Chapter 2
Modelling Teaching and Learning

Keywords Effective teaching · Learning situations · Pro-active · Interactive and retro-active teaching strategies · Classroom ecology · Structure and independence in teaching · Structured teaching · Constructivist oriented teaching · Creating learning opportunities

Introduction

In this chapter a first conceptualization of teaching and learning will be given. This will be done from the perspective that, obviously, teaching is expected to stimulate learning, but that it would be a strong overstatement to say that teaching determines learning. Instead learning is seen as a process that is, to a considerable extent, controlled by the learner, and in that sense relatively autonomous. Teaching, in this conception, is more like a "booster" to learning than a complete determinant. Such a view fits within a system's perspective on education as a hierarchical structure, in which there is loose coupling between the higher and lower levels, and considerably autonomy in the "production" process at each level.

Student Learning

As a "product" learning can be defined in terms of increased knowledge, skills and acquired norms and values. More interestingly, for our purposes, are characteristics of learning processes, evoked by situations that are expected to stimulate learning.

The following requirements seem to be essential elements experienced by learning subjects in "learning": situations (i.e. situations that evoke learning):

- awareness of the action demands of a situation, feeling challenged to solve a problem, read a text, accomplish a task;
- sufficient motivation and volitional energy to "do something"

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- interpreting the demand aspects of the situation in the light of previous knowledge, habits, available skills;
- executing cognitive operations, varying from simple memorization to so called higher order processes (see for example the taxonomy of cognitive objectives by Bloom);
- possibly applying meta-cognitive strategies which would imply that the previously mentioned operations are to some extent self-controlled and conscious (examples of such meta-cognitive strategies are being aware of objectives, setting targets, decomposing the learning tasks in sub-tasks, using problem-solving strategies, applying self-evaluations);
- delivering a relative (meaning that it would always be possible to learn more) end "product" of the learning experience that could function as auto-feedback to the learner or inform the outside world, particularly a teacher; incidentally auto-feedback would be an important aspect of self-regulated learning.

These characteristics of learning situations can be studied by means of direct or indirect (video recordings) observations of classroom situations and think out loud methods, (Veenman and van Hout-Wolters 2002).

Some students are better in applying the above-mentioned elements of learning processes than others. This would depend on cognitive aptitudes, motivational dispositions that are related to socio-economic background and gender, on cognitive styles and on preference for certain learning strategies. OECD, Artelt et al. (2003) distinguish three kind of learning strategies: memorization strategies, elaboration strategies (which involves exploring how knowledge learned in other contexts relates to new material) and control strategies. The latter kind of strategies are meta-cognitive strategies for self-regulated learning and involve: "checking what one has learned and working out what one still needs to learn, allowing learners to adapt their learning to the task at hand", ibid, p. 13. The latter strategies are highly correlated with effective learning and achievement.

Part of these student background conditions should be seen as given or antecedent conditions to learning at school, others, particularly the ones subsumed under the label of learning strategies, could be taught, by means of explicit lessons (in applying problem-solving strategies and "learning to learn" lessons), or become the object of normal day-to-day "reflective" teaching, where teachers could give cues and hints impinging on students learning strategies. Running ahead to the section on teaching, it is important to refer to approaches like questioning and formative assessment during lessons to facilitate such reflective teaching.

Figure 2.1 gives a schematic presentation of the variables in student learning; following the basic structure of the general conceptual framework in Chap. 1, Fig. 2.1 and Table 2.1 provide a summary of relevant background and partly teachable dispositions.

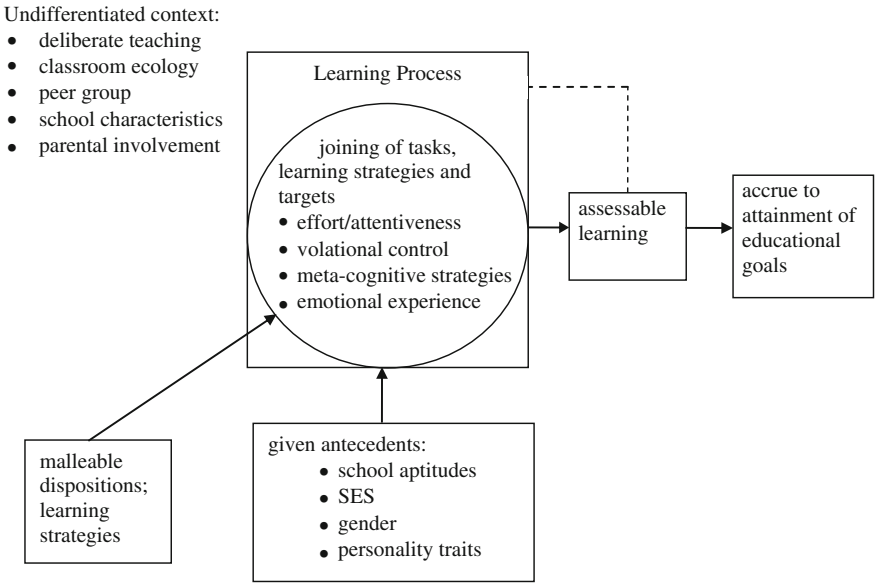

Fig. 2.1 Student learning

Table 2.1 Overview of variables in learning

Background variables	Partly teachable dispositions	Learning processes
General intelligence Scholastic aptitude Socio-economic status Gender Immigrant status Relevant personality traits, e.g. locus of control Cognitive style	Learning strategies: • Memorization strategies • Elaboration strategies • Control strategies • Domain specific strategies Subject matter interest Instrumental motivation Persistence Self-efficacy Subject matter based and general academic self-concept Meta-cognitive knowledge about cooperative reasoning	On-task behaviour Level of engagement Self-report on ongoing learning processes (think out loud procedures)

Teaching and Classroom Ecology

Seen within the framework of a hierarchical presentation of an educational system the first linking issue to be encountered is: what should a teacher do to create effective learning environment and boost learning? In connection to the description of learning situations in the previous section the basic issue could be seen in terms of pre-structuring

the learning situation before and during lessons, and raising the question as to how far pre-structuring should go. This would not be in a setting of total freedom: there is a given organizational arrangement, i.e. a classroom and a certain number of students assigned to that classroom/lesson, hence: ecology (e.g. class size, class composition).

For simplicity's sake, teachers will be seen as the prime "managers" of teaching and learning in classrooms. Later on teaching and learning will partly be attributed to the larger context of the school, characterized by certain organizational properties. The way teachers could influence student learning can be seen in terms of indirect conditions, such as the competencies the teacher brings to the teaching and learning situation, her/his influence on creating the learning environment, curricular choices, text books, media, and assessment tools and direct teaching strategies.

The Elementary Parts of Teaching: Matching of Content Elements, Psychological Operations and Didactic Considerations

In prescriptive formulations, which concern for example the structure of educational objectives, two-dimensional classifications are usually proposed (e.g. De Corte et al. 1973; Bloom et al. 1971). Subject matter content and psychological operations are the two basic dimensions This perspective comes down to breaking down the contents, for e.g. a geography lesson in smaller units, and, for each content unit specifying the cognitive, or affective or psychomotor behaviour/dispositions that should be acquired. On each of these three dimensions a continuum of operations has been specified that ascends in order of complexity. For example: perception of information, recognition of information, reproduction of information, interpretative production of information, convergent production of information, evaluative production of information and divergent production of information. An example of divergent production of information with respect to the geographical climate is the following objective: "On the basis of data on diverse factors that influence the climate of a particular region, deduce certain weather conditions" (De Corte et al. ibid.).

Elements defined by the two basic dimensions (content and psychological operations) could be seen as the demand structures for learning tasks.

In the act of teaching specific presentation forms and media should be applied when introducing the prime didactic elements as described above. The quality of teaching would thus depend on:

- adequate selection of content
- indicating target psychological operations (e.g. cognitive behaviour)
- knowledge about creating tasks (on the basis of the above two elements)
- instructional knowledge; a repertoire of presenting and guiding the execution of learning tasks
- knowledge about students, and typical behaviours for the learning task in question, including frequently made mistakes

The first three characteristics could, in principle, be taken care of outside the direct teaching situation, by curriculum experts and designers of teaching methods. Yet, knowledge about content, about tasks and about student thinking would constitute a basic teaching competency that is described as *pedagogical content knowledge* by Baumert et al. (2005) who found evidence of considerable impact of this variable on student achievement.

According to Baumert et al. ibid, pedagogical content knowledge is a combination of instructional knowledge, content knowledge, knowledge about student thinking and knowledge about tasks as independent tools; it involves in the case of mathematics as the subject matter area as given below:

- Knowledge About the Instructional Potential of Mathematical Tasks
  - local knowledge about tasks, e.g. multiple solutions
  - orchestration of tasks into instructional sequences
  - cognitive demand of mathematical tasks (e.g. multiple steps in modelling, complexity of language)
- Knowledge of Creating Mathematical Meaning in Classroom Interaction
  - multiple representations and explanations
  - cognition of mathematical representations
  - fast recognition of mistakes
  - making use of critical incidents (maintaining the level of cognitive complexity, keeping students responsible for their learning)
- Knowledge About Students' Conceptions and Students' Thinking
  - recognition of misconceptions
  - recognition of typical mistakes
  - knowledge about typical difficulties

In practical terms these aspects of pedagogical content knowledge are manifested not only in the curriculum and in the lesson preparation by teachers, but also in the realm of actual interactive classroom teaching and in monitoring and assessing student activities and work. Interestingly Baumert and his colleagues have worked out the characteristics of pedagogical content knowledge in the form of assessment type of instruments, using computerized tests and video clips to assess teacher competencies in specific content areas, in their case mathematics.

Table 2.2 provides a schematic overview of pro-active, interactive and retro-active phases in the structuring of teaching, based on content and psychological operations as the two basic dimensions.

Combination of content units and psychological elements, bearing in mind pedagogical and didactic considerations, can be seen as lying at the heart of instructional sub-disciplines as:

- curriculum development
- teacher training and teacher professional development
- lesson preparation

Table 2.2 Stages in preparing, executing and evaluating the teaching act

Content dimension	Psychological dimension
– Decomposition of content in sequences that represent the structure of the subject matter area	– Taxonomy of cognitive, affective and psychomotor operations that reflect increasing complexity
COMBINE BOTH DIMENSIONS IN	SEQUENCES OF INSTRUCTIONAL OBJECTIVES
− Creating tasks and task sequences with pedagogical potential	– Taking into consideration cognitive complexity and emotional meaning of tasks
COMBINE BOTH IN	LESSON PLANS AND SCRIPTS
− Actual teaching in which multiple representations and explanations of content elements are given	− Taking into consideration possible misconceptions, typical difficulties and frequently made mistakes
COMBINE BOTH IN	TEACHING
− Constructing content elements for the development of items for formative and summative assessment instruments	− Adding representations of expected psychological operations, with different degree of complexity to each content element of item
COMBINE BOTH IN	ITEM BANKS AND TESTS IN WHICH DIFFICULTY LEVEL AND ABILITY ARE IDENTIFIABLE DIMENSIONS

- actual teaching
- educational assessment
- providing feedback on the basis of assessment

Having identified a common structure in all these sub-disciplines, it leads to the following conjectures:

- consistency between these sub-disciplines for a specific educational objective should be seen as mutually reinforcing; the concept of *opportunity to learn* is a well-known example, as it stresses the consistency between didactic elements that are taught and tested;
- in case of omission of one or several of these sub-disciplines the remaining ones could compensate and keep the basic structure of good quality teaching intact.

Educational systems are likely to vary in the emphasis that is given to specific, singular, instructional sub-disciplines, or to specific combinations of these sub-disciplines. Centralized curriculum had gone out of fashion but is having a resurrection in the USA with the initiative of the common core curriculum. The school improvement movement, initiated in the writing of Matthew Miles and other authors (Miles 1998) emphasized bottom-up development, while a counter-movement can be seen in the work of authors who critically address the school improvement approach as an "ownership paradigm", (Muijs and Reynolds 2001) according to which each school is expected, more or less, to reinvent the wheel.

The use of assessment, particularly "summative assessment" for accountability purposes is quite contested in many countries, but very central in educational

reform in others. Each of the sub-disciplines can be seen as an area of leverage for educational reform and improvement.

Special attention should be given in this context to technology-enriched learning environments. In these applications content and psychological elements, as well as considerations about didactic strategies are integrated in a very explicit way. In the earlier application of computer assisted instruction (CAI) a strong emphasis was given to the presentation of subject matter and the provision of examples in the practice of basic skills in reading, spelling arithmetic and topography. Characteristic of CAI is the use of repetition (drill and practice) and feedback. The application of "branching", allows for taking into consideration individual differences, so that a degree of adaptiveness can be realized. Such programs have been quite successful, particularly for weaker students (cf. van Merriënboer and Kanselaar 2006, p. 287). In intelligent tutoring systems there is more specific attention for psychological and didactic aspects. In the SCHOLAR system (Carbonell 1970, ibid, p. 288) for example, the following four components were integrated: a domain or expert model (core of knowledge as well as frequently made mistakes), a student model, which represents the current level of expertise of the student, an instructional model (e.g. conducting a Socratic dialogue) and an evaluation and feedback model. In later applications dynamic visual representations, and multimedia components are added, while active learning, supported by hints and cues, "scaffolding", are used to support students. Techniques of gradually reducing these kinds of cues, indicated as "fading" can be built into interactive lessons in order to gradually enhance independent learning (De Jong 2006). In this context, Linn et al. (2006), discuss forms of inquiry learning that are supported by visualization techniques and assessment techniques that require students to link and connect ideas in science education.

Structure and Independence in Teaching

Having defined the nature of core instructional elements and the various sub-disciplines in which they are given shape, it is time to turn back to the core idea of seeing teaching as a set of conditions that should facilitate and "boost" student learning. In the section in which the learning process was modelled, student control strategies appeared to be the most effective. In the act of teaching seen as routine control, teaching could be seen as compensating for lack of student control in learning. Teaching as meta-control could address meta-cognitive strategies, by which student control strategies would actually be taught to students.

In a way student control strategies are the pendant of the main features of "structured teaching" and direct instruction, where it is the teacher who actively orders and controls the teaching and learning situation. When putting these two orientation s, with structured teaching on the one hand, and students effectively employing control strategies next to one another on the other hand, the following types of associations can be discerned:

- structured teaching happens as a *substitute* for student control strategies
- structured teaching happens as an *additional support* for student control strategies
- structured teaching happens as a *model and example* to enhance student control strategies (meta-cognition)
- structured teaching happens as a *suppressor* of student control, because students are not given sufficient leeway to develop and manifest this behaviour themselves.

Weaker students in primary and secondary education are more likely to benefit from the first two alternatives, whereas the last two alternative combinations are more probable when dealing with better students in secondary education (where obviously the third alternative is a positive and the fourth is a negative example).

The above interpretations suggest a resolution of the distinction between structured and more open, discovery-oriented teaching approaches, by making it conditional on student aptitudes. Doing so would bring the question concerning structure or independence in the realm of adaptive teaching and research in the tradition of aptitude treatment interaction research (ATI, cf. Cronbach and Snow 1981). Although taking this latter perspective seems to be the more plausible one, it still makes sense to contrast the traditions of structured teaching, mastery learning and direct instruction, with "constructivist ideas", about teaching and learning.

Direct Teaching

Doyle (1985), considers the effectiveness of direct teaching, which he defines as follows:

(1) Teaching goals are clearly formulated.
(2) The course material to be followed is carefully split into learning tasks and placed in a sequence.
(3) The teacher explains clearly what the pupils must learn.
(4) The teacher regularly asks questions to gauge what progress pupils are making and whether they have understood.
(5) Pupils have ample time to practice what has been taught, with much use being made of "prompts" and feedback.
(6) Skills are taught until mastery of them is automatic.
(7) The teacher regularly tests the pupils and calls on the pupils to be accountable for their work.

The question whether this type of highly structured teaching works equally well for acquiring complicated cognitive processes in secondary education can be answered in the affirmative, according to Brophy and Good (1986, p. 367). However, progress through the subject matter can be taken with larger steps, testing need not be so frequent and there should be space left for applying problem-solving strategies flexibly.

Table 2.3 Objectivism versus constructivism, adapted from Jonassen (1991, p. 9)

	Objectivism	Constructivism
Reality	External to the knower	Determined by the knower
Mind	Abstract machine for manipulating symbols	Conceptual system for constructing reality
Thought	Atomistic: decomposable	Gestalt properties
	Manipulates abstract symbols	Imaginative: enables abstract thought
Meaning	Corresponds to entities and categories in the world	Does not rely on correspondence to the world (determined by understanding)
Symbols	Represent reality	Tools for constructing reality

Constructivism[1]

Constructivism is an offshoot of what has been called the cognitive revolution in learning theory. Not only is it opposed to behaviourism but it is also set apart from objectivist instructional applications of cognitivism, such as intelligent tutoring, as these take the expert's knowledge structure as an external entity that is to be mapped on the students. Instead, constructivism emphasizes the active role of the learner in constructing knowledge. The real enemy of constructivism is objectivism.

Some of the opposing claims of both positions as stated by Jonassen (1991, p. 9) are summarized in Table 2.3.

Constructivism claims that reality is more in the mind of the knower, but does not go as far as denying external reality altogether (solipsism), however some radical constructivists come very close to a position of complete denial.

The image of student learning that goes with constructivism underlines the active role of the learner. Students are to be confronted with "contextual" real-world environments, or "rich" artificial environments simulated by means of interactive media.

Learning is described as self-regulated with lots of opportunity for discovery and students' own interpretation of events.

Learning strategies, learning to learn and reflecting on these learning strategies (meta-cognition) are as important as mastering content. Different ways in finding a solution are as important as the actual solution itself. Terms like "active learning" (Cohen 1988), "situated cognition" (Resnick 1987) and "cognitive apprenticeship" (Collins et al. 1989) were used to describe student learning.

Next, students are expected "to construct their own meaningful and conceptually functional representations of the external world" (Duffy and Jonassen 1992, p. 11). The teacher becomes more of a coach, who assists students in "criss-crossing the landscape of contexts", looking at the concept from a different point of view each time the context is revisited (Spiro et al. 1992, p. 8). Cohen (1988) used the term "adventurous teaching" for this approach.

[1]This sub-section is a direct citation from Scheerens (1994).

There is less emphasis on structuring goals, learning tasks and plans in advance; goals are supposed to emerge when situated learning takes place and plans are not so much supposed to be submitted to the learner as constructed in response to situational demands and opportunities.

Learning situations must be such that students are invited to engage in sustained exploration (real-life contents or simulated environments). Some authors writing from this perspective state that "transfer" is the most distinguishing feature (Tobias 1991), whereas others mention argument, discussion and debate to arrive at "socially constructed meaning" (see Cunningham 1991).

The role of assessment and the evaluation of students' progress was hotly debated. Radical constructivists took the position that performance on an actual learning task is the only legitimate way of assessment, since distinct "external" evaluation procedures could not do justice to the specific meaning of a particular learning experience for the student.

Others (e.g. Jonassen 1992) concluded that assessment procedures from a constructivist perspective should merely be different: goal-free, rather than fixed on particular objectives, formative rather than summative, and oriented to assessing learning processes rather than mastery of subject matter. Appraisals of samples of products, portfolios and panels of reviewers that examine authentic tasks were also mentioned as acceptable procedures.

In Table 2.4 some of the major distinguishing features of learning and instruction according to the constructivist position are contrasted with characteristics of more traditional instructional models like direct instruction and mastery learning.

Bipolar comparisons such as the one in Table 2.4 run the risk of oversimplification and polarization whilst also constructing "straw men". It should be emphasized that less extreme constructivist views can be very well reconciled with more "objectivist" approaches (cf. Merrill 1991). Also, more eclectic approaches are feasible, as can be seen when more teacher-controlled and learner-controlled instructional situations are used alternately (cf. Boekaerts and Simons 1993).

Table 2.4 Comparison of traditional and constructivist instructional models

Traditional instruction	Instruction inspired by constructivism
Emphasis on basic skills	Bias towards higher order skills
Subject matter orientation	Emphasis on learning process
Structured approach • Pre-specified objectives • Small steps • Frequent questioning/feedback • Reinforcement through high % of mastery	Discovery learning "Rich" learning environments • Intrinsic motivation • Challenging problems
Abstract-generalizable knowledge	Situation-specific knowledge, learning form cases
Standardized achievement tests	Assessment less circumscribed
	Alternative procedures

Input "given" entrance conditions	**Technology**				**Aims (type of outcomes)**
	Throughput				
	Instruction	*learning*	*classroom organization*	*Tasks*	
low aptitudes	direct	reactive receptive	whole class individual	highly structured	basic skills academic
high aptitudes	open	active productive discovery learning	groups	real life problems	higher order processes "real life" knowledge social skills

Fig. 2.2 Degree of structure in instructional technology conditional upon entrance conditions and goals

An important realization is that the optimal position on continua that represent dimensions of direct teaching versus constructivist teaching is likely to depend on "situational" characteristics like: the kind of instructional objectives that are aimed for and the aptitude of the learners. This last idea is in accord with the research approach referred to earlier as research into aptitude treatment interactions. It also encompasses the idea of adaptive instruction. A general, research supported idea being that weaker students benefit more from more structured teaching approaches.

These ideas are expressed in Fig. 2.2.

Constructivism has helped in enforcing the notion that in education the learner is the core producer of learning, and that teaching is more like an add-on or a boost to learning. More open, discovery kind of learning situations, where students are invited to self-regulate their learning, are usually seen as logical implications for teaching. But here, perhaps the step from description to prescription is too drastic. Strictly speaking one could say that even in a very structured teaching and learning situation, where, for example, worked out solutions to mathematical problems are used as inputs, learning could only take place if the learner could re-construct this stimulus material in a way that would allow him or her to apply to solution to other problems, related problems or practical applications; the ultimate moment of "construction" being the examination assignment or test item where the student would have to demonstrate his or her knowledge. Learning remains a self-directed constructive process even in the case of very structured teaching. Research evidence

in which structured and open teaching approaches were compared is relatively scarce; in the cases where it took place the evidence used to be more in favour of structured approaches (see previously given references and van der Werf 2005), more recent results, to be discussed in subsequent chapters, show both approaches as about equally effective. A further remark about constructivist teaching could be that it might give rise to structured approaches in teaching meta-cognitive strategies and learning from mistakes (see the section on feedback, below). More importantly is probably to get away from pitting these two kinds of instructional strategies against one another. As Fig. 2.2 illustrates, opting for more structured versus open learning situations could be seen as contingent on the learning objectives and the ability level of students. As mentioned before, different emphases can also be projected in the course of one lesson or the learning of a specific complex task. This is illustrated in computer-enriched learning environments, such as the SIMQUEST package in which computer simulations are integrated with supportive cognitive tools (De Jong 2006). The author discusses the option of a gradual withdrawal of cognitive tools, indicated as "fading", where the learner gradually takes over the learning process. Varying different degrees of support and scaffolding in the course of a lesson could show a similar moving from structured to more independent learning forms.

Pro-active and Retro-active Regulation in Teaching: The Case of Performance Feedback

Among the set of educational sub-disciplines that were defined in the previous section, curriculum development, teacher training and teacher professional development and lesson preparation could be said to have a *pro-active* orientation. Of actual teaching one could say that it has an *interactive* orientation while assessment and providing feedback have *a retro-active* orientation.

In this section pro-active and retro-active regulation will be compared; it should be noted that pro-active and retro-active regulations have a clear interpretation in core processes of school management and system-level governance as well.

The ideal of "synoptic" planning is to conceptualize a broad spectrum of long-term goals and possible means to attain these goals. As such it contains the basic logic of social engineering, and planned change, in our case design of teaching and learning situations. In models of planned change the various aspects of synoptic planning are usually structured as phase models; the following description of the different phases is partly based on Ackoff (1981, 74, 75).

In a *first phase* there is a reflection on values and normative aspects that should be attained through specific treatments or specific organizational behaviour. This first phase can also be taken as the phase of defining the problem domain.

In the *second phase* ends planning takes place in the sense that goals and objectives are specified.

In the *third face* means-planning takes place, where, ideally, there should be a rationale for selecting the means (examples in education are results of empirical educational effectiveness or practical experience on "what works" in education).

In a *fourth phase* resource planning is focused at determining "what resources will be required, when they will be required, and how to obtain those that will not otherwise be available" (ibid., 75).

In a *fifth phase* design of implementation and control determines "who is to do what, when, and where, and how the implementation and its consequences are to be controlled, that is, kept on track" (ibid., 75).

In a *sixth phase* (which, by the way, is not specifically mentioned by Ackoff), monitoring and evaluation, which can be seen as part of the control processes, are used for feedback and possible modification of means, goals or even values.

The feedback mentioned in this last phase turns the sequence in steps into a circle that can go on and on. Many authors, including Ackoff, do not take the sequence of phases too seriously and say in fact that they may take place in any order. Others, however, see the way one "steps into" the planning, implementation and feedback circle as non-trivial. Borich and Jemelka (1982) see the planned change process as society's attempts to "maintain equilibrium when the system threatens to become disadvantageously influenced by forces whose effects were previously neglected or would have been difficult to predict" (ibid., 216). They see a qualitative difference, however, in two ways of regaining equilibrium. The first being the traditional one where goals are formulated to determine behaviour, and which one could see as a pro-active orientation (J.S.) the second emphasizing that behaviour provides impetus for goals, which they see as a more *retrospective* orientation. They illustrate the difference in these two orientations with a citation from Weick (1969):

> This sequence in which actions precede goals may well be a more accurate portrait of organizational functioning. The common assertion that goal consensus must occur prior to action obscures the fact that consensus is impossible unless there is something tangible around which it can occur. And this "something tangible" may well turn out to be actions already completed. Thus it is entirely possible that goal statements are retrospective rather than prospective (Weick 1969, The Social Psychology of Organizing, Addison-Wesley, p. 8).

In a retro-active regulation of teaching the assessment instrumentation, for example a large item bank, takes the place of the intended curriculum, and assessments that have content validity with respect to the intended curriculum, are to be seen as tools to adapt teaching on the basis of assessment. In the ideal situation of an exhaustive item bank, "teaching to the test" could be seen as a fully legitimate and recommendable activity. This kind of assessment would usually be seen as formative assessment, implying that assessment would be expected to feed into ongoing teaching activity and lead to adaptation of these practices. When comparing formative and summative assessment, this could be seen as a relative difference, determined by two criteria:

- the relative duration of the feedback cycle, short in formative and long in summative;
- the instrumental or learning-oriented nature of the feedback in formative evaluation, with a stronger emphasis of judgmental aspects in summative evaluation.

The distinction should clearly be seen as relative concerning both criteria. It is difficult to do away with all judgmental "ego oriented" interpretations in formative evaluation, and some authors emphasize the instrumental improvement oriented impact of summative assessment (cf. Bell 1998).

The key mechanism linking assessment and teaching, expected to be reflective and adaptive by using the assessment information, is feedback. The term feedback stems from control theory, with the functioning of the thermostat as the classical example to illustrate it. When the measuring device indicates that the room temperature is below a certain level, the regulating mechanism switches on the heating (De Leeuw 1990, p. 126). In systems theory feedback loops are seen as positive when the loop exhibits self-reinforcing behaviour, (for example when good results increase positive expectations about students' learning, which, in its turn leads to setting higher standards, a more optimistic, achievement oriented climate, more self-confidence and achievement that is further increased) and negative when a loop exhibits goal-seeking behaviour. An example of the latter would be a teacher needing to increase his or her energy in keeping order, when the students' behaviour worsens (Clauset and Gaynor 1982).

In a review of the impact of formative assessment Black and Wiliam (1998) conclude that, across the board, formative assessment and feedback are positively associated with student achievement. However, it is often difficult to separate the impact of assessment-feedback from other regulatory mechanisms that are also active. This is illustrated in their analysis of feedback within the framework of mastery learning, a form of structured teaching comparably to direct teaching, as described in the previous section. Likewise, in reviews and meta-analyses effects of quantitative and qualitative aspects of feedback are sometimes not sufficiently separable.

Key elements of mastery learning are:

- The learner must understand the nature of the task to be learned and the procedure to be followed in learning it.
- The specific instructional objectives relating to the learning task must be formulated.
- It is useful to break a course or a subject into small units of learning and to test at the end of each unit.
- The teacher should provide feedback about each learner's particular errors and difficulties after each test.
- The teacher must find ways to alter the time some students have available to learn.
- It may be profitable to provide alternative learning opportunities.

Table 2.5 Positive and negative conditions affecting effective use of feedback

Positive conditions	Negative conditions
• Feedback not just about standard attainment but also instrumental information, to the extend that feedback recipients can actually use this information	• Feedback exclusively about standard attainment (stimulates a judgmental rather than an instrumental application of feedback)
• The above condition can reinforce the task-related (or *perceived* task related) nature of the feedback	• Feedback is taken "personal" and purely judgmental
• Standards experienced as realistic	• Standards perceived as unrealistic
• Feedback appeals to intrinsic motivation	• Feedback appeals to extrinsic motivation (implication: doubts about incentive schemes in education)
• Negative feedback is superior in stimulating incremental task-related learning progress	
• Positive feedback stimulates overall motivation if received from credible and relevant sources	

Sources Among others: Kluger and DeNisi (1996)

– Student effort is increased when small groups of two or three students meet regularly for as long as an hour to review their test results and to help one another overcome the difficulties identified by the means of the test (McNeill 1969, cited by Black and Wiliam 1998, p. 40).

Although research reviews and meta-analysis of mastery learning usually show positive associations with achievement, the effect sizes are higher when teacher-produced tests as compared to standardized tests are used, when programs are teacher-paced rather than student-paced, and when students are relatively younger. Characteristics of feedback given in the context of mastery learning are that feedback is based on comparing current achievement against a "mastery" level of achievement that such feedback is given rapidly and intended to be diagnostic, and, finally, that students are given the opportunity to discuss with their peers how to remedy any weaknesses.

In search for further insights into the specific characteristics of effective feedback from student assessment, Table 2.5 gives conclusions based on a review by Kluger and DeNisi (1996) on performance feedback (not limited to educational settings).

Feedback

An important characteristic of effective performance feedback is that it is task related or "instrumental", rather than ego related or judgmental.

The idea of instrumental feedback assumes that targets are identified as learning gaps and that there are ideas about mechanisms, means or techniques to bridge learning gaps. Experiencing of learning gaps is closely related to the role of standards

and achievement expectations in teaching. Research on standard setting points out that learning gaps should neither be unattainably high nor be low (cf. De Vos 1989). The assumption of instrumentality and mechanisms to close learning gaps is closely related to matching task characteristics to psychological operations of learners, and knowledge about frequently made mistakes. The relevance of taking task characteristics into consideration, when providing feedback, is highlighted by Black and Wiliam, ibid, p. 52. They say that "feedback appears to be most successful in 'heavily cued' situations, such as are found in computer-based instruction and programmed learning sequences, and relatively less successful in situations requiring 'higher order'—thinking such as unstructured tests and comprehension exercises". They also report evidence that feedback related to progress seems to be more effective than feedback related to absolute performance levels.

The role of the teacher in providing instrumental feedback is important as well. It seems that here we are back to the discussion on structure and independence that was central in the previous section. Teachers have the choice between providing complete solutions, heavily cued hints towards the correct solution, or an adaptive "scaffolding" response, in simpler terms students receiving as much help as they would need to solve the problem on their own.

Moreover, the discussion on effective feedback from student assessment shows the embeddedness in other aspects of teaching and learning situations that are relevant to enhance teaching effectiveness:

- setting of realistic standards
- careful consideration of the didactic aspects of learning tasks
- deliberate choices with respect to pre-structuring on the one hand and independent activity on the other hand
- motivational aspects, e.g. feedback that is experienced as threatening and solely judgmental
- aspects of cooperative learning, in those applications where feedback is discussed in small groups of students
- the quality of assessments

This embeddedness and association with the core elements of teaching (the combination of content selection, choice of target psychological operations and pedagogical and didactic aspects determined by student characteristics) is also illustrated in the way Mislevy et al. (2002) write about the construction of adaptive assessment. They describe a conceptual assessment framework that comprises student models, evidence models, task models and an assembly model.

Basically pro-active curriculum development and construction of didactic tasks on the one hand and achievement test construction on the other hand, can be seen as two sides of the same coin. De Groot and van Naerssen (1966) in this context have coined the terms didactic and evaluative specifications of educational objectives. As it was said before these two processes could mutually support one another, particularly when consistent, but could also replace one another. As an aspect of devolution in educational governance the evaluation and accountability mechanism sometimes seems to have replaced the pro-active curriculum development

mechanism as major form of regulation. When teaching is viewed from the perspective of boosting student learning the retro-active route of assessment and feedback has the advantage of forcing a close link to (intermediate and final) learning outcomes, and reflection on empirical successes and failures in student learning; including attention for meta-cognitive processes.

Providing Learning Opportunities

Early models on effective teaching, such as the well-known Carroll model (Carroll 1963), focus on effective learning time as a key condition. A second major dimension of providing learning opportunities is the content that is covered and that should be representative of the intended curriculum. In fact the deductive line of consistency between intended, implemented and realized (i.e. the way the curriculum is assessed) curriculum is about instruction being targeted and focussed.

Curricular emphases, which might differ between classrooms, schools, and between national educational systems, and classroom management are the two vehicles that should take care of providing learning opportunities. Since these categories have been well researched and documented frequently, no further elaboration will be given in this context.

Classroom Ecology and Climate

The term ecology refers to an approach in biology that is focused at living organisms' habits, modes of life and relations to their environment. Using this term metaphorically for what could be described in a more neutral and sober sense as the classroom *context* is proposed to express the idea that what we are dealing with here is a set of complex interactions between antecedent conditions, such as class size and classroom composition, habits and routines, institutional rules and norms of behaviour and normative orientations, usually gathered by the term classroom climate.

The extensive literature on the impact of class size on student achievement will not be reviewed here. In most general terms a first major outcome is that class size reductions need to be quite substantive before they have any effect; which makes class size reduction a less efficient strategy for improvement. A second important conclusion could be that considerations about class size are contingent on national educational cultures. Relatively larger class sizes in Asian countries do not appear to be considered problematic by teachers and do not preclude high achievement outcomes (cf. Woesmann 2005).

Classroom composition can be expressed in terms of mean scores on student background variables such as socio-economic background and scholastic aptitude, and in terms of the between student variation on these variables. In the latter case we are in the realm of the issue of homogeneous or heterogeneous grouping.

Composition effects, in terms of mean scores on background variables, are mostly studied as school-level variables (cf. Opdenakker and van Damme 2001; Stanat 2003; Baumert et al. 2005b; Willms 2004; Luyten et al. 2005). Substantial effects of composition in terms of mean SES level are shown in these studies, over and above the impact of these variables measured at student level. In more qualitative terms composition effects could reach a critical threshold, after which they bring about a "Gestalt switch" in school and classroom life. Anecdotal evidence about this phenomenon is the experience of a Dutch primary teacher saying that, within a program of inclusive education, she felt that she could manage two children with Down's syndrome in her class, but not three. Stanat (2003), suggests a critical level of around 40 % of immigrant student in a school, after which dramatic changes could occur. Luyten et al. 2005 discuss the strong correlations they found between school climate and school composition, measured as average SES, and interpret the joined effect of these factors as indicative of students from a more advantaged socio-economic background bringing more disciplined habits and more positive perceptions of school values to the school. This latter interpretation is related to normative orientations of the peer group that may be supportive or hostile towards school and classroom life.

The issue of **homogeneous versus heterogeneous classroom composition** has been studied, among others, by Slavin (1996, p. 164). On the basis of his "best evidence syntheses" he makes the following recommendations:

"Leave students in heterogeneous classes most of the time and regroup by ability only in subjects (reading, mathematics) in which reducing heterogeneity is particularly important". He also recommends that grouping plans should be flexible that teachers should vary their level and pace of instruction to correspond to student performance level, and that when within-class ability grouping is implemented, the number of groups should be small.

The matching of teachers and classes can be an issue of explicit deliberation in school policies. Depending on forms of streaming of students' high and low ability classes, decisions could be made, for example, to match the best, and the most experienced teachers to the classes with the lowest average ability (cf. Monk 1989, 1992).

Classroom climate could be defined in holistic terms as the general atmosphere in the classroom. When further analysed the major facets of a favourable, effectiveness enhancing climate are: a supportive style of interaction in teacher student interactions, achievement orientationachievement orientation, clear disciplinary rules, and good student–student interrelationships. Some of these facets are closely connected with more overtly "managed", "institutionalized" and "planned" aspects of teaching. Disciplinary rules could be said to be institutionalized at the school level and maintaining them is one of the important aspects of classroom management. Teacher support is closely connected to the issue of structure and clarity in teaching and feedback, while achievement orientation is connected to the use of explicit or implicit standards, as targets and as assessment norms. More affective aspects of the quality of interactions might be associated with classroom composition. Enacting disciplinary rules is sometimes connected to a larger realm of

normatively good behaviour at school and in the classrooms. In English speaking countries the term "ethos" is sometimes used for this. The school and classroom context, in this way, can be seen as a micro-world in which aspects of "citizenship" are dealt with in a more or less implicit way.

Motivational Aspects: Stimulating Student Engagement

The principle of variation in presentation and didactic methods during lessons is as old as systematic thinking about teaching. More attention for learning strategies of students stimulated by constructivist ideas, and considerations on variation in structured and independent work during lessons (e.g. Boekaerts and Simons 1993) has enforced the interest in what is sometimes generally indicated as "active teaching". "Activating is a syndrome that is centred around the idea of offering students multiple opportunities of active learning (Slavin 1995). In this sense (active teaching, J.S.) comprises teaching aspects such as cooperative learning, situated learning, discovery learning, peer-tutoring, student experiments, hands-on activities, group work, individual work, individual learning, and student discussion" (Seidel et al. 2005, 129).

Teaching forms that strongly appeal to stimulate students to become cognitively active are tasks that require higher order thinking, "cognitive activation" (really understanding what is taught and analysis of Klieme and Rakoczy 2003) deep understanding of content, meaningful contexts, authentic instruction, relevance of contents, appropriate and high level of language, and, variation of different presentation, are subsumed under the general term "**challenge**", by Seidel et al. ibid., p. 131.

Issues of applying standards in target setting and feedback have important implications for student motivation as well. Standards should be ambitious but not to a degree that they are unattainable. Standards are not only determined by planning acts of the teachers, but also enacted in classroom life by group averages (De Vos 1989). Applying standards in a more implicit way is connected to the issue of **teacher expectations** about students' achievement. A positive attitude in which teachers try to get the best out of all students, also the less capable ones, has always been seen as one of the key characteristics of effective schooling and teaching. Flexibility and an "empiricist" attitude would seem to be important characteristics of good teaching as well. The well-known phenomenon of "Pygmalion in the Classroom", which holds a strong message against too early judgment and stereotyping, should be taken in mind as clearly undesirable behaviour. An empiricist attitude could be served by frequent assessment, so that a priori judgments of teachers, are, so to say, continuously put to the test. The interaction of stereotyping and elaborated and rigid stratification in grouping, be it in ability groups, or school categories is one of the potential explanations of the generally lower performance and equity of strongly categorized educational systems (Luyten et al. 2005).

In Fig. 2.3 a schematic overview of the various aspects of teaching, discussed above is given. Figure 2.3 has the same structure as Fig. 1.1 that was introduced in Chap. 1 and, in reference to Fig. 1.3 in Chap. 1, it gives flesh and blood to the teaching level in the hierarchical framework. It should be noted that, while teacher characteristics have not been discussed in this chapter, they will be treated in Chap. 3. Similarly more detailed descriptions of the variables listed in Fig. 2.3 and Table 2.6 will also be given in Chap. 3.

Table 2.6 lists the key variables, once more, categorized as teacher characteristics, classroom ecology and climate and teaching processes. Teacher characteristics are seen as "given", although most of them should be seen as malleable through training and professional development. Classroom ecology and climate are partly "given" and partly malleable by teachers. Teaching processes, finally, are seen as malleable conditions.

In summary then, we could turn back to the key mechanisms by which teaching is seen to stimulate and facilitate learning. How can teaching stimulate learning?

We have seen that the core of teaching can be broken down in pro-active, interactive and retro-active component of confronting students with cognitively and motivationally challenging learning tasks, which take into consideration

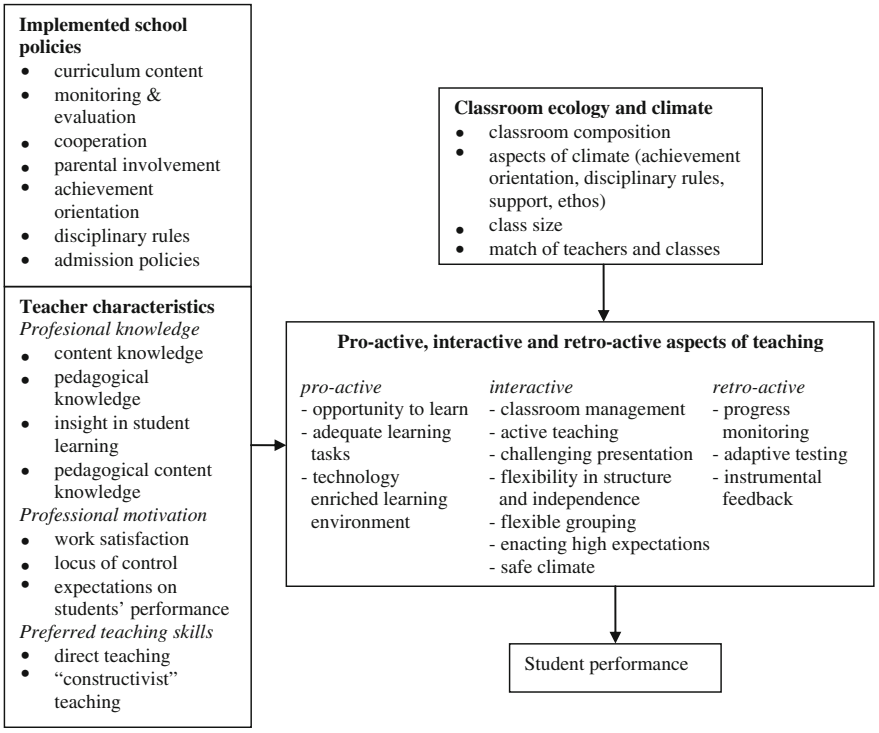

Fig. 2.3 Teaching

Table 2.6 Overview of teaching variables

Teacher background characteristics	Classroom ecology and climate	Teaching processes
Professional knowledge – Content knowledge – Pedagogical knowledge – Insight in student learning – Professional content knowledge *Professional motivation* – Work satisfaction – Locus of control *Preferred teaching styles* – Direct teaching – "Constructivist" teaching	– Class size – Classroom composition (average and heterogeneity) – Match of teachers and classes – Aspects of classroom climate, achievement orientation, discipline, support, ethos – Teacher expectations on students' achievement	*Pro-active strategies* – Opportunity to learn – Selection and design of adequate learning tasks – Technology-enriched learning environments *Interactive strategies* – Classroom management aimed at optimizing active learning time and opportunity to learn – Optimizing structure and independence in teaching – Learning to use learning strategies – Allowing for manageable adaptivity in teaching – Active teaching, diversity in preparation formats – A challenging presentation; cognitive activation; – Enacting high expectations *Retro-active strategies* – Setting realistic motivating standards – Progress monitoring and assessment – Adaptive testing – Instrumental feedback

psychological dimensions of the learner, and try to use knowledge of student learning to support learning processes. Alternating moments of structure and independence determine the specific way this support is given. Core inputs are professional teaching skills, while ecological factors, like class composition, have an important mediating role, as have aspects of classroom management that should culminate in optimized time on task.

Conclusion

This chapter started with a conceptualization of learning as a partly autonomous process determined by the learner. Teaching was seen as stimulating specific aspects of learning processes and creating a general context, in which learning would be enhanced. From an analytic perspective teaching consists of presenting content elements and stimulating certain psychological operations with learners.

In creating teaching and learning situations pro-active, interactive and retro-active aspects were distinguished. Pro-active aspects are related to curriculum and lesson planning, while teaching competencies and the development of those competencies among teachers could also be gathered under this pro-active dimension. The interactive dimension comprises the actual process of creating a learning environment and carrying out teaching acts, while the retro-active dimension is focused at reflection, evaluation, assessment and feedback.

Dimensions of teaching that were seen as central in variations that have been propagated in various teaching models were:

- structure versus independence in teaching and learning situations
- emphasizing pro-active and retro-active aspects
- the distinction between direct teaching activities and creating a classroom ecology
- creating learning opportunities
- stimulating student engagement

In the next chapter a further focus will be given on key factors on which empirical research has concentrated.

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