well as training. It is through the precision of these theoretical and methodological aspects that progress may be made in these two domains.

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6. Performance Requirements Analysis and Determination

Wim J. Nijhof and Martin Mulder

SUMMARY

In this chapter the authors describe a new method: the curriculum conference in order to fill the gap between job analysis techniques and curriculum design, and development techniques. The conference has been used in two cases, respectively in office automation and in mechanical engineering, in order to find generic objectives (cognitive, skills and attitudes). The conference proved to be an adequate procedure, although some practical and methodological issues remain to be solved. For vocational education lists with generic training, objectives are generated and validated with reference to new information technologies.

CONTEXT

In 1984 the Dutch government began a programme to stimulate and implement new technologies in general and vocational education. This programme, known as INSP, was a rather new innovation because it is the first time the Department of Education and Sciences (DES) has decided to coordinate departments of government in this field of education. Likewise, administrators have never tried to organize a centralized system of innovation in this field. The INSP organization is divided into five clusters:

(a) coordination of infrastructures;
(b) development of educational software and prototypes for primary, secondary, vocational education including adult education;
(c) in-service training;
(d) schooling and preservice training of teachers;
(e) educational research and evaluation on NIT.

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Each cluster has a project manager who builds a coordinating team together with a top coordinator.

It is quite clear that this organizational structure was set up to follow a top-down strategy in order to reach the best results in The Netherlands, especially in general education and particularly in primary and secondary education.

The developments in information technology and computer sciences confront business and industry and vocational education with new training demands and needs, linked to hardware and software. Organizations from business and industry and especially from technical schools tried, by means of lobby activities and politicians with a vested interest, to obtain sufficient training apparatus and training programmes. The Dutch Department of Education's policy included the introduction of some regional centres with a central and coordinating function for schools and factories. So far, however, the policy in The Netherlands has been very decentralized in the sense that every school has training facilities.

Every school expected to be given additional facilities as a consequence of the new demands and training needs arising from the developments in computer technology. However, the economic situation and cut-backs during the 1980s have left the Dutch government with insufficient funds to fulfil the needs of every school. Thinking over this problem the Department of Education and Sciences (DES) tried to discover if a policy could be formulated in the direction of general or generic training goals for all vocational schools in The Netherlands. Moreover, the concept of regional training centres could have a special function for all technical schools in training students in specific competencies (in-service training).

The Dutch educational system is highly categorized and selective in nature. Vocational education is split into three levels, a lower, a medium and a higher level. Each level has been further divided into tracks (technical, agriculture, commerce, health and so on). In the framework of this chapter we talk about the medium level of technical education and the lower level of administrative economics education.

These, then, are some components of the Dutch context to give a good understanding of what will follow.

INTRODUCTION AND OUTLINE OF THE ARTICLE

In this contribution we will report some of the results of a research project on the determination and justification of performance requirements for new employees (starters) and the determination of new information technology applications. This project, called BAVBO project, was awarded a grant by the Foundation of Educational Research in the Netherlands (SVO) and was carried out from December 1984 to January 1986. The whole project design and the results are documented in Nijhof and Mulder (1986), Nijhof, Mulder and Remmers (1986) and Nijhof, Remmers and Mulder (1986).

First the problem and research questions are described. In short, the problem is how to analyse and determine performance requirements and how to formulate generic training objectives in the field of office automation (OA) and flexible production automation (FPA). Second, the research and development design will be described. In the BAVBO project the curriculum conference (Frey, 1982) is used as a possible solution to the problem. The curriculum conference is a problem-solving method by groups in which results of research (literature, future developments, survey results and other data) are validated and transformed into a list of possible performance requirements. By means of rating and ranking, the scores are finally used to formulate generic training objectives, and the results and conclusions are described. We have separated the results and conclusions about the performance requirements in OA and FPA because the two domains are different. The evaluation of the curriculum conferences and the comparison between the training objectives in the two domains will be presented.

Finally, we will discuss some of the problems related to the curriculum conference (CC) as a tool for transforming and translating data into generic training objectives and designs for instruction.

DESCRIPTION OF THE PROBLEM AND RESEARCH QUESTIONS

Definitions and focus

New information technology (NIT) applications in business and industry raise new training needs in vocational-oriented curricula. By training needs, we mean discrepancies between the actual and desired situation (Kaufman and English, 1979; Stufflebeam *et al.*, 1985). By curriculum, we mean a document or plan in which instructional processes are planned (Johnson, 1967; Nijhof, 1983). NIT applications denote hardware and software which is available for OA and FPA. Other NIT applications were not investigated. These applications, however, are very diverse and performance requirements in the world of work are very differentiated. We perceive performance requirements as statements about the necessary knowledge and skills for carrying out certain tasks in working situations.

The client system of vocational education is so heterogeneous and so many stakeholders are involved in the decision-making process about new training objectives that the problem arises of how to analyse and determine performance requirements and how to formulate generic training objectives. When found and formulated these can be used as a starting point for further curriculum development.

Thus the focus of our research was mainly the 'what' of training NIT rather than the 'how'. By generic training objectives, we mean the broad knowledge and skill expected of school-leavers who possess the qualifying certificate from a vocational training institution. These skills are, of course, transferable to related job situations and are essential to the performance of many tasks (Smith, 1973, 1974; Mertens, 1974; Lipsmeier, 1982; Laur-Ernst, 1983; Nijhof and Mulder, 1986).

One of the considerations we have to take into account when discussing and determining performance requirements is the optimum configuration for instruction of NIT. We have distinguished four classes of instrumentation related to instruction or training: the traditional technology (that is formal teaching related to conventional apparatus), simulation apparatus, instruction and production apparatus. A combination of instrumentation possibilities gives a certain configuration for instruction.

Searching for solutions

The problem of performance requirements, analysis and determination, and formulating generic training objectives has two sides: first the problem of analysis of job information and second the problem of defining training objectives. The perennial problem, however, is to combine both sources of information in a process of transformation (see Figure 1).

There have been numerous attempts to solve the problem of job analysis, depending on the function this analysis has to fulfil (Teryek, 1979; Peterson and Bownas, 1982; Dedering and Schimming, 1984; Finch and Crunkilton, 1984; Carlisle, 1986; Nijhof, 1986). We assume that most of the job analysis techniques are known, so we will not elaborate further on this. The question is which technique or combination of techniques will lead to precise performance requirements and could be helpful in translating them into generic training objectives. Suffice it to say that in our opinion most of these techniques are not operational enough, nor adequate to solve this problem.

One of the best-known techniques designated for the design of new training programmes using specific task or job analyses is DACUM (Develop A CUrriculuM) (Norton, 1985). This technique uses a workshop of professionals in order to produce a so-called DACUM chart, a map with a systematic description of jobs in terms of duties and tasks. No indications are

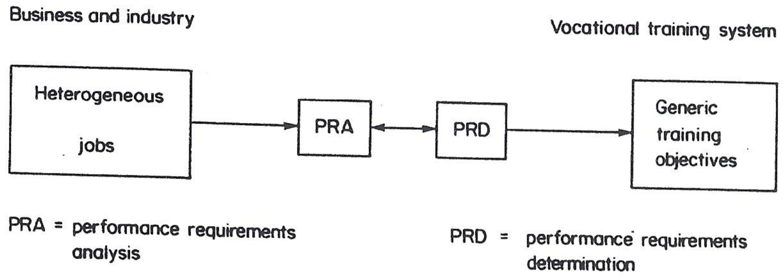

Figure 1. Both sides of the problem

given to determine the performance requirements or to formulate generic training objectives. This job will be left to a curriculum development team.

The techniques for determination or justifying performance requirements for educational purposes are to be found in curriculum design and development literature. Although there are many models (Andrews and Goodson, 1980), research synthesis indicates that very little progress has been made on performance requirements analyses related to this determination (Goldstein, 1980). Furthermore, recent strategies for curriculum design and development contain few procedural specifications for the process of determining generic training objectives (Oliva, 1982; Dick and Carey, 1985; Robinson, Ross and White, 1985). The missing link between the two domains of techniques is the structural relation between job (analysis) and educational and instructional requirements. Peterson and Bownas (1982) have tried to develop a matrix of performance requirements in which two categories of taxonomies, task taxonomies and educational taxonomies, are related to each other, but the practical implications and applications of this matrix are not yet clear.

Our aim must therefore be to try and develop a technique or procedure in order to fill this gap. To solve this problem the following research questions are formulated:

1. How can new performance requirements on new information technology applications be analysed within the heterogeneous world of work?
2. How can the decision-making process be structured in such a way that generic training objectives are determined?

ASSUMPTIONS, DESIGN AND EFFECTS

To enable us to cope with our research questions we designed a research and development project called 'Generic knowledge, skills, and attitudes on computer applications in office automation and flexible production systems'. The project consisted of four main stages:

Stage 1. Initial performance requirements analysis.
Stage 2. Curriculum conference.
Stage 3. Formation of training objectives.
Stage 4. Evaluation.

Our main consideration was how to solve the problem of the structural relation between job analysis and determining performance requirements. We believed this link could be found by using a problem-solving method by groups in which representatives of business and industry, on the one hand, and those from the vocational training system, on the other, would solve this problem by deliberation on the basis of data and by means of procedural specifications.

The curriculum conference (CC) is such a technique, developed by Karl Frey (1982). This technique is based on rationality, expertise from the educational field (curriculum expertise) and competence in deliberation. Solutions have to be found by consensus. Although Frey has used this technique mainly in projects oriented to general education, some experiences have been induced from vocational education. A curriculum conference is a strongly prestructured group deliberation situation of 1 to 3 days in which a maximum of 20 representatives of several social institutions (relevant to a particular subject) validate the results of a performance requirements analysis and specify the content (knowledge and skills) of a curriculum that has to be developed. The major task of the group is to reach consensus on its conclusions on the basis of (empirical) research findings, group scores and knowledge, skill and attitudinal statements. During the CC, chaired by the project manager of the research project, subject specialists are available to clarify problems that inhibit the decision-making process.

The theoretical background of the CC has been extensively described in Frey (1982), Hameyer, Frey and Haft (1983) and Nijhof and Mulder (1986).

Stage 1. Initial performance requirements analysis (PRA)

In this stage the target group for training is identified (namely 187 schools for lower administrative vocational education and 62 schools for medium technical vocational education). For these groups PRA was carried out by several techniques. We distinguished the following methods:

— interviews with subject matter specialists;
— questionnaires from expert performers (vocation-, job or task profile holders);
— questionnaires from representatives of personnel officers, training, research and development departments in business and industry;
— observations on the job, walk-and-talk techniques;
— surveys on task profiles with school-leavers;
— structured interviews with teachers, trainers;
— structured interviews with researchers;
— document analysis (curricula, instructional materials);
— literature on future developments on, and actual use of, NIT.

This whole range of data-gathering techniques has been used in order to make an aggregated description of the current state of NIT in schools and in factories and offices (Spenner, 1985).

Because performance requirements are analysed in a heterogeneous world

of work, it is necessary to detect those variables that are responsible for most of the variance in performance requirements. The variables we distinguished are: company size, type of economic activity, rate of technological innovation and vocational group of the respondent. The results of this stage were aggregated in three chapters of a research report with information about: (a) school-leavers/starters; (b) business and industry; (c) the vocational training system (split up into office administration and technical education).

As a result of a content analysis of the research findings a list of possible knowledge, skill and attitude aspects was compiled. This information was the input for stage 2.

Stage 2. The curriculum conference

Two curriculum conferences were organized, one for office automation and one for mechanical engineering (technical education). Representatives from both the educational system and from business and industry were selected to analyse the results of the information document and to rate the performance requirements on a scale with two dimensions: the level of performance (behaviour) and the level of relevance.

During the preparation of the CC the following steps were taken:

— formulating the goal of the CC;
— inviting the participants;
— producing the information document;
— producing the working document;
— practical preparation;
— planning the conference program (logistics);
— making guidelines for the participants.

The participants of the CC prepared for the sessions by reading the information document of 50 pages and by filling in a working document.

The working document contains: (a) forms to write down conclusions about the chapters of the information document from stage 1; (b) a questionnaire about the personal expectations of the CC and the assessment of the information document; and (c) the knowledge, skill and attitude score forms. The scores were formatted with a taxonomy developed by Olbrich and Pfeiffer (1980).

The taxonomy of Olbrich and Pfeiffer contains two dimensions. The first describes the job aspects: the kind of work, the sequence of tasks, the frame factors of work, conditions for cooperation and responsibility related to levels of mastery. The second dimension describes mainly the cognitive and affective aspects: the kind of learning behaviour, the organization of the learning process, the use of media, the use of subject matter and, lastly, the motivational aspects of learning. All of those are related to levels of mastery.

We used the second dimension because the job aspects have been covered by stage 1. In the cognitive dimension four levels of mastery of educational aims are defined: knowing, understanding, application and evaluation. There is a clear analogy with the well-known Bloom taxonomy (Bloom, 1956; Romiszowski, 1981)

The conference itself consisted of four stages: (a) introduction; (b) analysis of the information document; (c) deliberation and decision-making about the knowledge, skills and attitudes necessary; consensus ought to be reached; (d) evaluation of the CC.

Stage 3. Formulation of training objectives

Given the fact that the CC is a very intensive procedure for participants and the chairman, the research team must, after the conference, put the finishing touch on formulating the (training) objectives in operational terms. As a consequence of the deliberations, several arguments and statements are made about the context and the implications of the knowledge, skills and attitudes related to automation and NIT. It is therefore essential that a precise job should be done. Although it would be worthwhile to assess the final result from the participants, this did not take place because the refinement of the formulation of objectives did not change the substance, and also because of a lack of time and money.

Stage 4. Evaluation of the curriculum conference as a tool

One of the goals of the whole project was to evaluate the effectiveness and efficiency of the CC. Because of the use of the CC in two domains, we can speak of two different projects within the main route we described earlier. It becomes possible to formulate conclusions by comparing the two conferences. The design of the evaluation is depicted in Figure 2.

This design is based on the principle that in conventional research (surveys) respondents will rate statements offered by a research team. On the basis of cluster or discriminant analysis the interpretation can lead to dominant profiles of statements referring to cognitive, psychomotor and attitudinal skills. However, we know that the validity and reliability of such procedures might be low, especially when the non-response is very high or when the sample is biased (Bilderbeek and Smits, 1985)

Consensus in a CC might be a better measure. However, even here some methodological issues arise. The group is rather small and perhaps not representative of the population of expert workers in education and industrial training. On the other hand, deliberation can lead to a valid and reliable analysis of concepts and statements. Whatever route we take we may establish agreement. Finally we can discuss the question of whether group behaviour will model the behaviour of every member of the group. Dominant roles, charisma, the place and the status of members in the group can mould the

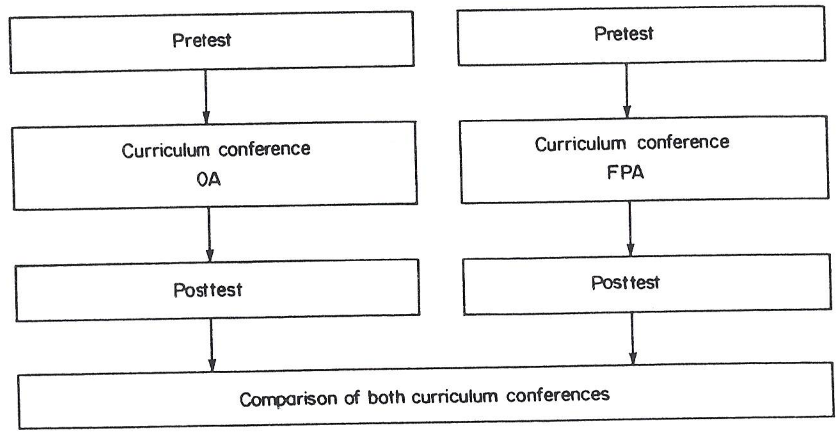

Figure 2. Design of the evaluation of the curriculum conference

deliberation process in an unwanted and unforeseeable direction. To allow some control of this process we can measure intervening variables like feelings in the group, group cohesion, satisfaction and commitment with the ultimate results.

In order to gather relevant data we used an analogy of the one-group pretest–posttest design (Campbell and Stanley, 1971). The pretest consisted of an individual questionnaire with three categories of questions: (a) personal data; (b) motives and expectancies; (c) assessment of the information document.

The posttest consisted of individual questionnaires with questions on the following topics: (a) the effectiveness of the information document; (b) information during the CC; (c) experiences related to expectancies and motives; (d) personal experiences during the CC; (e) judgement of the procedure as a whole.

The whole process of the two conferences has been registered on videotapes. These have been used for further analysis (communication structure, arguments analysis, deliberation and rationality). Some results of this analysis were added to the final report, while others are integrated in a comprehensive review article on the use of curriculum conferences (Mulder, Nijhof and Remmers, 1987), on the basis of several studies within our Department of Education, Division of Curriculum Technology, University of Twente.

RESULTS

In this section we will describe the results on the performance-requirements analysis of OA and FPA, the curriculum conferences and the determination of generic training objectives.

Performance requirements in office automation (OA)

The major characteristic of OA in business and industry is that it has structural consequences for the information flow in the organization. More complete data are available, which can be reached more quickly. These data can be used at policy level for management decisions. Office automation has radical consequences for lower administrative jobs because many of the tasks are taken over by automated systems.

The following performance requirements are stated by respondents from 25 firms:

- knowledge of hard- and software;
- an understanding of the place of the tasks in the working unit or department of a company;
- an understanding of the data source, data destination and the consequences of error;
- numeric and alphanumeric keyboard skills;
- perseverance;
- precision, coping with stress;
- interactive skills.

We have seen that the work of administrative personnel becomes more service and client oriented, which is easier with automated office systems. This process has the following consequences for performance requirements and therefore for the formulation of training objectives:

- basic language skills;
- commerical understanding;
- knowledge of the importance of information and information processing;
- client-oriented actions.

In small- or medium-sized companies, the performance requirements cover a broader range and are of a higher level compared with the larger companies, because of the more integrated functions in one job. Performance requirements stated by representatives of vocational education are:

- understanding of computer systems;
- knowledge of the English jargon;
- knowledge of some software packages (like text processing, financial programs, coding and decoding, sorting programs, file management, invoice program, spreadsheets, data communication);
- skills on text processing;
- keyboard handling;

- starting the system;
- data entry and data modification;
- working with menus;
- capable of reading instructions (manuals);
- working with integrated software packages;
- handling of output, listing;
- storage of data carriers.

Research on school leavers has pointed out that 16 per cent of the certificated students have found a job within 0 to 12 months after leaving school. Only 4 per cent of the population, however, worked with computers in 1985. Therefore it seems to be more appropriate to identify the performance requirements that are relevant for *further* training in administration because of the expected growth of automation in The Netherlands (Mulder and van Lent, 1988).

Performance requirements in flexible production automation (FPA)

The main characteristic of FPA is that rather independent working places and machinery will be integrated into group technology, controlled by some closely cooperating workers. Controlling the complex total of production methods requires knowledge of the relations between the various machines and machine parts and of the technological meaning of the sequence of production phases. We observed a much closer link between work preparation and production in the companies than we expected from our knowledge of the literature or from interviews with experts. This implies a much greater knowledge and (meta-)skill level for trainees and school-leavers than was expected. This is particularly true of a more general knowledge about planning, management of organizations and connections between parts of the organization, which is crucial when working with automated systems. Representatives of 20 companies have stated the following performance requirements:

- general knowledge of informatics (computer science);
- digital control technique;
- electronics;
- computer-aided design (CAD);
- robotics and process controlling;
- practical skills in traditional mechanical engineering, like milling, turning, lathing, installing;
- knowlege of tools and materials on computer numeric controlled (CNC) machines;
- subject matter (disciplines) like mathematics, stereometry and geometry will again become important;

- much emphasis is also laid upon administration;
- planning and management, work preparation and cost-effectiveness analysis competencies are considered to be extremely important.

Representatives from vocational education have stated the following requirements:

- theoretical knowledge of computer science;
- knowing how to handle CNC machines (programming, service, safety aspects, etc.);
- mastery of digital control techniques;
- elementary knowledge of electronics;
- computer aided design (CAD), as an essential tool and technique;
- electrotechnical engineering as a practical tool;
- business administration, management and organizational knowledge are important;
- robotics is not a major issue; attention has to be paid to developments in this field;
- process control is an important object, theoretical as well as practical;
- attitudinal components like quality control, responsibility towards apparatus, being systematic and having skills to communicate with people in the plant.

Comparison between office automation and flexible production automation

If we compare the results of the foregoing analysis we see that the performance requirements in OA stated by the representatives of the companies are more global than those in FPA. Within both domains the representatives of vocational education overestimate the rate of technological innovation in offices and factories and therefore the necessary performance requirements. All participants in both domains state that there is no structural communication between vocational education and companies in order to update the common knowledge, which has a negative effect on the revision of curricula for NIT.

NIT tends to upgrade the level of competency needed for work with FPA, including a higher degree of mental preplanning of the production process. Computer applications in office automation, however, seem to demand higher performance requirements in front office jobs and lower ones in back office jobs. For all the applications of NIT we see that knowledge of the non-automated working process remains very important. The attitudinal component of the generic cognitive training objectives are very much emphasized although these requirements have not yet been differentiated.

Two other aspects arise from the evaluation of the results. Representatives

from business and industry have more problems in explicitly and specifically formulating the necessary performance requirements. Their statements are rather global, whereas participants from the vocational system are used to formulating and specifying competencies. This might seem a trivial conclusion, and indeed it is, but it means that a mix of information sources for this group to analyse performance requirements might be very helpful and instructive. A second point concerns the preferable kind of instruction mode. Companies do not prefer computer simulation as an instruction tool, or instructional production machines, as the *only* preparation for work with very expensive computer numerically controlled (CNC) machines. They favour modest use of this new equipment, as well as conventional techniques of training.

The curriculum conference: processes and products

The CC as an approach to determining the design of a curriculum including instructional or training objectives has been effective but only partly efficient because of difficulties with the rating of statements at the preparation stage of the participants. The content dimension as used in the Olbrich and Pfeiffer taxonomy proved to be multi-interpretable and the scoring of the behavioural component was not clear. During the sessions these problems could be corrected, but it caused a partial loss of the data of the pretest.

The taxonomy for the analysis and rating of performance requirements ought to facilitate and structure the decision-making process. In practice, however, the use of taxonomies requires some kind of training. We tried to offer a 'simple' part out of the taxonomy of Olbrich and Pfeiffer, because validation processes must not be blocked by complex instruments. Certain well-defined clusters of generic knowledge, skills and attitudes on NIT applications related to OA and FPA systems have been formulated and justified and will presumably be translated into curricula. Corporations and non-profit organizations can provide additional specific competence-based training (on the job).

The generic training objectives

List of generic training objectives were compiled as a result of the curriculum conferences. This, however, proved to be no simple process of bargaining or deliberation, because the relationships between relevance and transferability of both lateral and vertical objectives within jobs had to be conjectured. The process of deliberation was sometimes tough and intensive, but open and constructive, and led to 51 objectives for OA and 68 for FPA. These objectives were grouped into main clusters, most of them induced from the prestudies and the school curricula (see Table 1).

Table 1: Clusters of generic training objectives for office and flexible production automation

Office automation		Flexible production automation	
1. Automation in working organizations	(12)	1. Basic informatics	(5)
2. Computer use and administration	(16)	2. Business administration	(9)
3. Data entry and control	(8)	3. Controlling technique	(12)
4. Data processing	(8)	4. CAD systems	(9)
5. Text processing	(7)	5. Electronics	(1)
		6. Electronic technology	(5)
		7. Measuring and regulation technology	(4)
		8. CNC technology	(8)
		9. Process technology	(2)
		10. Robotics	(13)
Total	(51)		(68)

(. .) = number of generic training objectives per cluster

A simple view of this table shows two dominant categories in OA related to NIT in organizations and administration, whereas the spread over categories in FPA is broader. For this the two dominant categories are use and knowledge of robots and control techniques. Table 1 gives a general overview of the number of objectives related to main categories. To give some insight into the nature of the generic training objectives we take four objectives from the FPA cluster 'measuring and regulation technology':

1. The student is capable to handle knowledge on cybernetics.
2. The student is capable to handle knowledge on automatization related to pneumatic analogical apparatus.
3. The student knows how to use electronic digital apparatus related to automatization of regulation systems.
4. The student knows how to use electronic analogous apparatus related to automatization of regulation systems.

He knows how to handle mathematical equations and tools in order to solve problems of this kind. He is capable to enact on the basis of detailed plans and prescriptions. (Nijhof and Mulder, 1986, p. 236).

Table 2 is more important for our purposes, however. The groups were required to make judgements of relevance on the cognitive (K) and skills (S) aspects, each of them consisting of four levels. The cognitive aspect contains: knowing (K1), understanding (K2), application (K3), and evaluation (K4). The skills aspect contains: observing (S1), handling (S2), executing (S3), mastery (S4).

After a general plenum discussion the participants decided to exclude levels

Table 2: Indication of the relevance and level of generic training objectives in office and flexible production automation

Office automation							Flexible production automation						
Cluster	K1	K2	K3	S1	S2	S3	Cluster	K1	K2	K3	S1	S2	S3
1		×		Not relevant			1			*			*
2			*			*	2		*			×	
3			*			*	3			×			×
4		×			*		4			*			×
5		*				*	5		×			×	
							6		×			×	
							7			×		*	
							8			*			*
							9			*		*	
							10		×				×

Cluster 1 to n, see Table 1.
K1 = knowing; K2 = understanding; K3 = application
S1 = observing; S2 = handling; S3 = executing
× = important; * = absolutely necessary

K4 and S4. No school-leaver or new employee can be expected to show complete mastery of a job; moreover, generic skills must give him or her the opportunity to learn and train in the future (on the job–off the job) in order to reach full competence and qualifications.

Table 2 presents the dominant scores on the knowledge and skill aspects in each cluster, showing relative importance and level of mastery. In this table, the mean of the unanimous subgroup scores are indicated. For a good understanding of the measure it is necessary to give some background information. During the curriculum conference the group as a whole is striving to reach consensus. It proved not be be realistic and feasible to discuss all the possible performance requirements in one group, so we decided to cover the whole by splitting up the group in five subgroups of four persons. Every group would take half of the main categories in such a way that the whole task was covered. Each group should argue the various aspects and reach consensus by rating and ranking. The mean score of all subgroup scores was taken as the criterion for decision-making.

As we can see from this table the conference members decided also to exclude the K1 and S1 objectives. The rationale is that knowing and observing are prerequisites for the other levels, but can be seen as basics, not as generic objectives with transferability. So the main categories are understanding (K2), application (K3), handling (S2), and executing (S3). Further, there is a strong correspondence between the cognitive and skills level. This means that understanding and handling, on the one hand, and application and executing, on the other, have common grounds and a related psychological basis. Most of the objectives selected in OA are absolutely necessary, whereas in FPA the number of important objectives (×) ($n = 11$) dominates the absolutely necessary ones (*) ($n = 9$).

It is remarkable to see that all the clusters are relevant or absolutely necessary, except cluster 1 for OA in the skills domain. The reason for cluster 1 is that a new employee should know how important automation is for the organization, but he or she need not be capable of handling or executing the implementation of automatization.

The conferences formulated clear but rather global statements with regard to attitudinal aspects. As a consequence of NIT and automation, OA and FPA employers expect much more flexibility from employees. This is because (meta-)cognitive skills like systematic thinking and planning, analytical reasoning, problem-solving attitudes, adaptiveness and an innovative attitude are essential to their function. As a consequence of these aspects we found that communication skills and taking initiatives are very important, as are those competencies of employees that concern possible risks in an organization, such as responsibility, cost-effectiveness, attitude and being accurate and precise. The reason for this is clearly because every fault or mistake can have tremendous consequences, especially in firms where precious apparatus is used and the production has been completely automated (Nijhof and Mulder, 1986, pp. 252 and 272).

Conclusions on results

Returning to research questions about the way in which performance requirements in NIT applications can be analysed within the heterogeneous world of work and how the decision-making process can be structured in such a way that generic training objectives are determined, we draw the following final conclusions.

First of all we want to avoid the mistake that there should be a one-to-one relationship between performance requirements and the curriculum content of vocational training objectives. Second, the vocational training system should not be technologically determined by business and industry. Many variables that are responsible for variance in the curriculum-development process should be taken into account during the process of performance-requirements analysis and determination. Various sources of information ought to be used.

Our conclusion is that the curriculum conference is a worthwhile instrument for filling the gap between performance-requirements analysis and the determination of instructional objectives. The structure of the curriculum conference itself and the guidelines for executing the conference and its

preparation proved to be successful in two cases, office automation and flexible production automation.

The conference is a generic method, a problem-solving method by groups, and its strength is based on a combination of expertise, rationality, cooperation and intelligence, which will lead to valid and reliable outcomes.

In our case we tried to find generic training objectives for two vocational domains closely connected to NIT. Although we did succeed, some practical and methodological issues have not yet been completely solved and need further discussion.

DISCUSSION

In this chapter the curriculum conference method as a tool was the central element in the process of generating and justifying instructional objectives for vocational training in new information technologies. We opted for this method because of our earlier experiences of it in the printing industry, and other experiences we had in combination with the National Institute for Curriculum Development in The Netherlands (SLO). Moreover, the conference is based on explicit assumptions on rationality and consensus-building from the argumentation theory of the Erlanger Schule (Frey, 1982; Hameyer, Frey and Haft, 1983; Nijhof, 1985) and on the generic guiding model from Frey and from Aregger (1973).

The conference is of practical use in the sense that the procedural specifications are clear, and are very open to the user. We, for instance, decided to use the taxonomy of Olbrich and Pfeiffer (1980) in order to arrange and rearrange the complexity of information and possible instructional objectives.

The conference model is quite suitable for research and evaluation purposes. Different studies are still in progress, comparing the processes and effects of the DACUM method and the curriculum conference (Hesse and Nijhof, 1988).

In this section we first discuss some problems related to the curriculum conference as a method, and second we will discuss the question of the implications of the generic skills for training and transfer.

The curriculum conference as method: some problems

The *selection of participants* is a crucial part of the CC. The question is who is the right person to participate in the decision-making process. There is no single and simple answer to this question. We distinguish fifteen personal and group criteria. The personal criteria are: knowledge of the target group, of the subject, and of job practice, communication skills, and positive attitude to education and training. Group criteria are: company size, sector of economic activity, rate of technological innovation, functional area, region, subjects and relation to curriculum development. A question related to the problem of selection criteria is whether one should select persons on these criteria and, if so, how? In many cases there is no possibility of selecting participants for a CC, because of practical constraints or ethical objections. Some people from small industries cannot be spared from their organization, not even for one day. Sometimes the processes of production are confidential, so people are not free to speak openly.

Even so, the group composition will influence the results. For purposes of research, to control the process variables, the selection of participants has to be carried out by means of well-defined criteria. Selection on the basis of an ideal group profile might be a solution.

The *information document* is a crucial source in the CC. Although these materials were available ten days or more before the CC, a certain number of participants did not read them or refused to fill in the working document. The consequence is a (partial) loss of data and a (partial) loss of reliability of the analysis and determination process due to the differences in preparation level. Part of the problem was that participants did not understand the taxonomy to be used in order to rate the cognitive and skill aspects of the job. This problem might be avoided by taking more time for instruction, reading and scoring. Frey prefers conferences that take longer than we were able to do—five days for a whole curriculum design. We used two days for justifying the instructional objectives and for arranging them in main clusters or disciplines.

A third problem has to do with the *reliability and validity* of the scoring procedure we used. Is it really true that differences between individuals can be eliminated by a rather short deliberation process? We have seen large shifts of individual scores towards group scores. Do these shifts hold after a period of time, or do they stand only during the conference days? If not, the curriculum conference has led to generic training objectives that are not very solid. A follow-up project (Van den Berg and Nijhof, 1987) checked whether the formulated generic training objectives hold for constructing instructional materials for mechanical engineering. For office automation the National Institute for Curriculum Development (SLO) used the objectives for constructing curriculum materials.

The participants believe the whole project has delivered many generic training objectives. These objectives can be added to the curriculum, or they can replace others. As far as the attitudinal aspects are concerned, we found many statements referring to general cognitive qualities and competencies. These are not new but underline the necessity to strengthen these competencies to such a degree that the generic training objectives are more or less bound to specific matter at higher levels than before.

A serious problem arises. Do we need an additional curriculum approach or do we need an integrated one? The second might prove promising. The

whole content and structure of the existing curricula together with the frame factors have not been part of the BAVBO project. For an implementation of these objectives in schools and training centres, curriculum teams have to be built with specific knowledge of the frame factors of mechanical engineering and with knowledge of the total structure of the curriculum.

Implications for transfer and training

In this last subsection we will discuss some implications of generic training objectives for instruction and for transferability.

Let us remind the reader of the fact that the focus of research was to generate generic skills and objectives related to new information technologies. Thus the main focus of the project was curricular in nature, that is to say, the 'what' question had to be answered. The question is, however, whether we can justify objectives that cannot be implemented in instruction or do not have the expected transferability. The quality of transfer was the most crucial point in the definition of generic skills. We have seen that the participants of the conferences decided to exclude two levels of objectives, the simple level of knowing (cognitive aspect) and observing (skills aspect) and the level of evaluation (cognitive aspect) and mastery (skill aspect). The question is whether or not the two other levels in the taxonomy of Olbrich and Pfeiffer have transfer abilities in principle. This depends on the definition of transfer, of course. 'In general terms, the word *transfer* refers to the influence of learning in one situation or context upon subsequent learning in another situation or context. Thus we would be concerned with transfer when we studied . . . the effect of learning in school on performance outside school or, more generally, the effect of past learning on present learning' (Ausubel and Robinson, 1969, p. 136). According to the theory of transfer Ausubel and Robinson distinguish three forms of transfer: lateral, sequential and vertical. Lateral and sequential transfer are essentially horizontal in that the learner stays within the same behavioural category in making a transfer (p. 138). Vertical transfer, however, facilitates learning from one behavioural level to a higher behavioural level, for instance comprehension can lead to problem-solving. If we stay within the taxonomy of Olbrich and Pfeiffer we know that the generic objectives have been formulated at the level of understanding (comprehension) and application, for the cognitive aspect. The skills aspects were handling and executing. From the connotations and descriptions of Olbrich and Pfeiffer we know that at these levels *rule learning* will take place and generalizations will be fostered by using similar situations, cases and circumstances. Also, in principle, all objectives must have transferability when the participants and the research staff have checked and formulated them according to this principle.

However, the kind of transfer might differentiate between lateral, sequential and vertical transfer. In office automation, for instance, within the domain of text processing, we must ask whether training with 'word perfect' will lead to lateral tansfer to other text-processing packages or whether knowledge of the basic principles of mathematics and electronics will lead to problem-solving in programming CNC machines (vertical transfer).

How the training should be carried out for generic objectives is an interesting question because different options are available. In our questionnaires and interviews we asked the companies and schools to indicate what kind of instruction (on-the-job–off-the-job–in-service training) would be the best at what stage of experience. We received no clear answer. The use of modern equipment, teaching machines, simulation apparatus, CNC machines are encouraged in mechanical engineering, but in a very wise arrangement. In office automation the biggest need is for text-processing machines. Classrooms in office automation courses look like real offices, so the experience in working with modern machinery stimulates the transfer from school to work.

The in-service training of teachers in new training techniques like simulation and CNC apparatus takes place within the framework of the national project on information technology (INSP). This special project is called NABONT and its purpose is to have personnel trained to an advanced level in schools and regional centres, in order to foster the transfer of knowledge between school and work and between teacher and student. Experimental studies will have to prove which kind of instruction will have better transfer effects (better retention of older learning, better results on standard tests, significantly better problem-solving behaviour and so on). However, first of all we need instructional plans and curricula based on generic objectives. Once these have been supplied the proof will follow.

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7. Mimicking the Training Expert: A Basis for Automating Training Needs Analysis

Andrew Shepherd and C. J. Hinde

SUMMARY

Training needs analysis (TNA) relies upon the expertise of human analysts to supplement the formal task analysis methods of occupational psychology. Therefore, providing a computer-based approach to TNA entails mimicking the human expert. An approach to TNA, based on modelling organizations with task and context prototypes, is described.

INTRODUCTION

Training analysis and design has been a central issue in occupational psychology for many years. A major preoccupation has been the development of formal methods of task analysis to identify training needs leading to training design. These are reviewed by Patrick (1980). The main approach has been to break tasks down and categorize the resultant task elements according to psychological types from which training hypotheses can be inferred; for example Miller's information processing approach (for example 1967) or Gagne's conditions for learning taxonomy (for example 1970). An implicit aim of this work is to provide techniques enabling unambiguous training decisions to be made without reliance upon the skills of the analyst. People inexperienced in training analysis could thus make reliable practical training decisions by applying straightforward rules or procedures. Unfortunately, such techniques can never be applied so easily. Diagnosis of a training problem and the selection of training conditions are substantially influenced by *contextual* factors such as technology, safety, profitability, custom and practice and organizational culture. Hence, training analysis and design

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