Orienting Teaching Toward the Learning Process

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ARTICLE

Orienting Teaching Toward the Learning Process

Olle ten Cate, PhD, Linda Snell, MD, Karen Mann, PhD, and Jan Vermunt, PhD

ABSTRACT

Based on developments in educational psychology from the late 1980s, the authors present a model of an approach to teaching. Students' learning processes were analyzed to determine teacher functions. The learning-oriented teaching (LOT) model aims at following and guiding the learning process. The main characteristics of the model are (1) the *components of learning*: cognition (what to learn), affect (why learn), and metacognition (how to learn); and (2) the *amount of guidance* students need. If education aims at fostering one's ability to function independently in society, an important general objective should be that one learns how to fully and independently regulate his or her own learning; i.e., the ability to pursue one's professional life independently. This implies a transition from external guidance (from the teacher) through shared guidance (by the student together with the teacher) to internal guidance (by the student alone). This transition pertains not only to the cognitive component of learning (content) but also to the affective component (motives) and the metacognitive component (learning strategies). This model reflects a philosophy of internalization of the teacher's functions in a way that allows optimal independent learning after graduation. The model can be shown as a two-dimensional chart of learning components versus levels of guidance. It is further elaborated from learners' and teachers' perspectives. Examples of curriculum structure and teachers' activities are given to illustrate the model. Implications for curriculum development, course development, individual teaching moments, and educational research are discussed.

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The rapid evolution in medical curricula can lead to confusion in teachers. As curricular content and process become more centrally controlled and guided by educational theory, teachers may have difficulty grasping the philosophies underlying curricular change and putting them into daily practice. Student-centered teaching, for example, may sound to many experienced teachers like a laudable approach, but not easily put into day-to-day practice. Particularly in clinical teaching, where models such as problem-based learning (PBL) are less well established, the teacher may have to independently develop or modify teaching methods to conform with current medical education philosophies. An understandable framework would be useful to help teachers reflect on their teaching practice, analyze what may explain unexpected student behaviors, develop and implement effective teaching methods, and understand why other strategies seem to fail in stimulating learning.

In this article, we propose a model for teaching that can help teachers understand what motivates students and why learners should be the central focus of teaching activities. Rather than insisting on specific teaching behaviors, the model aims at a common understanding of teaching and learning processes, from a perspective about the process of education different from the one teachers may currently have.

If teaching is to facilitate learning, clearly, teacher activities should be oriented toward the learning process.[1] Two dimensions are central to our model: (1) the analysis of critical features of the learning process and the linking of teacher functions to these features, and (2) the interplay between external regulation and self-regulation of learning.

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This model, although logical, requires new ways of thinking by many teachers, particularly those with other responsibilities, such as patient care and research. Although elements of this model are not new, educational theory now offers a better description of the underlying learning processes and helps to encourage appropriate teacher activities. The model we describe has links to constructivism, apprenticeship-based learning theory, and Russian educational theory; elements of the model were previously discussed by Vermunt.[2–5]

DIMENSION 1: CRITICAL COMPONENTS OF THE LEARNING PROCESS

The understanding of how people learn has grown substantially in the last few decades. Insights from cognitive psychology, developmental psychology, social psychology, information science, and neuroscience have improved our understanding.[6] Many factors have been proposed that both influence the quality and quantity of learning, and raise research questions to validate hypotheses about the learning process. A number of features are robust enough to use as descriptors of the learning process and as guidelines to shape teacher functions. Several authors distinguish among cognitive, affective, and metacognitive components of learning reminiscent of Bloom's domains of educational objectives.[7–9] We believe these three features, or components, are critical to the learning process and may provide a framework for understanding. Bloom refers to educational objectives (i.e., to the outcome of learning), whereas the elements we will discuss refer to the learning process itself. More recently, Mayer elaborated on the *skill*, *will*, and *metaskill*[10] needed for effective problem solving, which clearly parallel the components of our focus and are core elements in our learning-oriented teaching (LOT) model.

Cognitive Component of the Learning Process

Learning occurs when the learner acquires knowledge of a topic or subject matter through processing information by reading, listening, thinking, memorizing facts, relating new facts to existing knowledge, analyzing problems, acquiring psychomotor skills, etc. Essentially, the learner must make a selection from the vast external body of knowledge—from books, living examples, the Internet, other media, etc. This aspect of learning can be summarized by the question "*What* should be learned?" That is, what is the content or objective of the learning, where should this content be found, and how should it be structured to adequately process the information?

Affective Component of the Learning Process

The affective component of learning deals with the learner's motivation to start and persist in concentrated learning. This component pertains to extrinsic and intrinsic motivation, to emotional relationship to the content materials, and to readiness to study. Psychological constructs such as attribution style (interpreting causes of success and failure in learning and exams), self-efficacy (perceptions of one's ability to carry out learning tasks), and coping with all kinds of emotions involved in studying belong to this component.[11–13] The affective component may be summarized with the question "Why learn?"

Metacognitive Component of the Learning Process

The presence of cognitive skills and information combined with sufficient motivation to learn may not result in an adequate learning process if the student does not know *how to* learn. A learner needs *metacognitive skills* to process information: he or she must be able to plan study activities, to monitor and evaluate progress, to diagnose and address personal lack of knowledge. These have also been called *metacognitive regulation activities*.[14]

These three components represent essential questions that learners must address to adequately perform learning activities. These questions range from broad conceptional questions such as "What medical school should I choose to become a skillful plastic surgeon?" to detailed day-to-day questions, such as "Which book chapter shall I choose to read for tomorrow's assignment?" Table 1 gives examples of these questions on all three components, from the learners' macro and micro perspectives. We have chosen six labels in the cells, most of which were adapted from the work of Vermunt[15]: the content conception of learning, the purpose conception of learning ("learning orientation" in Vermunt's terminology), and the method conception of learning ("mental model"). Together, these establish the student's learning style. In all fields the learners can modify their perspectives of the learning process. The macro perspective reflects personality characteristics and opinions of the learner and shapes a dominant *learning style*, whereas the micro perspective pertains to specific *learning activities* that must be accomplished.

DIMENSION 2: THE INTERPLAY BETWEEN EXTERNAL REGULATION AND SELF-REGULATION OF LEARNING

Education serves at least two major two purposes: (1) generating domain-dependent knowledge and skills in students, and (2) helping them develop into adult, responsible members of the community, who can further develop indepen-

Table 1

The Three Components of the Learning Process and the Learner's Concerns Related to Each, from Macro and Micro Perspectives

Learning Process Component	Learners' Concerns from a Macro Perspective	Learners' Concerns from a Micro Perspective
Cognitive level: "Study what?"	*Content conception of learning*	*Cognitive processing*
	What am I to become? A cardiac surgeon? A medical researcher? Is a doctor a technician, a communicator, an investigator? Does he or she need detailed knowledge? Are management skills required?	**What should I study?** Read an assigned text for tomorrow? Will old exams be a better source of information? What are essentials; what are side issues? Practice examination of the knee? Write a paper on this-important topic?
Affective level: "Why study?"	*Purpose conception of learning*	*Motives and feelings*
	Why do I attend medical school? A good salary or job? To prove myself? To help people? To follow my personal interest? To do what others expect? To be a student? To get a degree?	**Why should I start studying now?** How important or interesting is this topic? Will I meet peers' expectations and values? Impress teacher or parents? Increase my future chances of training in this discipline?
Metacognitive level: "How to learn?"	*Method conception of learning*	*Metacognitive regulation*
	What is studying all about? How do I proceed to become a doctor? What school is best? Will there be a lot of reading and memorization? Imitation of preceptors? Studying for tests or for understanding? How much knowledge is in medicine? Will I be able to fulfill all curriculum requirements? Can I improve my ability to learn?	**How do I go about studying?** Allot sufficient time in the next days? Skip what I already know? Compare my knowledge with a peer? Make abstracts, schemas, item lists? Assess the results of my study effort and judge its effectiveness?

dently (i.e., without guidance by a teacher or a school). The latter purpose usually tends to be an implicit goal, accepted by many teachers, but given less specific attention in the curriculum. Although educational objectives, teachers' directives, the classroom context, educational texts, written tests, schedules, required attendance at classes, and other educational events determine much of the students' activities in school, after graduation they will have to continue learning independently without all these. If we want to prepare our students for society, a shift from a regulation of the student learning process by teachers and school to self-regulation of learning should therefore take place during the period of formal education. Before entering higher education, most students have limited ideas of what, why, and how to learn.[16] Education at the university level aims at independent functioning of graduates, not only in the domain of their training, but also in a broader sense. We know that in medical education, the transition from medical school to internship is a sudden confrontation with responsibilities for which students have only partially been trained. Even in PBL, where students are asked to set their own learning goals, the themes and materials are still carefully planned, and learning goals are designed to fit within the general objectives of the curriculum. A better shift from external guidance to self-guidance should therefore be a goal of formal education. Directives from the educational environment should become internalized and shaped into a personal-behavior repertoire.

According to educational psychology, students vary in their capability for self-regulated learning and growth towards independence.[17] Consequently, their need for external guidance may differ. Generally, we expect students to progressively exert more control over their own learning and would like to provide them, at any moment, with no more and no less guidance than they actually need. Receiving more guidance than needed will lead to wasted energy, and adverse effects may result. Students may become lazy, bored, or irritated. When too little guidance is given, students may not bridge the gap between their lack of knowledge and the required educational task. A balance should be found between guidance and self-regulation. Vermunt and Verloop have called this the search for *constructive friction* between learning and teaching, comparable to Vygotsky's *zone of proximal development*: the distance between the actual developmental level as determined by independent problem solving capability, and the level of potential development with the assistance of others.[18] Constructive friction leads to an effort by the student to master new knowledge and skills, by demanding more intellectual effort than routine activities take. A student whose capacity for independent learning is yet undeveloped needs more guidance to experience a con-

structive friction, while the same amount of guidance may not result in significant learning actions in students who already work very well on their own. Too little or too much guidance, relative to the needs of the student, will result in what has been called *destructive frictions* and, therefore, inadequate learning.[11] Either the student will fail to grasp the level of thinking and will refrain from learning, or he or she will experience repetition of known information and will not learn in this case either. Clearly, our goal is a transition from full external regulation to self-regulation of learning, while maintaining an optimal sensitivity for the student's capacity for self-direction. How can we realize this transition?

THE CONCEPT OF *SHARED GUIDANCE*

Now the teacher comes into the picture. Modern medical curricula emphasize the personal responsibility of students for their own learning. With a shift towards more small-group learning and more self-directed learning, mature studying skills are required of students. A constructivist philosophy (i.e., learners "construct" their own knowledge on the basis of what they already know)[19] may be used to justify a discovery-learning approach in the curriculum: students should *learn to learn*. What can teachers do besides providing assignments, scheduling independent learning time, or scheduling students in clinical rotations?

A traditional curriculum may be viewed as inefficient for many students because the presentation of information and the planning requirements are insufficiently geared to the students' needs; however, a curriculum may also do harm by asking too much of students. Both may result in "destructive friction" between competence and demands. Ideally, there is a stage of *shared guidance* of the learning process in which the teacher and the student work together. Collins et al.[3] call this stage *coaching* or *scaffolding*; Vermunt speaks of *shared control over the regulation of learning*.[20] This is where the teacher's role becomes essentially different from the extremes of either the traditional teacher's role or the role of an observer and evaluator of students' mature learning skills. Shared guidance requires awareness of what students know, what drives them and what metacognitive skills they possess, to generate an educational environment that leads to *constructive friction*. Shared guidance does not lead to a fixed set of teaching activities, since constructive friction at early stages of learning stems from demands that are quite different from those found in late stages of training. Instead, shared guidance requires a dialogue with students, a monitoring of their progress, and an adapting of the teaching to their perceived needs.

Table 2 illustrates the coherence of types of guidance with the components of the learning process.

ORIENTING THE TEACHER'S FUNCTIONS TOWARD LEARNING

Our initial question was: How can we help teachers to understand and facilitate learning? The LOT model is characterized by teachers' activities that are adapted to the learning process. If we present the model from a teacher's perspective, it may be helpful to start with the correspondence between the learning process and teachers' tasks (Table 3).

"Study what?" pertains to topics, books, subject matter and the like, but also to the *nature* of the knowledge and skills to be acquired; in short all educational objectives that are set by the school as well as the student. The parallel teachers' activities are summarized as *presenting*. This may include verbal explanations, defining of educational objectives, selection of reading materials, generation of relevant test items, modeling interactions with a patient, giving feedback on the content of papers, presentations, etc. These activities may also include choosing an appropriate learning environment, if that context is deliberately part of what is to be learned, such as is the case in clinical clerkships. In short, all activities that pertain to the adequate provision of content matter are included.

"Why study?" refers to all feelings that are related to starting and maintaining study activities. *Motivating*, therefore, may range from planning tests, to conveying enthusiasm to students in a lecture hall, organizing compelling experiences, helping students to acquire self-efficacy, helping them think of future consequences of current behavior, and stressing the importance of study activities.

Finally, "How to learn?" includes all relevant metacognitive activities that regulate learning. We have chosen the term *instructing* to include all teacher functions that help

Table 2

General Model of Guidance of the Learning Process*

Learning Process Component	Source of Guidance of the Learning Process		
	Full External Guidance (from the Teacher Only)	Shared Guidance (from both the Teacher and the Student)	Full Internal Guidance (from the Student Only)
Cognitive level Affective level Metacognitive level			

*See Table 4 for a use of this model, showing examples of teachers' activities within each learning-process component and at different stages of guidance.

Table 3

Correspondences of Learning and Teaching Processes

Learning Process Component	Learners' Concerns	Teachers' Concerns and Issues
Cognitive level	Study what?	*Presenting* (facilitating the provision of relevant information)
Affective level	Why study?	*Motivating* (stimulating students to invest in studying)
Metacognitive level	How to learn?	*Instructing* (helping students to go about studying)

students with such metacognitive activities and techniques as devising learning tasks, explaining how to go about acquiring knowledge and skills, organizing or giving personal feedback, etc. We use this term in a more strict sense than is usually done in educational literature, to stress the instrumental "how to" nature of it, excluding presentational and motivational elements.[21]

THE LEARNING-ORIENTED TEACHING MODEL

If we relate the analysis of the learning process to the types of guidance that we have distinguished in a two-dimensional model,[22] a chart may result as shown in Table 4. The model assumes the possibility to vary the amount of regulation of the learning process in all three components. The chart can be elaborated from students' and teachers' points of view by more detailed descriptions and adding examples.

Transitions at the Cognitive Level

Entering students will expect educational objectives to be set and the content of the education to be determined for them. They are prepared to listen to teachers explaining subject matter, expect study materials that are carefully composed of the most relevant issues for learning, and anticipate examinations that reflect learning assignments. Teachers may act as important role models and serve as examples, but above all they take the lead in determining what to study and prioritizing within the chosen subject matter. Later, students can be asked to generate personal learning objectives and receive feedback. Reading assignments can shift via suggested literature references to topics to be explored from sources of information the students themselves find. Guidance may then focus on validating the subject matter searched for and found by students, which implies feedback on questions such

Table 4

Examples of Teachers' Activities within the Three Learning-Process Components and at Different Stages of Guidance of Students

	Source of Guidance of the Learning Process		
Learning Process Component	Full External Guidance (from the Teacher Only)	Shared Guidance (from both the Teacher and the Student)	Full Internal Guidance (from the Student Only)
Cognitive level Learner: What to learn? Teacher: What to present to the student?	Lecture, determine objectives, write study texts, write exam questions	Help students in determining the importance of issues by themselves	Students determine objectives, choose relevant topics and information sources, apply self-assessment
Affective level Learner: Why learn? Teacher: How to motivate the student?	Organize tests, give assignments, set tasks	Stimulate students to figure out their own motives	Students are motivated by interest or demands of patient care
Metacognitive level Learner: How to learn? Teacher: How to instruct the student?	Tell how and when to study, show techniques	Give no more or less help than is really needed	Students know how to adequately acquire further knowledge

as: Are these relevant issues for my education? Is the obtained information correct, of high quality, and up to date? What alternative information sources exist? How can this information be applied to solving my learning problem or addressing my learning need? Ultimately, we expect students to have internalized the same type of guidance that was used externally at an early stage of training. The teachers' role may be limited to serving as an information source.

Transitions at the Affective Level

External motivations for learning include required attendance, written examinations, and assignments such as papers, presentations, and all other course requirements that are externally prescribed. Teachers and the educational institution can provide all these. Subsequently, motives for learning that extend beyond such school requirements but do not yet consider students fully responsible for their own learning may include the use of social incentives (e.g., shared tasks as in PBL, peer teaching arrangements), overt nonacademic rewards (personal contact with teachers), exposure to motivating experiences in contexts of future practice, and exposure to enthusiastic role models. Limited professional responsibilities can gradually be given to advanced students to create the feeling of the realistic need for continued learning. Ultimately, students are expected to develop an attitude that is inquisitive and a feeling of need for continued learning. This attitude may be overseen and enhanced by a supportive academic environment and by the perceived value and relevance of the content. In later stages, care for individual patients may become a strong personal motive for learning, rather than parental, teacher, or school requirements that extrinsically motivate. Teachers should give students genuine responsibilities—inpatient care, scientific research, or any other future role—before the end of medical school so that the emergence of internal motives can be encouraged. This accords with self-determination theory, which states that internalization and integration are processes through which extrinsically motivated behaviors become more self-determined.[23]

Transitions at the Metacognitive Level

Students may have rather variable learning skills and strategies in the early stages. These can be compensated by explicit guidelines (e.g., advance organizers, summaries, keyword lists, detailed learning objectives, lay-out features in study texts, formative tests and other feedback). Many of the required thinking strategies at later stages of training may, in the early parts of medical training, have been practiced through modelling and didactic guidance by teachers and with instructions in study materials. Later on, help with study skills may foster development and refinement of students' learning process. This implies providing help and feedback to learners when making their thought processes explicit (e.g., with concept maps), so the development and organization of their knowledge base can be assessed and facilitated. Students should learn to reflect, particularly upon how new knowledge and experience relate to existing knowledge and upon how new knowledge can be applied. The graduate should be capable of identifying knowledge deficits and be proficient in finding ways to correct these. The metacognitive skill to recognize personal knowledge deficiencies is difficult to acquire, and the motivation to correct these may be hard to generate; this may require a long period of shared guidance. The student's ability to assess his or her learning and planning for acquiring further knowledge—through continuing education, including managing time in a busy schedule, exploring techniques to keep up with journals, finding opportunities to apply and consolidate new knowledge, and learning effectively from new experience—may be considered a collection of mature, internalized, metacognitive skills.[24] Teachers could present students with unknown problems for which no information is provided and then ask them to find their own ways to learn to solve them.

PUTTING THE LOT MODEL INTO PRACTICE

The LOT model reflects an educational philosophy of internalization of teacher functions in the learner in a way that allows optimal independent learning after graduation. To establish this internalization, teachers should assess the need for guidance students have during their training. This is not an easy task, since the degree and nature of this need depend on individual differences between students and on their progression towards independence. Furthermore, within individual learners the development in each component of the learning process (cognitive, affective, and metacognitive) can vary; this may also depend on the particular content of learning. First-year residents may need, at the same point in their learning, much guidance in acquiring skills in new, complex diagnostic procedures (at the cognitive level), while guidance in performing a general physical examination will be redundant. Learning diagnostic procedures may not require guidance at the affective level, whereas the same resident might need to be asked to take a written examination on pharmacology to motivate her enough to spend time to learn the necessary information from books. This approach may be compared to competency-based training, theoretically leading to variations in length of required training to attain specific competencies.[25,26]

An important feature of the model is that a *timeline* is not defined. Transition from external to internal regulation may take place at the curricular level over several years, but at the course level within days, and it may even happen simultaneously, depending on the object of education, which may be large and broad or small and specific. Learners can, at the same time, be experts in one field but novices in another field. We know this from research in the field of medical problem solving.[27]

So, although the model has a temporal character, there is no direct link with specific placement in the curriculum, nor with an exact duration of time. Rather, the model should be used as a general frame of reference for teaching. This view is in accordance with spiral approaches to curriculum development, where content elements regularly return at higher levels in the program and become more and more integrated into a coherent knowledge and skills base.[28] The LOT model may be applied at the curricular level, at the course level, and sometimes even during single lessons. This may have practical value for educationalists and course designers as well as for teachers during everyday teaching.

EXAMPLES

Example 1: A Learning-Oriented Teaching Approach at the Curricular Level

In 1995, the University of Amsterdam Medical School curriculum planners felt increasingly uncomfortable with the traditional clerkship arrangements. After a revision of the four preclinical years, including much more clinical education, a change in the last two years was deemed necessary.[29] The traditional arrangement was a combination of 85 weeks of mostly hospital-based clerkships in a semistructured order in 11 different clinical disciplines, including six weeks of skills-training courses. The disciplines had no specific connections. In every discipline, students proceeded from being novices through a few weeks of experience to an accepted passing level in each discipline.

In the new arrangement, five phases of clinical training were devised, aimed at consecutively higher levels of responsibility for the student with lesser amounts of educational support. In Phase A, clerkships start with a combination of theoretical and clinical training in selected disciplines. Students' time is divided equally between the ward and independent learning and classroom courses. Phase B aims at general medical knowledge, skills, and professional attitude to prepare for higher responsibilities in Phase C. Whereas Phase A and Phase B each take place in the academic hospital and provide intensive course elements, in Phase C through Phase E, affiliated nonuniversity teaching hospitals also accommodate students. Phase D aims at higher-level skills in medical care in disciplines that already are familiar. Here, students are to acquire speed and routine in ambulatory care. In Phase E the clerks act as junior interns. The new arrangement as a whole considers the clinical training not as a series of multiple clerkships but as a construction of gradual development of medical responsibility, while an externally directed educational context is receding.

This curriculum development was partly inspired by the idea of learning-process–oriented teaching and has been summarized as a *Z-model curriculum*, in which a gradual increase of (clinical) responsibility is accompanied by a decrease of educational guidance of students. It contrasts with the older *H-model curriculum*, in which a sharp separation existed between a four-year theory phase succeeded by a two-year clinical phase. Other medical schools in the Netherlands have adopted this Z-model curriculum.[30]

Example 2: A Learning-Oriented Teaching Approach at the Course Level

The tutorial process in PBL reflects a move toward self-regulated learning. In the facilitatory tutoring method students learn to become self-reliant and eventually independent of the tutor.[31] In the example below, a variation to a PBL course was constructed with a further withdrawal of the tutor and replacement with peer students as teachers.

A small-group course in medical problem solving, developed at the University of Amsterdam Medical School,[32] consists of 30 sessions of 2.5 hours each, approximately once a month throughout years 2, 3, and 4. Clinical cases are discussed, drawing on knowledge acquired earlier in the curriculum. During the course, gradually more complex cases are discussed. In turn, three of the 12 students lead the sessions as peer teachers. All students are provided with case vignettes with sequential questions, reflecting a realistic course of clinical events. Peer teachers are provided with supplementary information on the patient (e.g., results of history, investigations), hints for literature preparation, and suggestions for guiding the sessions. A clinician–tutor ("consultant") is present and is provided with a complete case description including peer teacher hints and all model answers to the questions. The consultant intervenes only when the discussion heads to gross misconceptions on the matter. This teaching model allows the teacher to provide as much or little external guidance as needed at any moment. The consultant teacher can easily tailor his or her scaffolding to the students' needs. Indeed, if the consultant is absent, an experienced group can easily manage its own learning to a large extent.

Example 3: A Learning-Oriented Approach at the Session Level

Bedside teaching may be considered from the perspective of the LOT model. During these one- to two-hour sessions, a clinical tutor or attending physician–teacher interacts with learners and a patient to discuss the clinical problem, observe or demonstrate medical history-taking and physical examination, synthesize the clinical data, apply basic science principles to the clinical setting, and develop a problem list, differential diagnosis, and plan for investigation or management.[33] The learners may be at different levels (e.g., a ward team consisting of junior or senior students, interns, junior or senior residents, or fellows) or may all be nominally at the same level (e.g., three to six senior clinical students or clerks). However, in reality, *all* learners come with varied backgrounds and clinical experiences, and they will approach the same patient and clinical problem with different cognitive needs, motives to learn, and learning skills and strategies, as well as variable needs for external guidance (i.e., variable competence at internal guidance).

Junior students, in need of external guidance, may learn best if the tutor chooses the patient and topics (e.g., how to perform a general physical examination efficiently, the approach to the diagnosis and management of a common clinical problem), directs the discussion, acts as a clinical role model and prompts the student's thinking process with questions.

Senior residents, on the other hand, may come to the session with their own specific learning needs (e.g., how to refine a difficult maneuver in the physical examination to find out whether *this* treatment will be appropriate on *their* patient) relevant to the immediate care of their patient or to their future practice. They may ask and answer most of their own patient-related questions by searching the medical literature and using consultants and may need—as "junior colleagues"—only scarce and specific guidance at self-defined moments. They learn predominantly through internalized guidance, at the cognitive, affective and metacognitive levels. During the bedside teaching session they may learn, and act as role models for junior students, at the same time.

"Intermediate" learners (e.g., senior students, junior residents) may be somewhere between these two poles, needing shared guidance when involved in the three components of learning. The teacher may ask an intern to generate and focus case-based questions, and then help the intern to appraise and apply the answers. The intern may want to attend a bedside session because of the teacher's enthusiasm or because it is perceived as a "team" activity. The teacher may ask the intern to "think out loud" so that knowledge and reasoning skills can be addressed explicitly. If the intern is also asked to reflect on his or her learning process, a metacognitive element has been introduced.

To confound the issue further, any single learner may be at a different point of the external–internal continuum for each of the components of the learning process (e.g., be at the shared-guidance point for the cognitive component, the external-guidance point for the metacognitive component, and the internal-guidance point for the affective component), and these may vary according to the case material at hand, depending on prior experiences or future plans. A senior student may have expertise in handling a patient with type 2 diabetes, needing little guidance here, while being a novice in dealing with patients with a suicidal depression. This can prove challenging for the clinical tutor, who must provide different support for different learners at the same time, and whose role with the same learner may change over the course of a series of sessions. Awareness of different levels of the learning process and variable needs for guidance, however, will enhance the tutor's sensitivity and ability to deal with these complexities.

DISCUSSION

The model we have described may not be considered revolutionary. What we have done is translate existing concepts from educational psychology into a framework that can be used in curriculum and course development and in teacher training. These concepts may, however, lead to a redefinition of the teacher's characteristics and actions, moving from the traditional teacher–lecturer (indicated in the upper-left cell of Table 4) to a teacher with skills in all three components of the learning process, who has sensitivity to students' need for guidance. Our article should be viewed as a summary of the current state of "a model representation of the learning-teaching process under construction," and we welcome insights from others that can add to further understanding and strategies for implementation.

The model focuses on the *interplay* between learning and teaching, but does *not* give a complete description of either process. For example cognitive processing includes not only selection of information, but also encoding, processing, remembering, and recall of facts and insights. Also, the affective and metacognitive components include several specific processes that have been analyzed by Vermunt and Verloop.[18] However the model can be well understood without elaborating on these aspects. Teachers' functions have been put into a framework with three labels: presenting, motivating, and instructing (Table 3). They relate to other descriptions of teacher tasks in the literature. For example, Harden and Crosby[34] have recently distinguished six domains of teacher activity and 12 teacher roles (e.g., information pro-

vider, role model, facilitator, examiner, planner, and resource developer). This description corresponds with our model.

One practical application is that the model could be used as a diagnostic instrument. In unsatisfactory courses or a single teaching session, one may try to analyze problems in all facets of the model: Are adequate challenges present in each of the components of the learning process? Is too little or too much guidance provided?

Many elements of the learner's point of view in the model have been used in descriptive research. Vermunt, using many of the concepts that we have put into our model, devised an inventory of learning styles. Substantial empirical research in this area, mostly in the Netherlands, has focused on students' learning styles and strategies in higher education, as measured with the inventory of learning styles and related measures.[35–44] One study addressed differences between novice and advanced medical students,[41] others focused on other students and levels of education. Stability of learning styles was investigated,[37,41] and parts of the theoretical framework were further elaborated. A distinction between macro and micro perspectives (Table 1) was not made before, and we have added the idea of a *content conception*. This could be of value in determining study styles and strategies and might be explored for its validity for predicting success in learning and future (medical or other) practice.

The model described here could serve as a framework for curriculum and course development and actual classroom teaching as shown in the examples presented. In addition, teacher training and teacher evaluation may profit from the use of this model, if we succeed in describing teacher behaviors at presentational, motivational, and instructional levels that can be learned and observed. If we can measure the amount of guidance students need (i.e., the desired amount of *constructive friction*), it might be possible to actualize the dimension of external–internal guidance. Also, it may be possible to construct a teacher style inventory, parallel to learning style inventories, based on this model.[45]

Beyond its practical applications, the model may also offer a systematic framework for research: it does generate questions as to how it may be used and its validity for different purposes. For instance, how powerful is the model in changing perceptions of learning and teaching? Teachers should be able to *recognize* its validity and think of practical applications for their own teaching. The ease of finding examples in everyday medical teaching derived from the model may support its usefulness and face validity. Other research questions include: How can specific teacher activities of the shared guidance type at each of the three levels be formulated, carried out, and be tested for their effectiveness? How can we identify the needs of students for guidance or, in other words, how do we identify opportunities for realizing constructive friction and translate these into tools for teaching in the clinical or classroom setting? How much constructive friction can be devised for groups of students collectively? Can we measure progress of students in the three components of their learning competence as to their independent functioning in specific areas of learning (e.g., basic sciences or clinical skills)? How much difference between students' levels and learning styles should be taken into account when providing collective or individual shared guidance?

We believe it will be worthwhile to further investigate and validate these theoretical notions and encourage research in this field.

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