Learning for self-regulation

Improving instructional benefits for pupils, teachers, parents, schools, and society at large

on Friday, February 2nd, 2007

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Inaugural address

delivered (in abbreviated form)
on the occasion of the public acceptance of
the professorship in Educational Technology,
in particular with respect to the influence of learning tasks
on learning in primary and secondary education
at the Open University of The Netherlands
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1 Introduction

Chair of the Board of Professors
Dear family, friends, and colleagues
Ladies and gentlemen
A child mirrors life in many respects. The child’s growth and development illustrate various evolutionary and genetic influences across many, many generations. At the same time, the child’s interactions with characteristics of different environments create and stimulate many possibilities for individual variations in learning cognitive, social, motivational, and self-regulation processes, for example.

To protect and order children’s growth and learning, adults organise specific joint activities and invent pedagogical institutions like families and schools. Institutionalised learning has become an important element in the functioning of our society. Goudswaard (1981) describes Dutch trade, educational, and other influences on the development and institutionalisation of learning and teaching in the period 1798-1863. His work illustrates how learning was organised and changed in accordance with societal, industrial, and vocational changes. He also shows that the important questions about learning of the present decade were already the subject of discussion and some conflict more than two centuries ago.

Nowadays, compulsory education laws oblige primary and secondary schools to give each pupil positive encouragement in, for example, social, emotional, cognitive, creative, and ethical respects. This is a fairly smooth process for most pupils, but it is not as easy to achieve with others. At the end of the nineteen seventies, one of the research projects I conducted was a problem analysis of drop-outs in secondary education (Mooij, 1979, 1980). The Ministry of Education, Culture, and Science was interested in the effects of the Secondary Education Act (Mammoetwet), which came into force in 1963 and was put into practice in 1968. The Ministry expected the Act, once it had been implemented, to substantially reduce the drop-out rate. The research included a review of the international literature and various analyses of Dutch national statistical data on pupils’ educational careers, including transferring to a lower level of secondary education and leaving school without a diploma.

The implementation of the Secondary Education Act did not have any noticeable effects on the drop-out rate. A pattern of pupil, home or family, and school variables turned out to be responsible for a long-term process that led to pupils’ dropping out. This process was characterised by various types of variables: a pupil’s relatively low motivation for engaging in school activities and poorer performance already in pre-school; a home situation reflecting relatively low socio-economic, occupational, and educational conditions; and educational characteristics, which also proved to be important. Drop-outs were more likely to repeat grades in primary and secondary education, to have conflicts at school, to be truant, to be suspended, to have parents with less positive contacts with their school, and to have negative opinions of school and school activities. Comparable results have been found a number of times since then.

A recent report by the Inspectie van het Onderwijs (Education Inspectorate) (2005a) clarifies that both the number of drop-outs and the circumstances of their dropping out are roughly the same as in the seventies. The Inspectorate considers drop-outs to be problematic and acknowledges that there are many projects aimed at reducing the drop-out rate. As the Inspectorate reflects (p. 115), these projects are usually not evaluated so we do not know which measures are effective. The Inspectorate’s recommendations on reducing the number of drop-outs are about the same as those already given in the seventies. In 2006, In ’t Veld, Korving, Hamdan, and Van der Steen (2006) presented five intervention strategies to reduce the drop-out rate, and they investigated the costs and
benefits of each strategy. The proposed interventions are, in succession: integrate school and work; start compulsory education at a younger age; improve assessment and support in secondary education; support the educational care structure; and integrate school and individual coaching for specific 16-20 year olds. According to these authors, the first four scenarios will lead to positive outcomes. However, they also suggest a systemic educational approach to reducing the drop-out rate (p. 12) which they themselves do not explore.

In my opinion, a systemic approach will do much to introduce more clarity into the diagnosis, potential reduction and possible prevention of some persistent educational problems that express themselves in related phenomena, for example low school motivation and achievement; forced underachievement of high ability pupils; concentration of bullying and violent behaviour in and around some types of classes and schools; and drop-out percentages that are relatively constant across time. Such problems have a negative effect on pupils, teachers, parents, schools, and society alike.

In this address, I would therefore like to clarify some of the systemic causes and processes that we have identified between specific educational and pupil characteristics. Both theory and practice can assist in developing, implementing, and checking better learning methods and coaching procedures, particularly for pupils at risk. This development approach will take time and require co-ordination, but it will result in much better processes and outcomes than we are used to.

First, I will diagnose some systemic aspects of education that do not seem to optimise the learning processes and school careers of some types of pupils in particular. Second, I will specify cognitive, social, motivational, and self-regulative aspects of learning tasks and relate corresponding learning processes to relevant instructional and wider educational contexts. I will elaborate these theoretical notions into an educational design with systemic instructional guidelines and multilevel procedures that may improve learning processes for different types of pupils. Internet-based Information and Communication Technology, or ICT, also plays a major role here.

Third, I will report on concrete developments made in prototype research and trials. The development process concerns ICT-based differentiation of learning materials and procedures, and ICT-based strategies to improve pupil development and learning. Fourth, I will focus on the experience gained in primary and secondary educational practice with respect to implementation. We can learn much from such practical experience, in particular about the conditions for developing and implementing the necessary changes in and around schools.

Finally, I will propose future research. As I hope to make clear, theory-based development and implementation research can join forces with systemic innovation and differentiated assessment in educational practice, to pave the way for optimal "learning for self-regulation" for pupils, teachers, parents, schools, and society at large.
2 Diagnosis:

some systemic problems in regular education
The diagnosis concentrates on some systemic educational characteristics, their relationship to pupils’ problems and their cognitive, social, motivational and self-regulation effects on pupils in primary and secondary education. I have chosen to concentrate on four educational characteristics:
1. Educational organisation and freedom to provide education;
2. Age-based grouping of pupils and learning content;
3. Norm-based selection and “underachievement” of low ability pupils;
4. Norm-based selection and “underachievement” of high ability pupils.

2.1 Educational organisation and freedom to provide education

At the age of about four, almost all Dutch children enter pre-school, where they focus on play, social activities and many educational materials relevant to their development and learning. Pre-school usually lasts about two years and is integrated in primary school, which generally lasts six years. Secondary school may take between four to six years.

The organisation and content of learning processes in primary and secondary schools reflect the following main features. On the one hand, regular education is characterised by nationally prescribed global attainment targets (kerndoelen), core or compulsory school subjects, and administrative and certification rules. On the other hand, we have non-compulsory curricular subjects, the freedom to determine instruction and learning content, the freedom to found schools, and the freedom to determine the religious or ideological basis on which a school is founded. This latter aspect is part of the Dutch constitution.

One of the dynamic consequences of this systemic “inconsistency” is that national attainment targets have been changed regularly because the intended effects did not sufficiently affect instructional processes, or did not yield the desired effects on pupils. Another consequence is that evaluation or assessment and certification, including national examination standards, may vary or be adapted to the pupils’ mean attainment (cf. Van den Bergh, Rohde, & Zwarts, 2003). Also, school books and pupil monitoring systems exert a great deal of influence on what pupils, teachers, parents and schools actually do – and can do – in daily practice.

2.2 Age-based grouping of pupils and learning content

After entering pre-school, pupils of about the same age usually remain in the same group for the next eight years. Pupils who are the same calendar age of four years differ in their psychological or competence development, ranging from the “psychological age” of about two years to about eight years (cf. Mooij & Smeets, 1997). Alloway (2006) explains that there is a considerable degree of variability in working memory capacity at each age: for example, at 6.5 years, the 10th centile is close to the mean for 4.5 year olds, and the 90th centile approximates the mean performance level for 9.5 year old children. This means that, in a class of 30 young children, working memory capacity differences correspond to five or six years of regular development between the highest and lowest scoring individuals. However, the differentiation provided in the education system does not cover the psychologically relevant differentiation required by the pupils’ individual characteristics. Blok (2004) reviews both the literature and research on “adaptive education” and states that this term is interpreted as “adaptation in terms of deviation from the mean” instead of as “based on individual pedagogical and psychological capacities.”
In psychological tests, the actual performance of a child is usually expressed as the deviation from the mean performance of his or her age-mates, i.e. the “population mean” or “norm” (cf. Evers, Van Vliet-Mulder, Resing, Starren, Van Alphen de Veer, & Van Boxtel, 2002). Figure 1 illustrates this. The region in the middle of the curve contains the scores of children performing around the mean of their age with respect to domains of competence like general IQ or more specific language, arithmetic, social, emotional, or motor domains. A smaller proportion of children will perform or achieve at a very low ability level and another small proportion will achieve at a very high ability level. In age-based classes, then, pupils scoring in the lower left part of the ability curve will usually have the lowest achievement and get the lowest or insufficient school marks. This will not motivate them to continue their education. The pupils in the lower right part of the curve will be confronted with activities that demand too little for their level of competence.

Another procedure to assess the performance of a child can be based upon a specific “criterion” or one or more series of tasks that were psychometrically evaluated to be relevant from – for example – a mastery point of view. The child’s performance is then evaluated against a concrete absolute standard, which can be based in a specific curriculum or used in an individual education plan. Criterion-based learning may help a low ability pupil to continue making progress in his or her development or learning and to be motivated to continue in school at other competence levels than a high ability pupil.
2.3 Norm-based selection and “underachievement” of low ability pupils

A child achieving well below his or her age mean may have innate or development disabilities or physical handicaps. These children are more vulnerable than other children later on when they go to pre-school or school. They often require extra assistance at home or specific instructional or organisational arrangements at school (Meijer, Soriano, & Watkins, 2003). In many countries, specific groups of these children are excluded from mainstream education and referred to special education (cf. European Commission, 2005). Other indications of low ability or achievement can be found in social/emotional or behavioural problems. Different specific diagnostic instruments or tests are used in such cases, but teachers’ opinions about the percentages of pupils in need of specific educational support also differ (cf. Smeets, 2004). In addition, children from socio-economically disadvantaged homes or from ethnic minorities who hardly speak Dutch usually perform in the lower left region of the curve shown in Figure 1 (Peetsma, Van der Veen, Koopman, & Van Schooten, 2003).

Traditional pupil monitoring systems are often aimed at general concept validity, measured independently of specific educational methods or school books (cf. also Evers et al., 2002). These systems use the age-based organisation of pupils as the basis for a norm-based evaluation of the results of individual pupils, thereby reducing the possibility of criterion-based educational tools or programmes that offer pupils at risk effective and timely support. That is also evident in research on individual education plans to assist pupils with specific problems. The Inspectie van het Onderwijs (Education Inspectorate) (2005b) evaluated the quality of such plans with regard to dyslexia, ADHD, autism, and high ability. In all four cases, the quality of these plans required considerably improvement. This was expressed, for example, in the discussion of the usability of “action-directed diagnostics” versus “normed diagnostics”. One main reason for this debate was that neglecting criterion-based aspects in the procedure also reduced the immediate availability of specific educational programmes or individual education plans in educational practice.

Moreover, schools may receive additional financial support to prevent language, learning, motivation, and drop-out problems. As the Algemene Rekenkamer (General Audit Office) (2001a, 2001b, 2005) verifies, however, there is little evidence that this support has an effect on pupils at risk. The same can be concluded with respect to the longitudinal effects of projects aimed at increasing safety in schools and reducing pupils’ bullying and violence.

2.4 Norm-based selection and “underachievement” of high ability pupils

About 20 years ago, almost all Dutch schools denied that they had high ability pupils in their classrooms; nowadays, many schools claim that they have a large number of them. This is a question of definitions, of course, and also of popularity. Révész’s biographies (1952) show that we will probably never meet a true genius. By applying a current convention related to Figure 1, however, we can define the upper 3% of the population as highly able with respect to at least one domain of competence. In this situation, at least one out of every 33 pupils is highly able. Statistically, every age-based school class will therefore have one or more highly able pupils and also one or more pupils with special educational needs.
A pupil achieving much above the age mean in for example general intellectual ability, or language or arithmetic performance, differs considerably from his or her peers with respect to level of competence and “learning style” (cf. also Baroody, 1993; Gallagher, 1975; Heller, Möns, Sternberg, & Subotnik, 2000). In the Canadian Education Act, high ability pupils are defined as those who display “an unusually advanced degree of general intellectual ability that requires differentiated learning experiences of a depth and breadth beyond those normally provided in the regular program to satisfy the level of potential indicated” (Grayson, 2001, p. 123).

Given the learning potentials and capacities of high ability pupils, the functioning of such pupils in regular education should be a non-issue. We know that, already at the age of four years, highly able pupils may read, write, do arithmetic, or perform exceptionally well in social, emotional, expressive, or motor domains. Pedagogically and psychologically, they should be supported at and above their own level/levels of competence once they start pre-school. Although teachers and schools say they do support such pupils, or try to do so, they seemingly find it hard to imagine that such support should differ completely from a kind of adaptation to mean-based regular education. Special classes for Dutch high ability pupils even indicate negative school effects on the learning and motivational processes of these pupils; family support has positive effects.

In age-based pre-school and primary education, highly able children usually receive encouragement based on the characteristics of pupils of their calendar age, instead of on their own psychological or developmental age. They end up in a situation of instructional “forced underachievement” that can explain the motivational and learning problems experienced by these children and their parents from the time they start pre-school. However, as Guldemond, Bosker, Kuyper, and Van der Werf (2003) argue, “general intellectual ability” can be defined as a stable trait that is not influenced by environmental characteristics. These researchers performed a secondary analysis of quantitative cohort data on characteristics of “highly intelligent” pupils in Dutch secondary education. They offered two theoretical hypotheses:

a) a developmental hypothesis: high ability is a more or less varying result of series of interactions between innate personal characteristics and environmental characteristics;

b) a personality trait hypothesis: high ability is a stable personal disposition which is used by a person when faced with problems, unexpected events, or new situations.

Guldemond et al. (2003) concluded that hypothesis b) is correct: no reason exists to assume that highly intelligent pupils will have specific problems at school. Research on young children demonstrates that environmental variables influence the development of intelligence, particularly during the first few years of life. This is also suggested by the many qualitative case studies into the various problems of highly able pupils in pre-school and the first years of primary education. Driessen, Mooij, and Doesborgh (2007) have carried out a secondary analysis of the PRIMA cohort data, with a focus on high ability pupils in pre-school and primary school. The data set is not optimal for such an analysis (cf. Mulder, Roeleveld, & Vierke, 2006), but other comparable large data sets do not seem to be available in The Netherlands. Driessen et al. constructed four ability levels with respect to the pupils’ scores on (non-verbal) intellectual ability, language attainment, and attainment in arithmetic. Initial longitudinal results are based on the definition of “underachievement”, i.e. not achieving progress in learning according to IQ
potential (see for details: Driessen et al., 2007). In the field of language, this type of underachievement generally varied between 18-21%; in arithmetic, it was between 14 and 17%, with the phenomenon being fairly across grades. Underachievement was relatively highest in the lowest ability group. However, underachievement increased in the higher ability groups the longer the pupils’ school careers lasted.

Further longitudinal results compare language and arithmetic achievement in 2004 with language and arithmetic achievement in 2002, for the transitions from grade 2>4, grade 4>6, and grade 6>8, respectively. As the instruments used in grades 4 and above were calibrated, it is reasonable to expect that ceiling effects can be excluded. The results (Driessen et al., 2007) show that those pupils who are highly able, or able, have relatively lower scores with respect to language in group 4 compared to their scores in group 2. In fact, 93% of the highly able and 81% of the able pupils had relatively lower scores in grade 4 (2004) than in grade 2 (2002). Pupils who in 2002 scored above average, or average and below made some progress in language in 2004 (15% and 17%, respectively).

To illustrate this phenomenon, all pupils attending grade 2 and grade 4 in 2002 were grouped into deciles based on their ability score for language and arithmetic respectively. The lowest scores were grouped into decile 1 and the highest scores into decile 10. The raw language and arithmetic scores were converted into standardised scores or z-scores for 2002 and 2004. The scores in 2002 were then subtracted from the scores in 2004. The means of these differential scores (see Driessen et al., 2007) are presented in Graph 1.

Graph 1: Differences in z-scores (2004-2002) for language and arithmetic (grade 2-4 and 4-6)

Graph 1 illustrates that, during the transition from grade 2 to 4, the pupils scoring lowest on both language and arithmetic in pre-school grade 2 (deciles 1, 2 and 3) attained higher scores in the period 2002-2004, whereas the pupils in deciles 6-10 have a relatively lower score in 2004. Moreover, the pupils in deciles 1 and 10 gain or lose the most, relatively speaking. The same pattern emerges, although it is less pronounced, during the transition
from grade 4 to 6. Here the pupils in deciles 1 and 2 achieve higher scores in the period 2002-2004; the pupils in deciles 4-10 have a relatively lower score in 2004. Compared to the high ability pupils in grades 2-4, the high ability pupils in grades 4-6 no longer lose as much ground.\textsuperscript{18}

Moreover, studies of highly able pupils only revealed some statistically relevant relationships between changes in teaching situation characteristics and changes in teacher’s perception of the pupil’s behaviour and functioning from 2002-2004 (cf. Driessen et al., 2007). The results reflect the negative influences of, in succession, “class size,” “age-based monitoring,” “class mean performance,” and “non-acceleration,” on the transition of high-ability pupils from pre-school to primary school. These indications correspond to suggestions resulting from qualitative research on underachievement of high ability or gifted pupils.\textsuperscript{19}

\textbf{2.5 Conclusions for low and high ability pupils}

Given the above research outcomes, we can draw the following conclusions:

1. Dutch primary education does not currently seem to provide optimal achievement conditions in language and arithmetic for both low and high ability pupils. Low ability pupils may be confronted with educational materials and procedures beyond their level of competence, whereas high ability pupils may be forced to work at competence levels that are too low for their capacities and potentials. This is true since the beginning of their educational career in pre-school.

2. There are indications that specific educational support for low ability pupils has positive learning effects on these pupils; however, such support appears to be at the expense of the high ability pupils, in particular in pre-school and the first few years of primary education.

3. The instructional forced underachievement of high ability pupils seems to increase as their primary school career progresses.

4. Both low and high ability pupils can therefore be said to be “at risk” in pre-school and in regular primary education.

5. This also implies that, in pre-school and primary education, some of the learning potential of both low and high ability pupils seems to be underused or neglected.

6. High ability pupils seem to experience specific achievement, motivational, social, and self-concept problems in pre-school and the first years of primary school in particular. The “developmental hypothesis” of Guldemond et al. (2003) is then accepted at this younger age.

In line with Figure 1, we can illustrate these conclusions for low and high ability pupils as in Figure 2. The domain of motor behaviour may be an exception here because athletic activities or high-level sports are usually not restricted by the school curriculum or specific cognitive or assessment limits.\textsuperscript{20}
2.6 Achieving pedagogical “equality” by instructional differentiation

According to Meijnen (2004, 2005), we favour meritocracy in education and learning. If education indeed worked out like that, however, the pupils in the various deciles of Graph 1 should all improve their learning processes and the four lines in Graph 1 would have been more or less horizontal. We have seen that this does not happen. The negative scores for the high ability pupils were evidently caused by restricted instructional differentiation, as implied by Meijnen (op. cit.) and Bosker (2005).

In 1922, Parkhurst developed a pedagogy aimed at increasing each pupil’s self-regulation, to be promoted by a differentiated school practice that would assist both cognitive individualisation and effective social collaboration between pupils (Parkhurst, 1922, 1985). Her overall instructional design concerned a whole-school reorganisation. The goal was to include and adequately stimulate all pupils and to prevent motivation and achievement problems in ecologically valid ways. In her words: “Above all I wanted to equalize the pupil’s individual difficulties and to provide the same opportunity for advancement to the slow as to the bright child” (Parkhurst, 1922, p. 13).

In The Netherlands, in the year 1928, Kohnstamm (1963) performed an analysis comparable to Parkhurst’s. In 1928, Dutch primary education lasted about four years, which for most children constituted the whole of their school careers. Kohnstamm paid specific attention to the circumstances and experiences of children who dropped out in their third year. He proposed basing learning on curricular contents that are concrete and didactically relevant to pupils; individualising cognitive learning processes and the
corresponding assessments; and paying specific attention to the collective social and emotional aspects of learning and to the functioning of pupils in groups. The real challenge then is to design, develop, and implement a more integrated and supportive educational system that can respond to and improve the functioning of different characteristics of different types of pupils.\textsuperscript{22} This also becomes evident in the final report of the “No Child Left Behind” activities in the USA (National Conference of State Legislatures, 2005). Pedagogically and psychologically, educational facilities should inspire and support each child’s actual capacities and potentials in a social group context (cf. Kemp, 2000). Psychometrically, organisationally, and from a curricular point of view, we have access to some initial design information and relevant instruments (cf. Mooij, 2001b). We can integrate these two perspectives by concentrating on the pupils themselves as the main forces in “learning for self-regulation”. Starting from their first day at pre-school, pupils are usually eager to move on to the next stages of competence. Teachers, parents, and other professionals have to create situational conditions to continually facilitate the pupils’ motivation, responsible choices, and adequate learning behaviours. Adults are responsible for providing the desired conditions, but the pupils have to take over this responsibility from them during their school careers. As the pupils are different from the very beginning, facilitating them differently means treating them equally.\textsuperscript{23}
3 Theory:
self-regulation of learning in multilevel instructional contexts
3.1 Cognitive learning, learning tasks, and instruction

In 1965 Gagné defined learning as “a change in human disposition or capability, which can be retained, and which is not simply ascribable to the process of growth” (p. 5). He furthermore stated “Each type of learning starts from a different ‘point’ of internal capability, and is likely also to demand a different external situation in order to take place effectively” (p. 22). His learning theory was developed further by theorists and researchers who, for example, assumed that multiple elements of information are clustered into cognitive schemas that are used or modified in working memory during interactions with the environment or with other schemas, and can be automated and stocked in long-term memory. The internal capabilities of learners were a particular subject of research in experimental psychology, for example in attention processes in vision and hearing (Moray, 1969). Ainsworth (2006) refers to some recent developments, like “cognitive load theory”, “cognitive theory of multimedia learning”, “mental model construction of (symbolic) representations”, and modelling of “learning with multiple representations”. Paas, Renkl, and Sweller (2003) and Paas, Tuovinen, Tabbers, and Van Gerven (2003) summarise cognitive learning theory. They state that human cognitive architecture consists of a limited working memory, with partly independent visual/spatial and auditory/verbal processing units. Both long-term memory and adequate instruction can assist working memory to learn by schema construction and automation, or aid in the transfer of acquired knowledge or skills to new situations. Moreover, depending on the internal capabilities of the learner or instructional restrictions in the environment, working memory can become overloaded. Van Merriënboer (1997, 1999, 2005) developed a “four-component instructional design” (4C ID) model to emphasise the use of adequate instructional features and authentic and complex learning tasks. Instructional design should focus on a combination of performance support and fading, by scaffolding whole-task practice. In this respect “meta-cognitive knowledge” is “the declarative knowledge one has about the interplay between personal characteristics, task characteristics and the available strategies in a learning situation” (Veenman, Wilhelm, & Beishuizen, 2004, p. 90). These researchers demonstrated that meta-cognitive skillfulness is a general, person-related characteristic across age groups; it develops and contributes to learning performance, partly independent of intelligence. Meta-cognitive skillfulness seems to play a main role in the self-regulation of learning. Kalyuga, Ayres, Chandler, and Sweller (2003) hypothesised that novice learners lack sophisticated schemas in their long-term memory, so instructional coaching or guidance is needed for the task at hand. Contrary to this, experts bring their existing cognitive schemas to the process of constructing mental representations of a situation or task; they do not need instructional guidance. However, if this guidance is given and experienced learners cannot avoid it, the redundant information may have negative working, motivational and other consequences. The result is “cognitive overload”, which actually blocks learning processes. The authors called this phenomenon the expertise reversal shift and reported supporting research. The instructional conditions relevant to this shift correspond closely to the characteristics of the instructional situation of “forced underachievement” of high ability pupils treated before. A comparable situation applies for low ability or “novice learners” who are
confronted with learning tasks at too high a level of cognitive complexity.\textsuperscript{29} The interactions between pupil characteristics and instructional characteristics at the pupil level are therefore particularly relevant to the development of individual competence and the corresponding feelings of competence and self-regulation.

3.2 Integration of social, organisational, and self-regulation characteristics

Dillenbourg (2002) provides evidence that cognitive, social, instructional, and organisational aspects of education are integrated in school. Different cognitive and social characteristics of the pupils and their home situations\textsuperscript{30}, and cognitive, social and organisational characteristics of the learning tasks for pupils – individually, in small groups or in classes, or integrated throughout school – are known to stimulate different types of individual, collaborative and social comparison processes between the pupils involved and to effect or block various possibilities for learning.\textsuperscript{31} Blatchford (2003), for example, observed large and small classes of children aged 4-5 years. Compared to large classes, in small classes teacher-child contacts were more frequent and personalised, children were more likely to be on-task, and children interacted less extensively with their peers with respect to both work and social contacts. This perspective agrees with outcomes of research on differentiated collaboration in school practice between seven to nine-year-old primary school pupils in Sweden (Bergqvist & Säljö, 1998). The organisational structure greatly facilitated the transfer of many responsibilities from the teacher to the learners, as in Parkhurst’s (1922). According to Bergqvist and Säljö (1998) this was possible because the social, pedagogical, and learning roles were closely related to the more individualised and self-regulatory organisation of teaching and learning within and between age-integrated classes.\textsuperscript{32}

Underwood (2003) defined co-operative learning as learning in which learners work together in small groups to achieve a common goal; in doing this, they may choose to take responsibility for subtasks and work co-operatively, or they may collaborate and work together on all parts of the problem. Furthermore, learners working in small groups can take on different constructive or destructive roles in the learning processes. She referred to resistance to group work because of “freeloaders” or individuals who withhold effort if they can achieve their goal by letting others do the work, or because of plagiarism. According to this author, these problems are related to the way instruction functions.

If individual and collective tasks or contributions to group work are not perfectly clear, or not clearly evaluated, feelings of competitiveness may preclude co-operative or collaborative work. This was also made evident by Kaplan, Gheen, and Midgley (2002), who showed that the classroom goal structure is related to pupils’ patterns of learning and behaviour. Learning according to personal mastery goals was related to lower reports of disruptive behaviour, whereas learning in line with an individual performance-approach and performance-avoidance goals was related to higher reports of disruptive behaviour.

3.3 A multilevel approach to instruction and learning for self-regulation

Understanding and improving a pupil’s learning processes and consequent school career then requires a more comprehensive, multilevel approach of the relationships between instructional characteristics and learning processes. I will outline such an approach, which will assist in designing a more preventive educational situation for pupils at risk in particular.
Figure 3 illustrates the systemic organisation of educational and learning processes at different but related levels of analysis. At the bottom of this figure are individual pupils; higher up, they are organised into small groups or classes. Classes are organised in school locations, or schools. Groups of schools, or schools and institutes for youth health care can build a community, region or district, to provide for various community-related services (cf. Hermanns et al., 2005). Regions combine to build the national level, which is the original level for national educational policy and inspectorate or support institutes. Still higher up, the international level is characterised by different international policy and government institutes. Generally, the number and types of levels distinguished depend on the goal of an educational or learning analysis, investigation, or policy approach.

A multilevel approach can assist in clarifying how processes take place between different types of variables, at specific instructional levels and between different instructional levels. In the present situation, various pedagogical, psychological, or instructional and organisational characteristics on the one hand, and diverse characteristics of learning processes and outcomes on the other interact and produce more or less systemic variations in cognitive, social, behavioural, motivational, self-concept and self-regulation outcomes.

In the following, I will develop an initial specification of such a complex process. The theoretical results will promote developments that are expected to improve instructional and learning processes in practice. Trials and practical implementation can subsequently support the development of improved prototypes and implementation processes and outcomes, and so on.
3.4 Elaborating instructional and learning processes at and between different levels

3.4.1 Pupil level: A theoretical model of self-regulation and scaffolding

Self-regulation refers to “self-generated thoughts, feelings, and actions that are planned and cyclically adapted to the attainment of personal goals” (Zimmerman, 2000, p. 14). In competence-based learning processes, it is expected that, as a pupil exerts more control over his or her own learning processes, his or her degree of “self-regulated learning competence” will increase, something that usually motivates the selection and carrying out of more complex learning tasks. In primary education, this theory is empirically supported by the establishment of longitudinal relationships between school subject-related task motivation values, academic performance, and self-concept of ability (Nurmi & Aunola, 2005), although this is not always verified (Spinath & Spinath, 2005).

Paying explicit attention to self-regulation of learning, for example training pupils in self-regulative and problem-solving competence (Perels, Gurtler, & Schmitz, 2005), or intervening in practice by supporting teachers in structuring pupils’ self-regulated learning and deep-level processing (cf. Vermunt, 2006), has positive effects on pupils’ self-regulative processes. Schunk (2005) emphasises that intervention studies will help to understand whether principles of self-regulation generalise across contexts. Self-regulation effects will become stronger and more valid ecologically as pupils are allowed more initiative and responsibility, given a clear pedagogical and coherent instructional structure throughout school (cf. also Rozendaal, Minnaert, & Boekaerts, 2005).

At the pupil level, competence-based learning can then be characterised by the following cycle: estimation of the difficulty level of one or more learning tasks, followed by the selection of tasks to be performed; various types of support or coaching for learning or the carrying out of the learning tasks; and assessment or evaluation of the learning results according to specific criteria or norms, followed by the selection of the next or of other types of tasks. Increasing the possibility of achieving self-regulation or learner-control by these successive stages, or “scaffolding”, is expected to function as a main prerequisite for taking the next motivated and effective, or competent, learning steps. Figure 4 illustrates the theoretical cycle of learning task selection – coaching – assessment, and so on (see the three outside ellipses and black arrows).

Each of the three parts of the cycle can change from “performed by or dependent on instruction of others” via “performed by the learner himself or herself” to “assisting the learning of peers or other learners”. The “self-regulation process” in the middle of Figure 4 clarifies that selection, coaching, and assessment are coordinated systemically and dynamically, to achieve the smooth functioning and increase in efficiency of relevant competencies. Each learning cycle depends on the adequacy of a learner’s dynamic integration or “self-regulation” of all process information with respect to task selection, coaching, and assessment. The self-regulation process directs, supervises, and checks concrete learning activities or tasks, monitors progress, and analyses the potentials or difficulties of changing tasks, sets of tasks, or the learning situation. This self-regulation process seems to be essential for the person’s identity as a learner: choosing or performing the next learning tasks will promote the learning outcomes and related benefits; not choosing or not performing the next learning tasks will – in the long run – result in the pupil’s dropping out of education.
As implied in Figure 4, pedagogical, social, coaching, and organisational characteristics play a role in the development of a pupil's self-regulation. The specification of such characteristics implies relationships between variables at and between different levels of analysis. This multilevel design requires relationships with various aspects of learning processes, in particular diagnostic, instructional, managerial, and systemic aspects.

### 3.4.2 Diagnostic, instructional, managerial, and systemic learning aspects

The first learning aspect is the diagnostic specification of the actual level of competence of a learner in a general or specific cognitive, social, emotional, motor, expressive, or other relevant learning domain. Such a specification is required to estimate the relevancy of the next learning activities or tasks, or processes. Diagnostics may be based on former learning results, screening of performance by one or more coaches or experts involved, testing with criterion- or norm-based instruments, or more complicated evaluations or assessments given by a teacher, coach, peer, the learner himself or herself, or a combination of the above.

The second learning aspect refers to the specification of instructional consequences of the diagnostic value or indicator. In which ways, by which didactic procedures or specific treatments can – or should – which type of instructions be assigned to learners with specific diagnostic outcomes? Being prepared to answer such questions, and to take adequate and timely action by making provision for learning, is of great value from a preventive point of view.
This aspect also qualifies the validity of the diagnostic indicators used. A diagnostic task can, for example, be part of a structured set of learning tasks (“instructional line”), which in its turn may be part of some sets of tasks or instructional lines that are combined to build a specific curriculum (cf. Janssen-Noordman & Van Merriënboer, 2002). In such a situation, the meaning of the diagnostic indicator is valuable in itself but it is also valuable from an instructional point of view because it refers to curricular activities to be performed, or to an individual education plan to be carried out involving special education needs or high ability activities (cf. Mooij & Smeets, 2006).

Third, flexible and adequate management of both diagnostic and instructional learning aspects is necessary to evaluate and organise subsequent learning processes and learning progress in good time by individual pupils, small groups of pupils, group or classes, school locations, schools, or other types of institutes or organisations. The goal is to achieve multilevel transparency and balancing of individual and group or class-based learning progress, given the pedagogical choices made and the budgets available (cf. also Peetsma et al., 2003). Fourth, systemic aspects of learning are at stake. A child belongs simultaneously to a family, one or more peer groups outside pre-school or school, and a class in primary or secondary school in which it spends many hours every week. Moreover, the child may have contacts with, for instance, youth health care professionals. It is possible to integrate these different worlds into the same set of learning processes by focusing on a multilevel instructional learning cycle.

3.4.3 A multilevel instructional cycle for learning processes and effects

The four aspects of learning processes can be integrated into bottom-up specifications of variables at multiple levels, for instance the pupil level, small group level, class level, and school level in particular. Diagnostic, instructional, managerial, and systemic aspects can then be distinguished with respect to learning processes at the same level, but also between different levels simultaneously. Figure 5 illustrates this multilevel cycle and the corresponding general systemic relationships between diagnostic, instructional, and managerial learning aspects. Figure 5 will be described in more detail below with respect to three educational conditional dimensions.

3.4.4 Three educational conditional dimensions and the learning aspects

The first educational conditional dimension with which we can differentiate learning processes concerns the differentiation of learning materials and procedures. This is necessary to adequately stimulate the learning processes of pupils with respect to, for instance, cognitive, social, motivational, emotional, motor, expressive and self-regulatory capacities and potentials. Increasing differentiation in educational practice makes heavy demands on the information storage and processing capacities of teachers and coaches, pupils and parents (cf. Kounin, 1970). ICT is – potentially – a very powerful tool for monitoring multilevel differentiation of instructional materials and procedures in relation to the learning processes and effects of one or more pupils. ICT can also link different types of information, for various learners or groups of learners, across time, instructional situations or places, and media, in
order to support pedagogically responsible self-regulation. If adequately designed, ICT can therefore act as a second “educational conditional dimension” (cf. also Van der Veer, 2006).

The third educational conditional dimension is meant to further empower the first two dimensions combined. This third dimension concerns guidelines for various but related strategies to improve development and learning, including self-regulation of learning, for all learners. This improvement is expected to benefit not only the pupils in educational practice but also the other persons or institutes involved, such as teachers, parents, schools, and society at large, as will be clarified in the following sections.

### 3.4.5 A theoretical model with specific guidelines

The three educational conditional dimensions and the various learning aspects of Figure 5 can be combined in a theoretical set of guidelines as modelled in Table 1. The 15 guidelines conceptualise a general educational design assumed to promote multilevel instructional learning processes for different types of pupils. Moreover, the model can be used to structure and coach the transformation of a school or group of schools from an age-based or less-differentiating instructional system into a more differentiating instructional system with more optimal learning processes and effects.
Table 1 – Educational conditional dimensions and modelling guidelines for learning

<table>
<thead>
<tr>
<th>Learning aspect (DIMS)</th>
<th>Differentiation of learning materials and procedures</th>
<th>Integration by and use of ICT support</th>
<th>Strategies to improve development and learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagnostic</td>
<td>1.1. Identify a pedagogical-didactic kernel structure for different domains and subdomains</td>
<td>2.1. Facilitate construction and use of a pedagogical-didactic kernel structure</td>
<td>3.1. Use a learner’s entry characteristics to stipulate instructional lines</td>
</tr>
<tr>
<td></td>
<td>1.3. Include psychometrically valid indicators to evaluate learning progress</td>
<td>2.2. Enhance structuring, transparency, and flexible use of instructional lines</td>
<td>3.2. Create and control pro-social relationships in and around school</td>
</tr>
<tr>
<td></td>
<td>1.4. Organise and match flexible groups of learners and teachers/coaches</td>
<td>2.4. Encourage differentiated and multilevel evaluation of learning</td>
<td>3.3. Use collaborative didactic procedures to stimulate self-regulation</td>
</tr>
<tr>
<td>Systemic</td>
<td>1.5. Use integrated systems for monitoring, evaluation, and administration</td>
<td>2.5. Integrate instruction and learning across different contexts and points in time</td>
<td>3.5. Apply multilevel indicators to improve instruction and learning</td>
</tr>
</tbody>
</table>

Table 1 – Educational conditional dimensions and modelling guidelines for learning

3.4.6 Differentiation of learning materials and procedures

The first and diagnostically relevant differentiation guideline refers to the specification of a “pedagogical-didactic kernel structure” of competence domains, including the most relevant concepts and their measurement or evaluation. Competence domains are, for example: general intelligence; language; social-emotional performances; arithmetic/mathematics; physical-medical aspects; general psychological characteristics; or motor activities. Such domains can be further specified into subdomains, and so on.

An example of a competence domain is given by Sternberg and Grigorenko (2002), who defined successful intelligence as “the ability to succeed in life according to one’s own definition of success, within one’s sociocultural context, by capitalizing on one’s strengths and correcting or compensating for one’s weaknesses; in order to adapt to, shape, and select environments; through a combination of analytical, creative, and practical abilities” (p. 265).
The second, instructional differentiation guideline focuses on the curricular relevance of the pedagogical-didactic kernel structure. To be useful, diagnostic indicators from competence domains or subdomains have to correspond to, or be integrated with, skills and corresponding subskills that can be represented by specific sets of curricular learning tasks and activities. A specific set of such learning tasks or activities, including the diagnostic indicator, builds an “instructional line” which is assumed to be characteristic for a specific level of competence, or is validated as such.

Such a line can be composed of learning tasks or activities taken from different competence domains, skills, or subskills. This allows great flexibility in the design of instructional lines for different types of learners. Moreover, collaboration between different disciplines, societal sectors or professions can be made concrete e.g. regular education and special education, education for high ability pupils, vocational education, youth health care, developmental psychology, or pedagogy.

Third, integration of psychometrically adequate measures in successive instructional lines will greatly enhance adequate instructional support for achieving and evaluating continuous learning progress from both individual and group or collective points of view. This relevance was demonstrated above in the discussion of norm versus criterion-referenced testing and in the referral of a pupil to special education facilities.

Jepma and Meijnen (2004) illustrated this relevancy for teaching low ability pupils in special education. The corresponding relevance for high ability pupils was shown by Van Eijl et al. (2005). These researchers reviewed many materials and procedures for high ability pupils but were not able to link these to a main curricular structure of competence concepts, levels, or procedures.

The fourth guideline explains how to adequately organise and match learners into flexible groups of learners, with various types of teachers or coaches, in order to optimise learning processes and outcomes. In practice, this includes flexible management and the evaluation of specific combinations of learners or types of learners with specific instructional lines or sets of these lines, given the staff, material, and other resources available. Furthermore, in addition to activities required within the official curriculum, many non-official or non-compulsory activities can be chosen or developed by the learners themselves and be evaluated by the learners or in co-operation with, for example, the teacher.

The fifth conditional guideline is the systemic concentration on the adequate linking and integrated functioning of the diagnostic, instructional, and managerial differentiation aspects at different levels of analysis (cf. Figure 5). This can be achieved in particular by adequate collaboration between relevant persons and institutes (cf. sections 2.1 and 3.3) and by the creation and use of one or more integrated systems for monitoring, evaluating, and administrating the various multilevel types of information. Internet-based Information and Communication Technology can play several important roles here to empower the use of differentiated learning materials and procedures.
3.4.7 Integration by and use of ICT support

The first diagnostic guideline indicating the support function of ICT (see Table 1) is to assist in building and providing a pedagogical-didactic kernel structure at a "national level". This means providing comparable support for all schools, teachers, other professionals, and learners, although these users can select their own concepts and subconcepts for designing or creating their own curricular or learning domains and including levels of competence. Second, according to instructional guideline 2.2, ICT can further help to structure, enhance the transparency of, and promote the use of differentiated curricular-based instructional lines and corresponding learning procedures across different educational levels and sectors. Various types of users in or around schools can select instructional lines, or create or adapt these lines to one or more pupils, small groups, classes, school locations or schools, and so on. Third, availability of an ICT-based pedagogical-didactic kernel structure allows the flexible adaptation of education to individual learning characteristics, for example learners' cognitive styles (Triantafillou, Pomportsis, & Demetriadis, 2003) or individual education plans for either special education or high ability pupils. The same may encourage pupils to create or design instructional lines for themselves, which will stimulate interdependent forms of learning (Kirschner, 2006) and the pupils' self-regulation in various ways. Fourth, from a managerial point of view the possibility of evaluating learning processes or progress at different levels simultaneously is increased (Mitri, 2003). This differentiated evaluation can stimulate individual learning while at the same time providing information about relative progress compared to other users, criteria, or benchmarks. Fifth, from a systemic point of view ICT can integrate learning processes across different learning situations, either in school or outside school in youth health care support situations. ICT can assist in transmitting data and providing feedback with respect to many different but related psychological, learning, and instructional variables and their (possible) effects on pupils, at different levels. Moreover, ICT support of differentiated learning materials and procedures will have a more constructive impact if the support is directed at strategies expected to improve pupils' development and learning processes.

3.4.8 Strategies to improve development and learning

The first diagnostic guideline here (cf. Table 1) concerns the screening or evaluation of a pupil's initial or entry characteristics. This information can be used to check the parents' and the pre-school teacher's views of the child. The aims are to communicate about these views, to consider additional diagnostics or professionals where indicated, to discuss the assignment of regular or specific play materials or instructional (sub)lines just above the child's actual competence levels, and to encourage collaboration between home and school. Second, from the instructional point of view, it is important to immediately create and mutually control pro-social relationships between all persons in a small group, class or school. Collaborative social and didactic procedures can also be integrated into instructional lines to stimulate pro-social learning processes (Kaplan et al., 2002). Kreijns et al. (2003) specified how social collaboration and specific didactic support can result in positive group processes and outcomes (see also Crook, 1998). A combination of regular and risk-reducing pro-social activities or training programmes is often necessary to provide sufficient support for children, teachers and parents.
Third, instructionally supported collaboration between pupils in small groups enables more motivating and more self-regulated learning processes and outcomes. Such instructional support is required in particular for pupils with special educational needs and for high ability pupils, as they differ considerably in many respects: initial or entry level of competence, magnitude of learning steps, speed and accuracy in learning processes, use of meta-cognitive strategies, and degree of self-regulation during learning.48

Fourth, from a managerial point of view another potential benefit of collaborative self-regulation in small groups may be that this type of organisation enables the teacher to concentrate on those pupils most in need (Meijer, 2003). Pupils who are able to self-regulate or use ICT as elaborated here can, for example, use the pedagogical-didactic kernel structure to design, monitor, and evaluate their own learning processes in responsible ways (cf. Kirschner, 1997).

Fifth, by using integrated ICT systems as indicated, from different perspectives, it is possible to continually improve the progress of each learner across different learning situations or educational sectors. This is what schools should do, at least from a legal point of view (see Chapter 1 and section 2.1).

### 3.4.9 Multilevel hypothesis

Adequately differentiating instructional arrangements will result in qualitatively more supportive, more motivating, and more productive learning processes and effects than occurs in age-based education (cf. Schnottz & Lowe, 2003). ICT support of the associated multilevel instructional management also creates more responsible and more self-regulative possibilities for learners than is possible without ICT (Kensing, Simonsen, & Bødker, 1998). Moreover, shifting into a more differentiating, ICT-based instructional managerial system allows teachers or coaches, parents and other professionals to concentrate differentially on relatively slower or less adequate learners; simultaneously, high ability pupils can effectively engage in more self-regulated learning processes (King et al., 1985).

This support has to be provided to individual pupils, to small groups and classes, to school locations or schools, and, where relevant, to groups of schools or at regional/district or national levels. As this is achieved in educational practice, the age-based or less-differentiating educational system is transformed into a differentiated, ICT-based, instructional managerial system. The expectation is that this transformation will improve the learning processes and educational careers of low and high ability pupils in particular. A general multilevel hypothesis expressing this transformational expectation can be formulated as:

“As differentiation of learning materials and procedures, integration by and use of ICT support, and strategies to improve development and learning are achieved at multiple levels, it is expected that improvements will take place in multilevel differentiation and evaluation of learning processes. This will result in better self-regulation and learning outcomes, particularly for learners who initially deviated most from the mean in their group or class, or from their peers’ norm.”

The more such differentiated education becomes available, the more it will be possible to design evidence-based or comparative research in “regular education” to check empirically whether the supposed effects are in fact taking place (cf. Van den Akker, 1999).
4 Development:
prototype research and trials
4.1 Differentiation of learning materials, procedures, and ICT support

Differentiation of learning materials and procedures first of all required us to develop a prototype of a “Pedagogical-Didactic Kernel Structure” (PDKS), cf. Table 1. Moreover, the ICT support had to be elaborated by developing a software prototype concentrating on “Diagnostic, Instructional, and Managerial Systems” (DIMS). The prototyping of both PDKS and DIMS was carried out in different phases.

First, guidelines 1.1 and 1.2 of Table 1 were made concrete as follows. An inventory of Dutch instruments and tests for youth aged 0-20 resulted in a set of hierarchically structured competence domains and subdomains. The main domains contain skills related to language; general cognition; social-emotional performance; mathematics; physical-medical aspects; general psychological characteristics; and motor activities. The prototype reflects a multi-disciplinary classification based on measurable skills and subskills, with a focus on education. A “skill view” presents skills in a hierarchical order. The main characteristic of this view is that it applies in all instances or at all schools. An example of a skill view concentrating on a part of the language competence domain is given in Figure 6.

![Figure 6: Competence domains/subdomains of the pedagogical-didactic kernel prototype](image)

Development
In this structure, the only relationships are hierarchical ones. For example, a learner who is able to perform all subskills (e.g., “auditory discrimination word” and “auditory discrimination sound”) has reached the respective skill level (“auditory discrimination”). ICT-features can be of unique relevance because they allow easy manipulation and immediate demonstration of such ordering structures. In this respect, DIMS was designed to produce a “skill order view” that can describe conditional dependencies between PDKS skills from one or more domains. This allows the integration of skills from different domains into tasks that vary in complexity. The screen dump in Figure 7 presents a skill order view with respect to the early learning and production of sentences. The rectangles illustrate that, from left to right, “internal representation of information” and “production of sounds” (far left) are conditional to the production of “one-word sentences”, which in its turn is conditional to “two-word sentences”; these are conditional to “more-word sentences”.

Schools or school locations, teachers, professionals from other institutes, pupils or parents can use but not change such ICT-based skill order information. They can, for example, select one or more concepts and connect specific learning tasks or evaluation or diagnostic activities into self-made instructional lines leading to them. The instructional lines are then stored by the software and can be assigned to any pupil or group of pupils, or be changed whenever this is desired. It is thus possible to link fairly stable, general conceptual skill orders with user-based selection, flexibility, and changeability.

4.2 ICT-based strategies to improve development and learning

There are few suitable instruments in The Netherlands for measuring children’s pre-school entry characteristics. A psychometrically controlled screening procedure was developed earlier in longitudinal research involving 966 children, their parents and their teachers (Mooij & Smeets, 1997). The questionnaire can be administered by an infant day care teacher when the child is about to leave the day care centre to go to pre-school, by the parents when the child enters pre-school, and by a pre-school teacher after the child’s first few months in pre-school. The procedure estimates a child’s level of competence in various domains by comparing its behaviour with the behaviour of same-age peers in general. This particular reference is used because this is the only comparison parents can
usually make to evaluate their child’s behaviour. The seven scales refer to the estimated level of, respectively, social interaction/communication; general cognition; language proficiency; (preliminary) arithmetic; sensory-motor level; emotional-expressive level; and expected educational behaviour/motivation.

DIMS can be used to assess a child’s levels of competence from the perspective of an infant day care teacher, a parent, and a pre-school teacher (cf. www.dims.nl). DIMS can also compare various results of the screening of entry characteristics. For example, five types of scale scores and diagrams are given for each behaviour domain. Per domain, the first score and diagram represent the age norm indicating the population benchmark; the second scale score and diagram indicate the parents’ estimation of their child’s performance compared to age-mates; the third score and diagram represent the pre-school teacher’s estimation; the fourth score and diagram are given by the infant day care teacher; and the fifth score and diagram represent the mean of the teacher’s scores for the children in this class.

A teacher’s didactic coaching of one or more pupils, but also the self-regulation of learning by one or more pupils, can be further assisted by skill order views (cf. Figure 7) that indicate the actual level of competence and subsequent choices with respect to the next learning activities, either ordered into instructional lines or as separate activities. Such PDKS-based choices or planned deviations provide a very important, common frame of reference for collaboration between teachers and pupils, pupils in small groups, schools and parents, parents and children, and schools and (for example) youth health care or advisory professionals (cf. Hermanns et al., 2005). Moreover, the same type of software is used to generate or evaluate empirical benchmarks at different educational levels in various types of large-scale monitoring and intervention research (see further Mooij, 2001a, p. 114-118; www.veiligvo.nl).

The two prototypes and the guidelines set out in Table 1 need to be implemented primarily by teachers, pupils, parents, and management at school locations or schools. In particular, the teachers should be encouraged to develop and implement this kind of teaching and learning.52

I will now report on some examples of implementation and changes in educational practice.
5 Implementation: examples and changes in educational practice
5.1 Pre-school and primary education

Collaboration with pre-school and primary school teachers resulted in the specification of practical requirements and the possibility of implementing the pedagogical-didactic kernel structure (PDKS) by means of concrete diagnostics and related instructional lines.\textsuperscript{53} The actual implementation commenced with the screening of the entry characteristics of four-year-old pupils. The teachers, parents, and day care centre teachers at three pilot pre-schools had to familiarise themselves with this type of intake, after which entry characteristics were screened 357 times in the period 2003-2005 (cf. Mooij & Smeets, 2006). Persons completing the questionnaire usually agreed that the screening results helped them arrive at a clearer, multiperspective view of a child’s entry characteristics. It became easier for them to establish a common frame of reference that facilitated more accurate communication about a child.\textsuperscript{54} Moreover, other play and learning materials had to be introduced, as it became evident that differences between pupils were more pronounced than the traditional materials had accounted for. The outcomes were also used to plan further educational support for each child in the form of specific play or diagnostic and learning activities and corresponding instructional lines. Finally, the teachers became more interested than before in creating different types of small groups of pupils, as this organisational feature seemed to provide better conditions to foster pro-social and effective, self-regulative learning relationships between pupils.

In one of the pilot pre-schools, the pilot teacher’s attention was subsequently drawn in particular to the prototype of the PDKS and the age-independent collaboration of pupils in small groups throughout pre-school and primary school. According to this teacher, her school now uses a child-oriented curriculum (guidelines 1.1-1.4 of Table 1) to introduce strategies to improve pupil development and learning (guidelines 3.1-3.4). Daily school practice is based on three general rules for the whole organisation and for all pupils. In the teacher’s words, the general collaborative rules are:

1. Ensure that each child feels all right; reflective discussions are good instruments for achieving this.
2. Make transparent what a child likes to do and let the child determine what he or she is going to do.
3. Make the school comfortable and efficient for each child.

With respect to tasks and activities that may be part of a pupil’s weekly task schedule, the teachers initially place a pupil at a specific instructional or competence level. Thereafter, pupils themselves choose another pupil to cooperate with on the basis of the other pupil’s competencies. The other pupil may be chosen for a specific domain of competence, so that a pupil may choose multiple partners. Each pupil is usually included in various small, collaborative groups of pupils. The formulation for executing tasks or activities is:

– What do you want to do? Decide for yourselves.
– Why do you want to work on this task or activity?
– How are you going to do that?

A pupil’s work plan can be designed by the pupil for a longer period of time and for various areas of competence: expressive behaviour, arithmetic, language, motor behaviour and so on. Where necessary, the teacher advises or coaches. S/he also checks the plan for
completeness of skills covered, strategies, and goals. In addition to the pupil’s plan, the school also has a plan setting out the skills and goals to be achieved for each pupil. To coordinate these plans, which may differ, the pupil, the parents, and the school collaborate closely. Where necessary, external professionals are called in. The input of external professionals is evaluated on a regular basis.

In collaboration with the pilot teachers from the various pre-schools involved, different examples of instructional lines for regular, special education, and high ability pupils were integrated into DIMS. Further development and implementation are necessary, however.

5.2 Secondary education

A comparable programme to the one in primary education was also set up in secondary education (Mooij, 2001b). For sector-related and budgetary reasons, however, the innovation activities had to be split up (cf. Mooij, 2004). From the start of 2003, collaboration took place with three National Educational Advisory Centres in seven secondary school locations (most of these belonged to agricultural schools). Information about the project goals, procedures, and results in the period 2003-2006 is available on the Internet (cf. "Livelink").

This project involved various innovation partners: seven school locations, each with some teachers and school management; all three National Educational Advisory Centres; the Ministry of Agriculture, Nature and Food Quality; a software development institute (Antenna), and a research and development institute (ITS). The ITS had also designed a framework for concrete curriculum and software development, including evaluation procedures to structure the necessary implementation in practice (cf. Livelink; Mooij, 2006).

From the start of the project, discussions between the partners concentrated on the relevance of diagnostic features in the curriculum and the related development and implementation of specific evaluation or assessment aspects. These discussions reflected different notions and evaluations of, and different institutional positions with respect to, concepts such as “natural learning” and “new learning.” The differences were related mainly to groupings of schools according to the educational policy of the Advisory Centre coaching the schools. Blok et al. (2006) also describe this phenomenon.

One main consequence was that diagnostic-based curriculum development and the corresponding implementation of continuous learning, either individually or in collaborative small groups of pupils, became blurred. The Advisory Centres decided to concentrate first on introducing ICT at the schools. This introduction and the follow-up implementation were successful, but comprehensive curricular development and assessment has yet to take place.

Another systemic possibility to improve learning in the proposed direction is to use software such as DIMS in multilevel repeated measurement or monitoring. One example is the development and application of a national monitor to increase school safety (see Mooij et al., 2006). The initial monitor results, involving about 89,000 pupils, teachers and school staff, reveal (among other things) that the most vulnerable pupils are still in the same instructional circumstances as some 15 years ago. This two-yearly national monitor can also assist in initiating and supporting a bottom-up instructional, curricular, and social innovation process in and between school locations, as sketched in this address and elsewhere (Mooij, 2001a, p. 114-118). That will require fine-tuned collaboration between
schools, school locations, teachers, research, educational development and advisory institutes, and national policy (see also Van den Born, 2006b).

5.3 Conclusions

Some preliminary conclusions can be drawn. First, the design of necessary instructional innovations proved to be adequate in educational practice. The initial results make concrete what may be meant by the “value added” of schools in the “quality map” of the Inspectie van het Onderwijs (Education Inspectorate) (Janssens & Visscher, 2004).

Second, in pre-school and primary and secondary education, responsible collaborative and management processes leading to innovation at school locations and schools require many more facilities: development and implementation time; structured discussions of and decisions about essentials and irrelevancies; collaborative performances of “evidence-based proofs of better practices”; and more collaborative evaluations of intermediate innovation outcomes.

Third, differentiation of teaching-learning situations and the corresponding differentiated assessments of learning progress constitute essential conditions for stimulating school motivation, achievement, and responsible self-regulation of pupils. However, we are not yet able to check the hypothesis formulated above against sufficient quantitative data. Fourth, priority has to be given to careful collaborative development, implementation, and empirical control of the multilevel innovation of instructional processes and their effects on various types of pupils. Nowadays, however, such collaboration is not easy to achieve in The Netherlands. National educational policy is withdrawing, and more and more responsibility and financial support are being handed to school boards or schools. As a result, schools and school locations are more dynamic and more divergent, but they also lack co-ordination and management with respect to more fundamental educational issues (cf. Waslander, 2004). Moreover, as reported also by Blok et al. (2006), the organisational and commercial goals of advisory or support institutes may become more important than achieving evidence-based improvements in pupils’ learning and self-regulation processes.

Research carried out by Blok et al. (2006) underpins the necessity of the approach presented in this address. These investigators carried out an extensive national and international review of research and eight case studies of Dutch pre-schools and primary schools considered to be innovative with respect to “new learning.” The authors describe this type of learning in terms of six characteristics:

1. attention is given to self-regulation and meta-cognition;
2. self-responsible learning is integrated;
3. learning occurs in an authentic environment;
4. learning is a social activity;
5. learning occurs by means of ICT;
6. use is made of new assessment methods that match the other five points to a greater or lesser extent.

Their case study schools use many different concrete materials and methods to attain these characteristics. Relatively speaking, the least use is made of ICT, for various reasons. Moreover, the lack of new procedures for evaluation and assessment, and the traditional or age-based pupil monitoring systems, are considered the main problems in these schools.
6 Future research
In the years ahead, I intend taking up the following main lines of research.

In collaboration with my colleagues at the Open University of The Netherlands, I will focus my first research line on the further theoretical elaboration and model specification for optimising the educational careers of pupils and students. This is in keeping with the main aim of the Open University, which is to concentrate on “lifelong learning”. The self-regulation model presented, the subsequent multilevel instructional model and the guidelines presented in Table 1 share many characteristics with the four-component instructional design (4C ID) model as developed by Van Merriënboer (1997, 2005). The challenge is to further specify and check the models in both theory and practice, in and between various types of organisations.

My second line of research will focus on instructional, cognitive, social, and self-regulative processes and their effects on pupils in and around schools. Adequate specification of instructional, social, and cognitive roles from the very start at school will help pupils to develop desired self-regulation of learning processes. This type of research is in line with the experience and cognitive results gained in a “computer-supported intentional learning environment” (CSILE). Repeated application of, for example, the national monitor on school safety, and intermediate interventions to increase school safety, will constitute part of this line of research. I welcome collaboration with educational support or advisory institutes.

Third, for pupils in the lower left part of the at-risk curve shown in Figure 2, I will research instructional variables and cognitive learning in particular. Alloway (2006), for example, claims that deficits in working memory appear to be unique to learning difficulties in literacy and mathematics, and are not found in problems of a behavioural or emotional nature. I will design early instructional intervention research, to make up for memory impairments and associated learning deficits. The self-help strategies recommended by Alloway (2006) may promote the development of such pupils as relatively independent learners able to identify and support their own learning needs.

Another aspect of this line of research is to focus on the integration of pupils with emotional/behavioural disorders (E/BD). Chen (2006) reviews intervention research on social skills development and summarises important, effective trends. In collaboration with my colleagues from the Open University and the ITS of Radboud University in Nijmegen, I will perform intervention research concentrating on efforts to promote both cognitive and pro-social skills and performance in regular and special education settings.

Fourth, to aid pupils in the lower right part of the at-risk curve (see Figure 2), I will continue to design and check adequate educational practices for high ability pupils. Research generally indicates that the cognitive performance of gifted pupils can be improved considerably. The problem here is the flexible specification of learning materials and procedures that match competence levels and integrate responsible self-regulation facilities. As sketched, I will further develop and check such educational practices in collaboration with pupils, teachers, and parents; my colleagues from the ITS; other institutes at Radboud University in Nijmegen; and colleagues from educational support and advisory institutes.
7 Acknowledgements
I wish to conclude by expressing my gratitude, first of all, to the Chair of the University Board, Fred Mulder, for his confidence in my appointment at the Open University of The Netherlands. I hope to improve the collaboration between the Open University of The Netherlands and the ITS of Radboud University in Nijmegen in several ways. We have already discussed some relevant issues.

Second, I am glad to be able to say that I very much appreciate the cooperation with my new colleagues at the Open University. I would like to mention in particular the following colleagues at the Educational Technology Expertise Centre: Wim Jochems, who enthusiastically supported my coming but left when I came; Jeroen van Merriënboer, for his admirably accurate advice and timely coaching; my colleagues Fred Paas, Saskia Brand-Gruwel, Paul Kirschner, Frans Prins, and Tamara van Gog for their collaboration in the field of special interest we have developed and in other research; and, of course, Els Boshuizen for her stimulating discussions. I am grateful in particular to Audrey Wigman and Marion Timmermans for their unfailing management support.

Third, I am indebted to Erik de Gier, director of the ITS, my home ground at Radboud University. He unhesitatingly acknowledged the opportunity to form a constructive alliance between Heerlen and Nijmegen and to enrich and promote the functioning of both institutes involved. The preparatory work carried out by Jeroen Winkels, former director of the ITS, was certainly important too.

Fourth, I would like to thank my parents. They gave me every possible support. Barbara, my beloved wife and constant friend, makes me keep on learning. My children Joris and Sofie help me to experience how self-regulation can be achieved: by enabling other persons to become communicative and respected learners who create their own way in life.

I have spoken


Brush, Th., & Saye, J. (2001). *Defining hard and soft scaffolding in technology-enhanced student-centered learning environments*. Paper presented at the conference of the Association for Educational Communications and Technology (AECT), November 8-10, Atlanta, USA.


Gillies, R. M. (2004). *The effects of cooperative learning on junior high school students during small groups learning.* Learning and Instruction, 14(2), 197-213.


Yan, L., & Kember, D. (2004). Avoider and engager approaches by out-of-class groups: The group equivalent to individual learning approaches. Learning and Instruction, 14(1), 26-49.


Notes

1 Cf. Icke, 2006; Noorlander, 2005.
3 Algemene Rekenkamer (General Audit Office), 2001a; Schuyl, 1995.
4 One example is the creation and – after some ten years – the withdrawal of ‘basic secondary education’, a national core curriculum for the lower secondary educational sector (cf. Roelofs & Terwel, 1999; Roelofs, Visser, & Terwel, 2003; Terwel, 2006).
6 Durkin, 1966; Gallagher, 1975; Hoogeveen, Van Hell, Mooij, & Verhoeven, 2005; Mooij, 1991a.
8 Hermanns, Ory, & Schrijvers, 2005; Inspectie van het Onderwijs (Education Inspectorate), 2005b; Van der Veen, 2003.
10 Bekkes, 2005; Mooij, 2001a, 2005.
11 Baroody, 1993; Durkin, 1966; Mooij, 1991b, 1999a; Révész, 1952.
14 Cf. Butler-Por, 1987; Durkin, 1966; Mönks & Idenburg, 1987; Mooij, 1992.
17 The four levels are: highly able: 2.5%; able: 7.5%; above average: 15% (these percentages are the same as those used by Guldemond et al., 2003); and average and below: 75%.
18 For grade 2_4, the language and arithmetic standard deviations in decile 1 have about the value 1.20 and they decrease fairly steadily to about 0.60 in decile 10. For grade 4_6 a comparable pattern is found, but the standard deviations in language are somewhat larger and those in arithmetic are somewhat smaller.
20 The at-risk conclusion with respect to high ability pupils is in line with Purcell, Burns, Tomlinson, Imbeau, and Martin (2002), who discovered a huge gap between what schools or teachers in the USA do for high ability pupils and what is really needed for those pupils to learn. More evidence on this issue is provided by Colangelo et al. (2004) and Hoogeveen et al. (2005).
21 Important in her school practice is to clarify how aspects of the learning environment can motivate a pupil to match their own ‘IQ’ in relevant achievement in school: “I would like, however, to impress upon all instructors the necessity of abandoning the old idea of trying to keep the class or form together. It is a fallacy which, in view of the difference of speed and ability in pupils, has never been, and can never be, a reality” (Parkhurst, 1922, p. 159-160). She also foresaw the problems associated with this advice: “But the difficulty found in adjusting the school collectively to the fresh angle of vision is merely proof of the great necessity of the change” (p. 157).
When her instructional design was implemented into other schools, however, one essential change with respect to the continuity in learning processes was not included. Parkhurst had based
instructional and assessment processes upon each pupil’s initial characteristics and school subject differentiated learning progress, but in follow-up schools the instruction and assessment were adjusted to the pupils’ mean age again. Such inconsistencies may happen in development and implementation processes, but in this case the consequences for educational and learning processes in ‘Dalton schools’ are still underestimated. The educational analysis and learning innovations Parkhurst made in her school in 1922 are therefore still relevant and valid for The Netherlands in 2007, even for Dalton schools.

In The Netherlands we already have many different educational programmes, learning trajectories, or compensatory activities for pupils achieving in the lower left region of the ability curve (see for example Algemene Rekenkamer (General Audit Office), 2001a, 2001b, 2005; Hermanns et al., 2005; Verdurmen, Van Oort, Meeuwissen, Ketelaars, De Graaf, Cuijpers, De Ruiter, & Vollebergh, 2003). The same situation applies to pupils achieving in the lower right region. There are many learning materials and educational procedures or programmes for high ability pupils, but they are generally hardly or never checked for level of competence, psychological adequacy, or statistical effects on pupils (cf. Hoogeveen et al., 2005; Mooij, 1991b; Van Eijl, Wientjes, Wolfensberger, & Pilot, 2005).

Gagné (1965) concentrated on cognitive learning processes and identified eight prototypes of cognitive learning which are, in order of increasing complexity: signal learning, stimulus-response learning, chaining, verbal-associate learning, multiple discrimination, concept learning, principle learning, and problem solving.

These same authors conceptualised cognitive load as a multidimensional construct representing the load imposed on a learner’s cognitive system by performing a particular task. According to their cognitive load theory (CLT) relevant task characteristics are: format, complexity, use of multimedia, time pressure, and pacing of instruction. Relevant learner characteristics are: expertise level, age, and spatial ability. More specifically, these authors stated that cognitive load consists of three categories. The first of these is intrinsic cognitive load, which is based on element interactivity of the information in the learning process. The second category is germane cognitive load, which consists of resources assisting in learning by, for example, instructional features focusing on schema acquisition and automation, or stimulating supportive learning strategies of learners. The third category is extraneous cognitive load, which relates to the lack of fit between learner’s capabilities and qualities of the instruction in the learning situation.

This can be achieved by simple-to-complex sequencing of whole tasks into task classes and by differentiation between types of learning tasks, e.g. from worked-out examples or completion assignments to conventional tasks. Instructional design can promote learning by just-in-time presentation of information about the nature of learning tasks. Supportive information has to be presented before equivalent learning tasks, while procedural information has to be supplied during specific task performance (see also Janssen-Noordman & Van Merriënboer, 2002; Van Merriënboer, Kirschner, & Kester, 2003).

Cf. also Veenman, Prins, & Elshout, 2002. Prins, Veenman and Elshout (2006) revealed that intellectual ability and meta-cognitive skilfulness were related to some extent. Novice learners used meta-cognitive skills in the relatively easy phase of learning; for advanced learners, meta-cognitive skilfulness was the main determinant in the intermediate learning phase.


31 Blok, Oostdam, & Peetsma, 2006; Davis, 1966; Kirschner, 2006; Magnusson & Allen, 1983; Marsh, Chessor, Craven, & Roche, 1995; Mooij, Terwel, & Huber, 2000.


36 Some research has been carried out in The Netherlands, but the results have to be interpreted from the point of view of age-based education (see Chapter 2). Breekveldt and Brugman (2005) have researched scaffolding in arithmetic by classmates in the upper years of regular primary education. The results clarify that a pupil high in social status, or of the same sex, is better able to coach another pupil; no relationship was found between competence level in arithmetic and coaching (cf. also Guldemond, 1994). Observation research by Elbers and De Haan (2003) in primary education revealed that pupils from ethnic minority groups are less prepared for collaborative coaching than other pupils.


38 See also Black, McCormick, James, & Pedder, 2006; Cronbach, 1983; Davis & Rimm, 1985; James, Black, McCormick, Pedder, & Willam, 2006.


41 Byrne, 1998; Gallagher, 1975; Magnusson & Allen, 1983.

42 Brush & Saye, 2001; Mooij, 2007.


44 Clark & Estes, 1999; Mooij, 2001a, 2001b; Mooij, Sijbers, & Sperber, 2006.


46 Alschuler, 1980; Howard & Jenkins, 1970; Mooij, 1999c, 1999d.


48 Alloway, 2006; Bearne, 1996; Colangelo et al., 2004; Kerry & Kerry, 1997; King, O’Shea, Joy Patyk, Popp, Runions, Shearer, & Hendren, 1985.

49 The software prototype was developed by the ITS, with ing. M. Sperber taking a leading role (see www.dims.nl).

50 Dr. D. Aarnzten played a major role in this construction process.

51 The DIMS prototype also enables user-based integration and evaluation of diagnostic or other psychometric checks. Furthermore, instructions or instructional lines refer to learning materials or procedures present in or around classes or schools, so pupils need computer access only to get instruction or feedback. This procedure is adapted to the functioning of young pupils, promotes didactical variations in many respects, and makes optimal use of available learning or other materials and procedures.
Cf. also Blok et al., 2006; De Bruijn, Overmaat, Glaudé, Heemskerk, Leeman, Roeleveld, & Van de Venne, 2005; Griffin & Beagles, 2000; Lonenberg & Korthagen, 2003; see also the “Dynamic Scaffolding Model” for teacher development with Matthews and Foster (2005).

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Cf. also Cornell, Delcourt, Bland, Goldberg, & Oram, 1994; Mooij, 2002; Walker et al., 1998.

55

Cf. Mooij & Smeets, 2006; Mooij, in press a, in press b.

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See https://livelink.groenkennisnet.nl/

57

Cf. also De Jong, 2006; Simons, 2006; Stevens, 2006; Van den Born, 2006a; Van der Werf, 2006a, 2006b.

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Cf. also Baker, Bridger, & Evans, 1998; Blumenfeld et al., 2000; Earle, 2000; Finn-Stevenson & Stern, 1997; Mangione & Speth, 1998; Murphy & Lick, 2001; Onderwijsraad (Education Council), 2006; Remillard, 2000.

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Longitudinal observation revealed, for example, how social relationships between pupils and between pupils and teachers are shaped from the pupils’ very first day at school: Within about six weeks of entering a new secondary school, pupils learn how to deal with or reject teachers’ authority and to block non-desired learning processes effectively (Arbeitsgruppe Schulforschung, 1980; Jackson, 1968; Mooij, 1982; Willis, 1978). Quantitative research verified the relevance of social, didactic, and evaluational characteristics at the individual, class, or school level in these social processes (Fekkes, 2005; Mooij, 1993, 1994a, 2001a; Salmivalli et al., 2005; Yan & Kember, 2004).

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Cf. Coie & Miller-Johnson, 2001; Glover, Gough, Johnson, & Cartwright, 2000; Mooij, 1999c, 1999d; Mooij, Selten, & Smeets, 1998; Van Overveld & Louwe, 2005. Veenman, Denessen, Van den Akker, and Van der Rijt (2005a, 2005b) report on the effects of an intervention programme in which Dutch primary teachers are trained to promote elaborative or collaborative support in arithmetic between pupils in small collaborative groups. The results of the pre-test and posttest control group design demonstrate more elaborative behaviour, and better arithmetic achievement, in the experimental groups than in the control groups. A comparable conclusion was drawn by Gillies (2004) with respect to the effects of co-operative learning with small groups in high school. Compared with students in unstructured groups, students in task-structured groups were more willing to work with others on the assigned tasks, provided more elaborate assistance to each other, and developed a stronger perception of group cohesion and social responsibility.

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Alloway (2006) states that little evidence exists that remediation or direct training of working memory skills leads to improvement in academic attainments. She therefore suggests reducing working memory demands in the classroom through four effective management approaches.

67

Trends shown to be effective are: development of various social multilevel strategies i.e. for a small group, class, and school simultaneously; (combination of) modeling and role-play design; emphasis on co-operative learning as part of the curriculum, peer mediation and conflict resolution; cognitive-behavioural interpersonal problem solving; anger management; self-control strategies; curriculum-based interventions, and multi-age grouping.

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Colofon

Text prof. dr. Ton Mooij
Graphic design Polka Design graphic designers
Printing Alfabase