

Innovations in vocational education and difficulties in their empirical substantiation

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SUMMARY

As a consequence of findings and theses on the change in demand for qualifications, the debates on lifelong learning and a large number of articles on the theory of didactics, since the mid-1980s the concept has become established that traditional methods of teaching and learning in vocational education are dysfunctional and should be replaced or complemented by methods which are more activity- or problem-oriented, as well as being of a self-regulated nature. However, as concerns vocational education, empirical verification of the assumptions which form the basis of this shift in didactic theory is largely lacking. This article aims to help reduce this deficit and may serve as a basis for a critical questioning of the viability of common assumptions.

Initial problem

Following on from findings and theses on the shift in demand for qualifications, supported by constructivist theoretical articles and further strengthened by the debates on lifelong learning, since the mid-1980s the concept has become established that traditional methods of teaching and

learning in vocational education should be replaced or complemented by methods which are more activity- or problem-oriented, as well as being of a self-regulated nature (¹). Above all, this is explained by the international discussion on and spread of the approaches of cognitive apprenticeship, cognitive flexibility theory, anchored instruction and guided inquiry (see Carver and Klahr, 2001; Magnusson and Palincsar, 1995; Straka, 2002). A central characteristic of the new learning/teaching strategy is groups of learners actively working out contexts, independently and if necessary with the support of teachers as required (see Mulder 2002, p. 59 et seqq; Reinmann-Rothmeier and Mandl, 1998). Traditional forms of teaching are considered to have more of a complementary function, supporting the process of self-construction of knowledge (see Mulder, 2002, p. 60). The expectations attached to the current paradigm on the international educational/psychological research scene are extremely promising: the aim is to avoid passive knowledge being amassed, to ensure that relevant existing knowledge is more profoundly assimilated, to effectively encourage problem-solving abilities specific to each subject and to promote cross-curricular abilities. OECD research such as PISA, TIMSS and others shows that these are aspects which it would be advantageous to promote in many countries. Apart from this, the new teaching/learning strategy is meant to help improve social skills; after all, the point is to bring the development of skills into line with changes in demand.

The theoretical assumption is that teaching/learning strategies oriented towards the construct of an activity-centred approach and stronger self-regulation are more effective than traditional teaching methods in:

- ensuring that connections are made with preconceptions and/or misconceptions are brought to light and can therefore be dealt with,
- ensuring that the learner asks questions independently and gains a deeper understanding of the subject matter,
- encouraging the application of knowledge and
- promoting metacognitive abilities and motivation (see Bransford, Brown and Cocking, 2000; Nickolaus, 2000; Sembill et al., 1996).

In the Federal Republic of Germany an attempt was made, after initial problems which it must be said still exist today, to find a fixed place for the current didactic paradigm in lessons at vocational schools, and to push on the reform process by means of stipulations in the curriculum (e.g. see Halfpap, 2000). This was preceded by numerous pilot schemes during which new methodical approaches were tested out.

However, the academic studies which accompanied these pilot schemes were limited to formative evaluations, which do not allow any certain conclusions to be drawn on the effectiveness of the educational activity programmes. Recently, some rather tentative studies have been carried out which have been able to fill some of the existing gaps. To some ex-

(¹) For example, see Achtenhagen and Grubb, 2001; Achtenhagen and Thàng, 2002; Buijten 2004; Halfpap 2000; Nickolaus 2000; Ott 1999; Mulder 2002.

tent, however, the results throw doubt on whether the expectations connected to the current paradigm will be fulfilled. For an overview of the research results and desiderata for Germany in the field of industrial and technical vocational education, reference should be made to the summary by Nickolaus, Riedl and Schelten (2005). In a handbook article, Achtenhagen and Grubb (2001) sum up the general situation regarding findings in the international field of vocational education, describing it as deficient. This article introduces some results from empirical studies carried out in the school sector of technical vocational education in the Federal Republic of Germany.

The effects of basic methodological decisions in lessons at technical vocational schools on the development of skills and motivation

In the Federal Republic of Germany, after the paradigm shift in didactics and methodology, some initial comparative studies were made involving preliminary business courses; their results confirmed assumptions on the advantages of constructivist learning environments in developing skills and motivation. For example, in 1998 Sembill et al. came to the conclusion that the development of knowledge in activity-centred experimental classes is at least no poorer than in classes taught in the traditional manner, and on the other hand, problem-solving skills and motivational development are considerably better. In his investigation, also set in the commercial sector, Bendorf (2002) established above all that the ability to transfer knowledge is more developed in those classes taken as case studies which fall under the heading of an activity-centred approach as it is understood here.

In industrial and technical vocational education, only a small number of studies have been carried out in the last few years into the effect of methodological strategies, chiefly in preliminary electrotechnical training. As well as the findings and assumptions reported above (see also Nickolaus 2000, Nickolaus 2001 and Weinert 2000), another significant reference point for these studies was the ATI research findings, as considerable differences must be assumed in this sector and between individual skilled occupations as concerns aspects of cognition and motivation, and in various studies, students with weaker cognitive skills have been diagnosed as having considerable problems regulating their own learning. The ATI research has produced findings which, despite considerable constraints (e.g. see Terhart, 1997 pp. 81-84; Bracht, 1975; Helmke and Weinert, 1997) provide evidence that inse-

(?) Generally it must still be taken into account that teaching methods are comparatively weak predictors of learning success. On this subject, see the results of Helmke and Weinert (1997) replicating a meta-analysis following on from Fraser et al. 1987 (see also Nickolaus 2000; Wang et al., 1993). Variance explanations are often in the 2 - 4 % range.

cure, timid, less well-achieving learners are overtaxed in less structured forms of teaching, or document advantages for this group in directive teaching methods (Flammer, 1975) ⁽²⁾. Weinert (2000) summed up the findings on the influence of choice of method on skills development, primarily as related to the field of general education. According to this summary:

- variable forms of directive instruction are especially suited for acquiring factual knowledge,
- forms of situated learning and didactic strategies using project work, group teaching and creative exercises are particularly effective in promoting the acquisition of life-related procedural knowledge, and
- teaching methods involving independent learning, which enable subjective learning experiences to be acquired in a targeted manner and metacognitive insights to be developed under supervision, prove advantageous in encouraging the acquisition of metacognitive skills and learning strategies (Weinert, 2000, p. 46).

In the run-up to implementing the new didactic paradigm, there was no investigation into whether and to what extent the findings outlined above could also be replicated for preliminary industrial and technical education. As mentioned previously, in the field of technical vocational education, studies have until now mainly been carried out in the field of preliminary electrotechnical education; this topic will be discussed in the following. A universal aspect of the studies is the fact that they are limited to specialised vocational skills, mapping them in a skills model discriminating between three aspects:

- (1) Declarative knowledge, whose development can be investigated on the one hand in the sense of differentiation or the increase in elements of knowledge, and on the other hand with regard to depth of knowledge, in the sense of the elements being more closely interconnected.
- (2) Procedural knowledge, i.e. knowledge of the procedures and strategies needed to deal with a task, which must be adapted according to each situation.
- (3) The ability to work out subject-related problem-solving tasks at an everyday level.

In two of the studies (Nickolaus and Bickmann, 2002; Nickolaus, Heinzmann and Knöll, 2005) the group chosen for investigation was electrical fitters ⁽³⁾, whose education consists mainly of learning their trade and who are a rather weak group in terms of cognition in the field of electrotechnology.

These studies showed that, in the case of electrical fitters, contrary to all expectations, benefits for skills development did not appear in activity-

⁽³⁾Training courses for electrical fitters are among those for which there is greatest demand in the skilled trades sector (Howe 2004; BMBF: Berufsbildungsbericht 2004). The job includes fitting, testing (taking measurements) and correcting faults in electrical installations in homes and manufacturing plants. They should be able to perform all steps independently: customer-friendly planning, preparation, installing and putting into operation of all wiring, sockets, switches and fuses in complete systems or subsystems.

centred classes, but instead in those taught using a directive method; following this, another study was carried out involving electronics technicians⁽⁴⁾, a group including better-achieving alumni from schools of general education.

Going back to the findings outlined briefly above⁽⁵⁾ the following hypotheses were formulated on the skills aspects of the skills model:

H1: 'Declarative contextual knowledge (i.e. factual structural knowledge), which also includes a necessary basic understanding of the technical system required to work out everyday problem-solving tasks, is more finely developed in systematic instructional teaching than in self-guided methods of acquiring knowledge.'

H2: 'The ability to independently work out everyday problem-solving tasks develops better in self-guided methods of acquiring knowledge than in systematic instructional teaching; the same is true of procedural knowledge relevant for examinations.'

H3: 'Any remaining differences at the end of the first year of training in the ability to work out everyday problem-solving tasks are reduced just by going over the problem (with guidance) a few times in succession.'

H1 follows on directly from the findings summarised by Weinert (2000). As concerns the ability to work out everyday subject-related problem-solving tasks, we also primarily draw on findings made outside vocational education (Weinert, 2000; Helmke and Weinert, 1997). As regards this kind of ability, however, it must be borne in mind that the nature of the problem is an important factor in problem-solving performance (Bransford et al., 2000) and its relationship to relevant predictors. The more concrete (and thus easier to grasp) the formulation of the problem is, the stronger linear relationships between intelligence and problem-solving ability become, for example (Strohschneider, 1991). As concerns typical everyday problems confronted by electrical fitters, which are generally characterised by a relatively low level of complexity and clearly-defined targets, and possible solutions which are known in principle, the question arises of whether poor training in the skills required for this may actually mainly be because problem-solving strategies are generally not systematically taught as a subject in training. In this context, another factor which must be taken into account is the note by Schelten and Riedl on the final organisation of the learning activity in activity-centred lessons (Nickolaus, Riedl and Schelten, 2005); if there are no systematic teacher-led reflections and generalisations of experiences acquired situatively, there is a risk that knowledge will not be transferred to other contexts. Another factor which could prove problematic is the other danger connected with activity-centred strategies: not enough

⁽⁴⁾ Electronics technicians fall into the category of industrial occupations. Electronics technicians also carry out installation, tests and maintenance work, but on more complex electrical systems. The different requirements for these electrical vocations range from selection processes to significantly different entry requirements for school-leavers, related to IQ, school background, aspects of previous knowledge and motivation (see Knöll, Gschwendner and Nickolaus, 2006).

⁽⁵⁾ For an overview, see Weinert 2000, in more detail Helmke and Weinert 1997.

declarative knowledge being acquired, which can be seen as a necessary prerequisite for the ability to work out problem-solving tasks. Some of the questions raised here apply equally to the development of procedural knowledge. With this in mind, and returning to the current paradigm, it seems urgently necessary to examine H2, especially in courses of dual (combined theoretical and practical) education.

The reason for examining H3 was the circumstance mentioned above: typical problems which skilled workers are confronted with every day generally have known solution processes and can therefore, in principle, be taught in a traditional, directive manner; and in the past, at least, there was not (enough) systematic training in lessons, for example in fault analysis. Another point to be made is that deficits of this kind can probably be compensated for quickly in practice, on the job.

As regards the framework of conditions for motivational variables (Deci and Ryan, 1985, 2002) a great variety of data is now available on preliminary business courses thanks to the works of Prenzel et al, 1996, 1998; Hardt et al, 1996, 1998; Lewalter et al, 1998; Wild and Krapp, 1996 (see also Beck, 2002). Nonetheless there is still a lack of data on motivation development in the context of different teaching strategies. The findings of the research group headed by Sembill et al., 1998, indicate that motivation develops better with self-guided methods of acquiring knowledge in settings which are relatively restricted in terms of time. Based on this, we have formulated Hypothesis 4 ⁽⁶⁾:

'Self-guided methods of acquiring knowledge also have a positive effect on learning motivation over prolonged periods.'

Structure of the investigations

The hypotheses were examined or are being examined within the scope of field experiments, to ensure that the studies are also valid for teaching practice. The field experiments each covered the first year of training. In the first study, involving electrical fitters, four classes (N=69) were studied, two of which were mainly taught using the directive method and two mainly using the activity-centred method. A more extensive replication study involving electrical fitters covered ten (N=224) classes, and one involving electronics technicians covered eight classes (N=189). For information on the development of skills and motivation, data were gathered at three points (initial, midway and final test). The information on problem-solving ability

⁽⁶⁾ In this paper, Hypothesis 4 will be tested only in a cursory manner for reasons of space, with central findings being pointed out (Knöll, Gschwendtner and Nickolaus, 2006).

⁽⁷⁾ To give an idea of the tasks chosen and to see how they are related to the skills aspects, here we will describe one task each for declarative and procedural knowledge. The following task addresses the subject of procedural knowledge: 'An apprentice has rented a room and would like to roughly work out the energy costs (electricity charges) he will have to pay. His room is furnished with a ceiling lamp, a television, a fridge and a hotplate. What variables does he have to work out, and how can he do that?' The following task addresses declarative knowledge: 'What groups can materials be divided into according to their electrical properties?'

was collected in a one-off survey at the time of the final test. The test materials used to gather data on declarative and procedural knowledge were developed with experienced teachers and approved by both the activity-centred teachers and those teaching using the directive method (7). Problem-solving ability was tested using a simulation programme in which two (electrical fitters) or three (electronics technicians) faulty electrical systems were simulated (8). The ability to analyse the faults simulated in the systems was evaluated using a documentation system performed at the same time.

The lesson itself was documented thoroughly to determine the level of self-regulation and practical orientation (SRPO). An evaluation of this data shows that a mixture of methods is used in all the classes and that the SRPO values achieved in the classes taught using the directive and the activity-centred methods differ considerably. As well as the data on the development of skills and motivation, and the documentary data on the instructional/methodological structure of the lesson, data was also gathered to monitor conditions, e.g. on teaching quality and to match up the results for training carried out in school and in a company.

Selected results of the studies

The results are set out below as they relate to the hypotheses. The setting for this article means that only selected results can be presented; more results will be described in articles to follow. Further reference may be made to the more detailed descriptions by Nickolaus and Bickmann, 2002; Nickolaus, Heinzmann and Knöll, 2005; Nickolaus, Heinzmann and Knöll, 2006 and Knöll, Gschwendter and Nickolaus, 2006.

The effects of basic methodological decisions on the development of declarative knowledge

In the first investigation, restricted to four classes of electrical fitters, the classes taught using the directive and the activity-centred methods did not differ significantly in the initial test in declarative knowledge; in the midway and final tests, however, there was an extremely significant difference in favour of the classes taught using the directive method. As expected, previous knowledge proves the strongest predictor (explains 22 % of the variance), but the teaching method also helps explain 5.5 % of the variance (9).

(9) The software used can simulate faults in two technical systems (hotplate and cordless electric screwdriver) and faults diagnosis using testing processes (current, voltage and resistance measuring). To do this, a simulated measuring device was available which could be applied to pre-set measuring-points in the technical systems. For the hotplate simulation, there were several possible measuring points: directly at the power supply (mains), at the input and output of the six-step switch, in the path of the current to the three heating elements). The switch controls three heating elements using different switch methods (serial, parallel and non-uniform connections) which produce varying electrical results in the hotplate. The fault to be diagnosed is faulty heating elements. In the electric screwdriver the following faults were simulated: a faulty control system (rep. 3), a faulty motor (rep. 4) and a faulty storage battery (rep. 5). The repair tasks were ordered so that they became progressively more complex and difficult.

In the second, wider study of the electrical fitters (ten classes), the classes taught with the directive method achieved better mean results than those taught with the activity-centred approach, despite slightly worse initial results in declarative knowledge in the midway and final tests. However, the differences remained below the significance level.

There were similar results in the classes of electronics technicians, where slight advantages were recorded in all the tests in favour of those taught with the directive method; however, statistically these did not prove significant. As concerns the hypotheses, we ascertained that although there tend to be some advantages in the development of declarative knowledge as expected for the classes taught with the directive method, the differences generally remain below the significance level.

The effects of basic methodological decisions on the development of procedural knowledge

Here the results from the two studies involving electrical fitters proved to be absolutely contrary to expectations; nor was the hypothesis that procedural knowledge develops better in classes taught using the activity-centred approach confirmed by the electronics technicians. In the first study involving electrical fitters, there were distinct, but not significant, differences in favour of those taught using an activity-based approach in the initial tests. By the time of the midway test (after 6 months) there was a distinct shift in the range of results in favour of those taught with the directive method; in the final test, the differences between the mean results becomes significant, in favour of those taught with the directive method. In the second study involving electrical fitters a similar picture emerges. Initial differences in favour of those taught using the activity-centred approach switch around so that in the midway test there are already significant advantages for those taught with the directive method; in the final test, however, these are considerably smaller and are no longer significant. From a comparative, international point of view, it seems interesting that in this study, the organisational form of the preliminary training, which also varied (full-time schooling v. dual education), also goes some way to explaining the variance. The systematic education of those attending school full-time proved more favourable for developing procedural knowledge; with the electrical fitters, the combination of a dual education and activity-centred lessons at a vocational school proved problematic. This may conceivably be attributed to the fact that the electrical fitters' unsystematic education in small companies tends to increase, rather than reduce, problems with building up a good foundation of knowledge using activity-centred teaching methods with relatively poor learners. In the study of classes of electronics technicians, the teaching methods had no significant effect on the development of procedural knowledge.

As concerns the hypothesis, we are still able to record that this has

(*) For more detail see Nickolaus, Heinzmann and Knöll, 2005.

clearly been proven false for the vocational fields studied here. Contrary to expectations, where apprentices are somewhat less able (electrical fitters), there are solid advantages in favour of those taught with the directive method; with more able apprentices (electronics technicians) the methodological approach proves irrelevant for the development of procedural knowledge.

The effects of methodological decisions on the development of subject-related problem-solving abilities

In this regard, the results for the classes of electronics technicians are not yet available, and we will therefore restrict ourselves to describing the results for the electrical fitters. As mentioned above, the ability to solve subject-related problems was established by measuring ability to diagnose faults in electrical systems. In the first study, the analyses of the apprentices were restricted to three different types of fault in an electrical system (cordless electric screwdriver) with no intervention by the teacher between the fault analyses. For the second study, as well as the cordless electric screwdriver, another electrical system (hot-plate) with two faults was simulated. After all the repair tasks had been dealt with, there were some additional teacher-led reflections on systematic fault analysis processes. These interventions were limited to about 5 minutes each.

First, the following overview shows the problem-solving frequency in the first and second studies, without taking into account the quality of the solution (quality of the explanation, number of steps to the solution).

Whereas the variation in the percentage of solutions in the first study is primarily caused by the nature of the problem, in the second study the interventions added between the problems, reflecting on the problem-solving process, play a major role. This interpretation is mainly supported by two partial findings: a) the extremely varying development of problem-solving frequency in repair tasks 3 and 4 involving the electric screwdriver and b) the significant rise in problem-solving frequency between repair tasks 1 and 2 as well as 3 and 4 in the second study. Whereas the degree of difficulty in the problem set is the same for repair tasks 1 and 2, there is a distinct rise in difficulty between repair tasks 3 and 4. In the first study there is a correspondingly distinct drop in the percentage of solutions between repair tasks 3 and 4. In the second study, on the other hand, despite the

Figure 1: Problem-solving frequency in fault analysis in %

	1st study (N=69)		2nd study (N=152)	
	solved	unsolved	solved	unsolved
Repair 1, hotplate	—	—	52.6	47.4
Repair 2, hotplate	—	—	73.5	26.5
Repair 3, electric screwdriver	63.8	36.2	55.3	44.7
Repair 4, electric screwdriver	21.7	78.3	69.7	30.5
Repair 5, electric screwdriver	59.4	40.6	62.7	37.3

higher degree of difficulty the interventions lead to a considerably higher percentage of solutions, about three times as high as in the first investigation. This means that substantial increases in skills can even be initiated by only short interventions explaining the fault analysis or reflecting on it together by asking questions and developing ideas, when the intervention is system-related and directive, i.e. with instructions and explanations about the fault analysis path.

According to hypothesis H2, the ability to deal with everyday problems should be better

- developed in classes taught using the activity-centred approach in than those taught using
- the directive method. Comparisons of the mean values do not, however, confirm this assumption.
- In the first study, there were some advantages for those taught with the activity-centred approach for repair tasks 3, 4 and 5 (Figure 2); however, these remained below the significance level.
- In the second study, contrary to expectations, in individual repair tasks there were advantages for those taught using the directive method. The main surprise here is the partial finding that those taught using the directive method do better when there is a change of system (transfer). This surprising finding seems to us primarily to be explained by the more strongly developed knowledge in classes taught using the directive method, which does not at least prove to be any more passive than in those taught with the activity-centred method, and which can be identified as the strongest predictor for the ability to solve subject-related problems.

Another apparent point of note is that in contrast to their procedural knowledge, the problem-solving ability of those apprentices taught in school does not develop as well as in those who have gone through the dual system of vocational education.

In summary, it was ascertained that contrary to expectations, the classes taught using the activity-centred approach do not by any means generally do better, but in part actually do worse; that short system-related directive interventions reflecting on the fault analysis procedure can have a substantial positive effect; and that declarative and procedural knowledge

Figure 2: Mean values and results of mean value comparisons in fault analyses

	1st study (N=69)		2nd study (N=152)	
	Directive	Activity-centred	Directive	Activity-centred
Repair 1 (hotplate 1)			3.50	3.22 n.s.
Repair 2 (hotplate 2)			4.40	3.90 *
Repair 3 (electric screwdriver)	3.05	3.12 n.s.	3.89	3.31 *
Repair 4 (electric screwdriver)	1.60	2.06 n.s.	4.25	3.84 n.s.
Repair 5 (electric screwdriver)	3.06	3.44 n.s.	3.92	3.91 n.s.

contribute the most to explaining problem-solving ability. According to our findings, Hypothesis H2 does not stand up. In our opinion it would be of interest to look into the question of whether the alignment of results found in the second study, which at least partly confirms H3, should be understood as an indication that any remaining differences in achievement soon balance out in practice on the job. In the current discussions on the didactic/methodological organisation of education, too many expectations may have been placed on the contribution this can make to practical vocational skills, with more important variables, such as the potential for learning arising from related employment (e.g. see Curtain, 2000, p.41), not being taken into account.

An additional point is that the tendency is for H4 to be confirmed, but that the differences in the development of motivation between the teaching methods remain below the significance level. With the electronics technicians in particular, there are distinct trends towards the development of motivation in classes taught using the activity-centred approach, and sometimes also significant advantages. What is significant here are the differences between extrinsic and intrinsic motivation. With the electrical fitters, in the first study there were some advantages tending in the same direction, i.e. the participants in the classes using the activity-based method were more often intrinsically motivated while those in classes taught with the directive method were more often extrinsically motivated. In the second, wider study, however, no significant differences in the development of motivation could be established in classes taught with the directive or the activity-centred methods. Generally, i.e. irrespective of the teaching method, during the first year of training, the development of motivation proves poor ⁽¹⁰⁾.

Discussion of the results

In general we have ascertained that some of these findings give reason for serious doubt to the general validity of current theoretical assumptions about relationships between basic methodological decisions and the development of skills and motivation in preliminary electrotechnical courses. It is still open whether this can also be confirmed for further courses and in other industrial and technical occupations. However, the current state of research, which is rather unsatisfactory, suggests that in other industrial and technical occupations there are also serious difficulties in corroborating current assumptions (Nickolaus, Riedl and Schelten, 2005). There are various possible explanations for the findings, which are largely both contrary to expectations and well-founded.

First, it is conceivable that the field involved plays a role and that the com-

⁽¹⁰⁾ As motivation and extrinsic motivation increase; introjected, identified, intrinsic motivation und interest drop.

paratively high degree of abstraction in electrotechnical subject matter blocks the effect of the advantages of a constructivist learning environment.

Second, it is worth considering whether one possible cause to be included in reflections should be the quality of teaching in each method selected. It is possible that teachers are also not yet as used to putting the current paradigm into action as they are to traditional teaching methods. However, the data on quality collected to monitor conditions do not support this supposition.

Third, it is fair to assume that the unexpected findings could be attributed to the studies being conducted at this particular stage of the course. In other words, it is possible that activity-centred lessons only reach their full potential at the specialised stage (e.g. in the third year of the course) when the emphasis is on specific use of basic knowledge on the basis of a foundation built up earlier (also see Tenberg, 1997).

Fourth, it is worth checking whether the causes may be found in some learners having a more successful balance of self- and outside regulation, or of situation and systemisation in the subject. The assumption formulated before the study involving electronics technicians, that the electrical fitters' comparatively adverse initial circumstances are the reason why their achievement develops in this unexpected manner in activity-centred classes, is partly supported by our overall results. At least, in contrast with the electrical fitters, the achievements of the electronics technicians, who are cognitively stronger, do not improve significantly in the classes taught with the directive method.

In our opinion, the results put forward here give reason to provide much more detailed justification for methodological decisions than currently is often the case, at the same time questioning the validity of current assumptions. Further studies also prove necessary, including studies on the effects of the vocational field and the type of course involved. It would certainly also be of great interest to carry out comparative international studies on the subject which could also look at the effects of macro-structural conditions (dual education system and full-time schooling).

Bibliography

- Achtenhagen, F.; Grubb, W. N. Vocational and Occupational Education: Pedagogical Complexity, Institutional Diversity. In *Handbook of Research on Teaching*. Fourth Edition, Washington 2001, p. 604-639.
- Achtenhagen, F.; Thàng, P.-O. (Ed.). *Transferability, Flexibility and Mobility as Targets of Vocational Education and Training*. Göttingen 2002.
- Achtenhagen, F. Greetings and Introduction. In Achtenhagen, F.; Thàng, P.-O. (Ed.). *Transferability, Flexibility and Mobility as Targets of Voca-*

- tional Education and Training*. Göttingen 2002, p. 10-12.
- Beck, K. (Ed.). Teaching-Learning Processes in Vocational Education. Frankfurt am Main inc. Peter Lang 2002 (*Konzepte des Lehrens und Lernens*; Vol. 5).
- Beck, K.; Dubs, R. (Ed.). Kompetenzentwicklung in der Berufserziehung. Kognitive, motivatonale und moralische Dimensionen kaufmännischer Qualifizierungsprozesse. *Zeitschrift für Berufs- und Wirtschaftspädagogik*, Supplement 14. Stuttgart 1998.
- Beck, K.; Heid, H. (Ed.). Lehr- Lern- Prozesse in der kaufmännischen Erstausbildung – Wissenserwerb, Motivierungsgeschehen und Handlungskompetenzen. *Zeitschrift für Berufs- und Wirtschaftspädagogik. Supplement 13*. Stuttgart 1996.
- Bendorf, M. Bedingungen und Mechanismen des Wissenstransfers. *Lehr- und Lern-Arrangements für die Kundenberatung in Banken*. Wiesbaden 2002.
- Bracht, G. H. Experimentelle Faktoren in Beziehung zur Wechselwirkung zwischen Schülermerkmalen und Unterrichtsmethoden. In Schwarzer, R.; Steinhagen, K. (Ed.). *Adaptiver Unterricht. Zur Wechselwirkung von Schülermerkmalen und Unterrichtsmethoden*. Munich, Germany: Kösel, 1975, p. 94-108.
- Bransford, J. D.; Brown, A. L.; Cocking, R. R. (Ed.). *How people learn. Brain, Mind, Experience, and School*. Washington: National Academy Press 2000.
- Bruijn, de E. Changing pedagogic and didactic approaches in vocational education in the Netherlands: from institutional interests to the ambitions of students. In *European journal of vocational training*, No 31, 2004/1, p. 27-36.
- Bundesministerium für Bildung und Forschung (BMBF) (Ed.). *Berufsbildungsbericht 2004*. Bonn, Berlin: Bundesministerium für Bildung und Forschung 2004.
- Carver, S. M.; Klahr, D. *Cognition and Instruction. Twenty-Five Years of Progress*. Mahwah: Lawrence Erlbaum 2001.
- Curtain, R. The workplace of the future: implications for vocational training. In *European journal of vocational training*, No. 19, 2000/1, p. 29-37.
- Deci, E. L.; Ryan, R. M. *Handbook of Self-Determination Research*. Rochester: University of Rochester Press 2002.
- Deci, E. L.; Ryan, R. M. *Intrinsic Motivation and Self-Determination in Human Behavior*. New York, London: Plenum Press 1985.
- Flammer, A. Wechselwirkungen zwischen Schülermerkmalen und Unterrichtsmethoden. In Schwarzer, R.; Steinhagen, K. (Ed.). *Adaptiver Unterricht. Zur Wechselwirkung von Schülermerkmalen und Unterrichtsmethoden*. Munich, Germany: Kösel, 1975, p. 27-41.
- Fraser, B. J.; Walberg, H. J.; Welch, W. W.; Hattie, J. A. Syntheses of educational productivity research. In *International Journal of Educational Research*, 11th yr (1987), H. 2, p. 145-252.

- Halfpap, K. Curriculum development in the dual vocational training system in Germany. In *European journal of vocational training*, No. 21, 2000/3, p. 32-40.
- Hardt, B. *et al.* Untersuchungen zu Motivierungspotential und Lernmotivation in der kaufmännischen Erstausbildung. In Beck, K.; Heid, H. (Ed.). *Lehr- Lern- Prozesse in der kaufmännischen Erstausbildung – Wissenserwerb, Motivierungsgeschehen und Handlungskompetenzen. Zeitschrift für Berufs- und Wirtschaftspädagogik. Supplement 13.* Stuttgart 1996, p. 128-149.
- Helmke, A.; Weinert, F.E. Bedingungsfaktoren schulischer Leistung. In Weinert F.E. (Ed.): *Psychologie des Unterrichts und der Schule. Enzyklopädie der Psychologie* Vol. 3. Göttingen etc. 1997, p. 71-176.
- Howe, F. *Elektroberufe im Wandel. Ein Berufsfeld zwischen Tradition und Innovation.* Hamburg: Dr. Kovac 2004.
- Knöll, B.; Gschwendtner, T. Nickolaus, R. Einflüsse methodischer Grundentscheidungen auf die Entwicklung zentraler Aspekte beruflicher Handlungskompetenz in anforderungsdifferenten gewerblich-technischen Ausbildungsberufen. In: Gonon, P.; Klauser, F.; Nickolaus, R. (ed.): *Kompetenz, Qualifikation und Weiterbildung im Berufsleben.* Opladen: Barbara Budrich, 2006, p. 27-40.
- Lewalter, D. *et al.* Die Bedeutsamkeit des Erlebens von Kompetenz, Autonomie und sozialer Eingebundenheit für die Entwicklung berufsspezifischer Interessen. In Beck, K.; Dubs, R. (Ed.). *Kompetenzentwicklung in der Berufserziehung. Kognitive, motivationale und moralische Dimensionen kaufmännischer Qualifizierungsprozesse. Zeitschrift für Berufs- und Wirtschaftspädagogik, Supplement 14.* Stuttgart 1998, p. 143 - 168.
- Magnusson, S. J.; Palincsar, A. S. The learning environment as a site of science education reform. In *Theory Into Practice*, 34th yr. (1995), H. 1, p. 43-50.
- Mulder, R. Innovation in Secondary Vocational Education: Problem Based Learning in Technical Education. In Achtenhagen, F.; Thang, P.-O. (Ed.). *Transferability, Flexibility and Mobility as Targets of Vocational Education and Training.* Göttingen 2002, p. 54-65.
- Nickolaus, R.; Bickmann, J. Kompetenz- und Motivationsentwicklung durch Unterrichtskonzeptionsformen. In *Die berufsbildende Schule*, 54th yr. (2002), H. 7-8, p. 236-243.
- Nickolaus, R.; Heinzmann, H.; Knöll, B. Differenzielle Effekte von Unterrichtskonzeptionsformen in der gewerblichen Erstausbildung. In Eckert, M./Reinisch, H./Tramm, T. (Ed.): *Tagungsband zur Herbsttagung 2003 der Sektion für Berufs- und Wirtschaftspädagogik* (in print).
- Nickolaus, R.; Heinzmann, H.; Knöll, B. Ergebnisse empirischer Untersuchungen zu Effekten methodischer Grundentscheidungen auf die Kompetenz- und Motivationsentwicklung in gewerblich-technischen Berufsschulen. In *ZBW 1/2005*, p. 58-78.
- Nickolaus, R.; Riedl, A.; Schelten, A. Ergebnisse und Desiderata zur Lehr-

- Lernforschung in der gewerblich-technischen Berufsausbildung. In *ZBW 4/2005*, p. 507-532.
- Nickolaus, R. *Differenzielle Effekte von Unterrichtskonzeptionsformen in der gewerblichen Erstausbildung. Antrag an die Deutsche Forschungsgemeinschaft auf Gewährung einer Sachbeihilfe*. Hanover 2001.
- Nickolaus, R. Handlungsorientierung als dominierendes didaktisch-methodisches Prinzip in der beruflichen Bildung. Anmerkungen zur empirischen Fundierung einschlägiger Entscheidungen. In *ZBW*, 96 Vol. 2 (2000), p. 190-206.
- Ott, B. Structural characteristics and target categories of holistic vocational training. In *European journal of vocational training*, No. 17, 1999/2, p. 52-61.
- Prenzel, M. *et al.* Selbstbestimmt motiviertes und interessiertes Lernen in der kaufmännischen Erstausbildung. In Beck, K.; Heid, H. (Ed.) *Lehr-Lern-Prozesse in der kaufmännischen Erstausbildung – Wissenserwerb, Motivierungsgeschehen und Handlungskompetenzen. Zeitschrift für Berufs- und Wirtschaftspädagogik. Supplement 13*. Stuttgart 1996, p. 109-127.
- Prenzel, M.; Drechsel, B.; Kramer, K. Lernmotivation im kaufmännischen Unterricht: Die Sicht von Auszubildenden und Lehrkräften. In Beck, K.; Dubs, R. (Ed.) *Kompetenzentwicklung in der Berufserziehung. Kognitive, motivationale und moralische Dimensionen kaufmännischer Qualifizierungsprozesse. Zeitschrift für Berufs- und Wirtschaftspädagogik, Supplement 14*. Stuttgart 1998, p. 169-187.
- Reinmann-Rothmeier, G.; Mandl, H. Wissensvermittlung: Ansätze zur Förderung des Wissenserwerbs. In Klix, F.; Spada, H. (Ed.): *Wissen*. Göttingen; Bern; Toronto; Seattle: Hogrefe Verlag für Psychologie (Enzyklopädie der Psychologie; Vol. 6), 1998, p. 457-500.
- Sembill, D. *et al.* Prozessanalysen selbstorganisierten Lernens. In Beck, K.; Dubs, R. (Ed.). *Kompetenzentwicklung in der Berufserziehung. Kognitive, motivationale und moralische Dimensionen kaufmännischer Qualifizierungsprozesse. Zeitschrift für Berufs- und Wirtschaftspädagogik, Supplement 14*. Stuttgart 1998, p. 75-79.
- Straka, G.; Macke, G. *Lern-lehr-theoretische Didaktik*. Münster etc. Waxmann, 2002.
- Strohschneider, S. Problemlösen und Intelligenz: Über Effekte der Konkretisierung komplexer Probleme. In *Diagnostica – Zeitschrift für Psychologische Diagnostik und differentielle Psychologie*. Volume 37, 1991, p. 353-371.
- Tenberg, R. *Schüleraussagen und Verlaufsuntersuchung über einen handlungsorientierten Metalltechnikunterricht*. Frankfurt am Main: Lang 1997.
- Terhart, E. *Lehr-Lernmethoden. Eine Einführung in Probleme der methodischen Organisation von Lehren und Lernen*. Weinheim, Munich 1997.
- Wang, M. C.; Haertel, G. D.; Walberg, H. J. Toward a Knowledge Base for

School Learning. In *Review of Educational Research*, Vol. 63 (1993), H. 3, p. 249-294.

Weinert, F.E. Lehr-Lernforschung an einer kalendarischen Zeitwende: Im alten Trott weiter oder Aufbruch zu neuen wissenschaftlichen Horizonten? In *Unterrichtswissenschaft* 28th yr. (2000) 1, p. 44-48.

Wild, K. P.; Krapp, A. Lernmotivation in der kaufmännischen Erstausbildung. In Beck, K.; Heid, H. (Ed.). Lehr- Lern- Prozesse in der kaufmännischen Erstausbildung – Wissenserwerb, Motivierungsgeschehen und Handlungskompetenzen. *Zeitschrift für Berufs- und Wirtschaftspädagogik. Supplement 13*. Stuttgart 1996, p. 90-107.