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Citation for published version (APA):

Hoogveld, B., Paas, F., & Jochems, W. (2003). Application of an instructional systems design approach by teachers in higher education: individual versus team design. *Teaching and Teacher Education*, *19*(6), 581-590. https://doi.org/10.1016/S0742-051X(03)00055-6

DOI:
10.1016/S0742-051X(03)00055-6

Document status and date:
Published: 01/08/2003

Document Version:
Peer reviewed version

Application of an Instructional Systems Design Approach by Teachers in Higher Education: Individual versus Team Design

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Date of resubmission: 17-01-2003

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Abstract

The differential effects of teachers' individual and collaborative performance on the application of an Instructional Systems Design (ISD) approach were investigated. Forty-two higher education teachers were trained in an ISD approach and subsequently had to apply the approach both individually and as a member of a design team. The main hypothesis that the resulting collaborative designs would be better than individual designs was confirmed for low individual achievers but not for high individual achievers. In addition, a negative relationship between attitude towards the ISD approach and the attitude towards collaborative design was found. The implications of these results for a new role of the teacher as a designer are discussed.

Keywords: Collaborative Design, Instructional Systems Design Approach, Competency-Based Learning

Application of an Instructional Systems Design Approach by Teachers in Higher Education: Individual versus Collaborative Design

The National Center for Education Statistics (NCES) has recently described Vocational Education at the turn of the century as an enterprise in transition (Levesque, Lauen, Teitelbaum, Librera, & M. P. R. Associates, Inc., 2000). The NCES report emphasizes the increasing importance of competency-based education (CBE) and concludes that the rapidly growing demand of competent employees does not match with the supply of competency-based Vocational Education in the U.S. A similar trend is noticeable in the Netherlands (HBO Raad, 2001a, 2001b).

CBE is aimed at providing students with the knowledge, skills, and attitudes that enable them to recognize and solve complex problems in their domain of study or future work, that is, authentic tasks (Keen, 1992). Examples of such tasks can be found in the competency-based curricula of Public Administration (Van Merriënboer, Bastiaens, & Hoogveld, in press) and Natural Sciences (Van Petegem., Sloep, Gerrissen, Jansen, & Schuwer, 2000) at the Open University of the Netherlands. For instance, student policy advisors must learn to anticipate future decision making in the political context of the a big city's Administration by learning to collect all documentation that is possibly relevant and relating this to the decision formation process. To this end, the student policy advisors are confronted with such problems and the solutions of senior policy advisors. The natural sciences students participate in a web-based virtual office and must learn to analyze available information, search for new information about environmental incidents and environmental policy making in industrial companies.

The implication of the trend towards more competency-based education is that teachers will have to adopt the new roles of coach of the student's learning processes (Vermunt &

Verloop, 1999; Samuelowicz, 2001) and designer of authentic learning experiences (Rowland, 1992; Rowland, Parra, & Basnet, 1994; Tennyson, 2001), and change their working style accordingly. Lang, Bünder, Hansen, Kysilka, Tillema, and Smith (1999) and also Reigeluth and Avers (1997) have emphasized the importance of the role of teachers as stakeholders in the design process of curricula. Consequently, teachers in higher education will be confronted with new instructional design problems associated with the translation of competency-based curriculum concepts into concrete learning tasks.

Competency-based curricula for Higher Vocational Education focus on students' mastery of whole, complex, and authentic, job-oriented tasks. Instructional Systems Design (ISD) approaches are considered to offer opportunities to support the design of learning tasks for complex cognitive skills, and for the sequencing of these tasks throughout the curricula. Hoogveld, Paas, Jochems, and Van Merriënboer (2001) have shown that teachers experience difficulties in coping with these instructional design problems. Training teachers to use an ISD-approach has been identified as a possible solution to this problem (Hoogveld, Paas, Jochems, & Van Merriënboer, 2002). The study of Hoogveld et al., 2002 showed that a group of higher education teachers that was trained to apply an ISD approach was able to design better learning tasks for CBE than another group that was trained to optimize their experience-based design approach.

This paper focuses on the question whether an ISD approach, once trained, can best be applied individually or in a team. In most Vocational Education Colleges the design of the curriculum is a matter of teamwork. So, it can be expected that the implementation of competency-based learning will be the responsibility of a team of teachers. However, the evidence regarding the surplus value of collaborative design is not conclusive. On the positive side, collaborative design approaches have been shown to be more successful than individual approaches (Sonnentag, Frese, Brodbeck, & Heinbokel, 1997). Furthermore, if the process of collaborative design is considered from the perspective of the research on individual learning versus collaborative learning, it can be expected to be more effective than individual design (Enkenberg, 2001; Dillenbourg, Baker, Blaye, & O'Malley, 1996). Another reason to arrive at the expectation that teamwork with an ISD approach results in better design performance than individual work can be found in the results of interaction analyses in collaborative learning research (Clark & Schaeffer, 1989). In this research, the shared understanding of meaning has been found to promote effective problem solving as an important step in the process of collaborative problem solving. On the negative side, there are indications that low achievers become progressively more passive when they work together with high achievers (e.g., Mulryan, 1992). Finally, a reason for the expectation that collaborative work is more effective than an individual work during instructional design with an ISD approach, can be found in the Cognitive Load theory (Sweller, 1988; see for an overview also Sweller, van Merriënboer, & Paas, 1998). Cognitive Load theory is concerned with the development of instructional methods that efficiently use people's limited cognitive processing capacity to stimulate meaningful learning. Designing learning tasks for these highly integrated complex skills is expected to impose a very high load on the teacher's cognitive system, and may account for the problems teachers experience during the design of learning tasks for CBE. A potential solution to these problems can be found in a collaborative approach to design in small interdisciplinary teams. The holistic and integrative way of thinking that is required to design CBE forces teachers to look over the borders of the subject that they are used to teach in the knowledge-oriented curriculum. In practice this process can be promoted by stimulating teachers to work collaboratively on the design task. In terms of cognitive load, the proposed interdisciplinary collaboration can increase the available cognitive capacity, and consequently, relatively decrease the cognitive load.

To gain more insight into the significance of collaborative design and individual design with an ISD approach, this study compares the design performance of individual teachers with that of collaborative teams of teachers. Because the positive results of collaborative work dominate in the referenced research, it is hypothesized that the resulting collaborative designs will be better than the individual designs. In addition, it is determined if collaborative design performance varies as a function of the quality of the individual design performance.

All teachers in this study are trained to apply the Four-Component Instructional Design (4C-ID) model of Van Merriënboer (1997), a well-recognized ISD methodology. This method especially supports and facilitates the design of complex cognitive skills in a whole-task approach. The 4C-ID approach provides methods and techniques for: (a) analyzing a complex cognitive skill into its constituent skills and their interrelationships, (b) analyzing the different knowledge structures that may be helpful or are required to be able to perform the constituent skills, and (c) designing a training blueprint, with as a base a sequence of whole task practice situations that support integration and coordination of the constituent skills. Authentic whole learning tasks, supportive info, just-in-time info and part task practice constitute the four components of the 4C-ID model. The basic element of a 4C-ID design is the *learning task*, which in the view of the method must always consist of the type of problems a practitioner in the domain normally has to solve. However, in complex domains, this level is often too high for students in the domain. According to the model, this might impose a cognitive overload on the limited working memory capacity of the learner, and, consequently, interfere with learning. The results of analyses of the task and the mental models and heuristics of expert problem solvers are used to program learning experiences with forms of the whole task, in such a way that cognitive overload is prevented. In the 4C-ID method this is attained by systematic control of the task complexity, by sequencing simple to complex forms of the whole task, and by fading the support within a level of same complexity. In addition, supportive information and JIT information are presented at the moments, the learners needs it. Sometimes, when a high level of automation is required a series of learning tasks is programmed as *part-task practice*.

The 4C-ID model can be characterized as a relatively non-prescriptive ISD method. According to Klauer (1997) and Moallem (1998), who found that, in general, ISD methods are not very well accepted by teachers because of their prescriptive character, the 4C-ID method can be expected to be rather attractive to teachers. Detailed information on the 4C-ID methodology can be found in De Croock, Paas, Schlanbusch, and van Merriënboer (in press) and in Van Merriënboer, Clark, Moore, & de Croock (2002).

Method

Participants

The participants were 25 teachers (15 men and 10 women) from 18 faculties from 10 different institutes for higher education from all regions in the Netherlands. Their mean age was 43.4 years (*SD* = 7.3 years) and their average teaching experience was 12.2 years (*SD* = 9.3 years). All participants indicated to have ‘some’ instructional design experience and were involved or interested in being trained in an instructional design methodology for learning tasks in competency-based education. The participants were recruited by electronic mail and advertising. The one-day training in the 4C-ID methodology was offered to them in exchange for their participation in the experimental design test after the training.

Materials

Data were collected by means of a 14-item open answer questionnaire on general data regarding the teachers' attitude towards instructional design tasks, their experience in design of study units, the problems experienced during design of study units, their attitude to collaborative design, the type of task specialisation, and the number of study units they expect to design in the future. The attitude towards the 4C-ID method was measured on a 21-item five-point Likert scale that was based on the scale used by Hoogveld et al. (2001). The numerical values of this Attitude to Method (ATM) Scale ranged from '1' to '5', corresponding to the verbal labels of 'completely disagree' to 'completely agree'. The content of the items consisted of the general appreciation for, and, attractivity of the trained methodology, the expected suitability of the method for solving design problems in the school context and the learnability of the method and the ease of explaining it to interested colleagues. Nine items of the ATM scale, covering the same content, were chosen to compare the participants'attitude towards individual versus collaborative design with the 4C-ID method. This attitude towards collaborative design (ACD) scale was measured on the same 5-point Likert scale. The design performance of the individual teachers and collaborative teams of teachers was measured independently by two experts on a scale containing two series of ratings on each of the seven design phases of the 4C-ID method. Participants' resulting design materials, of each design phase, such as the skill decompositions in graphical trees in Inspiration 5 Pro, and the clusters of skills, indicated by Venn diagrams in Inspiration, their descriptions of factors that complicate the task in Word for Windows, their descriptions of learning tasks and application of problem formats in Word for Windows, had to be rated on a 4-point scale with the following labels: 1 = very little or not, 2 = little or only partly, 3 = good, 4 = very good. Two experts, one of which was an independent expert in the 4C-ID methodology, not involved in the research project, and the other being the experimenter had to rate the test design materials of the participants, independently of each other. The ratings regarded the *recognition* of correct applications of the 4C-ID approach and the~~ir~~ *quality* of the design. For example, in the phase of skill hierarchy, quality was related to the completeness of decomposition and the building of a logical hierarchy of subskills. For the phase of skill clustering the quality was related to the extent to which the clusters of subskills reduced the complexity of the main skill. In the phase of the taskclasses the quality was related to the correct identification of factors for task complexity and the correct application of these factors to create classes of learning tasks to master simple to complex forms of the whole complex task. In the learning task phase the quality was rated as the extent to which the participants were able to diminish the quantity of learner support by applying various problem formats. In the supportive information phase, the selection of the relevant cognitive strategies for normal task performance was the criterion for appropriate design. In the just-in-time information phase, the restriction to necessary information such as principles, knowledge, rules, to complete learning tasks was the criterion. Finally in the part-task training phase, the correct decisions to train or re-use recurrent skills was decisive for the quality of this phase. Apart from these ratings, the experts had to rate the recognition as well as the quality of the total design on the same 4-point scales. For the overall rating of the total design the criterion for good designs discriminates in the consistent application of all the principles during the complete design, while for poor designs this is very little or not the case. During the rating process the experts had to use a rating protocol consisting of the exact descriptions of the rating values and the criteria for applying each of the score values as well.

All participants received a 12-hour training program on the 4C-ID methodology, supported by Powerpoint slides. The training, which took place in the multimedia laboratory of the Open University of the Netherlands, was divided into three blocks of 4 hours, spread across one-and-a-half day. The first part of the program consisted of the introduction and overview of the Four Component Instructional Design model, illustrated with two cases. The introduction was followed by a more elaborated explanation of each of the following seven phases of the 4C-ID design cycle: 1) hierarchical skill analysis, 2) skill clustering, 3) construction of task classes, 4) design of learning tasks in task classes and: 5) design of supportive information, 6) just-in-time information and 7) part-task training for these learning tasks. Each phase was explained and illustrated with a worked-out example of design of a training for higher education students in searching for literature, a well-known complex skill in most higher-education programs. During the training the participants used an IBM-compatible computer with Microsoft Office software and Inspiration 5 Pro (Inpiration Inc. 1997, 1998) as tool for concept mapping. The design task during the training was divided into part-task training per phase and consisted of a blueprint, which participants had to construct for a training in literature search. The concept mapping tool was demonstrated just-in-time in the phases of hierarchical analysis and task clustering.

The test consisted of two design tasks: a) design a training for a company rescue officer and b) design a training for an ICT-helpdesk officer in an university or polytechnic. Both tasks represented relevant topics that were expected to challenge the participant teachers to design a short training program. Participants were not given details or further information about the task situation or professional performance criteria for the tasks. In both tasks the participants were asked to use the seven phases of the 4C-ID model. All design materials produced by individuals and teams were saved electronically for later expert assessment. Electronic versions of the scales measuring the attitude towards the 4C-ID method and the attitude towards collaborative design had to be answered.

Design and Procedure

Before the start of the training the participants had to complete the 14-item general-data questionnaire. All participants received the same training program. In a within-subjects design the participants were randomly assigned to one of the two starting conditions; designing individually or designing in a small team. After assignment to the conditions, each participant was randomly assigned to a team. In line with Cooper (1999), a team size of two or three teachers was considered optimal for design work. With regard to cooperation within a team, the team members were only required to decide about who is responsible for the data input of the design into the team's computer and who is responsible for the time management. So, after the training, half of the participants would start in the individual design condition, and then work in the collaborative design condition. The other half had to start with the design task in a team, and to end with the individual design task. After attribution to a starting condition, participants were again randomly assigned to one of the two tasks to start with. This procedure was used to exclude possible effects of order in the design of the test. Differences in outcome therefore can be interpreted as differences of the experimental condition, where in each respondent has equal chance of starting individually or in a team and equal chance also to start with task 1 or task 2. During the training exercises the trainer was available for support. During the experimental design tasks the trainer was not available for support. Instead, all the demonstration materials and the training slides were available on the desktop of the computer.

The individual-design and collaborative-design condition as well started with a plenary explanation of the task and the procedure. This information was also available on paper and on the pc. In the collaborative design condition the participants were asked to assign an input-manager who would put in the design results discussed in the team and a time supervisor, who had to keep track of the available time. The individuals and groups had one-and-a-half hours available for each design task. After each task there was a 15 min. break. After each of the design tasks the participants had to complete two scales measuring the attitude towards the 4C-ID method and the attitude towards collaborative design, respectively. All data were saved electronically.

Two trained experts/raters were asked to assess the participants'design results. The raters had to work following a securely defined rating protocol in which each rating act had to be commented.

Results

General characteristics of the respondents

The participants indicated that they had been producing on the average 2.5 study units per year during the last two years (individually =1.2, team = 1.3). The average professional experience as a teacher was 12.5 years. The problems the participants had been experiencing during the design of study units, consisted of the constraints of continuous revision of units and simultaneously keeping up-to-date the expertise required for revision ($N = 13$); lack of adequate amount time for proper design ($N = 15$); no stimulation from colleagues during periods of innovation ($N = 4$); and problems in the selection of content. Overall, the participants preferred collaborative design or a mix of individual and collaborative design when designing study units ($N = 41$). On the average, the participants expect to produce 3.3 study units per year during the coming years.

Attitude towards the 4C-ID Method (ATM) Scale

The item consistency of the ATM scale determined by Cronbach's Alpha was 0.88. The mean scores of the items greater than the grand mean of all items (*M* = 3.6, *SD* = 0.1), are significantly different from the scores below the mean. More positive scores were obtained for the items that focus on the contribution of the method in solving design problems, on the estimated quality improvement of the study units, the amount of control over the coherence of parts of design, the attractivity of the method, the clarity of the principles used in the method, the feeling of being a designer, the amount of support provided by the method, the estimated re-use, and the advisability of the method for other colleagues. Less positive scores were obtained for the items related to the ease of application of the method, the need for recurrent training in the method, the estimated capacity to explain the method to a colleague, the measure of concurrence with other methods, estimated efficiency, appropriateness for the type of design problems, usefulness for the whole school, and the need for more theoretical elaboration on the method. These findings are consistent with the findings in the earlier study of Hoogveld et al. (2001).

Attitude towards collaborative design (ACD) Scale

The item consistency of the ACD scale, determined by Cronbach's Alpha was 0.67. The grand mean for all items is 3.0 (*SD* = 0.15). Items that focus on quality of design have higher but not significantly higher mean scores than items that focus on collaborative design performance and design efficiency.

Relationship between the attitude towards the 4C-ID method and the attitude towards the collaborative design

Wilcoxon signed ranks tests on a stratification of the 42 ranked mean scores on the 9 comparable items of the ATM and the ACD scale into high and low stratum on the ATM scale, revealed that individuals with a high ranking on the ATM Scale are significantly lower ranked on the ACD Scale ($M_{rank\text{ATM}} = 10.4$ $M_{rank\text{ACD}} = 21.4$, $Z = -2.89$, $p < .004$) and that individuals with a low ranking on the ATM scale were ranked significantly higher on the ACDscale ($M_{rank\text{ATM}} = 21.3$, $M_{rank\text{ACD}} = 32.0$, $Z = -2.83$, $p < .005$). Note that 1 = the highest and 42 is the lowest ranking.

Design performance

The Average Measure Intra-class Correlation, determined across all the paired scores of both experts was .83. There was a significant correlation between the scores of both experts on 'recognition' of the application of the Four Component Instructional Design method and on the 'quality of design' (Pearson $r = .95$, $p < .001$). Therefore, the average of both types of scores can be used as a performance index. The hypothesis that collaborative design products would be better than individual design products was tested with a paired comparison T test of the average expert end-scores. The analysis revealed no significant differences in the overall design performance of participants in both conditions ($t = -1.358$, $p < .182$).

To determine whether this effect was the same for low and high achievers the dataset was ranked from high to low individual performance and stratified into two equally sized groups of 21 participants each; the lower performance group representing the low achievers and the higher performance group representing the high achievers. Subsequently, this rank order was used to pair each individual score with the associated collaborative design score. Paired sample t-tests revealed that the design scores of the high individual achievers did not improve in the collaborative design condition ($M_{\text{individual}} = 2.8$; $M_{\text{team}} = 2.7$; $t = 0.42$, $p < .680$), but that the low individual achievers improved significantly in the collaborative design condition (individual $M_{\text{individual}} = 2$; $M_{\text{team}} = 2.5$; t = - 3.48, $p < .002$). Consistent with this finding, a similar analysis, now on the basis of sorting from the team point of view, revealed that the team scores of high achieving team members improved significantly compared with their individual scores, ($M_{\text{individual}} = 2.4$; $M_{\text{team}} = 3.5$; $t = - 4.7$, $p < .00$), whereas the team scores of low achieving team members did not improve ($M_{\text{individual}} = 2.4$; $M_{\text{team}} = 2.1$; $t = 0.2.1$, $p < .51$).

Insert Figure 1 about here

Figure 1 shows a graphical representation of the means per design phase. Both the average and the individual expert mean scores of the participants on each of the design phases show very similar descending values from the first to the last phase. This trend was present in the individual and collaborative design conditions for the recognition scores, the quality scores, and for the end scores. The only exception on the trend was the part-task aspect of the design. These effects were tested with a linear regression curve fit function with each time the preceding design-phase mean score as independent and the subsequent score as dependent variable. The results for the mean scores for the individual condition are presented in Table 1, the results for the collaborative design condition in Table 2. In the individual condition the trend is significant except for the just-in-time and part-task design phases and in the collaborative design condition the trend holds except for the part-task phase.

Insert Tables 1 and 2 about here

A paired sample t-test of the mean scores per phase, the mean for the first phase paired with the mean for the following phase and so on, revealed that all pairs, except the cluster-class phases, have significant differences. ($t_{\text{hier-clust}} = 3.2$, $p < .002$; $t_{\text{clust-class}} = 1.75$, $p < .088$; $t_{\text{class-task}} = .014$; $t_{\text{task-supinfo}} = 17.64$, $p < .0001$; $t_{\text{suppinfo-jitinfo}} = -13.09$, $p < .0001$; $t_{\text{jitinfo-parttask}} = 2.22$, $p < .032$).

A Wilcoxon signed-ranks test used for testing for differences in the same phase between conditions revealed significant effects only for the just-in-time and part task phases ($Z_{\text{jit info}} = -3.4$, $p < .001$; $Z_{\text{part-task}} = -2.052$, $p < .040$).

Relation design performance scale with other measures

There was a positive relationship between the collaborative design score and the experienced amount of support of the 4C-ID method in solving instructional design problems (Kendall's tau = .45, $p < .001$). The relation between pleasure in collaborative work and the design performance score was not significant. (Kendall's $Tau_{\text{high}} = .27$, $p < .24$; $Tau_{\text{mid}} = .00$, $p < .1$; $Tau_{\text{low}} = -.19$, $p < 1.00$).

Discussion and conclusions

Hoogveld et al. (2002) have identified the training in an ISD design methodology as a potential solution for the problems that teachers in higher vocational education experience in implementing the principles of competency based education in their curricula. The application of such a methodology in the form of designing concrete learning tasks usually is a matter of team collaboration. Because it is not clear whether the design results of this collaborative effort is superior to those of individual design efforts, this study trained teachers in using an ISD methodology and compared the effectiveness of its application individually or in a team. The results of the experiment revealed that only low individual achievers could profit from collaborative design work, while low team achievers do not. For high individual achievers there was no advantage of working in a team. High team achievers perform better in the team than as an individual. The fact that less good designers seem to benefit from the good designers and that good designers do not experience this as a disadvantage can be interpreted as an advantage of a collaborative approach where teachers work together in teams. However, in terms of efficiency it should be noted that the collaborative design teams worked just as long as the individual designers did. From this point of view, it could be argued that the educational institutions should identify the teachers who are good designers and let them do the design work. On the other hand it could be investigated whether the teachers who were identified as less good designers can be trained to become good designers.

The other results of this experiment give more insight into the attitude of teachers towards the application of ISD methods, and specifically the 4C-ID methodology. The attitude towards the method (ATM) and to collaborative design work (ACD) varied both from generally positive to neutral, respectively. Remarkably, a significant negative relationship was found between the attitude towards the ISD approach and the attitude towards collaborative design. High scores on the attitude to method were associated with low scores on the attitude to collaborative design and vice versa. It could be that it were the low achievers who liked to work in a team because they expect to profit from the methodological input of high achievers. Therefore, the latter group has to invest extra effort to master the method and communicate it to the low achievers. Consequently, the high achievers might be expected to be more interested in individual work.

In terms of cognitive load theory (Sweller et al., 1998), the present results suggest that collaborative design performance is beneficial to the low achievers and imposes an extra load on the cognitive capacity of the high achievers. It seems that within a group, the quality of the output cannot solely be predicted by the sum of the cognitive capacities of the different group members. The relation between group work and the associated cognitive load represents an important topic for future research.

Curiously, in both the individual and the collaborative design conditions, the design performance decreased significantly from the first to the last step in the design-methodology. This trend might be explained by the increasing complexity of the methodology in each new design step, by incomplete mastery of the methodology, and by the contrast to their own methodology, resulting in high cognitive load during the application of the method, introducing time pressure later in the design cycle. The tendency of teachers to directly translate skills into learning tasks instead of completing the design cycle, as shown in an earlier experiment (Hoogveld et al., 2001) may also partly explain the decline in performance scores. A final alternative explanation relates to a kind of snowball-effect, which is caused by an improper or incomplete hierarchical analysis in the beginning of the design and its increasing negative consequences for later steps in the design.

The relatively short duration of the training and application in this study, as well as the laboratory setting are also factors that need to be considered in explaining the present results. It is clear that a complex methodology like the 4C-ID method can only be mastered after a few days of training and that the proper application can only be tested in a ecologically valid environment like the school. So, the question is whether the same results would have been found with a longer duration of the training, with more time to apply what was learned, and in a school setting. This question can only be answered in future research.

To conclude, the hypothesis that the collaborative application of a trained ISD method to the design of learning tasks results in better design performance than the individual application, could only be confirmed for the low individual design achievers and high collaborative team designers. It is clear that this study is only a first step in the identification of methods that can enable teachers to cope effectively with their new role of instructional designer in the translation process from competency-based curriculum concepts into concrete learning tasks.

Author Note

The authors thank the participating teachers and institutes for their interest and cooperation in the research activities. Special thanks also go to Ir. W. van der Vegt for preparing and programming the software for this experiment.

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Table 1

Curve Fit of Individual Mean Scores per Design Phase

independent	dependent	R^2	*df*	*F*	*p*	*b0*	*b1*
hierarchy	clustering	.43	40	29.95	.000	1.07	.56
clustering	task classes	.12	40	5.54	.024	.79	.57
task classes	learning tasks	.11	40	4.61	.038	1.33	.34
learning tasks	supp info	.37	40	20.26	.000	.56	.51
supp info	jit info	.01	40	.43	.517	1.09	.07
jit info	part-task	.01	40	.42	.520	1.34	.14

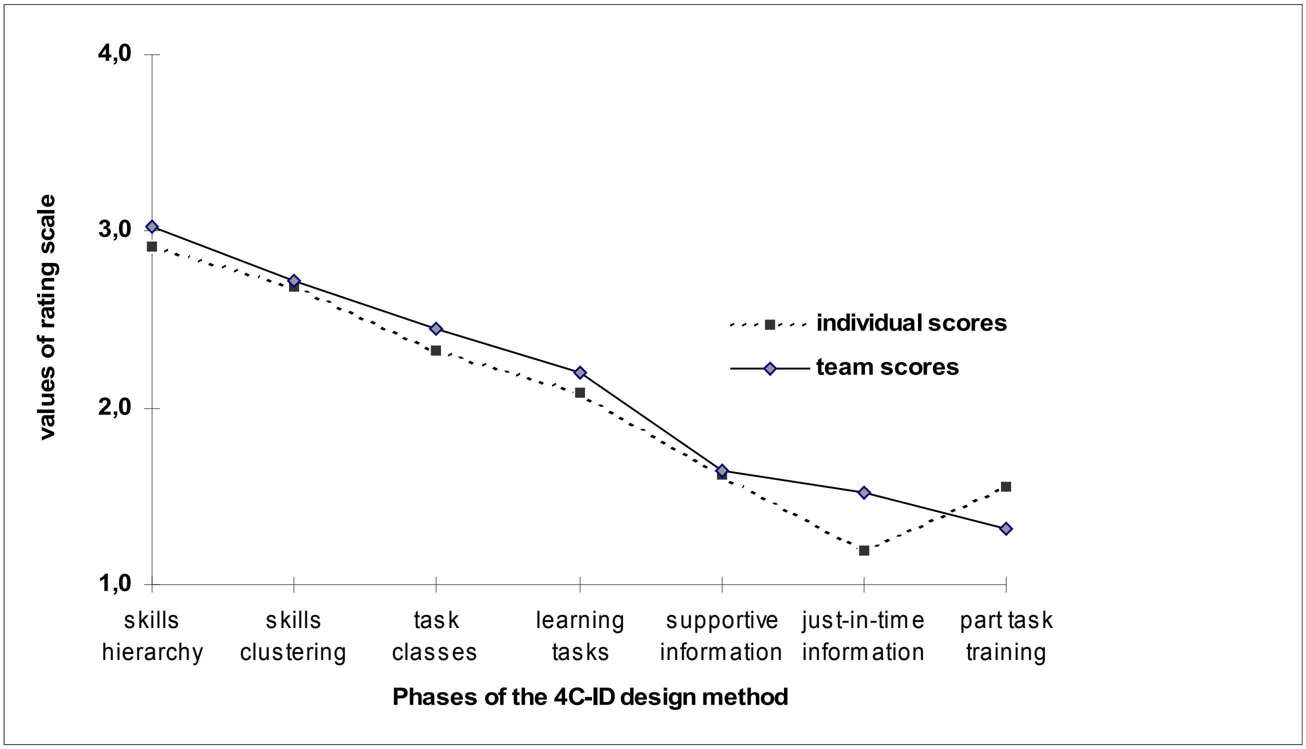
Table 2

Curve Fit of Mean Collaborative Design Scores per Design Phase

independent	dependent	R^2	*df*	*F*	*p*	*b0*	*b1*
hierarchy	clustering	.39	40	25.14	.000	.33	.80
clustering	task classes	.34	40	20.54	.000	.42	.77
task classes	learning tasks	.55	40	49.11	.000	.67	.64
learning tasks	supp info	.20	40	9.67	.003	.06	.04
supp info	jit info	.26	40	13.95	.001	.89	4.39
jit info	part-task	.02	40	.10	.757	1.35	- 0.03

Figure Caption

Figure 1. Trend across design phases: mean individual and collaborative design scores.


4,0
3,0
2,0
1,0
values of rating scale
individual scores
team scores
skills hierarchy
skills clustering
task classes
learning tasks
supportive information
just-in-time information
part task training
Phases of the 4C-ID design method