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Exploring Teachers' Instructional Design Practices from a Systems Design Perspective

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Abstract

Curricular changes in higher vocational education have rendered teachers' instructional design activities increasingly important. Using a repertory grid technique, this paper sets out to analyse current design activities of ten teacher trainers. Their actual approach is compared with an instructional systems design (ISD) approach and related to innovative teacher roles. Teachers' activities show an imbalance in two ID phases, that is problem analysis and evaluation. The results suggest that they attempt to translate curricular goals directly into concrete lessons and they pay relatively little attention to evaluation. In line with this finding, they underrate the two innovative teacher roles of the "diagnostician" and the "evaluator". It is argued that imbalanced or incomplete design approaches and perceived roles may hinder innovation in education. Implications for the support of teachers' design activities are discussed.

Keywords: Curriculum reform, teacher training, instructional design approach

Exploring Teachers' Instructional Design Practices from a Systems Design Perspective

Dutch teacher training colleges have been shown to be successful in changing the framework of their curriculum, but to experience problems in translating the desired changes into new learning practices (HBO-Raad, 1996). Desired changes in the curriculum can be related to the more general paradigm changes in society and organisations, such as the transition from the "Industrial Age" into the “Information Age” (Kerr, 1996; Reigeluth & Nelson, 1997). In the Age of Information students will have to take more and more responsibility for their own learning processes, which are initiated and controlled by realistic, job-oriented or competency-oriented learning tasks. These changes are referred to as the “new learning” (Simons et al., 2000). The implementation of this type of curricular change into new learning practices will affect teachers' role perceptions. Teachers will have to change their role from being "transmitters of content" to becoming "coaches of students' learning processes” (Pratt et al., 1998; Vermunt & Verloop, 1999). From this viewpoint, teacher trainers' problems of curriculum innovation can be interpreted as problems of instructional design (Enkenberg, 2001). In addition, the increasing emphasis on real life problem solving tasks requires teachers to develop complex design skills. Teachers' participation in the curriculum redesign process is considered to be a crucial factor in the success of curriculum innovation (Beijaard, 1994; Lang et al., 1999).

We assume that the acquisition of expertise in instructional design can help teachers to translate the abstract new curriculum framework into concrete new learning tasks. This translation process requires teachers to widen their scope from the lesson level to the level of curriculum development in their college. Systems approaches to instructional design are believed in particular to provide help in solving teachers’ problems of translating new curriculum principles into concrete learning tasks. Systems approaches namely, treat the design of lessons, as parts of the curriculum, holistically within the total curriculum as a “system” (Reigeluth & Avers, 1997). Indeed, Klauer (1997) has argued that the application of an ISD method could broaden teachers' design repertoire.

However, ISD methods are seldom applied by teachers. Moallem (1998) has argued that this might be because systems approaches do not correspond with the nature of the personal theories, which teachers construct by reflecting on their instruction. Klauer (1997) has identified the “prescriptive” character of ISD methods as a possible reason. Finally, Reigeluth and Nelson (1997) and Visscher-Voerman (1999) argue that classical ISD designs offer little opportunity to teachers, as important stakeholders of design, to “preview” in an early stage the effects of design. Unlike the negative criticism of some radical constructivists on the value of ISD approaches for teachers, in this paper we take a neutral stance to explore that value (see also Spector, 1995).

The purpose of this exploratory study was to obtain more insight into teachers' actual design practices. To elucidate the extent to which this practice corresponds to the main phases of a general ISD approach, we first compare the design practices reported by the teachers with a widely accepted model for instructional design (Leshin et al., 1992). In addition, we examine the extent to which teachers recognise themselves in, attach importance to, and experience a training need for new teacher roles that support process-oriented learning. Finally, teachers are invited to compare their own design approach with an ISD approach, that is especially suitable for the design of realistic, competency based learning tasks, which are required for curriculum innovation. The Four Component Instructional Design model of Van Merriënboer (1997) meets this criterion.

Three instruments have been developed to investigate the teacher trainers' design approaches: the "Knowledge Elicitation Interview", the "Role Grid Scale", and the "ISD Comparison Scale". These instruments were developed on the basis of the "Repertory Grid Technique" (Kelly, 1955; see also Fransella & Bannister, 1977; Herman, 1996; Pope & Keen, 1981; Munby, 1982). The Knowledge Elicitation Interview is used to describe and elucidate the teacher's implicit practical knowledge. The teacher trainers report in detail all activities they normally perform while developing a new study unit. Each activity is considered as an element of the personal constructs representing the teacher's design approach. Constructs can be made explicit by having the teacher trainer sort the reported design activities into categories, to which names are attributed.

To construct the Role Grid Scale, we adopt six teaching roles described by Vermunt and Verloop (1999). According to Vermunt and Verloop, process-oriented teaching and learning promote self-regulated knowledge construction. This implies a series of new roles in which teachers have to learn to achieve process-oriented learning. These roles are quite different from the roles teachers play in the knowledge transmission model of teaching. In process-oriented learning the main tasks of the teacher are to initiate, support, and influence the thinking processes of students in their learning process. The associated roles are: (a) diagnostician, (b) challenger, (c) model learner, (d) activator, (e) monitor, and (f) evaluator. We hold that these roles and the concept of process-oriented learning are good instances of the desired teacher perspectives for "the new learning". Following the Repertory Grid Technique, these roles are represented as elements of three given constructs: (a) the recognition, (b) the importance and (c) the training need in the role. The differences of teacher trainers' ratings between recognition, importance and training need may be interpreted as an indication of a teacher's position on a continuum between the knowledge transmission model and a model of process-oriented teaching and learning.

The ISD Comparison Scale is constructed by specifying design activities and design phases that ISD experts normally use to develop units of study. The design activities are based on the Four Component Instructional Design (4C-ID) model of Van Merriënboer (1997). This model focuses on a detailed analysis of complex cognitive skills to be trained. A training design for the type of skills requires a task hierarchy, decisions about types of tasks, sequencing of tasks, and supportive knowledge. The teacher trainers rate the difference of each of the specified design activities in the worked out ISD approach with their own approach.

We conclude the introduction to this study with a final remark about the relationship between learning process-oriented teaching roles and the design approaches of the participant teacher trainers. Process-oriented teaching and learning, as cited by Vermunt and Verloop (1999), or “new learning” (Simons et al., 2000), require not only new coaching roles for the teacher, but also the role of “designer” of (authentic) learning tasks that initiate, facilitate, or stimulate students’ learning actions. The 4C-ID model (Van Merriënboer, 1997) has been characterised as a learning process centred design approach (Clark & Estes, 1999). A comparison of differences of an expert ISD approach with the approach of the participants may, therefore, be considered to reflect their effort to realise new curriculum or teaching concepts.

Methods and Materials

Participants

In two typical teacher-training colleges in the Netherlands, the Hogeschool Maastricht and the Hogeschool Limburg, ten instructor-teachers (5 men and 5 women) were selected for participation. Within their college, all participants were involved in the design process of new study units for various subject areas.

Materials

There were five instruments for collecting the data. The General Interview was used to collect general data such as the teachers' experience with developing units of study, their general experience as teacher trainers, their subject area, the importance of innovation in daily practice, and the time required to develop units of study.

The Knowledge Elicitation Interview was used to elicit the teachers' design experience. Here an adapted Rep(ertory) Grid Technique was applied (Munby, 1982), in which the teacher trainers were invited to describe for instance to a new colleague the way they normally approach the design of a study unit. Each design activity that was reported represented an "element" in the terminology of the Rep Grid Technique. These elements had to be categorised by the participants using their own criteria, yielding their personal “constructs” (Herman, 1996) of their design approach. The strength of each element in relation to the construct was to be measured on a nine-point scale, where 1 indicates a very weak relation and 9 a very strong relation to the construct (Pope & Keen, 1981; Gaines & Shaw, 1993).

The Role-Grid Scale was used to collect data on the significance of innovative teaching Roles for the participants. The instrument consists of three constructs and six elements. The "constructs" are (a) *recognition* of each of the six roles in current teaching practice, (b) perceived *importance* of each of these roles for innovation processes in the teacher training college, and (c) perceived *training need* in each of these six roles.

The constructs were measured on a nine-point categorical scale. For the construct "recognition" the scale extremes were defined as follows: rating 1 means: "you hardly recognize or do not recognize this role; it doesn't belong to your repertoire of roles", and rating 9 means: "you fully recognize this role, it really belongs to your repertoire of roles". For the construct "importance" the scale extreme 1 was defined as: "you think this role is not at all important for your profession" and scale extreme 9 as: "you think this role is really important for your profession". For the construct "urgency for training" scale extreme 1 was defined as: "you do not think training in mastering this role is at all urgent for you", and scale extreme 9 as: "you think training in mastering this role is extremely urgent for you". The six "elements" correspond to the six teacher roles, which were defined as follows: a) the diagnostician: as a teacher you are skilled in recognising the learning styles and the problem solving strategies of your students; (b) challenger: as a teacher you are skilled in challenging your students to try new learning and thinking strategies; (c) model learner: as a teacher you are able to demonstrate the learning and thinking strategies that are characteristic for the domain you are specialized in. In this way, you elucidate and facilitate knowledge construction principles and the application of knowledge in your domain; (d) activator: once your students have a clear idea of learning strategies and their application, you encourage your students to re-use these strategies; (e) monitor: as a teacher you coach and monitor the learning processes of your students. Once they perform at a basic level and are able to perform the task autonomously, they may consult you in case of problems; (f) evaluator: in process-oriented learning you assess the quality of your students' use of thinking strategies.

The ISD Comparison Scale was used to compare an ISD approach to developing units of study with the respondent's own approach. This instrument consisted of a given grid with one construct and 29 elements. The construct pertains to the "degree of similarity" between a given approach and the participants' own approach. The participants had to compare 29 elements of the given instructional design approach (based on the 4C-ID-model of Van Merriënboer, 1997) with their own approach, using again a 9-point categorical scale with verbal labels ranging from "low similarity" to "high similarity".

The nine-point scale was printed in very large fonts and on a large sheet of paper. This scale had to be used in all of the three instruments (the Knowledge Elicitation Interview, the Role Grid Scale, and the ISD Comparison Scale), by putting the printed definition of the extremes of each variable ("construct") at both ends of the scale. An audiocassette recorder with a microphone was used to record the respondents' spoken reactions. The score of each respondent's (numbered) element and construct during the interview session was registered in an Excel Spreadsheet on a laptop computer. Further interview materials consisted of a set of white lined system cards that enabled the participants to note the element names and a set of yellow "post-it" labels to write the construct names on. Printed instructions were developed for the Knowledge Elicitation Interview, the Role Grid and ISD Comparison Scale to read or present to the participants.

Procedures

Each instrument contained a printed protocol with clear instructions and examples showing the respondents how to answer and categorise. A checklist for the interviewer was provided. All interviews and scores were taped on an audiocassette recorder. During the interviews, notes were taken down. The grid scores of the Knowledge Elicitation Interview, the Role Grid Scale and the ISD Comparison Scale were typed immediately during the interview into prepared tables on a laptop computer.

The elements elicited in the Knowledge Elicitation Interview had to be noted by the respondents on system cards, one catchword per card per idea, while the spoken examples were recorded on audiocassette and noted on paper. The cards had to be sorted by the respondents and the sorting category names (i.e. the construct names) had to be specified in catchwords on the post-its. The examples had to be recorded and noted. In the Role Grid Scale the experimenter was reading the task from the protocol and the respondents were given both the construct and role descriptions on paper. They were asked to score the constructs and role descriptions on the nine-point scale. The ISD Comparison Scale used an identical procedure. The Debriefing Interview questions were read from the protocol and the answers were noted by the experimenter and recorded on tape.

Results

General Interview

On average, participants had 13 years of experience as a teacher trainer. Most of them also had experience in various other jobs in teacher education, secondary education or primary education. The following subject areas were reported: instructional science, music, and social studies/philosophy of life, art education, and calligraphy/writing skills. The design experience expressed as the average cumulative number of new units of study was 4 units. Most of the respondents revised their units of study every year. With regard to the final responsibility for the design of units of study, 6 respondents shared this with colleagues and 4 respondents were individually responsible. Eight respondents also taught the study unit they had designed, while two of them did not. The design of a complete new study unit took on average about 40 hours of work. The respondents reported the following activities of curriculum innovation in their teacher training colleges: (a) acquiring new teaching techniques and methods, (b) development of methods of self-responsible learning, (c) being more of a coach than a transmitter of knowledge, (d) shifting from theory to practice, (e) solving assessment problems, and (f) developing a professional attitude within their students.

Knowledge Elicitation Interview

The ten teachers generated between 8 and 15 design activities (elements) and between 3 and 5 constructs to categorise these elements. In total 118 elements and 41 constructs were reported. The design elements were compared with a prototypical model of instructional design of Leshin et al. (1992). The following numbered elements of the seven sub-classifications of this model were used by two experts to categorise all design activities reported by the teachers: 1 = analyse the problem, 2 = analyse domains, 3 = analyse and sequence tasks, 4 = analyse and sequence supporting content, 5 = specify learning events and activities, 6 = perform interactive message design, 7 = evaluate instruction. (Leshin et al., 1992). This categorisation of the design activities (i.e., elements) resulted in an absolute frequency distribution according to the seven design steps of the model of Leshin et al. (1992), which is presented in Figure 1.

Figure 1 about here

The number of respondents generating the elements of each design is indicated in Figure 1. The frequency distribution shows the absolute frequencies of activities concerning problem analysis (category 1), interactive message design (category 6) and evaluation of the implemented design (category 7), that is 3, 3, and 7 respectively. To determine whether these values differed from the model, we assumed that the activities reported by the teachers would be equally distributed across the seven design categories of the model. This resulted in a mean expected frequency of 17 for each of the seven categories. A Chi-square one-sample test (Siegel, 1956) showed that the observed frequencies differed significantly from the expected mean frequency ($\chi^2 = 75.25$; $df = 6$; $p < 0.001$). Binomial tests (Siegel, 1956) performed to determine the locus of this difference revealed significant differences for the categories relating to problem analysis, specify learning events and activities, perform interactive message design, and evaluation of the implemented design (respectively, $N = 20$, $x = 3$, $p < 0.001$; $N = 62$, $x = 45$, $p < 0.001$; $N = 20$, $x = 3$, $p < 0.001$; $N = 24$, $x = 7$, $p < 0.032$). The other categories relating to analysing domains, analysing and sequencing tasks, and analysing and sequencing supporting content were not significantly different from the expected mean (respectively, $N = 34$, $x = 17$, $p > 0.1$; $N = 35$, $x = 18$, $p > 0.1$; $N = 32$, $x = 15$, $p > 0.1$).

The constructs that were generated by the teachers were sorted by the experts to the following four main categories of the model: 1 = analysis of needs; 2 = selecting and sequencing of content; 3 = developing lessons; 4 = evaluating the instruction. (Leshin et al., 1992). The constructs showed a wide range of individual differences. To reduce their number, the constructs were categorised along the four main design phases of the Leshin Model. The resulting absolute frequency distribution per category of the classified constructs is shown in Figure 2. This distribution of constructs looks similar to that of the distribution of elements and, therefore, is analysed in the same way. The absolute frequencies of the categories were significantly different from the expected mean frequency of 10 ($\chi^2 = 10.5$; $df = 3$; $p < 0.02$). Further Binomial tests of the difference of each category from the expected mean frequency of 10 showed no significant differences (analysing needs: $N = 21$, $x = 10$, $p > 0.1$; selecting and sequencing content: $N = 15$, $x = 5$, $p > 0.1$; developing lessons: $N = 29$, $x = 10$, $p > 0.1$; evaluating instruction: $N = 16$, $x = 6$, $p > 0.1$).

Figure 2 about here

Role Grid Scale

Each teacher generated three series of six role scores on the nine-point scale. These series of six scores corresponded to one of the constructs: recognition, importance, or training need. The mean scores of all participants on each role were calculated for each construct. The differences in ranking of the mean scores of roles between the three series are displayed in Table 1.

Table 1 about here

In the case of ties, the roles were ranked alphabetically. The ranks ranged from 1 for the highest mean score to 6 for the lowest mean score. With regard to the constructs recognition and importance, the roles of diagnostician and evaluator were ranked lowest. However, for the construct “training need” these roles were ranked highest. Conversely, the roles of the challenger and the model-learner were ranked highest for the constructs “recognition” and “importance”, and lowest for the construct “training need”.

ISD Comparison Scale

The frequency distribution of the raw scores was negatively skewed, with a standard error of skewness of 0.68. Skewness applied to all variables, except for the design activities of determination of recurrent skills and criteria for feedback on performance. For each design element, we calculated the mean value of the scores across all subjects. Table 2 shows the mean scores per design element.

Table 2 about here

In the table the design elements are categorised in the design phases of the worked-out approach. The Grand Mean of all the design-element scores is 6.7 on the nine-point scale. The value nine was specified as having a strong resemblance to the participant's own design approach, while the value one indicated a marked deviation from that approach. A Wilcoxon Signed Ranks test on the difference between the mean scores below and above the Grand Mean revealed a significant difference ($Z = -3.06$; $p < .002$).

Discussion and Conclusions

A small-scale exploratory study was conducted among ten teacher trainers. The general intention was to obtain more insight into the way teacher trainers design their units of study in daily practice. Due to curriculum changes in Dutch Teacher Training Colleges, we expected shifts in perceived teacher activities from *lesson-like* towards more *designer-like* activities, and in perceived teacher roles from *transmitter of knowledge* to *coach of learning processes*. Using the Knowledge Elicitation Interview, elements and constructs of ten teacher-trainers' design practices were elicited. The elements and constructs were scored as categories and main categories of a prototypical ISD model (Leshin et al., 1992). The Role Grid Scale enabled more insight to be gained into the way that these teachers perceive new teaching roles, which are believed to be required for the innovation of education. In addition, the ISD comparison scale was used to obtain information on the discrepancy between elements of the Four Component Instructional Design model (Van Merriënboer, 1997) and the elements in the teachers' actual design approach.

The Knowledge Elicitation Interview revealed substantial differences in frequencies of design elements and constructs. High absolute frequencies were observed for elements that had been categorised in the design phase “specifying learning events”. Low absolute frequencies were found in the design phases of “problem analysis”, “interactive message design”, and “evaluation of instruction”. Differences between these frequencies and the expected mean frequency were significant. The analysis of the frequency distributions of the constructs reveals a similar pattern. We suggest two possible explanations for this observation. One is that the approach of these teacher trainers to developing learning tasks and study units is based upon a traditional knowledge transmission concept, and primarily consists of existing routines in determining content and selecting well-known learning tasks and teaching strategies. This might account for the problems that teacher trainers’ experience in translating new curriculum principles of competency-based and process-oriented learning into concrete lessons.

Another possible explanation is that the teacher trainer's approach to developing learning tasks or study units may not even be considered as an (instructional) design-approach. According to Visscher-Voerman (1999) an instructional design is expected to incorporate the typical phasing of the so-called ADDIE model (Rosset, 1987; Wedman & Tessmer, 1993). ADDIE stands for: Analysis, Design, Development, Implementation, and Evaluation. From the perspective of the ADDIE model, it can be argued that the teachers do not follow a complete design cycle in their design approach, because they pay little attention to the phases of Analysis and Evaluation. This suggests that training in a complete instructional design methodology might be most helpful to teachers. Although Klauer (1997) and Moallem (1998) have speculated about possible causes, it remains unclear why teachers do not frequently use an ISD approach for preparing their study units.

Analysis of the Role Grid findings resulted in the observation of changes in ratings of the six teacher roles between the three constructs recognition, importance, and training need. The roles “diagnostician” and “evaluator” keep the same lowest-two ranks for the constructs recognition and importance and change to the first two ranks in the construct “training need”. This is an almost complete inversion of the ranking order. At the same time we see a comparable inversion of the block of the first four ranks of roles (monitor, model-learner, challenger and activator). Finally, what is remarkable is that the “activator” role keeps the same rank in all three constructs. A possible interpretation of this effect is that for increasingly recognised roles, which are also seen as important for innovation, there is a decrease in the training need and vice versa. This effect seems quite logical: what you already do, needs no further training. But the observation that this effect exactly applies to the “diagnostician” and “evaluator” roles seems to be highly compatible with the trend observed in the results of the Knowledge Elicitation Interview: low levels of analysis and evaluation during the design of a study unit. The inversion effect seems to affect the “activator” role to a lesser extent, possibly because this is a difficult role that combines different roles, such as diagnosing existing student strategies and stimulating their re-use. Although these effects are difficult to test in this study, a replication with the Role Grid Scale in follow-up research with 36 participants (Hoogveld et al., 2001), confirms these effects.

The results of the ISD Comparison Scale can be interpreted as follows. Most design-elements with mean scores under the Grand Mean fall within the Analysis Phase of design. Further, two important design elements refer to the phase of Evaluation. These elements are a worked-out evaluation plan (for collecting evaluation data) and the collection of data for product evaluation, both of which must be carried out in phases of design, preceding the actual phase of evaluation. Two scores, the definition of exercises per skill and the timing and format of supportive knowledge are design elements that are typical for the learning process orientation of the model used (Van Merriënboer's 4C-ID model). Low scores for the worked-out monitoring and tutoring plan in the development or learning materials production phase, preceding the phase in which monitoring and tutoring actually occur, could be an indication that teachers directly execute monitoring and tutoring without designing it beforehand.

To summarise, the present results consistently indicate that the cause for the low correspondence of the model approach with the teacher's own approach is located at the analysis and evaluation activities. The Knowledge Elicitation Interview as well as the ISD Comparison Scale shows that the teacher trainers seem frequently to omit or neglect the phases of problem analysis and evaluation in instructional design. In addition, this effect is compatible with the low *recognition* ranking of the diagnostician and evaluator roles, found in the Role Grid.

We can only speculate as to the possible causes of these phenomena. One explanation is the lack of experience in the application of design methods, which is also indicated by Klauer (1997). Another possible explanation might be the increasing complexity of the design of study units, for instance in analysing complex skills and finding appropriate learning tasks for practising those skills. This type of complex design activities indeed requires a sound ISD approach, instead of the use of teaching routines. The results of the Role Grid Scale and the General Interview show that the teacher trainers are in transition from a knowledge transmission-oriented teaching concept towards more process-oriented teaching concepts. Teachers should therefore develop a design attitude and learn design skills to solve their problems related to curriculum innovation.

In future research we hope to gain more insight into teachers' potential for educational design and developing a designer's attitude. The relatively low values for the recognition of the diagnostician and evaluator roles, but relatively high values for the training need in these roles, suggest some optimism for further research. In presenting the effects and trends, we realise that our conclusions are based on a small sample of participants and colleges. However, the results of a recent study of Hoogveld et al. (2001), which used more participants and confirms the claims made in this study, add strength to our conclusions and emphasise the importance of further research in this field.

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Table 1

Ranking of mean scores of roles on the constructs 'recognition', 'importance', and 'training need'

rank	recognition	importance	training need
1	monitor (7.7)	model-learner (8.1)	evaluator (7.0)
2	model-learner (7.4)	monitor (8.1)	diagnostician (6.3)
3	challenger (6.9)	challenger (8.0)	monitor (5.9)
4	activator (6.5)	activator (7.6)	activator (5.0)
5	diagnostician (5.3)	diagnostician (7.5)	challenger (5.0)
6	evaluator (5.1)	evaluator (7.1)	model-learner (4.4)

Note. Ranking ranged from 1 (highest mean score) to 6 (lowest mean score).

Table 2

Mean scores on ISD comparison scale.

Design phase and design activity	Mean
Analysis phase: Exploration of problem	
acceptance of task to design a study unit	6.0
estimation of available time for design task	6.1
determine position of study unit in curriculum	6.6
importance of study unit for the student	8.1
check if there is existing information or experience	7.1
exploring the value system around this study unit	5.5
difficulty of the educational problem	6.2
estimate of successful solution of the problem	5.8
Analysis phase: Analysis of the problem	
global diagnosis of skills	7.2
sequencing of subskills	6.4
sequencing of learning processes	6.1
determination of prior knowledge	7.4
determination if skills are recurrent or new	5.0
analyse, determine and sequence supporting knowledge	6.8
Design of learning tasks	
define exercises per skill	6.6
define criteria for feedback on performance	7.0
timing and format of supportive knowledge	6.1
define criteria for achievement of objectives	7.8
define an appropriate learning environment	7.3
planning of exercises and practice in time	7.2
Learning materials production phase	
elaborate instruction	8.1
produce supportive knowledge	7.9
perparation of practice	6.7
worked out monitoring and tutoring plan	6.2
worked out evaluation plan (for collection of evaluation data)	5.4
Implementation of design phase	
collection of data for process evaluation	6.8
collection of data for product evaluation	6.5
Evaluation phase	
evaluation of design: educational problem solved?	7.5
evaluation of the process	7.0

Note. Activities with mean scores below 6.7 are underlined.

Figure Captions

Figure 1. Absolute frequencies of reported design activities, sorted in categories of the model of Leshin et al. (1992). Note that the number of the teachers, that generated these elements, are given between parentheses

Figure 2. Absolute frequencies of reported design constructs, sorted in main categories of the model of Leshin et al. (1992). Note that the number of the teachers, that generated these elements, are given between parentheses