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Teachers' conceptions of student learning and own learning

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New learning theory, underpinning the idea of teaching for self-directed learning, provides new conceptions of learning: the self-regulation of learning, the construct-character of knowledge, the social nature of learning and a dynamic model of intelligence. What conceptions teachers hold may be related to their tolerance of uncertainty. We constructed a Learning Inventory and administered this to teachers in Dutch senior secondary education, where an innovation is heading for more independent learning. We found empirical confirmation of the five dimensions underlying teachers' conceptions of learning, both for student learning and for their own learning. Tolerance of uncertainty explained the other four dimensions in conceptions of student learning, but not in teachers' conceptions of their own learning. Teachers generally endorse the process-oriented conceptions, although some differences are noted between teachers' conceptions of student learning and their own learning.

Introduction

Teachers in Dutch senior secondary education are encouraged to promote students' self-directed learning. In the national policy of the Ministry of Education, senior secondary schools should be transformed into 'houses of study', learning communities for students. This innovation is based on the new ideas of learning, including concepts like self-regulation, active learning, social learning and knowledge construction (Simons *et al.*, 2000). An important change for teachers is that they are supposed to attend to the learning processes of their students, to focus on students' processes of knowledge construction and utilization, and to provide students with proper guidance to improve their learning strategies. Teaching aimed at fostering self-directed learning may therefore be called process-oriented teaching (Vermunt & Verschaffel, 2000; Bolhuis & Voeten, 2001). The required shift in teacher role will be difficult to make when teachers' conceptions of learning deviate from the new ideas of learning that underlie the innovation. As Putnam and Borko (2000) recently noted, not enough attention has been paid to the demands on teachers who have to learn new ways of teaching. Trying to understand what teachers know about learning (and teaching) and how they themselves think they learn may contribute to understand the troubles and pitfalls in building a house of study. Several studies

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suggested that teachers' learning-related beliefs affect their teaching practices (for a review, see Kagan, 1992; Fang, 1996). Therefore, in connection with an innovation of classroom practices, it is important to study teachers' learning conceptions.

Our research aimed at investigating the conceptions of learning held by teachers in senior secondary education. We were especially interested in seeing whether teachers' conceptions of learning are in agreement with a process-oriented view of learning and teaching. We also wanted to see whether the views teachers hold on student learning agree with the views on their own learning as teachers.

Conceptions of learning that seem important in relation to promoting self-directed learning in school were selected from the literature: (1) self-regulation of learning, (2) learning as active construction of knowledge, (3) the social nature of learning, and (4) a dynamic view of intelligence. The first three topics refer to central issues in research on self-directed learning. Together they cover the gist of what is meant by the 'new' learning processes. The fourth topic is related to motivation for learning; it is seen as an important factor that influences learning. Persons who see intelligence as a malleable quality will pursue learning goals rather than performance goals (Dweck & Leggett, 1988). That is, such persons will probably be concerned with increasing their competence. In this way a dynamic view of intelligence is very much related to a focus on learning processes, while a view of intelligence as a fixed entity may divert one's attention from learning processes.

Self-regulation or internal regulation is a leading theme in research on self-directed learning and meta-cognition (Candy, 1991; Simons, 1997; Schunk & Zimmerman, 1998). Regulating one's own learning is more motivating and stimulates better learning than external regulation (e.g. by a teacher). An inquiry-oriented approach to teaching requires a shift away from complete teacher control to a supporting and guiding role for the teacher. The counterpart of this change is the requirement for students to regulate their own learning. But learners will differ in their tendency to rely on external regulation of their learning, or to take themselves initiative and responsibility. Teachers ought to be sensitive to this requirement and to existing individual differences. They must be aware that learners will have to learn how to regulate their own learning. We studied to what extent teachers' beliefs are oriented toward the traditional view of external regulation, according to which the teacher is the expert who is in charge of the learning processes, or toward the process-oriented view, which entails sensitivity for the learners' internal regulation processes.

Traditionally, teachers conceive the subject matter as a static body of knowledge to be transmitted to the students. In a process-oriented conception of teaching, however, the learner should be actively constructing knowledge (Shuell, 1988). This introduces a shift in the conceptualization of knowledge away from seeing knowledge as (only) a given set of facts and procedures. When the teacher is transmitting these facts and procedures, then learning is mainly the absorption of knowledge, whereas the constructive view of knowledge implies that learning depends on the learner's activity. Learners should be independent thinkers and critically examine the procedure of knowledge construction. Inquiry-oriented classroom practices engage students in activities that require reasoning, discovering, problem-solving, data gathering, applying and communicating ideas. More traditional practices see a teacher giving step-by-step instructions followed by opportunities for the students to practice the newly taught facts or procedures. It has been shown that students' conceptions of knowledge and knowing are related to the cognitive processes they engage in while learning (for a review, see Hofer & Pintrich, 1997). Several aspects of knowledge and knowing may be distinguished, but in this study we restricted ourselves to the idea that the student actively constructs knowledge as opposed to acquiring knowledge as a reproducible entity. The reason was that this idea seems central to the school as a house of study.

Learning in the sense of knowledge construction is a social rather than an individual phenomenon, according to social learning theory (Bandura, 1986) as well as self-regulation theorists (Zimmerman *et al.*, 1996). Teachers with a social view of learning find it important to learn from and with each other, for themselves and for students. They are convinced of reaching better results by social or collaborative learning. In the more traditional view, learning is an individual process whereby learners develop themselves and acquire intellectual skills. Many schools still practice learning mainly as an individual action, in spite of efforts to introduce cooperative or collaborative learning (Slavin, 1995, 1997; Bolhuis, 2000). In this study, we concentrated on teachers' views about the value of individual learning activities versus learning activities in small groups. We consider the latter as in agreement with a process-oriented view on teaching.

The learner's implicit theory or conception of intelligence plays an important role in the motivation to get involved in self-directed learning (e.g. setting learning goals and choosing learning strategies). Self-direction is based on a dynamic (or incremental) rather than a static (or entity) conception of intelligence. The dynamic conception of intelligence leads to a learning-oriented behavior pattern, seeking challenges that foster learning. Students who believe in fixed ability and who are oriented at performance goals will tend to give up when confronted with learning difficulties, whereas students who believe in dynamic ability and who pursue learning goals will tend to persist despite of difficulties (Dweck & Leggett, 1988). The dynamic conception implies that intelligence or ability develops as a result of learning experiences, whereas the static view takes intelligence as a fixed entity (Dweck & Leggett, 1988; Dweck, 1989; Wong, 1991). In the dynamic view, good teaching makes a difference in helping learners develop their intelligence and learning capacities. Regarding teachers' views on student learning, this dynamic conception of intelligence is related to holding high expectations for students. Regarding teachers' views on their own learning, the dynamic conception relates to seeing opportunities to grow as a teacher and to keep learning throughout one's career. The dynamic view is process oriented because it naturally leads to a focus on learning processes.

Huber and Roth (1999) presented evidence that the ability to respond to the demands of self-directed learning, including self-regulation and the active construction of knowledge in social learning situations, differs according to the learner's tolerance of uncertainty. Persons with a low tolerance for uncertainty tend to avoid, deny or distort information that is inconsistent with their prior knowledge. They try to avoid situations that may bring about potentially inconsistent information. Persons with a high tolerance for uncertainty are motivated to learn from new situations and information that is inconsistent with what they already know (Huber & Sorrentino, 1996). Huber and Roth (1999) reported various studies on the consequences of differences in tolerance of uncertainty in students as well as teachers. Students with a high tolerance of uncertainty engage more often and more actively in open and cooperative learning, and achieve better learning results than do students with a low tolerance of uncertainty. While self-directed learning and process-oriented teaching are more profitable and motivating for students and teachers with a high tolerance for uncertainty, traditional teaching and learning are more attractive for teachers and students with a low tolerance for uncertainty. A mismatch between teachers and students is detrimental to student learning. Teachers with a high tolerance of uncertainty may neglect the problems of students with a low tolerance of uncertainty. Teachers with a low tolerance of uncertainty are less able to create learning situations that truly stimulate self-directed learning (Huber & Roth, 1999). Because of these strong relations of tolerance for uncertainty with teaching and learning, we suspected that tolerance for uncertainty might explain the other four conceptions. We expected a lower tolerance of uncertainty to go together with more traditional conceptions (i.e. with a preference for external regulation, for the reproductive knowledge conception, for the individual learning conception and for the more static conception of intelligence), whereas a higher tolerance of uncertainty will go together with the process-oriented poles of these conceptions.

The conceptions as discussed come from different theoretical perspectives, but they all seem to relate to self-directed learning. One goal of our research was to find empirical evidence of the different conceptions and of possible relations between them. Several models of the relations between the learning conceptions and tolerance of uncertainty were hypothesized. A first possibility would be a bipolar one-factor model in which all five learning conceptions are specifications of a process-oriented versus a traditional view of learning. This model broadly matches the conclusion of Kember and Kwan (2000) suggesting that lecturers' conceptions of teaching could best be described by two opposing orientations: transmissive teaching focusing on a teacher-directed or content-directed approach, and facilitative teaching (i.e. facilitating students' learning processes). The second alternative would be a model with several factors, possibly five (representing each of the five conceptions selected from the research literature) or only two (tolerance for uncertainty as a factor to be separated from process orientation). Finally, we hypothesized a model in which tolerance for uncertainty underlies the other four learning conceptions. These models were tested for teachers' conceptions of student learning and for their conceptions of their own learning.

The second goal of our research was to establish whether teachers involved in an innovation directed towards process-oriented teaching endorse more process-oriented or more traditional conceptions of learning. Based on the factor model resulting from answering the first question, we evaluated to what extent the views of the teachers on student learning as well as on their own learning agree with the ideas of process-oriented teaching.

The third goal was to compare whether teachers' conceptions of student learning differ from or are in agreement with the conceptions of their own learning. Teachers, certainly when involved in an innovation, are learners themselves. They may be supposed to reflect on the learning processes of their students as well as on their own learning. As teachers they have a responsibility for the learning of their students and for their own learning. In the literature on adult learning it is stated that the orientation to learning of adults differs from the orientation of children or adolescents. Children are supposedly more in need of external regulation whereas adults are capable of internal regulation. And children are supposedly subject centered whereas adults are problem centered. This view implies that young students are in need to learn to become independent self-directed learners, whereas teachers simply could be supposed to be independent self-directed learners. This view was challenged by Boulton-Lewis *et al.* (1996). We investigate the agreement between teachers' conceptions of student learning and their own learning by comparing the factor models obtained, the correlations between factors and the factor means.

Method

Participants

All participants at a conference on the 'house of study' received the first version of the Learning Inventory, 'Learning: What do you think?'. Usable inventories were returned by 259 teachers (69% male). Almost three-quarters of them were teaching senior classes. The second version of the inventory was administered to teachers of senior classes in eight different secondary schools. Responses were obtained from 260 teachers (73% male). Most of the teachers in both samples (70–80%) had at least 15 years of experience. This is the regular situation in Dutch secondary schools. Beginning teachers (0–2 years) were better represented in the second study. This was to be expected since the first version of the inventory was administered at a conference.

The subjects taught were science, social studies, foreign languages, Dutch, arts and crafts and physical education. In the second sample relatively more teachers taught arts and crafts or physical education than in the first sample.

The Learning Inventory

Each item of the Learning Inventory consisted of two opposite statements about the same topic, a more process-oriented statement and a more traditional statement. The items were in random order, with the process-oriented statements as often on the left as on the right. The participants were asked to indicate whether they endorsed the statement on the left or on the right. A four-point scale was used: (1) I quite agree with the statement on the left, (2) I agree somewhat more with the statement on the left than I do with the one on the right, (3) I agree somewhat more with the statement on the right than I do with the one on the left, and (4) I quite agree with the statement on the right. The first part of the inventory included items on student learning, and the second part consisted of items on the teacher's own learning.

For two of the five theoretical dimensions the items were based on inventories of other researchers. The intelligence items were adapted from the Nature of Intelligence inventory used by Chiu *et al.* (1994) and by Lynott and Woolfolk (1994). The items pertaining to tolerance of uncertainty were inspired by Huber's (1995) inventory. The items were translated, and adapted to the Dutch situation. Opposite statements were looked for to join into one item; in some cases we needed to add an opposing statement. The items on the internal or external regulation of learning, the constructive or factual nature of knowledge and the social or individual nature of learning were based mainly on teachers' utterances in interviews (Ebbens, 1994), but also on expressions used in public discussions about the on-going innovation, the house of study. Two teachers, two teacher educators and two colleague researchers commented on the draft version of the inventory to improve the validity and clarity of the wording.

The first version included 75 items: 38 concerning student learning and 37 pertaining to the teacher's own learning, with seven or eight items for each of the pre-supposed factors. Based on the analysis of the data gathered with the first version we removed 24 items. The second version included 25 items on student learning and 26 on the teacher's own learning, with four to six items per factor. Table 3 (presented later) shows all items on student learning (24 items retained in the final version) and Table 4 (also presented later) shows all items on teacher learning (22 items retained in the final version). In the tables, items have been arranged in such a way that the proposition on the right side always refers to a process-oriented view of learning, while the proposition on the left indicates a more traditional view.

Procedures

Data-analysis aimed at: (1) checking the adequacy of the items, improving them when necessary, and (2) examining the theoretical models that were specified in the research questions, for teachers' conceptions of student learning as well as their own learning. The imputation procedure of PRELIS (Jöreskog & Sörbom, 1996) was used to deal with missing values. To examine the theoretical models we applied confirmatory factor analysis to the covariance matrices, using the method of maximum likelihood. Computations were performed by LISREL 8.14 (Jöreskog & Sörbom, 1993). Following the advice of Hoyle and Panter (1995), several fit criteria were applied. Next to the chi-square test we used: the root mean square error of approximation (RMSEA), which is a measure of the discrepancy per degree of freedom between the model and the covariance-matrix in the population; the standardized root mean square residual (SRMR), which is the average difference between observed and reproduced correlations; the non-normed fit index (NNFI), indicating the proportional improvement of the fit of the model relative to the independence model; and the expected cross validation index (ECVI), which is a measure to indicate the fit of the model for the data of a new sample from the same population. The ECVI was used to compare models, a lower value indicating a better fit. Fit was considered acceptable when both SRMR < 0.08 and RMSEA < 0.06 (Hu & Bentler, 1999). The NNFI should at least be close to 0.90.

After improving the learning inventory we administered the second version to a new sample of teachers. In the 260 questionnaires returned, there were only a few missing values; they were resolved by imputing the score with the highest frequency within the same dimension. Again confirmatory factor analysis was used. The data were analyzed with LISREL 8.30 (Du Toit *et al.*, 1999). The data-analysis aimed at: (1) examining the theoretical models once more, and (2) answering the questions in the second and third research goals about teachers' endorsement of learning conceptions both of student learning and their own learning.

Results

Modifications of the Learning Inventory

The LISREL analysis of teachers' conceptions of student learning resulted in an inadmissible solution when the items on Tolerance of Uncertainty were included, due to multicollinearity problems. Therefore we left out these items. Ten other items were removed because they appeared to be inadequate indicators of the factors. In two cases we decided that an item should load on another factor than the one the item was intended for. After these changes we tested three models: a one-factor model (implying that all items, except those for Tolerance of Uncertainty, measure process orientation), a four-factor model with the four hypothesized bipolar dimensions of process orientation,and a second-order model (assuming a second-order factor to explain the correlations between the four factors). The four-factor model, with all correlations between factors left free, fit better than the alternatives and had a reasonably good fit ($\chi^2 = 247.5$, degrees of freedom $= 164$, SRMR $= 0.056$, RMSEA $= 0.044$, NNFI $= 0.89$). All factor loadings were statistically significant and all but one were at least 0.40 (the exception was 0.35). But the factors were highly correlated. We concluded that after leaving out the items on Tolerance of Uncertainty, four correlated dimensions in teachers' conceptions of student learning could be distinguished.

Also in the analysis of teachers' conceptions of their own learning the items on Tolerance of Uncertainty were left out of the confirmatory factor analysis, and 10 other items were removed because they seemed not to behave well. Due to a multicollinearity problem the four-factor model gave a non-admissible solution. We accepted the one-factor model, which showed a reasonable fit ($\chi^2 = 275$, degrees of freedom $= 170$, SRMR $= 0.058$, RMSEA $= 0.050$, NNFI $= 0.87$), but with low loadings for some items. The four dimensions of process orientation seemed not distinguishable for these teachers in the case of conceptions of their own learning.

From the data on the first version of the Learning Inventory we can only draw preliminary conclusions about the dimensionality of the learning conceptions. On the basis of the data a second version of the Learning Inventory was constructed. Four items indicating Tolerance of Uncertainty were removed, solely on the basis of

Table 1. Goodness-of-fit indices for three factor models of teachers' conceptions of learning ($n = 260$)

	χ^2	Degrees of freedom	RMSR	RMSEA	ECVI	NNFI
Teachers' conceptions of student learning						
Two-factor model	509.2	251	0.066	0.063	2.34	0.74
Five-factor model	399.1	242	0.058	0.050	1.99	0.84
Tolerance of Uncertainty explains the other four factors	407.6	248	0.059	0.050	1.98	0.84
Teachers' conceptions of own learning						
Two-factor model	305.8	208	0.059	0.043	1.53	0.87
Five-factor model	266.6	199	0.054	0.036	1.45	0.90
Tolerance of Uncertainty explains the other four factors	300.5	205	0.057	0.042	1.53	0.87

the frequency distributions. In total, we left out 24 items that appeared inadequate, and we slightly restated two items.

Dimensions of the Learning Inventory

Data were collected from a new sample ($n = 260$). Three alternative models were tested: (1) a model with two correlated factors: Process Orientation and Tolerance of Uncertainty, (2) a model with all five pre-supposed factors and with all correlations between factors left free to be estimated, and (3) a model in which Tolerance of Uncertainty was expected to explain the correlations between the other four factors.

Teacher conceptions of student learning. One item was found inadequate and removed, and one item was assigned to another factor.[1] The goodness-of-fit measures for the three models are presented in the upper part of Table 1.

The fit of the two-factor model was clearly inadequate. The other two models fit reasonably well. This replicates the finding for the first version that the four pre-supposed factors of process orientation (External versus Internal Regulation, Reproductive versus Constructive Knowledge, Individual versus Social Learning, and Fixed versus Dynamic Ability) could be distinguished in teacher conceptions of student learning. In addition, Tolerance of Uncertainty appeared to be a separate factor. The correlations between the factors are presented in Table 2 (above the diagonal). These correlations were all positive and moderately high to very high. As expected, the four factors of process orientation correlated highly with Tolerance of Uncertainty. From the small differences in fit indices between the second and third model we concluded that Tolerance of Uncertainty adequately explained the correlations between the four factors of process-orientation. The chi-square difference was only 8.5, degrees of freedom = 6, $n = 260$, $p = 0.20$. Table 3 presents the 24

Table 2. Correlations in the five-factor model

	External versus Internal Regulation	Reproductive versus Constructive Knowledge	Individual versus Social Learning	Fixed versus Dynamic Ability	Tolerance of Uncertainty
External versus Internal Regulation	–	0.62	0.72	0.58	0.82
Reproductive versus Constructive Knowledge	0.83	–	0.47	0.60	0.69
Individual versus Social Learning	0.79	0.97	–	0.62	0.73
Fixed versus Dynamic Ability	0.54	0.77	0.88	–	0.67
Tolerance of Uncertainty	0.70	0.65	0.67	0.47	–

Note: Above the diagonal, teachers' conceptions of student learning; below the diagonal, teachers' conceptions of their own learning.

items that were retained in the final version of the Learning Inventory for conceptions of student learning. In addition to an English translation of the items, the table includes means, standard deviations and standardized loadings estimated for the final model. Loadings were satisfactorily high and of the same order of magnitude as for the first version of the inventory.

Teacher conceptions of own learning. Four items were removed, because they did not fit well into the pre-supposed factor structure. The same three models were tested as for conceptions of student learning. The goodness-of-fit measures are presented in the lower part of Table 1.

All three models showed a reasonably good fit. For conceptions of own learning the models seemed to fit better than for conceptions of student learning. We concluded from the fit indices that the five-factor model presents the best fit for teachers' conceptions of their own learning. In contrast with the data on the first version of the Learning Inventory we could now empirically distinguish all five pre-supposed factors, including Tolerance of Uncertainty (χ^2 difference between the five-factor model and the two-factor model was 39.2, degrees of freedom $= 9$, $n = 260$, $p = 0.000$). This result is in agreement with our expectations and with the results for teacher conceptions of student learning. However, now the model in which Tolerance of Uncertainty explains the other factors fit less well than the five-factor model with all correlations left free (χ^2 difference $= 33.9$, degrees of freedom $= 6$, $n = 260$, $p = 0.000$). In this respect the results for the teachers' own learning differed from those for their conceptions of student learning. The correlations between the four factors of process orientation were in the case of conceptions

Table 3. Factors of teachers' conceptions of student learning: factor loadings, item means and standard deviations

Number[a]	Traditional statement	Mean[b] (standard deviation)	Process-oriented statement	Factor loading
	Factor 1: External Regulation	versus	Internal Regulation	
04	School is compulsory for students, thus you can expect motivation problems	2.52 (0.91)	Students lose their motivation in school if everything is presented in a predigested way	0.50
11	In general students are not able to work on their own	**3.07** (0.75)	Basically students are perfectly capable of working on their own	0.53
17	If I do not tell students exactly what to do, nothing worthwhile will be achieved	**2.85** (0.81)	I think students achieve better results when they have a certain amount of freedom in how they work	0.67
21	It is the teacher's responsibility to evaluate the students' learning achievements	**2.67** (0.87)	If students do not learn to evaluate their learning achievements, they have only learned half the lesson	0.60
23	Learning will be most successful when an expert (teacher) is in charge	2.54 (0.85)	Learning will be more successful as the students themselves take the initiative	0.43
	Factor 2: Knowledge as Reproducible Entity	versus	Knowledge as Actively Constructed	
01	One can assist student learning the most by precisely formulating the tasks	**2.82** (0.89)	One can assist student learning the most by stimulating the students to search for answers	0.48
07	It is important that students know definitions by heart, they should be able to say them in their sleep	**3.09** (0.89)	Students should understand the reasoning behind definitions; in that way they will always be able to derive the definition	0.59
12	It is important that students are kept informed about facts and have a thorough knowledge of them	**2.97** (0.80)	It is important that students learn to think on their own and to pass their own judgment	0.65
19	Old-fashioned learning by rote is the most effective way to learn part of the subject that I teach	**2.96** (0.94)	Utilizing knowledge is not learned by memorizing lists and rules	0.58
	Factor 3: Individual Learning	versus	Social Learning	

02	When students cooperate they often learn the wrong things from each other	**3.47** (0.62)	Students learn a lot by explaining things to each other	0.54
06	When students discuss the subject matter together, they will not be any wiser in the long run	**3.38** (0.74)	When students discuss together, they learn to handle different points of view and acquire deeper insight	0.46
09	Students learn best when they work individually on the subject matter	**3.06** (0.74)	Students learn a lot from each other when they work together on the subject matter	0.58
20	Cooperating is too distracting. Learning is done best alone	**2.97** (0.68)	Students learn more by cooperating than they do when working on their own	0.60
	Factor 4: Fixed Ability	versus	Dynamic Ability	
08	Some students cannot be expected to make much progress	**3.40** (0.71)	All students should be challenged to perform, even if they find this difficult	0.51
13	A student's low achievement is often caused by the student's limited ability	**2.83** (0.72)	A student's low achievement often has a cause that can be helped	0.35
16	Bright students were already bright when they entered school	2.43 (1.00)	The school's task is to help students to become brighter	0.49
22	Low achievers remain low achievers, no matter what the teacher does	**3.31** (0.62)	Low achievers can make progress when the teacher manages to help them in the right way	0.58
24	Smart students will always do well	2.57 (0.87)	Smart students became smart (partly) because of a positive environment	0.42
	Factor 5: Intolerance of Uncertainty	versus	Tolerance of Uncertainty	
05	It is better not to confront students with problems they cannot understand	**3.40** (0.74)	In school it is all right to also confront students with real-life problems that do not have solutions	0.37
10	Students should only be given tasks at school that they are able to handle	**3.28** (0.73)	Students must be allowed to try things. They should be allowed to stub their toes	0.52
14	Students should learn to behave themselves at school and to comply with rules of behavior	**2.61** (1.03)	Showing respect for each other does not mean that you have to accept everything	0.48

Table 3.—*Continued.*

Number[a]	Traditional statement	Mean[b] (standard deviation)	Process-oriented statement	Factor loading
15	We should not bother students with all kinds of contradictory views. School should offer unambiguous knowledge	**3.58** (0.64)	It is interesting to make it obvious for the students that there are different solutions to problems and different explanations for phenomena	0.48
18	Mistakes and bad marks are bad news for students. We should handle these cautiously	**3.29** (0.69)	Mistakes and bad marks are not a problem in themselves, provided that you help students to learn from them	0.33
25	We should keep outside the school all unpleasantness we can do nothing about	**3.32** (0.75)	Unpleasantness is part of life. We have to deal with that in school as well	0.44

[a]Number indicates the position of an item in the Learning Inventory.
[b]All items were scored on a scale from 1 to 4, a higher score indicating a more process-oriented view of learning. Means in bold are significantly higher ($p < 0.05$) than the neutral scale point (2.50).

of own learning even higher than they already were for conceptions of student learning (see Table 2). Especially, Reproductive versus Constructive Knowledge correlated extremely high with Individual versus Social Learning ($r = 0.97$), much higher than was the case for teachers' conceptions of student learning ($r = 0.47$). Tolerance of Uncertainty correlated highly with the other factors, but these correlations were lower than the intercorrelations of the aspects of process orientation. Table 4 presents the items of the final version of the inventory with the descriptive statistics and the estimated standardized loadings for the five-factor model.

Concluding summary. The five factors hypothesized to underlie learning conceptions of teachers could indeed be confirmed by our data. This was the case for teachers' conceptions of student learning, as well as for teachers' conceptions of their own learning. However, correlations between the factors were very high, especially for conceptions of own learning. In teachers' conceptions of student learning, Tolerance of Uncertainty could explain the other four factors, but that was not the case for teachers' conceptions of own learning. For own learning, Tolerance of Uncertainty correlated less strongly with Fixed versus Dynamic Ability ($r = 0.47$) than was the case for teachers' conceptions of student learning ($r = 0.67$).

Do teachers endorse traditional or process-oriented conceptions of learning?

All items were scored in such a way that a high score represents a more process-oriented view on learning. The mean scores on almost all items were above 2.5 and many were above 3 (see Tables 3 and 4), whereas the maximum possible score was 4. For 20 out of 24 items on student learning the mean was statistically significant above the neutral point (2.5). The four exceptions (items 4 and 23 about regulation, and items 16 and 24 about ability; see Table 3) remained close to the neutral point. For the items in Table 4 on the teachers' own learning, 19 out of 22 had a mean score that was statistically significant above the neutral point. The exceptions were one item on External versus Internal Regulation (37) and two items on Tolerance of Uncertainty (28 and 31), which had means close to the neutral point. Thus, the item means clearly reveal that teachers on average preferred the process-oriented statements to the more traditional statements, when thinking about student learning as well as when thinking about their own learning.[2]

In the case of the teachers' conceptions of student learning the highest means were obtained for the items about tolerance of uncertainty (mean = 3.25) and about the social nature of learning (mean = 3.22). The highest approval was obtained for the item 'It is interesting to make it obvious for the students that there are different solutions to problems and different explanations for phenomena' as opposed to 'We should not bother students with all kinds of contradictory views. Schools should offer unambiguous knowledge'. And also teachers appeared to believe that students need no protection against the uncertainties of learning. They tended to agree that 'Students must be allowed to try things. They should be allowed to stub their toes', rather than 'Students should only be given tasks a school that they are able to handle'. With respect to the social versus individual nature of learning, the statement

Table 4. Factors of teachers' conceptions of their own learning: factor loadings, item means and standard deviations

Number[a]	Traditional statement	Mean[b] (standard deviation)	Process-oriented statement	Factor loading
	Factor 1: External Regulation	versus	Internal Regulation	
30	Research results are useful when researchers present them with ready to use applications	**3.00** (0.89)	I find research results useful when they give me new ideas or make me think	0.50
33	I learn most from a study day when I am told exactly what it is about and what I should do	**3.01** (0.75)	I learn most from a study day when I have to find out and experience for myself how it works	0.65
37	In order to learn something new, I prefer to follow a well-structured course given by an expert	2.43 (0.93)	In order to learn something new, I prefer to make my own plan and work things out in my own way	0.26
44	I think that a teacher's manual should give me clear instructions for use, preferably for each chapter	**2.79** (0.97)	If a teacher's manual thoroughly explains the main idea, I can do the rest myself	0.46
	Factor 2: Knowledge as Reproducible Entity	versus	Knowledge as Actively Constructed	
34	The most important characteristic of experts is their excellent control of knowledge and skills in their domain	**2.63** (1.00)	The most important characteristic of experts is their independent ability for further development in their domain	0.38
39	Learning is getting the answers	**3.35** (0.66)	Learning is asking questions	0.45
48	In the course of time one learns more precisely how things work	**3.07** (0.81)	In the course of time one learns to view things from different points of view	0.53
50	A method should not ask students questions without also providing the answers	**3.08** (0.81)	It is appropriate that a method raises questions that one can discuss with students without the answers already given	0.50
	Factor 3: Individual Learning	versus	Social Learning	
29	It is not easy to discover who is right when opinions differ	**3.27** (0.67)	Differing opinions make it possible to get deeper insight	0.55

38	I do not believe that you learn a lot by discussing things with others	**3.46** (0.62)	You learn a lot by comparing your opinion with that of others	0.53
43	It is important that you know how certain problems should be solved	**3.46** (0.62)	You can learn a lot from how other people approach problems	0.51
45	When you have had the right teacher training you know what you should do	**2.81** (0.87)	I would like to see how my colleagues do it	0.44
47	I think that the authoritative opinions are the ones that count	**3.30** (0.66)	I find divergent opinions often interesting	0.44
	Factor 4: Fixed Ability	versus	Dynamic Ability	
27	When you have worked a number of years you are so experienced that you will not learn much more	**3.56** (0.59)	I think I will keep on learning during my career	0.64
35	Good teachers are good from the start; weak teachers will always flounder	**3.00** (0.87)	Teachers are stimulated by their work towards further development	0.46
40	You cannot teach old dogs new tricks	**3.62** (0.60)	You are never too old to learn	0.58
46	Some teachers will always make a mess of it	**3.19** (0.88)	You can learn to overcome a rookie's problems	0.38
	Factor 5: Intolerance of Uncertainty	versus	Tolerance of Uncertainty	
28	I like it when students' questions show that they are doing their work as expected	2.48 (1.01)	I like it when students ask unexpected, 'strange' questions	0.38
31	I like to know beforehand what is in store for me	2.46 (0.93)	I find it so boring when everything is always predictable	0.58
36	I feel happiest when I can do my work in the manner that I am used to	**2.66** (0.87)	I like to try out new things, even if they are not always a success	0.58
41	I am greatly annoyed when students notice that I have made a mistake	**3.49** (0.72)	It does not bother me if the students notice that I have made a mistake	0.22
49	It makes no sense to me to explore problems that cannot be solved	**2.83** (0.90)	The most interesting problems are in fact those that cannot be solved	0.43

[a]Number indicates the position of an item in the Learning Inventory.
[b]All items were scored on a scale from 1 to 4, a higher score indicating a more process-oriented view of learning. Means in bold are significantly higher ($p < 0.05$) than the neutral scale point (2.50).

endorsed most was ‘Students learn a lot by explaining things to each other’. The items on internal regulation had the lowest average score (mean = 2.73) among the five factors. Teachers tended to agree on ‘Basically students are perfectly capable of working on their own’. But for two of the five statement pairs, the average was at the neutral scale point. For instance, the statement ‘Learning will be most successful when an expert (teacher) is in charge’ attracted almost as much agreement as ‘Learning will be more successful as the students themselves take the initiative’.

Regarding their own learning, teachers also generally preferred the process-oriented statements over their traditional counterparts. But now the highest means were obtained for the items on the dynamic view of intelligence (mean = 3.34). Teachers tended to agree that they will keep on learning during their career, and that ‘one is never too old to learn’. For themselves, teachers generally endorsed the social view on learning (mean = 3.26), as well as the idea of knowledge as construction rather than factual (mean = 3.03). Items about tolerance of uncertainty got the lowest average score here (mean = 2.78). ‘I like to know beforehand what is in store for me’ attracted as much agreement as ‘I find it so boring when everything is always predictable’.

Differences between conceptions of student learning and own learning

To be able to compare the factors of student learning with the factors of own learning, latent variable scores (Jöreskog, 2000) were computed for all teachers. The main advantage of this method is that the correlations between the latent variable scores remain equal to the correlations between the latent variables in the model. In addition, the use of latent variable scores made it possible to compute correlations of the factors for the teachers’ own learning with the factors for their conceptions of student learning. Because of the small sample size we refrained from analyzing both sets of items simultaneously. For each factor, the mean of the latent variable scores was made equal to the mean of the observed item means, with equal weighting of all items belonging to that factor.[3] Table 5 presents the means and standard deviations of the latent variable scores, together with the correlations of the factors for own learning with those for student learning. All factor means were clearly above the neutral point, again indicating that the teachers were favorable of a process-oriented view on learning.

The analyses so far confirmed that the same five factors could be distinguished for teachers’ conceptions of their own learning as for their conceptions of student learning. However, some differences were noted in the pattern of correlations within these two sets of factors (see Table 2). There were substantial correlations between the two sets of factors (see Table 5), but in general the between-sets correlations seemed to be somewhat lower than the intercorrelations of factors within each set. Also, it was certainly not the case that a factor of own learning correlated highest with the nominally same factor of student learning. Teacher thinking about student learning seemed to have much in common with the teachers’ conceptions of their own learning, but there was also evidence that teachers distinguish their conception of student learning from their conception of own learning. This was confirmed by a

Table 5. Correlations of factors for teacher conceptions of their own learning with the factors of their conceptions of student learning: means and standard deviations of factors

	Conceptions of student learning						
Conceptions of own learning	Regulation: External versus Internal	Knowledge: Reproductive versus Constructive	Learning: Individual versus Social	Ability: Fixed versus Dynamic	Tolerance of Uncertainty	Mean	Standard deviation
Regulation	0.58	0.47	0.53	0.50	0.61	2.81	0.49
Knowledge	0.65	0.55	0.59	0.58	0.72	3.03	0.43
Social	0.63	0.52	0.57	0.57	0.71	3.26	0.37
Ability	0.44	0.38	0.43	0.45	0.56	3.34	0.38
Tolerance	0.52	0.43	0.38	0.40	0.50	2.78	0.54
Mean[a]	2.73	2.96	3.22	2.91	3.25	$n = 260$	
Standard deviation[b]	0.55	0.53	0.41	0.49	0.50		

[a]Means were computed by averaging the means of items (minimum = 1, maximum = 4) with a non-zero loading on a factor.
[b]Standard deviations of the latent variable scores computed by LISREL. The correlations were obtained between latent variable scores.

principal component analysis on the intercorrelations of all 10 factors. The first principal component was a general component with high loadings for all 10 variables, explaining 65% of the total variance; the second principal component explained an additional 11% of the variance and represented the distinction between student learning and own learning. A direct oblimin rotation with Kaiser normalization resulted in two highly correlated ($r = 0.67$) components representing process orientation for student learning and for own learning.

Differences in conceptions of student learning versus own learning were also apparent in the means of the factors.[4] A multivariate analysis of variance was executed, using the procedure GLM in SPSS, to test for any differences in mean scores of factors for teachers' conception of student learning versus their conceptions of own learning. The differences were statistically significant, Wilks' lambda = 0.29, $F(4, 256) = 153.3$, $p = 0.00$. Figure 1 shows the mean profiles of the five factors for student learning and own learning.

When asked about their own learning, teachers generally preferred process-oriented conceptions more strongly than they did when asked about student learning. The one exception is Tolerance of Uncertainty. Teachers seemed much more convinced that uncertainty is essential in learning when talking about students (mean = 3.25) than they were when talking about their own learning (mean = 2.78). An almost as large mean difference between own learning and student learning, but

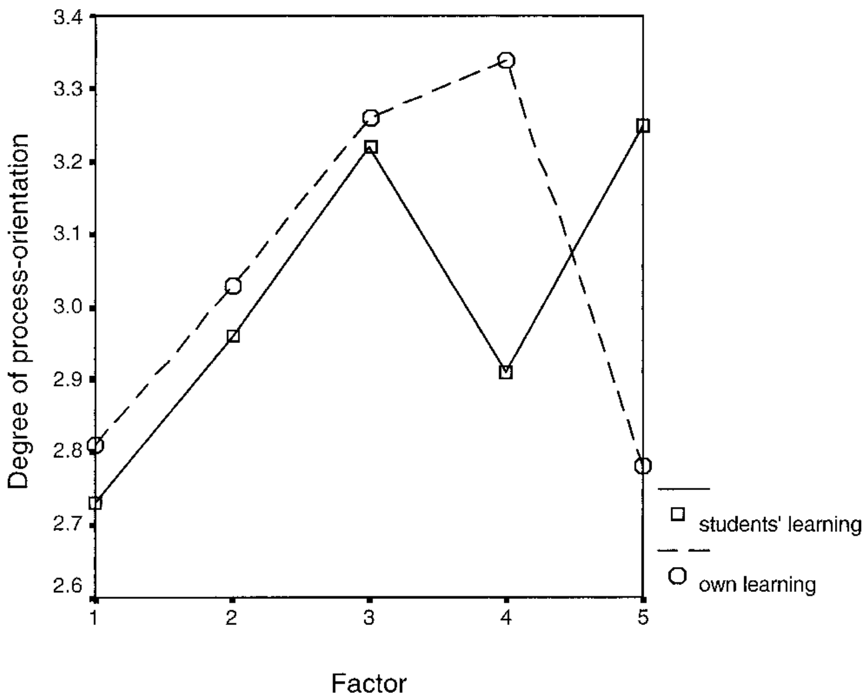

Figure 1. Means of factors for teachers' conceptions of students' learning and of their own learning. 1 = External versus Internal Regulation, 2 = Reproductive versus Constructive Knowledge, 3 = Individual versus Social Learning, 4 = Fixed versus Dynamic Ability, 5 = Tolerance of Uncertainty

in the opposite direction, was found for Dynamic versus Fixed Ability. Although teachers' conception of intelligence was by and large dynamic, it seemed much more dynamic when their own learning was involved (mean = 3.34) and less dynamic for student learning (mean = 2.91). For the other three factors, average differences between the conceptions of own learning and student learning were much smaller and not statistically significant except for Internal versus External Regulation (mean = 2.81 in case of own learning and mean = 2.73 in case of student learning).

Discussion

The data in this study confirmed that five dimensions in learning conceptions as derived from various perspectives in recent theory on learning underlie teachers' conceptions of student learning as well as their own learning. The Learning Inventory ('Learning: What do you think?') made it possible to examine these five dimensions, pertaining to the self-regulation of learning, knowledge as actively constructed by the learner, the social nature of learning, a dynamic model of intelligence and tolerance of uncertainty. Although the dimensions can be differentiated, they do correlate highly with each other, especially for conceptions of own learning. Tolerance of Uncertainty explained the other four factors in teachers' conceptions of student learning, but this was not the case for teachers' conceptions of their own learning. Compared between the two samples, the part of the inventory on teachers' own learning seemed to yield less stable results than the part on student learning. Further research is recommended to improve the inventory, especially the part on teacher learning. In the present version of the inventory the answers on the items about the teachers' own learning may have been influenced by the preceding items about student learning. This possible order effect needs to be investigated, to make sure that the high intercorrelations for some dimensions are not the result of a methodological artifact. In addition, it may be useful to compare the present item format (forced choice between opposite statements) with another item format that does not require a choice between a process-oriented statement and a more traditional statement. One could, for instance, study whether the factor structure remains the same when a teacher is asked to rate all statements separately.

Teachers in our study generally supported process-oriented conceptions of learning. In the past teachers have been involved in educational innovations aiming at active and self-directed learning by students. Although being convinced of underlying principles does not necessarily equal competence in translating these principles into practice (Bolhuis, 2000), it is still important to know that teachers do endorse process-oriented conceptions of learning. Process-oriented teaching requires teachers to clarify their mental models of learning. Data on teachers' conceptions of learning offer an opportunity for teachers and teacher trainers to become aware and further develop ideas about learning. Making teachers' conceptions (mental models) more explicit by discussion, and confronting a possible inconsistency between conceptions of own versus student learning may be useful in this process (Richardson, 1996).

Comparison of teachers' conceptions on student learning and on their own learning in this study revealed agreement as well as some interesting differences. A main agreement was that the factor structures for the two sets of items were comparable, with relatively high loadings for all pre-supposed factors. Teachers especially endorsed the closely related conceptions of knowledge as actively constructed by the learner and of learning as a social process, both for students and themselves. However, there were also distinctions between teachers' conceptions of student learning and their own learning. First, teachers expected much more tolerance for uncertainty in student learning than they did for their own learning. This discrepancy may lead to a poor tuning of the teacher to students with a low tolerance for uncertainty, who need a more structured and stepwise support in practicing independent learning. The relatively low tolerance for uncertainty in the teachers' own learning also suggests that teachers themselves may need a more structured support in their learning process (Huber & Roth, 1999). Second, teachers in our study held a more dynamic conception of intelligence for themselves than they did for students. A positive conclusion is that teachers believe that they keep on learning throughout their career. On the contrary, teachers seemed to hesitate a little more about the students. Teachers endorsed about as much that it is a school's task 'to help students to become brighter' as they agreed with the statement 'bright students were already bright when they entered school'. Thinking this way may reduce the teacher's responsibility for student learning. Finally, teachers' support for internal regulation was relatively low, which is remarkable, considering the focus in the study-house innovation on student regulation of learning. Perhaps the focus on self-directed learning in this innovation is too much on individual study (Winne, 1995a, 1995b). An individual interpretation of regulation does not match the teachers' strong support for social learning. Also, an individual interpretation may cast doubts on their own importance as a teacher.

In summary, we found empirical evidence supporting five dimensions in learning conceptions and relationships between them, although these dimensions were derived from different theoretical perspectives. In this respect the study may contribute to the integration of new learning theory as called for, among others, by De Corte (1998) and Vosniadou (1996). A further discussion of these learning conceptions and their relevance to teaching for self-directed learning is an important challenge to teacher education and staff development in schools.

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Notes

1. Item 15, included in Table 3 as an indicator for Tolerance of Uncertainty, was originally meant as an indicator for Knowledge as Construction.
2. These results were confirmed when using a somewhat different scoring system for the items in which the difference between the two middle responses was made twice as large as the other differences between scale points: -2 for quite agree with the traditional statement, -1 for agree somewhat more with the traditional statement than with the process-oriented statement, $+1$ for agree somewhat more with the process-oriented statement than with the traditional view, $+2$ for quite agree with the process-oriented view. In this case 0 was seen as the neutral point.
3. This procedure was applied to get a convenient way of comparing factors. The confirmatory factor analysis cannot identify means of latent variables. It must also be noted that in comparing the means of factors we are in fact comparing the means of the sets of items used, not means of latent variables.
4. Comparability of 'factor scores' for student learning and own learning may be an issue here. Results of the comparison between means may be influenced by the presence of more or less extreme statements in the scales. We had no possibilities to ascertain the equivalence of statements for student learning and own learning.

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