should suggest to every trainee, whether in school or on the university campus, appropriate methods of teaching that are interesting, motivating to pupils, and conducive to learning.

As a general rule, if the pupils feel the desire to learn and engage in the activities assigned to them by the student teacher they, most probably, will accept and enjoy his/her authority.

Given the view of teaching as a practical activity which is learned from the experience of doing it, the search for security initially mostly involves minor, but myriad, administrative tasks, organizational arrangements, managerial proficiency, teaching techniques, and pedagogical strategies, which might be considered prerequisites of professional credibility (Elliot, J. 1993). The student teachers should be trained to devise and use appropriate rewards and sanctions to maintain an effective learning environment and to keep pupils interested and motivated (Cohen, L., Manion, L. and Morrison, K. 1996). Often an indirect but powerful way of improving teaching is to improve the ways in which students learn (Brown, G. and Atkins, M. 1988). Hence, teaching can be regarded as providing opportunities for students to learn (Brown, G. and Atkins, M. 1988).

Trainee's vocal qualities, such as hesitation, stumbles, errors, use of pauses and silence, nonverbal cues, such as gestures, facial expressions, body movements, and the quality of audio-visual aids which are used may convey meanings and attitudes which highlight, qualify, or distort the essential messages of teaching (Brown, G. and Atkins, M. 1988).

Finally, the pupils' first-hand experience and involvement are major motivators for learning and acceptance of a trainee's authority.

4. Discussing in Scheduled Meetings What Actually Works as Opposed to What Is Desirable in Classrooms and Laboratories

Questions student teachers usually ask the university supervisor are: "What should I do when?" He replies: "Well, it depends on...!" (Elliot, J. 1993). It may be difficult for the university supervisor to avoid recasting competences in narrow behavioral and skill-based terms (Cohen, L., Manion, L. and Morrison, K. 1996). There are four possibilities to commend that this may be a good practice. For example, if the student teacher says:

- I like this practice, and it accords with my personal philosophy and education (value or belief).
- This practice works for me, and I feel most comfortable with it (pragmatic).
- I can prove this practice is effective in enabling children to learn (empirical).
- I (or others) expect to see this practice, and it should be adopted (political) (Bourne, J. 1994).

In fact good teaching takes many forms (good teaching comes in many guises) (Soled, S. W. 1995). Though the student teacher has a commitment to the individual student – to know him, to know where he stands in his work, and to know how to help him as individual – in the face of large numbers of students, he can never carry out these objectives and must always make compromises with his ideals (Perrodon, A. F. 1996). As the supervisor usually tells student teachers that children learn by doing, he has to accept a demonstration done by the trainee instead of giving the pupils the opportunity to do the activity themselve considering the large numbers of pupils and the scarcity of materials, equipment, safety measures in the working place, and funding. Small group teaching is usually appropriate for promoting intellectual skills, including problem solving, changing attitudes, and enhancing critical thinking and open-mindedness. Overuse of this methods can be self-defeating, however, and it is not an effective method for imparting information. Tests are usually administered not to improve teaching but for creating raw data to categorize pupils. Some pupils just want to pass examinations and are not interested in developing dynamic qualities such as exercising initiative and accepting responsibility. Finally, recent research has shown, and been con-

firmed by professional observations, that a large amount of school work is structured around text books and printed material and many of the teachers demonstrations and explanations consist of presenting material contained in text books. Analyses of these materials show that they are often unwittingly complex and confusing and there is a very high level of mismatching between tasks and children s attainment (Aggarwal, J. C. 1995).

This is, in fact, the case in developing countries and it is not surprising to find out that student teachers, too, stick to the material in the text book and use it as a defense to justify what they do.

5. Fostering Student Teachers Ability to Discern Appropriate Responses to Situations in the Classrooms in the Face of Uncertainty and Doubt

How does the student teacher feel the first time he/she enters the classroom for practice teaching (Perrodon, A. F. 1966) ?

Most student teachers recall that hollow feeling in their stomachs and the general uncertainty about the situations into which they were moving and their ability to operate in such situations (Perrodon, A. F. 1966). They often feel very inadequate in the face of a whole new world about which they have read a great deal and experienced only little (Perrodon, A. F. 1966). Practice provides an opportunity to analyze the characteristic defenses which a teacher employs in the face of stress, to test the appropriateness of these defenses, and to develop rational and controlled behavior to handle the stress situations (Perrodon, A. F. 1966).

If student teachers are going to work, especially in tough schools, they are right to doubt their abilities to communicate and keep things under control because, nowadays, teaching demands a high degree of flexibility and improvisation along with the ability to read situations with speed and accuracy and maintain a repertoire of responses (Francis, H. 1985). Especially at the beginning of practice teaching the university supervisor plays a prominent role in encouraging his student teachers, in alleviating their doubts, and in persuading them that these are natural feelings which most people have the first time they address a public audience. He should, from the very beginning, emphasize that one of the most crucial factors in practice teaching is preparation – formulating aims and objectives purposefully, selecting appropriate content, deciding on the best method of presentation, and writing up the actual lesson notes (Cohen, L. and Manion, L.

1977). In order to verify personal field experiences student teachers need to receive systematic, objective feedback about their behavior (Cohen, L. and Manion, L. 1977).

To be competent, a student teacher must have knowledge of child development, of the material to be taught, and of suitable methods; his skills must enable him to teach, advise, and guide his pupils (Aggarwal, J. C. 1995). Failure of the majority of the class to learn the material adequately is due in part to poor motivation at the outset of the lesson; the teacher's subsequent inability to sense the frustration in the class usually leads to discipline problems (Cohen, L. and Manion, L. 1977).

Technical skills of teaching include (Aggarwal, J. C. 1995):

- Using stimulating material and variation in movement, gestures, interaction techniques, and sensory channels in order to alleviate boredom and inattentiveness.
- Encouraging the students to respond through the use of praise and acceptance as well as through nonverbal signs such as nodding and smiling.
- Skill in forming questions which encourage students to elaborate on or raise the level of their responses and questions which elicit responses that require a higher intellectual level from the students instead of responses that involve only fact stating. Finally, personal competence may include qualities such as self-esteem, willingness to take responsibility, taking initiative, open-mindedness, and willingness to learn (Elliot, J. 1993).

6. Informing and Training the Student Teachers How to Teach for Understanding, in Contrast to Teaching for Pure Memory Learning (Rote Learning)

Every subject probably has its own style of thinking but also has features in common with other such styles.

The value and precise nature of the type of thinking varies from subject to subject (Brown, G. and Atkins, M. 1988). Teaching for understanding won't happen in classrooms where students sit silently and passively (Soled, S. W. 1995). University supervisors should enhance an awareness in student teachers to take individual differences among pupils in the classroom into account by expressing the same information in different forms.

This can trigger ideas and associations that aid understanding. Since students learn in different ways, the greater the number of ways a student teacher presents key points, the greater the chance is that a higher proportion of students will understand (Brown, G. and Atkins, M. 1988).

The task of the trainee is to master concepts drawn from areas such as philosophy, sociology, and psychology, and to apply them in particular situations at the appropriate time with the verification of his/her supervisor. One of the purposes of teaching practice is to enable a student teacher to refine his/her understanding of the curriculum and to convey this understanding to pupils, taking into consideration their prior knowledge, their developmental stage, and the manner of participation and motivation. Discussion rather than instruction should be the core activity in the classroom. Student teachers should encourage divergence in discussion and avoid using the position of authority to promote their own view by adopting an attitude of procedural neutrality (Elliot, J. 1993). Laboratory work should not involve a series of routine experiments specified precisely by the student teacher but rather a set of guided inquiries in which the pupil can develop hypotheses to test and chooses methods and designs appropriate experiments (Brown, G. and Atkins, M. 1988). Student teachers should be taught to abandon obsolete and irrelevant methods of teaching. Learning to teach for understanding requires changes in beliefs and attitudes, feelings and self-conception, perception, and actions as well as knowledge (Francis, H. 1985). It would be unfortunate if student teachers were only allowed to influence children's learning with nothing more than common sensical conceptions of what we might aspire to in fostering learning. Psychology has much to say in this matter of aspiration. There is a substantial body of literature on the nature of learning under different conditions, showing the power of particular environments to attain particular goals (Francis, H. 1985).

Finally, research has found only little evidence of teaching for understanding in contrast to teaching for pure memory learning, as demonstrated by the lack of any genuine discussion taking place in the lessons that were observed (Brown, G. and Atkins, H. 1988).

7. To Help Student Teachers to Reflect on Their Practice and to Write It Down for the Supervisor to Read and Evaluate Critically

Weekly meetings on campus offer student teachers the chances to critically examine, reflect, and evaluate the effectiveness of their teaching. One common method a university supervisor may use is to present video recordings of lessons they taught or structured practical situations and ask them to examine, analyze, comment and reflect upon them, and propose new methods and techniques to improve the quality of teaching. Student teachers are experimenters. Inevitably, some of their endeavors will not work out, but such occasions can be just as educational as the successful ones. In this capacity they can think up imaginative and innovative approaches to traditional problems and decide in what way theory supports practice (Cohen, L., Manion, L. and Morrison, K. 1996). The problem faced by students in attempting to become effective teachers is first and foremost the need to become effective researchers who are capable of inquiring into their practice teaching and, hence, adequately identifying the problem; who are capable of taking appropriate actions to effect change; and who are capable of monitoring changes (Elliot, J. 1993). The central aim of the exercise is to develop reflective student teachers. A student teacher must be given the opportunity to find out things he genuinely wants to know about (Perrodon, A. F. 1966). Helping trainees to view their teaching is particularly important because the way in which they interpret school experience is very often influenced and shaped by their own set of attitudes, beliefs, and values (Kerry, T. and Mayes, A. S. 1995).

During practice teaching, students are constantly turning over situations in their minds. It is clear that these situations are practical and pose a considerable variety of problems (Elliot, J. 1993). The quality of student teaching and student learning depends substantially on the quality of their judgments and actions, which should be based on sound assessments of situations, events, and people (Elliot, J. 1993).

The decisions student teachers make and the assessment of their effect may well be expected to affect and be affected by personal qualities and pre-dispositions such as confidence, perceptiveness, energy, insight, commitment, perseverance, will, the capacity to analyze situations, and so on (Elliot, J. 1993). Besides reflection, what enables a student teacher to develop his/her ability to improve practically throughout the period of practice teaching and to benefit from both his/her university supervisor and cooperating teacher? Every student teacher should write down on a daily

basis whatever he/she deems educationally worthwhile and submit it, at periods agreed upon, to the supervisor to read critically in order to understand the nature of his/her thinking and learning. Finally, teaching practice is highly paradoxical (Cohen, L. and Manion, L. 1977). This is why a student teacher should evaluate his own teaching each day because, as a matter of fact, teaching simply is a personal invention.

The Role of Cooperating Teachers

1. To Open Their Practice to Student Teachers Questioning and Scrutiny

At the beginning of practice teaching the cooperating teachers should help the student teachers become acquainted with the different parts of the school, the school ethos, the prevailing atmosphere, the staff room, morning assembly, the quality of relationships between the principal and his staff and among the staff themselves, the facilities, the prevailing system of control and discipline, the school's philosophy of education, and the school's expectations of the student teacher (Cohen, L. and Manion, L. 1977). They should help the student teachers to adapt to the environment of the school; understand the pupils they are going to teach; learn from lesson observation and related activities; and gather specific information relevant to the work they will undertake during their practice (Cohen, L. and Manion, L. 1977). As student teaching is a transitional period between the university and a teaching career it provides student teachers an opportunity to assess their strengths, weaknesses, and potential as a teacher while the day-to day-guidance of an experienced cooperating teachers is available (Perrodon, A. F. 1966). Cooperating teachers need to know what skills and competence should be developed by the student teachers in their care in order for them to be equipped to begin teaching (Field, B. and Field, T. 1994).

They need to act as collaborators working alongside trainees, interpreters, and role models. They should help trainees to feel good about teaching; to learn to manage their workloads; and to become part of the school community (Kerry, T. and Mayes, A. S. 1995). Student teachers, with the help of cooperating teachers, need to be able to recognize the different types of theories and to be able to be aware of their power and its

limitations and appropriate use (Neagley, R. and Dean, Eran N. 1980). They should help trainees to be able to:

- Demonstrate an understanding of the knowledge, concepts, and skills of their specialist subjects and of their place in the curriculum.
- Demonstrate an ability to select and use appropriate resources.
- Decide when to teach the whole class, groups, pairs etc.
- Create and maintain a purposeful and orderly environment for the pupils'.
- Maintain the pupils interest and motivation (Cohen, L., Manion, L. and Morrison, K. 1996).

The cooperating teachers are considered the key to the success of the student teaching program (Perrodon, A. F. 1966). A major issue in teacher education has been the introduction of specified areas in which student teachers should demonstrate competence. The development of this competence should be monitored throughout the entire period of practice teaching by the cooperating teacher (Cohen, L., Manion, L. and Morrison, K. 1996).

Competence is required in five main areas: subject knowledge; subject application; class management; assessment and recording of pupils' progress; and further professional development (Cohen, L., Manion, L. and Morrison, K. 1996).

Finally, the responsibility of cooperating teachers is to help student teachers plan and execute their lessons, to spend most of the time in the classroom observing the student teacher's performance, to learn how to help them improve, to give an objective evaluation of student teacher's abilities or lack thereof, and to provide on-the-spot feedback and guidance that is appropriate for each student teacher.

2. To Be Concerned with Improving the Quality of Their Work

As the nation scrambles to upgrade its educational system, many of the current educational reforms are calling for new images of teaching that break with past traditions. Universities have a stake in and responsibility for school improvement just as the schools have an interest in and responsibility for the education of those who will staff the schools (ICET, 1997). Cooperating teachers, in particular, have to embark on the journey of trans-

forming their professional culture from one of an unreflective craft into one which emphasizes reflective judgments as a basis for improving the quality of teaching and learning (Elliot, J. 1993). As student teachers enter into practice teaching with a host of theoretical concepts about teaching which they learned in their university studies, they usually attempt to implement them in practice. The cooperating teachers and the student teachers should exchange ideas and discuss new teaching strategies. Often an indirect but powerful way for the cooperating teacher to improve his/her own teaching is to improve the way in which pupils learn (Brown, G. and Atkins, M. 1988). It might be profitable for cooperating teachers, who willingly, shoulder the responsibility for improving learning and instruction, to learn all they can about supervisory, instructional, and curricular theories (Neagley, R. and Dean, Eran N. 1980). Understanding what teaching and pedagogy mean is most important for improving teaching. The term pedagogy has been used to refer to the kind of thinking or reasoning used in the critical transformation of subject matter into teachable (or learnable) form. Such thinking is open-ended and cyclic; each cycle includes, in order, the process of comprehension, transforming, instruction, evaluation, and reflection and results in a new comprehension that, in turn, starts a new cycle of thinking at a higher level of understanding and performance. Pedagogical thinking is developmental, and it is not something that can easily be accomplished (International Yearbook on teacher education, 1997). The catchwords in education today seem to be innovation and change (Neagley, R. and Dean, Eran N. 1980). The concept of improvement implies that teaching behavior can be organized to accomplish these objectives (Perrodon, A. F. 1966). The cooperating teacher should be viewed as a creative and reflective practitioner and a catalyst for all forms of development (Cohen, L., Manion, L. and Morrison, K. 1996). Cooperating teachers need, however, the confidence, perceptiveness, and flexibility that enable them to respond to circumstances that vary not just from year to year, but from day to day and period to period (Cohen, L., Manion, L. and Morrison, K. 1996). Finally, the cooperating teachers who resist change and innovation insist on making student teachers a carbon copy of themselves and deprive them of the opportunity to try their wings in their own way.

3. To Give Trainees an Appropriate Set of Values as well as the Knowledge, Skill, and Competence for Successful Classroom Practice

Student teachers must be helped by the cooperating teachers to grow as individuals: this includes their beliefs and values, personality and feelings, and sensitivity and competence, as well as their understanding.

What people believe is much more important than what they know (Francis, H. 1985). In order to be competent the student teacher's attitudes and values should be positive so that his/her example is likely to be followed, as he transmits explicitly, and implicitly, the national aims and moral and social values (Aggarwal, J. C. 1995). Effective teaching is concerned not only with success but also with appropriate values (Brown, G. and Atkins, M. 1988). The quality of student teacher performance is related to its consistency with the educational values that constitute the goals of education. These are not instrumental values such as effectiveness and efficiency but rather the conceptualization of human potential – which an educational process aims to foster and develop in pupils (Elliot, J. 1993). The aspect of self-knowledge which the cooperating teachers fosters in student teachers appears to be linked not only to the search for what is best in instructional strategies, but also to the aims and values, albeit sometimes hidden and implicit, underlying those strategies (Elliot, J. 1993). It has been claimed that when we talk about educational aims we are referring to educational values (Elliot, J. 1993).

The cooperating teacher plays a role in challenging the trainees to consider issues of belief and values during their practice teaching (Kerry, T. and Mayes, A. S. 1995).

If we focus on the field of teaching, then answers to questions about what to teach novices, when to teach it, and how to teach it depend in part on implicit theories about the role of experience in the ability to learn teaching skills, attitudes, and ways of thinking that the teacher educators believe to be desirable (Aggarwal, J. C. 1995). A cooperating teacher's attitude toward professional growth of the student teacher will be implicit in the kinds of comments he/she makes to the student teacher (Perrodon, A. F. 1966). Through the concerted efforts of the cooperating teacher and the university supervisor, a future teacher should become familiar with appropriate methods of teaching. Finally, the cooperating teachers should be exemplary in their respect of the beliefs and values of others and in their perseverance to serve the society and educate the younger generation, whether

student teachers or pupils, to cope successfully with the demands of living in modern societies.

4. To Help Student Teachers Learn Professional Common Sense

The cooperating teachers, through their long experience, develop a sort of professional common sense with which they implement typical means to bring about typical ends in typical situations which they create in daily practice. They not only should help the trainees acquire this kind of knowledge, but also approve such professional common sense that is potentially open to questioning and revision (Elliot, J. 1993).

It is through this that a student teacher becomes able in educational settings to typify ends, means, situations, and motives and to construct solutions to problems (Elliot, J. 1993). Professional common sense implies a recipe which allows the student teacher to construct a scheme of interpretation to understand events within situations and a perception of how to respond (Elliot, J. 1993). Recipes are difficult to teach and are picked up most easily through imitation and practice (Elliot, J. 1993). During observation of lessons being taught by cooperating teachers many student teachers merely transpose what they see into common sense terms.

A common sense interpretation has structure, of course, but the structure is such that it is tied to the concrete reference points in time and space which bind the perceptions to the here and now. An observer adopting a common sense perspective would thus perceive the gross external features of a lesson, for common sense is simply content with a miscellaneous collection of information. The relevance of theoretical concepts in this and other contexts lies in the fact that by a process of abstraction inner meanings can be developed that are not tied to concrete reference points (Cohen, L. and Manion, L. 1997). Finally, the term pedagogy itself implies structure. It implies the elaboration or definition of specific means adapted to produce the desired effect such-and-such learning on the part of the child (Moon, B. and Mayes, A. S. 1995).

5. Help the Student Teachers Achieve a Level of Professional Confidence

As the student teachers step into the classroom they have very mixed feelings. Good cooperating teachers know that student teachers who are overly anxious, insecure, and fearful of the consequences do not learn well.

A student teacher who is frozen with fear of either the students or the cooperating teacher will do far less than his/her best (Perrodon, A. F. 1966). A student teacher may be uncertain of what will be expected of him/her, wonder whether he will get along with the cooperating teacher, worry over the fact that students may not like him/her, or have doubts that he/she is capable of managing a classroom. As a result he/she may act inappropriately and fail miserably to live up to his or her own expectations (Perrodon, A. F. 1966). Student teachers need the encouragement from their respective cooperating teachers to help them build confidence and develop favorable attitudes toward the teaching profession (Aggarwal, J. C. 1995).

Some of the characteristics shown as determining good teaching practice are self-confidence, academic ability, and prior experience (ICET, 1997). Student teachers learn to build confidence through observing others teach and through teaching in collaboration with cooperating teachers and independently. They only gradually build up the confidence and acquire the professional competence that is required for coping with complex classroom situations. They should be encouraged to reflect on their actions to develop their personal theory (International Yearbook on teacher education, vol. 2, 1997). Cooperating teachers should gradually introduce student teachers to teaching, as a cushion against the reality shock which so many of them experience (Perrodon, A. F. 1966). Common sense would suggest that a student teacher's beginning load should be lighter, that it should include little preparation and free periods for planning. Finally, student teachers should build on the rapport the cooperating teachers have established with the pupils (Perrodon, A. F. 1966).

6. To Encourage Student Teachers to Realize That Discussion Rather Than Instruction Should Be the Core Activity in the Classroom

The traditional image of teacher-as-information-fount and students-as-information-absorber has to be changed; instead, teachers should create an environment in which students encounter genuine problems and explore these problems in collaboration with their teachers and other students.

This casts a teacher as a guide, coach, or orchestrator and facilitator (Soled, S. W. 1995). The most common mode of teaching seems to be direct instruction; however, direct instruction is known to have serious limitations on the development of higher order learning (Francis, H. 1985). Learning takes place best when the student teacher maintains a democratic

atmosphere in which pupils discuss their ideas freely with each other and where the student teacher adopts the role of adapter of the curriculum to the needs, abilities, and interests of the students (Perrodon, A. F. 1966). A genuine discussion could be optimized when the pupils are encouraged to gather information from various sources about the subject of a lesson in advance and come to the lesson prepared to discuss and confirm the validity of their ideas; this creates an atmosphere of constructive competition among them. Thoughtfulness is measured in terms of the number of interpretative, evaluative, and speculative utterances made by pupils (Brown, G. and Atkins, M. 1988). If pedagogical input takes the form of chalk and talk, then contact with pupils is minimal and diagnostic work is virtually nil. In this case, the student teacher appears to spend too much time in managing the pupils rather than in managing learning (Francis, H. 1985). Bad teaching reduces motivation, increases negative attitudes to learning, and yields lower achievement (Brown, G. and Atkins, M. 1988). If the cooperating teacher has not accustomed pupils to free expression and discussion in his/her teaching, then it will be more difficult for the student teacher to promote discussion and for the pupils to discuss coherently, to question, and to think.

Finally, subtle questioning represents the core of Socrates method. His goals of enhancing intellectual and oral skills, of developing attitudes, and of improving understanding of oneself and others are as relevant today as they were in the fifth century B. C. (Brown, G. and Atkins, M. 1988).

7. To Foster a Student Teacher Training Process which Develops Dynamic Rather Than Passive Qualities

In order for student teachers to develop dynamic qualities such as exercising initiative, willingness to take responsibility, open-mindedness, and willingness to learn, the cooperating teachers should offer them as many opportunities as possible to work out their ideas and tackle problems within their capacity.

Dynamic qualities cannot be developed easily without the deliberate socialization of the student teachers into teaching whereby they become a participating member of the society of teachers in the cooperating schools (Kerry, T. and Mayes, A. S. 1995). Dynamic qualities are a kind of personal competence which require a certain degree of connoisseurship on the part of the cooperating teachers to find how each student teacher should be

assisted most appropriately, especially considering the individual differences among student teachers, so as to meet the required level of these qualities.

As a general rule, the cooperating teachers should accept and respect the student teachers as they are and abstain from criticizing them, and instead guide and encourage them in a wise, friendly, and diplomatic way. Development of dynamic qualities requires creativity, vim, and vigor on the part of student teachers. Creativity can be promoted by a kind of responsible freedom that student teachers should enjoy in the classroom as well as in the school. Good mentoring needs the well-cultivated minds of conscientious teachers who believe and are capable of unleashing the mental and spiritual power of student teachers. Student teachers should feel that teaching is where they belong and where they can fulfill their aspirations for a meaningful life. Good educators know that teaching is a psychologically and mentally demanding profession and that the cooperating teachers play a key role in inspiring dynamic qualities in the hearts and minds of tractable and in-experienced novices. Neither university supervisors nor principals spend as much time as the cooperating teachers do side by side with their student teachers. This fact explains the great influence the cooperating teachers enjoy in shaping the very foundations of the teaching-learning process of student teaching.

The Role of Principals at Cooperating Schools

1. Keeping Order in the School so That Everything Runs Smoothly

As an organization, a school has certain distinguishable features common to all organizations. It has, for example, specific objectives which determine what goes on within its walls, how its activities are structured, and what rules and regulations govern its procedures (Cohen, L. and Manion, L. 1977).

Under the leadership of a well-informed, capable, and discerning principal, the role expectations for all individuals who staff the school have to be defined clearly. Some of the factors found to be associated with positive attitudes on the part of students were related to the way their school was managed: effective discipline; well-maintained premises; a good reputation; and well-behaved students (Moon, B. and Mayes, A. S. 1995). Of

primary importance is the establishment and maintenance of satisfactory human relations among all staff members (Neagley, R. and Dean, Eran N. 1980). Obviously, principals should instruct the cooperating teachers about how to relate to student teachers and to pupils on a human level so that a pleasant atmosphere, which is necessary for the success of student teaching, prevails in the schools.

2. To Make Wise Professional Judgments and Decisions Regarding Progress in the Training Process

The cooperating school principal should be recognized as the educational leader of the school for effective implementation of student teaching phases and scheduling. Practically speaking, not all student teachers get along with their cooperating teachers or pupils. Some student teachers begin practice teaching in a satisfactory way but others may fail to do so for various reasons. In the latter case the principal has to know the reason(s) for failure, first by listening to the explanations made by the failing student teachers, and then asking their cooperating teachers to explain the reasons behind any difficulties their trainees are being faced with. Subsequently, a principal may decide to change the cooperating teacher for a particular student teacher, or change one class for another, or extend or shorten a certain phase of student teaching, etc. Some student teachers' performance may not change during the period of practice or it may decline after a good start, in which case the principal should inquire about the reason(s) and consult the university supervisors of those trainees as well as their cooperating teachers in hope of finding a remedial solution. Moreover, the performance of the pupils being taught by a particular trainee on tests may be unsatisfactory, in which case the principal has to assess and hypothesize the cause(s) and to take certain measures in collaboration with the university supervisor and the cooperating teacher of that trainee.

In fact, with every student teaching course, new problems are likely to occur which the principal has to deal with and solve and over which he/she must consult with the persons who share the responsibility for successful student teaching at his/her school.

3. To Cater to the Training Needs of Student Teachers

Student teachers need, first and foremost, a quiet place where they can rest and prepare for their lessons. They need more materials, audio-visual aids, laboratory apparatus, books, and transparencies than other teachers at the school do.

All resources should be available for trainees so that they can work to the best of their potential. Above all, they need to be treated with respect, especially by the principal of the cooperating schools, because he/she is the most influential person there. The principal should not maintain a psychological barrier between him/her and the student teachers and he/she should sit down with them regularly and listen to what they have to say and help however necessary to make their experience in the school enjoyable and conducive to good learning, about how to teach, manage classrooms, understand school ethos, socialize with the teaching staff, and benefit from the facilities in the school and so on.

4. Surveillance and Control over the Performance of the School and Teachers, Particularly the Cooperating Teachers

The principal of a cooperating school may be a specialist in a certain discipline but he/she has to be a generalist in the approach to the school program as a whole (Neagley, R. and Dean, Eran N. 1980). There can be no understanding of the curriculum in action unless the principal visits classrooms regularly, and he/she should ensure that all staff activities contribute in some way to the improvement of learning and instruction in the school (Neagley, R. and Dean, Eran N. 1980). Principals and teachers in every school need to get together and, within any local and national guidelines, define what they mean by good and effective teaching (Moon, B. and Mayes, A. S. 1995).

The direct responsibility for improving instruction and learning rests in the hands of the school principal (International Yearbook on teacher education, vol. 2, 1977). The cooperating school principal should pay cooperating teachers special attention and make sure that their teaching is exemplary for the student teachers to emulate and improve their teaching and behavior.

5. To Make Judgments About the Educational Quality of the School and Whether the Performance of Student Teachers Is Consistent with Educational Values

The professional judgments and decisions of the principal are ethical and not simply technical in character (Elliot, J. 1993). In their judgments principals should select and utilize educational theories eclectically in terms of their perceived relevance for discerning and discriminating the practically significant features of the situation in the school and the training program (Elliot, J. 1993). Wise professional judgments and decisions rest on the principal's understanding of situations (Elliot, J. 1993). Somehow principals, university supervisors, and cooperating teachers have to learn how to work more effectively in their conflicting roles of helper and evaluator of the student teachers (Perrodon, A. F. 1966).

The values and ethics of the teaching profession are the most sacrosanct dimension of student teaching and must be perpetuated for generations to come. The survival and prosperity of the human race depend on these values and ethics. It is the honorable responsibility of schools and the educational system as a whole to safeguard them, and not only of the principals of schools. The principals of schools are the token of these values and ethics.

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