Towards more powerful learning environments through combining the perspectives of designers, teachers, and students

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In order to reach the main aims of modern education, powerful learning environments are designed. The characteristics of the design of PLEs are expected to have positive effects on student learning. Additionally, teachers’ conceptions of learning and teaching do influence the implementation of a PLE. Moreover, students’ perceptions of a learning environment affect their subsequent learning behaviour and the quality of the learning outcomes. The different perspectives of educational designers, teachers, and students are summarized in the Combination-of-perspectives (COOP) model. Combining these perspectives by mutual exchange of conceptions and perceptions is expected to have positive effects on the power of PLEs.

Nowadays, a lot of attention is paid to the development of powerful learning environments (PLEs). Educationalists and teachers attempt to create learning environments for students that are supposed to be optimal for learning. Principles from cognitive psychology and constructivism are used to design and develop such learning environments. Mostly students themselves do not participate in the development of learning environments that are specifically intended for them. Although it is common practice not to involve students in the development process, this is not self-evident.

Research (Elen & Lowyck, 1998, 1999) has shown that students do not always experience a learning environment in the way it was intended by the designers. Rather than the learning environment itself, the students’ perceptions of a learning environment determine how much they will learn and how effective a learning environment will be (Entwistle, 1991). The way students perceive and interpret a learning environment is influenced by their conceptions about learning, tasks, and environments, together called ‘instructional metacognitive knowledge’ (Elen & Lowyck, 1999). Discrepancies between

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designers’ and students’ interpretation of a learning environment will usually cause suboptimal use of a learning environment (Elen & Lowyck, 1999). In addition, there may be a discrepancy between designers’ intentions with a learning environment, and teachers’ conceptions of learning and teaching, which will lead to an implementation that differs from the intentions of the designers. These discrepancies are not an insoluble problem, however. Because students and teachers have their own perspective on the learning process, they should be involved in the design of the learning environment. What is really needed is a reciprocal relationship between designers, teachers, and students, so that there is exchange of ideas about learning and perceptions of learning environments. Only in this way, can more congruence be created between interpretations of learning environments by designers, teachers, and students, which will lead to the development of more effective learning environments and, eventually, more effective learning.

Underpinning this idea, the elements mentioned above are discussed in this paper. First, the main aims of modern education are described. Second, the characteristics of PLEs are explained in the light of those aims. Third, it is important to look at teachers’ conceptions about learning and teaching, as mainly teachers implement learning environments into practice. Fourth, student conceptions and perceptions about learning and education are discussed. Fifth, the Combination-of-perspectives (COOP) model summarizes the perspectives of the different participants involved in the educational process, making discrepancies between them visible. In addition, the ultimate goal of creating more congruence between perceptions of learning environments by students, designers, and teachers is elaborated. Finally, the COOP model is discussed.

**Aims of modern education**

In the current view on learning, constructivism has a central position. Learning is seen as an active process of interpreting and constructing individual knowledge representations (Jonassen, 1991). Students have to process information actively and construct the knowledge through experience. Active knowledge construction in context contributes to advanced thinking and learning activities, resulting in high-quality knowledge acquisition (Spiro et al., 1991; Collins, Brown, & Newman, 1989; Brown, Collins, & Duguid, 1998). Instruction should provide tools and environments for helping students to achieve this.

Problem-solving skills are essential for living in a complex society. People are confronted with a variety of problems in daily life and at work. In order to effectively solve problems, three categories of skills are required (De Corte, 1990): (a) the flexible application of a well-organized domain-specific knowledge base, (b) systematic search strategies for problem analysis and transformation, and (c) metacognitive skills. Because real-life problems have a context that differs from the learning context, students should also be able to transfer knowledge and skills they learned at school to new situations. They have to become competent in applying the knowledge in their worlds, beyond the school walls (Dijkstra, 2001). In education, it is not a matter of reaching short-term goals, but of integrating acquired knowledge and skills with more general goals, such as understanding the surrounding reality, and adapting to changing circumstances (Dijkstra, 2001).

Furthermore, people currently have at their disposal vast amounts of information, due to an increase in use of modern media, such as the Internet. In order to satisfy
information needs, people have to find their way through what is available. This requires
the ability to select, process, and organize information. Moreover, fast changes in work,
technology, and society make it impossible to teach students everything at school, and
during their youth. Individuals need to continuously update their knowledge, attitudes,
and skills after graduation, however, without the support from teachers. They have to
develop their professional competencies independently. An important goal of modern
education is to prepare students for this lifelong process of learning (Van Hout-Wolters,
Simons, & Volet, 2000). Students should acquire a self-directed way of learning: they
should mainly regulate their learning processes themselves, and should be able to work
without the help of others, and learn in an experiential way.

In brief, education should be directed at reaching goals with regard to the acquisition
of high quality knowledge, problem-solving skills, transfer of knowledge and skills, and
self-directed learning skills. To catch these main aims of modern education, the term
powerful learning environments is used, by which the current ideas about design and
arrangement of learning environments are summarized.

Characteristics of powerful learning environments

There is a significant amount of information about the characteristics of PLEs. Specifically, De Corte (1990, 2003), Merrill (2002), Van Merriënboer and Paas (2003),
and Vermunt (2003) have all recently published work about designing such learning
environments, and there is considerable agreement about the most important
characteristics of PLEs. While different authors have also stressed different aspects of
the design, all characteristics can be brought back to the general educational aims
mentioned earlier.

In order to stimulate active knowledge construction and the acquisition of problem-
solving skills, the learning environment should be problem-based, in that students are
engaged in solving real-world problems (Merrill, 2002). Learning tasks or problems
should be complex, realistic, and challenging in order to elicit an active and constructive
learning process in students (Van Merriënboer & Paas, 2003). Additionally, Merrill
(2002) has described four other characteristics of PLEs that seem to be common in
different current instructional theories. They can be seen as four phases of the learning
process, which is directed to the acquisition of high quality knowledge and skills,
problem-solving skills, and to transferability of learning outcomes. First, prior
knowledge and experiences of the student must be activated, in order to build new
knowledge on pre-existing knowledge. Second, new skills or knowledge must be
demonstrated to the student through modelling. Third, the student should have the
opportunity to apply their new knowledge and skills. Fourth, the newly acquired skills
and knowledge must be integrated into real-world activities of the student. These
features described by Merrill fit well with the ideas behind cognitive apprenticeship
three basic principles for the design of a PLE. First, the learning environment must aim at
integrated sets of learning goals, directed at the acquisition of knowledge, skills, and
attitudes in an integrated way. By this integration, students become able to recombine
acquired skills, knowledge, and attitudes effectively to solve problems in new situations
(Van Merriënboer, 1997). Second, in the design, variation in learning styles of students
must be taken into account. For instance, well-designed environments must allow for
deductive approaches (i.e. study general information, and then examples) as well as
inductive approaches (i.e. study examples, and then general information) to learning,
and must also support both inquisitorial approaches (i.e. mainly study through discovery and asking questions), and expository approaches (i.e. mainly study through processing pre-structured information) to learning (Van Merriënboer & Kirschner, 2001). Finally, the instructional design must be aligned with the human cognitive architecture, especially the limited processing capacity of the human mind, which is a prerequisite for being able to effectively construct your own knowledge (Sweller, van Merriënboer, & Paas, 1998).

Another way of stimulating active knowledge construction processes is the inclusion of small group, collaborative work, and ample opportunities for interaction, communication, and cooperation in the learning environment (Van Merriënboer & Paas, 2003). This idea originates from Socrates, who stressed the importance of dialogue and discussion for knowledge construction a few thousand years ago. Recently, cooperation during knowledge construction, called collaborative learning, has received renewed interest. By a process of interaction and negotiation, students have an active and constructive role in the learning process.

A self-directed and independent way of learning and thinking can be stimulated by gradually transferring the responsibility for the learning processes from the instructional agent to the students themselves (Vermunt, 2003). Starting with explicit external regulation and support, the teaching process is directed to teach students how they can obtain control over their own learning processes. As students acquire self-directed learning skills, external support is gradually withdrawn. Teaching methods gradually change, dependent on, and complementary to, the growing competencies of the students, defined as process-oriented teaching (Vermunt & Verschaffel, 2000). The acquisition of self-regulation skills can be improved by stimulating students to articulate and reflect upon their learning and problem-solving processes (De Corte, 1990). Articulation helps students to spell out and make explicit their knowledge and

Figure 1. Characteristics of powerful learning environments that contribute to reaching the main aims of modern education.
problem-solving procedures. Reflection leads students to compare their cognitive strategies and solution processes with those of experts or other students' (p. 13).

Figure 1 summarizes the described characteristics of PLEs which have a supportive role in reaching the modern aims of education. They all contribute to one or more of the educational goals, which are pursued in current education systems. There is a considerable amount of evidence that these characteristics lead to better student learning (see e.g. Bollhuis, 2003; Johnson & Johnson, 1994; Schmidt, de Volder, de Grave, Moust, et al., 1989; Spires & Donley, 1998; Vermunt, 1995).

Educationalists use these characteristics to design blueprints of PLEs, ranging from classroom-based courses and electronic learning environments, to complete educational approaches, like problem-based learning and competence-based education. However, a design of a learning environment that is well suited to reach the modern aims of education does not give the guarantee of practical success. Implementation is crucial in determining the factual characteristics of a learning environment, which influence student learning. Because teachers, instead of designers, often implement already designed learning environments into practice, it is worth examining the conceptions teachers have about learning and teaching. These conceptions strongly influence the implementation, and consequently the impact of the PLE on student learning.

Teachers' conceptions of learning and teaching
Having conceptions is inherent in human beings, because they attach meanings to their surrounding world. Conceptions can be seen as lenses through which people perceive and interpret the world (Pratt, 1992). Consequently, conceptions influence the way people act and react to their environment, which is in accordance with these perceptions. For teachers, a considerable part of their surrounding world is the teaching context, and they have formed specific conceptions of learning and teaching. Because of this, it is impossible that teachers implement PLEs into practice exactly as intended by the designer. Teachers perceive the learning environment through the lenses of their own conceptions, and will act and react accordingly.

There exists a large body of research on teachers' conceptions of teaching and learning. Kimber (1997) reviewed 13 of these studies, and developed a model that synthesizes all the findings. According to him, all conceptions can be placed on a continuum between a teacher-centred/content-oriented pole, and a student-centred/learning-oriented pole, linked by an intermediate conception. Kimber's synthetic model contains five conceptions of teaching: (1) imparting knowledge, (2) transmitting structured knowledge, (3) student-teacher interaction, (4) facilitating understanding, and (5) conceptual change and intellectual development. According to the conception of imparting knowledge, teaching is seen as presenting information to students, who only have to passively receive this information. The focus is on the lecturer and his/her knowledge, which gets transmitted by lecturing. According to the conception of teaching as transmitting structured knowledge, the focus is still on the transmission of knowledge, but there is more attention for the student. The teacher structures and arranges the presented information in a way that students have more chance of receiving the information. The conception of student-teacher interaction is the intermediate conception and forms the transition between the teacher-centred/content-oriented orientation, and the student-centred/learning-oriented orientation. The interaction between the teacher and the students is seen as important now, because of the recognition that student understanding and discovery are essential, manifesting
itself in a degree of interaction. With regard to facilitating understanding, teachers who have the student-centred conception of teaching see teaching as a process of helping students to learn and develop deep understanding. Desirable learning outcomes are no longer limited to the intake of information, but include understanding and the ability to apply the acquired knowledge. According to the conception of conceptual change and intellectual development, a learning environment focuses on students’ prior knowledge and tries to change pre-existing conceptions by arguing, applying ideas, and focusing on conflicts between conceptions, in a sympathetic and supportive environment.

Recently, Samuelowicz and Bain (2001) have shown that there is no intermediate conception between the teaching-centred orientation and the learning-centred orientation, as Kember described. It is not the teacher-student interaction per se that differentiated the orientations, but the purpose and the nature of the interaction. Interaction is either focused on improving the transmission process (for example maintaining students’ attention), or it is used to help students construct appropriate understandings. Thus, there are relatively hard boundaries between teaching-centred and learning-centred orientations. What is important with regard to the implementation of PLEs is that a clear distinction can be made between both dimensions. The orientation of teachers’ conceptions determines the compatibility of teachers’ perceptions of the environment with the design of the PLE.

Research has shown that teachers’ conceptions of learning and teaching do influence the factual organization and implementation of a learning environment, and by consequence the quality of student learning. Teachers’ conceptions influence students’ approaches to learning, mediated by the teachers’ approaches to teaching (Trigwell, Prosser, & Waterhouse, 1999). A teaching orientation of learning facilitation is significantly correlated with desirable and meaningful student learning approaches (Gow & Kember, 1993). Moreover, there is also a clear relationship between a knowledge transmission orientation of teaching, and surface or less desirable student learning approaches (Gow & Kember, 1993). For example, teachers who think about teaching as transfer of knowledge from the teacher to the students depress students’ intrinsic interests, and their use of a deep learning approach.

In short, teachers seem to have different conceptions of teaching and learning that can be described as teacher-centred/content-oriented, or student-centred/learning-oriented. The conceptions within the student-centred/learning-oriented orientation are compatible with the ideas of constructivism and PLEs, and it is expected that teachers having one or more of these conceptions are well able to bring a PLE into practice. In light of the aims of modern education and the characteristics of PLEs, the teacher-centred/content-oriented conceptions of teachers are problematic for implementing PLEs. Aims that are pursued by designers of a learning environment will probably not be reached. This clearly indicates that the influence of teachers’ conceptions of learning and teaching should not be underestimated, while looking at the effects of realizing a PLE.

The perspective of the student
It has been shown that in practice it is not the concrete learning environment that influences learning processes of students, however, students’ perceptions of the learning environment are crucial. It is the perception of the characteristics of the learning environment that affect students’ approaches to learning and the quality of the learning outcomes (Entwistle & Tait, 1990). This position fits within the cognitive
mediational tradition (Doyle, 1977), which stresses that instructional interventions do not directly influence student learning. The learning effects are mediated by students’ perceptions and interpretations of the learning environment. In other words, students’ perceptions of a PLE determine their subsequent learning and the learning outcomes. The characteristics of the learning environment themselves do not have direct influence on student learning. For this reason, student perceptions should have a central position in our thinking about PLEs and reaching the aims of modern education. Although a learning environment can be designed to be very powerful and be well implemented, students’ perceptions of that learning environment will determine what kind of learning activities will be employed, and of what quality the learning outcomes will be.

In order to get a grasp on the content of students’ perceptions, the origin of the perceptions is important. A study of Tsai (2000) showed clear relations between secondary school students’ epistemological beliefs and their perceptions of a constructivist learning environment. Students’ perceptions of a learning environment can be seen as the result of the interaction between the student with the learning-related characteristics (internal variable), and the learning environment (external variable; e.g. Luyten, Lowyck, & Tuerinckx, 2001; Wierstra & Beerends, 1996). As described earlier, conceptions play a central role in perceiving and interpreting the environment, and in the way of reacting to it (Pratt, 1992). Students, more specifically, have conceptions about ‘the way in which instructional features may help or hinder them to learn or to realize (instructional or learning) tasks’ (Elen & Lowyck, 1999, p. 149). Part of this metacognitive instructional knowledge is students’ knowledge about learning: conceptions about the self with respect to learning, motivational strategies, control strategies, and conceptions about cognitive strategies. These four kinds of conceptions, although differently labelled, are in accordance with the dimensions of the construct ‘learning style’ (Vermunt, 1996); conceptions of learning, motivational orientations, regulation strategies, and cognitive processing strategies. Because these characteristics are likely to influence students’ perceptions, they will be described in more detail.

First, students have conceptions of learning. Marton, Dall’Alba, and Beaty (1993) have described six qualitatively different conceptions of learning, building on five conceptions described by Säljö (1979). In the most primitive conception, learning is seen as increasing one’s knowledge by collection, consumption, and storing of information. According to the second conception, learning is equal to memorizing and reproducing information. These are thought to be the core activities in the learning process. The conception of learning as applying stresses the acquisition of the ability to apply knowledge or skills. Common in these first three (quantitative) conceptions, is that knowledge is seen as something external to the student, which must be taken in and stored. On the other hand, meaning is fundamental in the next three (qualitative) conceptions of learning. The conception of learning as understanding stresses gaining meaning during the learning process. Learning is seen as grasping new ideas, gaining more insight, and developing a conception of something. According to the conception of learning as seeing something in a different way, the change of already existing conceptions is crucial. The student sees learning as changing his way of thinking about the subject matter. Finally, the conception of learning as changing as a person closely relates to the former conception. Differing the way of thinking and seeing the surrounding implies that you change as a person.

Second, students differ in their motivational orientations and their goals of learning. Several types of motivational orientations have been described. Beaty, Gibbs, and Morgan (1997) mentioned four different motivational orientations: personal, vocational,
academic, and social. Students having a personal orientation are focused on their personal development as a goal of learning and studying. Students can also be motivated for learning by the goal of getting a job after graduation, called vocational orientation. Academic orientation refers to students’ goals concerning the academic side of university or school life, such as intellectual interest and educational progression. Finally, students’ goals can be directed to the social side of school or university life, termed social orientation. These motivational orientations can be further classified by making a distinction between intrinsic and extrinsic interest in learning (Beaty et al., 1997). All motivational orientations, minus the social one, have to be further specified by the locus of students’ interest: interest in the learning content or studying as a means to an end. For instance, a student with a personal motivational orientation and an intrinsic interest in learning prefers challenging learning materials for self-improvement and broadening. In contrast, a student having a personal orientation with extrinsic interest is fixated on getting feedback and passing the course, aimed at compensation or proof of capability. The distinction between intrinsic and extrinsic interest parallels, respectively, with Dweck’s learning and performance goals (1986). The former refers to the primary focus on gaining new skills and knowledge; the latter refers to the emphasis on positive evaluations from others. Taken together, the balance between the motives for learning and the extent to which students are intrinsically or extrinsically interested in learning, forms an important student characteristic.

The third relevant learning-related student characteristic is regulation, concerning the way of regulating the learning processes. Self-regulated learning includes metacognitive strategies (such as planning, orienting, steering, and testing) and effort management strategies that reflect students’ persistence at difficult and boring tasks and working diligently (Pintrich & De Groot, 1990). Students differ in their locus of control: external regulation or self-regulation (Vermunt, 1998). Externally regulated students largely depend on the teacher and the learning environment for the regulation of their learning processes. The environment determines what must be learned and how it must be done. On the contrary, self-regulated students take the initiative for learning in their own hands. They are able to regulate the learning-processes themselves, and even are actively involved in the choice of the learning content.

The use of different kinds of cognitive processing strategies is the fourth student characteristic. Students differ in their preferences for using different kinds of cognitive processing activities. There has been five important activities described (Vermunt, 1998; Vermunt & Verloop, 1999). Students’ thinking activities can be directed to relating to and structuring the learning materials, for example, by linking new knowledge to prior knowledge and structuring parts of knowledge into organized wholes. Critical processing refers to examining facts, arguments and conclusion, rather than just accepting any information that is presented. Students using a memorizing and rehearsing strategy do not perform deep processing activities, as in the former strategies. They memorize and rehearse the subject matter, in order to be able to reproduce it. Focusing on analysing during learning means that larger wholes get broken down into parts, and details are emphasized. Finally, students using a concrete strategy try to form tangible images of the subject matter, by thinking of examples and relating it to personal experiences.

Taken together, these four learning-related student characteristics are intended to influence how students perceive a concrete learning environment. The perception of a learning environment is shown to be central in determining the effects of a learning environment on student learning.
In addition to the learning-related student characteristics, students’ expectations of a learning environment play an important role with respect to students’ perceptions. Students form expectations about a learning environment, based on information they get about the main activities and goals of a learning environment. Relating the features of a learning environment with students’ own characteristics will convince students that they can or cannot successfully execute the learning behavior that is required to reach the goals of the learning environment. According to Bandura’s self-efficacy theory (1977), students form outcome expectations, referring to expectations about the usefulness of certain learning activities for reaching the goals. Additionally, they have efficacy expectations: beliefs about their own ability to perform those learning activities. Both outcome expectations and efficacy expectancies must be positive, before a student will put forth effort to reach the educational goals. Another type of expectation of a learning environment is the anticipation of the consequences of goal achievement and the value of these consequences (Driscoll, 1993). If a student does not assign any value to the learning outcomes that are pursued by a learning environment, their expectations will be negative. This may be due to incongruence between the learning environment and the student’s motivational orientation. In short, expectations of a learning environment seem to play a role in students’ anticipation on a learning environment and their perceptions of it, and originate from the comparison of the features of a learning environment and their personal learning-related characteristics.

Combining the different perspectives
Research has shown that students prefer congruence between their learning habits and the characteristics of a learning environment (Vermetten, Vermunt, & Lodewijks, 2002). Students show a clear preference for learning environments that even promote their habitual approaches to learning (Entwistle & Tait, 1990). Small differences between students’ learning strategies and teaching strategies in a learning environment may represent a challenge for students to increase their learning and thinking skills (Vermunt & Verloop, 1999). These constructive frictions, however, evolve into destructive frictions if the differences between student characteristics and the learning environment get so large that they may cause decrease in students’ learning and thinking skills. Negative effects of characteristics of a learning environment on students’ learning processes are also called mathemathantic effects (e.g. Lohman, 1986). Clark (2001) has explained these mathemathantic effects by referring to levels of self-efficacy of the student. Self-efficacy judgments tend to be low when students perceive the required mental effort for performing a learning task as being high. Much mental effort is required, for example, for learning novel and difficult tasks. When the task requirements are perceived extremely high or even impossible to obtain, the self-efficacy reaches such a low level that the ‘efficacy threshold’ will be reached. At the efficacy threshold, mental effort stops and attention will be automatically directed at different or novel goals. Thus, the intended learning process is cancelled, because the student perceives not to be able to meet the requirements of the learning environment. It becomes clear that it is not a superfluous luxury to look seriously at the interaction of students with a PLE.

The Combination-of-perspectives (COOP) model depicts the variables that have been mentioned in this paper (see Fig. 2). It combines the perspectives of educational designers, teachers, and students. In education, the design-process is often executed by two participants. Designers develop blueprints for a learning environment, based on their ideas about constructivism and characteristics of PLEs. Designing in such a context can be
Figure 2. The Combination-of-perspectives (COOP) model.
seen as developing study books or educational approaches that form the building-blocks of a learning environment. The educational designer can be seen as a ‘distal’ designer. Often teachers implement such designs into the classroom. They can be seen as ‘proximal’ designers. It is often the role of the teachers to use these blocks of the distal designer to build or create a concrete learning environment for students. In doing so, teachers rely on their practical experiences, condensed in their conceptions of teaching and learning. Students participate in this learning environment, bringing along their learning-related characteristics and expectations of a learning environment. These variables are likely to influence the way students perceive the learning environment (e.g. Tsai, 2000). In general, conceptions appear to influence perception-processes (Pratt, 1992). Conceptions of designers and teachers therefore influence the way they perceive the learning environment. Furthermore, the COOP model illustrates that designers and teachers do not have a direct influence on student learning. In contrast, students’ perceptions of a learning environment do influence student learning and the quality of learning outcomes (Entwistle & Tait, 1990), and whether the goals of a PLE will be reached or not.

Thus far, the model is quite straightforward. The added value of the COOP model lies in the feedback loops, depicted as dotted arrows in Fig. 2. These loops promote involvement of students in the design and development of a learning environment. Additionally, feedback from teachers’ perceptions to designers’ conceptions is proposed. Teachers’ perceptions can be valuable information for designers. Bringing together the expertise of the designer and the teacher can contribute to optimization of the design of a learning environment (The Design-based Research Collective, 2003). The mechanisms that are depicted by the feedback loops show a parallel with human factors engineering. Norman (1986, 1988) used a three-conceptual-models approach for optimizing man-machine interaction: the designer’s model, the user’s model, and the system image. The designer uses his model to create a system. The designer’s model and the user’s model can differ, which causes a gap between the way the user interprets the system and the way the designer intended it. Research in the field of educational psychology shows the existence of discrepancies between designers'/teachers’ intentions or conceptual model, and users’ perceptions, as well (see e.g. Winne & Marx, 1982). Recently, studies of Broekkamp (2003) showed inconsistencies between teachers’ and students’ perceptions of task demands. Students generally did not have an accurate perception of their teachers’ intended task demands.

In order to look for possibilities for creating optimal congruence between designers and teachers on the one hand, and students on the other hand, the first step is to use students’ perceptions as feedback or input for both teachers and designers. The COOP model can be seen as an aid for identifying any possible discrepancy between perceptions of designers, teachers, and students. The second step is to reduce these differences. For man-machine interaction, Norman (1986) describes two possible solutions to bridge the gap between the system image (created by the designer) and the user’s model. First, designers can adapt the system, moving closer to the user by making better matches to the needs of the user. Second, the user can bridge the gap by creating plans, action sequences, and interpretations, moving his goals and intentions closer to the description of the system. The same two kinds of solutions can be proposed in education, in order to create more congruence between designers’ and teachers’ conceptual models of a learning environment and students’ perceptions of it. Either designers or teachers can adapt the learning environment to students’ perceptions, or
students can be stimulated to adapt to the learning environment. Which option is chosen depends on the kind of the discrepancy.

For example, if students perceive a high amount of emphasis on the reproduction of knowledge in a non-reproduction-oriented learning environment, then this is an undesirable situation. It is possible that the learning environment gives unintended signals to students that reproduction is a good learning strategy. It seems meaningful, therefore, to examine and observe the educational practice, the behaviour of the teacher, and to analyse the tests students have to make. As a result, the design of the learning environment has to be altered. Another example is that students perceive little differentiation in a learning environment. All students do the same things. Excellent students do not perform extra assignments and students getting bad marks do not perform extra exercises. It is conceivable that the learning environment gives opportunities for differentiation, but students do not use them. In this case, a way to stimulate and motivate students to use these opportunities has to be found. Taken together, these examples illustrate that it is situation dependent whether the learning environment has to be adapted, or the perceptions of students have to be redirected. The ultimate goal is to optimize the power of a learning environment, and this should be the basis for which one of the two options for creating optimal congruence is chosen.

Discussion

Based on the literature referred to in this paper, the COOP model has been described, summarizing the different perspectives of the participants involved with the creation and realization of a learning environment. Educational designers use their knowledge about characteristics of PLEs to design learning materials and select instructional strategies for a PLE. Teachers' conceptions of learning and teaching influence the way they implement a learning environment. However, students' perceptions of a learning environment determine their subsequent learning behaviour, and, consequently, the quality of the learning outcomes. Students' perceptions are thus central in exploring the effects of PLEs on student learning. Perceptions are the result of the interaction of the student, with his/her learning-related characteristics, and the learning environment. Students' perceptions may be mediated by their expectations of the learning environment.

In order to optimize PLEs, a reciprocal relationship between designers, teachers, and students is proposed. According to the COOP model, students' perceptions of a learning environment should provide input in the design process of PLEs as carried out by educational designers and teachers. In order to fine-tune the learning environment, designers and teachers have to take the perspective of the students into account. Discrepancies between the educational aims of designers and teachers on the one hand, and students on the other hand, are suboptimal for students' learning. In the case of appearing discrepancies, there should be an attempt to reach more congruence between the different perspectives. Designers and teachers can adapt to the perspective of students, in order to optimize their learning. However, if students' perspective is incompatible with the characteristics of PLEs, designing compensating learning activities for students can help bridge the gap between different perspectives. The aim of such compensating activities is that students gain skills and acquire attitudes they need to make best use of the PLE, to get the most favourable profit from, and see the value of, the learning environment. In addition to the feedback loop from students' perceptions to teachers' and designers' conceptions, a loop from teachers' perceptions
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The COOP model is a general model that is well applicable to a wide range of educational practices. A source of variation for the COOP model may be the factual presence or absence of all participants involved. In the design and implementation process, the educational designer and the teacher are not necessarily both involved. In nursery school teachers themselves design the learning environment and educate the pupils, without the intervention of a designer. Often they even develop the learning materials themselves. In electronic learning environments the role of the teacher mostly disappears. The educational designer develops the electronic learning environment that is directly offered to the students. In university class the professor designs and implements the learning environment, in that he/she prepares, develops, and teaches the lesson. The model can easily be adapted to such variation in the presence of all participants involved by deleting either the designers’ blocks in the model or the teachers’ blocks. Always present are the students and the teacher and/or the designer. The ultimate goal of the COOP model is to make any possible discrepancy between the participants visible and, eventually, to promote fine-tuning between them. The nursery school teacher, the designer of an electronic learning environment, and the professor all have to take into account the students’ perceptions of the learning environment. In all cases there has to be a fine-tuning of the perspectives of the participants involved, as proposed in the COOP model.

Although the COOP model and the need for a reciprocal relationship between designers, teachers, and students seems quite clear, comment is required. First, the idea of learning-related student characteristics on learning behaviour is not new. For example, Van Rossum and Schenk (1984) have demonstrated the relations between students’ views on learning, their learning approaches and the quality of their learning outcomes. Also, the influence of students’ conceptions of learning and their approaches to learning has been established (Dart et al., 2000). Students having qualitative conceptions are likely to use deep approaches to learning, characterized by elaborating the materials and actively constructing knowledge. What is particularly important in the COOP model, however, is the emphasis on students’ perceptions of a learning environment, which is expected to mediate this relationship.

Second, student characteristics are not stable personality traits, but are the reflection of students’ learning experiences. It has been shown that the same students use different learning strategies in different learning contexts, and that these differences are rather large (Vermetten, Lodewijks, & Vermunt, 1999). In that sense, perceptions of a learning environment therefore also influence students’ learning-related characteristics. Moreover, in this study, high correlations were found between reported learning strategies among different learning contexts, indicating the existence of individual consistency in the use of a learning style. Although students adapt their learning strategies to the characteristics of a learning environment, they do have habitual ways of learning.

Third, there seems to be a tension between what students consider as important for learning (conceptions of learning), and what they consider as important in a concrete learning environment (Elen & Lowyck, 1999). According to students’ conceptions, they prefer to learn in an active and constructive way and to participate in discussions. However, while functioning in a concrete learning environment, students often want to hand over the responsibility for learning to the teacher, and prefer clear learning goals and description of the learning content. It is hypothesized that prior experiences with learning environments have caused students’ different views on the demands of
functioning in education, compared with their own conceptions of learning which reflect their preferred way of learning (Elen & Lowyck, 1999). From a practical viewpoint, the COOP model can be helpful in exploring the different perspectives of designers, teachers, and students, and in identifying discrepancies between them. Next, the identified discrepancies will hopefully yield concrete suggestions for the optimization of a learning environment and harmonization between participants involved. As in the tradition of human factors engineering, congruence between the different participants creates a situation where students use a learning environment as it is intended by teachers and designers. Future research is intended to deliver tools that can help to create more powerful learning environments PLEs, by stimulating a reciprocal relationship between educational designers, teachers, and students during the development-process.

From a theoretical point of view, the COOP model can contribute to the search for ways to optimize learning processes and learning outcomes. According to this literature-based model, close cooperation between designers, teachers, and students is expected to influence the effects of PLEs. Investigating this model could give insight in ways to optimize learning environments and learning processes. Future research will explore the different variables, as described in our model, in order to validate the model, and make possible discrepancies between the three perspectives visible and, eventually, investigate the effects of creating more congruence on the quality of student learning.

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