Education and self-regulation of learning for gifted pupils: systemic design and development

Ton Mooij*

Radboud University/ITS, Nijmegen, and Open University of the Netherlands/OTEC, Heerlen, The Netherlands

Gifted pupils differ from their age-mates with respect to development potential, actual competencies, self-regulatory capabilities, and learning styles in one or more domains of competence. The question is how to design and develop education that fits and further supports such characteristics and competencies of gifted pupils. Analysis of various types of educational interventions for gifted pupils reflects positive cognitive or intellectual effects and differentiated social comparison or group-related effects on these pupils. Systemic preventive combination of such interventions could make these more effective and sustainable. The systemic design is characterised by three conditional dimensions: differentiation of learning materials and procedures; integration by and use of information and communication technology (ICT) support; and strategies to improve development and learning. The relationships to diagnostic, instructional, managerial, and systemic learning aspects are expressed in guidelines to develop or transform education. The guidelines imply the facilitation of learning arrangements that provide flexible self-regulation for gifted pupils. A three-year pilot in Dutch nursery and primary school was conducted to develop and implement the design in collaboration with teachers. The results constitute prototypes of structured competence domains and supportive software. These support the screening of entry characteristics of all four-year-old pupils and assignment of adequate play and learning processes and activities throughout the school career. Gifted and other pupils are supported to work at their actual achievement or competency levels since their start in nursery school, in self-regulated learning arrangements either in or out of class. Each pupil can choose other pupils to collaborate with in small groups, at self-chosen tasks or activities, while being coached by the teacher. Formative evaluation of the school development process shows that the systemic prevention guidelines seem to improve learning and social progress of gifted pupils, including their self-regulation. Further development and implementation steps are discussed.

Keywords: education design; gifted pupils; self-regulation; information and communication technology; early education; school development

Introduction

‘Gifted’ or ‘high-ability’ pupils differ considerably from their peers with respect to their development potential, actual competencies, self-regulatory capabilities, and learning styles in one or more domains of competence (see Gallagher 1975; Heller et al. 2000). In the Canadian Education Act, for example, gifted 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, 123). However, when Purcell et al. 2002 investigated the curricula, textbooks, and studies relating to gifted learners in the USA, they found an immense gap between the curricula for gifted learners and the learning needs of such learners. The prevailing curricula
were mostly characterised by mediocre educational standards and uninspiring textbooks. As a consequence, gifted pupils may experience serious motivational, social and cognitive problems in education as a result of underachievement (see also Butler-Por 1987; Heinbokel 1988; Pendarvis, Howley, and Howley 1990).

Like other pupils, high-ability pupils require and deserve instructional support that is in keeping with their potentials and abilities, self-regulatory capabilities and motivation (Révész 1952; Khatena 1982; Davis and Rimm 1985; Mehlhorn 1988). Within current education systems, however, identification of gifted or talented pupils is usually not included and giftedness often goes unrecognised from the start of a pupil’s educational career (Brown et al. 2005). Moreover, even those pupils who are identified as gifted are generally confronted with education that is not fitted to their learning needs and self-regulatory potentials (Colangelo, Assouline, and Gross 2004). Gifted pupils’ ability for self-regulation to learn at any place challenges both the practical and theoretical aspects of institutionalised education and learning. In the regular system they have to ‘learn how to learn’ when they already have learned and achieved many curricular parts which are still new to their peers (see Black et al. 2006). Education and learning are interrelated closely and an educational design fitting one pupil or group of pupils does not need to be optimal for another pupil or group of pupils (see also James et al. 2006). The question for research then is how to design and develop education that really fits and further supports the development potential, actual competencies, self-regulatory capabilities, and learning styles of gifted pupils.

To answer this question, at first different types of educational interventions to support gifted pupils are analysed in order to know more about these interventions and their effects on gifted pupils. Concentration is on longitudinal studies considered to be methodologically adequate in design and analysis. The outcomes of these various interventions are used in designing a systemic preventive combination, to make education more effective and sustainable. The design is characterised by three educational conditional dimensions: differentiation of learning materials and procedures; integration by and use of information and communication technology (ICT) support; and strategies to improve development and learning. The relationships between these dimensions and diagnostic, instructional, managerial and systemic learning aspects build a comprehensive set of guidelines to develop or transform education. To check the empirical relevance of the design, a pilot study of three years’ duration was carried out in collaboration with teachers from Dutch nursery and primary school. The goal was to try to develop and implement the design in practice. First the prototype results of the school and systemic innovation are introduced and evaluated, and then development steps are discussed.

Theory

Types of curricular interventions and effects on gifted pupils

Curriculum- or content-directed interventions

Reis et al. (1998) concentrated on condensing or compacting curricula for high-ability pupils in heterogeneous second through sixth grade classes. For one school year, about half of the regular curricular content was omitted and replaced by independent study, projects, alternative assignments, advanced content, interdisciplinary units, and such. The statistical results revealed that the curriculum achievement of the treatment pupils did not differ from the achievement of the control pupils, which suggests that compacting does not result in achievement disadvantage.

Blumen-Pardo (2002) randomly assigned gifted and non-gifted second-grade pupils between six and eight years of age to experimental and control groups. The experimental teachers had participated in an in-service training workshop to develop a creative classroom atmosphere, teach creative problem-solving and creative-thinking techniques, and involve pupils in activities that require creative thinking. The intervention contained homogeneous grouping and lessons on
comprehension, memory, evaluation, convergent and divergent problem solving, and time and stress management. The programme took place in regular classrooms. Significant effects, however, were found on figural creative performance and second-grade school achievement, for both gifted and non-gifted pupils. The non-gifted pupils exhibited more marked improvement in achievement than the gifted pupils, which emphasises the fact that ‘the gifted group still requires greater challenges than can be expected in regular classrooms’ (Blumen-Pardo 2002, 56).

This last effect was also found by Landrum (2001), who matched gifted pupils in grades three through six with non-gifted pupils from the same classrooms. The teachers were trained to seek assistance from specialised gifted education personnel or were involved in a team intervention with several other staff members. The higher cognitive processes of both the gifted and non-gifted pupils improved as a result of the training.

VanTassel-Baska et al. (1998) assessed secondary gifted pupils’ growth in integrated science skills after being taught a new 20–36-hour gifted science unit. The new science curriculum emphasised learner outcomes, authentic assessment, scientific process and experimental design, real interdisciplinary problems, meta-cognition, scientific habits of mind, collaborative learning, and hands-on activities. Gifted pupils were identified according to ability, achievement, and performance criteria profiles. The researchers compared results of gifted pupils participating in the curriculum intervention with non-participating pupils of the same ability. They found significant differences between the experimental and control gifted classes, in favour of the experimental classes.

Social comparison processes and effects

Marsh et al. (1995) predicted varying development of different parts of the self-concept depending on educational experiences. In two studies of gifted pupils in grades four through six, experimental pupils attended a special class while control pupils attended regular mainstream, mixed-ability classes. The results showed that the gifted pupils who attended special classes experienced systemic declines in three components of their academic self-concept (reading, maths, and school) but no differences in four components of their non-academic self-concept (physical, appearance, peer relations, and parent relations) when compared with the gifted pupils who attended regular mixed-ability classes, and after control for such background variables as gender, age, and initial ability level. The researchers interpreted the observed differences in terms of social comparison theory or the ‘big-fish-little-pond/little-fish-big-pond effect’ (see also Davis 1966). This effect implies that a high-ability pupil in a special class with a high mean score – on comparing his or her performance with the performance of (most) class-mates – will feel relatively less competent than would be the case in a mixed-ability class with a relatively lower mean performance score. The corresponding self-concept for the high-ability pupil is expected to decline accordingly. In reverse conditions, the opposite process will occur. This relative effect may be independent of the pupil’s ‘absolute’ level of motivation or achievement.

Zeidner and Schleyer (1999) identified children as gifted in grades two and three of Israeli primary school. In grades four through six, the pupils were placed in either special, full-time, homogeneous classes for gifted pupils \( (n=321) \) or in regular, mainstream, mixed-ability classes with a one-day pull-out programme for gifted pupils \( (n=661) \). After control for a number of background variables, statistical analyses revealed the following with regard to the gifted pupils in the special homogeneous classes compared with the pull-out gifted pupils: lower academic self-concept; higher levels of test anxiety; more negative labelling due to their gifted status; more favourable judgement of their classroom teachers; higher levels of school satisfaction; higher levels of appropriateness for instruction; and no differences in motivation. The researchers concluded that placement in a regular mixed-ability class with a one-day pull-out programme...
positively affected the personal-social adjustment of gifted children when compared with placement in a special homogeneous gifted class on a full-time basis.

Delcourt et al. (1994) studied 1010 second and third year primary pupils in the USA. In addition to a control group, each of four quasi-experimental groups was characterised by a specific educational programme. The programmes involved four types of grouping arrangements: within-class programme or pupils attending heterogeneously grouped classes; pull-out programme; separate-class programme; and education within a school for gifted pupils only (special-school programme). The researchers tested the pupils at the time of entrance into the programme, after one year, and one year after the end of the programme. They concluded that gifted pupils attending special programmes (i.e. special schools, separate classes, pull-out classes) performed better than their gifted peers in mixed-ability classes. Teachers’ perceptions of pupils’ learning characteristics also appeared to be influenced by the type of programme used in school. Type of grouping arrangement did not influence pupils’ perceptions of their social relations for either gifted or non-gifted pupils.

Ziegler, Finsterwald, and Grassinger (2005) investigated the development of helplessness with regard to the subject of physics among German high school pupils in mixed ability classes. Their results indicated that ability self-concept for physics and test anxiety were significant predictors of helplessness. Moreover, those gifted girls reporting a higher level of test anxiety were more likely to develop helplessness with respect to the study of physics than the other gifted girls and non-gifted pupils.

Educational acceleration

Studies regarding the skipping of one or more classes may report positive cognitive or achievement and social or emotional effects on gifted pupils (e.g. Gross 2004; Kulik 2004), in particular when two or more of these pupils are combined in small groups while skipping class (Mehlhorn 1988; Mooij 1992). However, as Noble, Robinson, and Gunderson (1993, 129) emphasised, ‘adult and peer support are crucial to their sense of psycho-social well-being’. Caplan et al. (2002) investigated the adjustment of early-entrance college students defined as gifted and entering college early because of acceleration during elementary or high school. Their findings stipulated that socio-emotional adjustment of the early-entrance college students did not suffer as a result of their educational acceleration, while perceptions of family cohesion, family conflict, family expressiveness, and overall self-concept were found to predict college adjustment.

Saturday or summer school programmes

Freeman and Josepsson (2002) studied the influence of a special Saturday programme on 200 grade one through ten primary pupils identified as gifted by classroom teachers or school principals. The research was carried out in Iceland. After pre-testing, intervention activities included: having guest speakers, visiting places of educational interest, participation in high school classes, extracurricular work, a pupil newspaper, an essay contest, the writing of stories and poetry, a chess club, and a talent show. Three years after completion of the programme, post-testing was used to compare a target group of 111 pupils who had participated in the course with a control group of 44 pupils who had refused to participate. The target group scored higher than the control group with respect to: IQ range, level of education for both parents, preference for an easy-going teacher, having had real problems at school, the filing of formal complaints at school, a positive attitude towards school, and a stronger self-concept with respect to school. These results seem to imply that the target pupils and their parents were more demanding and more assertive at school than were the control pupils and their parents. The authors concluded:
The less successful aspects of the programme suggest that there should be:

- close focus between individual gifts and provision
- careful monitoring of each child’s progress
- close coordination with classroom teachers …
- more help from school for potentially gifted children who are less well educationally supported at home … (Freeman and Josepsson 2002, 44–5)

Neber and Heller (2002) worked with German pupils who were nominated by their high school principals or teachers for a 17-day residential summer school for gifted pupils. The programme was characterised by multiple teaching methods, objectives at diverse levels, self-regulation, and, in particular, cooperation. Concerning post-test evaluation, the researchers found ‘very significant differences for self-regulatory learning strategies …, motivational beliefs …, and learning preferences’ (Neber and Heller 2002, 223). Their general conclusion was that, with these gifted pupils, less developed individual motivational and cognitive characteristics were promoted by participation in the summer school.

Furthermore, Chan et al. (2000) studied 98 gifted junior high school pupils between the ages of 12 and 15 years. The pupils participated in the ‘Chinese University Summer Gifted Program 1998’, which was a seven-day residential programme of enrichment courses and workshops specially designed and organised for pupils nominated by their schools as gifted or talented in specific areas. The results showed that the pupils, parents, and residential counselors were generally positive about the programme. The pupils’ self-report post-test scores for verbal fluency, figural fluency, and leadership skills were significantly higher than the respective pre-test scores.

Conclusions

The intervention studies first of all illustrate that this type of quantitative research is concentrated in the USA. The general focus is on cognitive, intellectual and creative competence domains and related variables, but instruments or procedures to identify giftedness or effects on giftedness differ (see also Brown et al. 2005). Moreover, educational interventions or treatments differ, which will impact the degree to which teachers are supported, enabled, and trained to adapt or change curricular and learning characteristics. Another methodological point is that studies characterised by random assignment of pupils to treatments hardly exist, which makes it more difficult to draw conclusions. Explanation of pupil effects because of specific attention for specific educational situations cannot be excluded in many designs (‘Hawthorne effects’). Given this state of play, the intervention research on curriculum compacting provides some evidence for the first conclusion, that increasing the quality and cognitive achievement levels of curricular characteristics for gifted pupils positively influences related individual competences of those pupils and, if included, also of non-gifted pupils.

Introduction of curricular interventions also changes the grouping of pupils, which in particular affects social comparison processes between gifted pupils or between gifted and non-gifted pupils. The relevant intervention research indicates that, depending on the initial level of competency or achievement of a pupil, individual comparison with one or more other pupils may affect positive or negative developments in specific self-concepts and come to influence the motivation and achievement for school subjects or specific related activities (see also Bowerman 1978). The research also seems to indicate that differences between effects of interventions may reflect differences in class or school social climate with respect to competitive or collaboration ambitions of pupils, teachers, or families involved. More research is needed here, but the second conclusion can be that, even if educators try to treat pupils individually, the pupils themselves will compare their characteristics, capacities, learning processes, achievements or outcomes, and respective self-concepts almost constantly with those of other pupils. Social competitive or
collaborative class and school characteristics then need to be integrated in the design of education and learning for gifted pupils, to effect positive or desired outcomes.

Third, educational acceleration is generally shown to effect positive cognitive and socio-emotional outcomes for a gifted pupil if social support is given by the pupil’s family, peers, teachers and the social class or school environments. Furthermore, the Saturday and summer school activities suggest that these out-of-school initiatives may support the pupil’s development of specific characteristics. However, the relevancy for learning in school is not clear.

All in all, the research demonstrates that, compared with regular education characteristics, compacting and acceleration in particular seem to have positive effects. However, these improvements for gifted pupils are fragmented in specific projects, do not start at the beginning of the school career, and concentrate on temporary adaptations to the existing system. The educational functioning of a gifted pupil could be promoted much more, and better, in a comprehensive and preventive approach than in a fragmented project-based approach (see also Durkin 1966).

A systemic design to improve education and learning

Sternberg and Grigorenko (2002) argued that intelligence is not completely innate. Instruction and assessment can therefore help pupils to identify and concentrate on their strengths and compensate for any weaknesses. They 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’ (265). Play and learning situations in nursery school and onwards should therefore be differentiated adequately, to handle the differences between children who are actually present with respect to, for example, cognitive, social, emotional, motor, and expressive competencies, self-regulatory capacities and abilities, and various potentials. As clarified by Sternberg and Grigorenko (2002), each pupil should take an active stand, be the regulator of their own learning processes.

In particular, high-ability children score high on self-regulation capacity with respect to one or more domains of competence. This allows them to develop specific school competencies like reading, writing, or arithmetic even before or without going to school (see, for example, Durkin 1966; Baroody 1993). In nursery school already their performance may be problematic for teachers because regular education is usually not prepared for this situation. Continuity in development and learning of gifted pupils should, however, be based on a clear screening or description of their initial competencies, availability of related educational and instructional differentiation and support, adequate possibilities for self-responsibility and self-regulation in development and learning processes, evaluation and assessment with respect to individual but also group-based level of competency or learning progress, and integrated monitoring of learning progress across learning situations in and outside school. Such differentiation of learning materials and procedures exemplifies a first conditional dimension to support gifted and other pupils in a comprehensive educational approach.

Mooij (2004) used the concept of ‘Pedagogical-Didactic Kernel Structure’ (PDKS) to denote the overall hierarchical structure of competence domains characterised by ordered concepts and subconcepts. This architecture may include normed concepts to indicate age-based levels of competency, while other concepts are criterion-based and refer to, for example, evaluations or observations by teachers, other professionals, or learners themselves. The main purpose of the PDKS is to assess differentiated levels of competency in relation to, but also independent of, age. Normed or criterion-based concepts can be made part of learning trajectories with particular learning tasks or activities. The resulting ‘instructional lines’ can be assigned to one or more
specific pupils, small groups of pupils, classes, or schools. The relevance of such is, for example, shown by van Eijl et al. (2005), who reviewed materials and procedures for gifted pupils but were not able to link these to main curricular concepts, levels or procedures. This, however, would have been of most practical value to pupils, teachers, and parents.

Differentiation of learning materials and procedures can therefore be elaborated with respect to diagnostic, instructional, managerial, and systemic aspects of learning: see the first column of Table 1. This specification results in five guidelines that reflect a first dimension of a conditional framework to improve education, as given in column 2 of Table 1.

Realising this differentiation in practice, with many pupils per class, requires much of the information storage and processing capacities of teachers and coaches (see Kounin 1970). Internet-based ICT can help to keep track of and monitor the various differentiation materials and procedures in relation to the learning processes and effects involved (see also Ely 1999; Blumenfeld et al. 2000; Watkins 2001). ICT enables education and learning to function independently of place and time (Sinko and Lehtinen 1999) and age, and can also support self-regulated learning (see Neber and Schommer-Aikins 2002). Integration by and use of ICT support is therefore a second conditional dimension to specify guidelines in order to improve education for gifted or other learners: see the third column of Table 1. The proposed ICT should support and connect a conceptual reference structure – like the PDKS – to instructional lines characterised by specific learning tasks and evaluation or assessment tasks or activities. These lines can be used with individual pupils or (small) groups of pupils in psychometrically reliable and valid ways. ICT can also help the management of individual or group learning progress in different instructional or organisational contexts, in or outside school, at multiple levels (see Mooij 2007).

Table 1. Model of educational conditional dimensions and learning aspects: guidelines to improve education and learning processes.

<table>
<thead>
<tr>
<th>Learning aspect (DIMS)</th>
<th>Educational conditional dimensions</th>
<th>Integration by and use of ICT support</th>
<th>Strategies to improve development and learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Differentiation of learning materials and procedures</td>
<td>1.1. Identify a pedagogical-didactic kernel structure for different domains</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>Diagnostic</td>
<td></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>Instructional</td>
<td>1.2. Structure domains of competence in terms of sub-skills and instructional lines</td>
<td>2.3. Facilitate individualised instruction, collaborative learning, and self-regulation</td>
<td>3.3. Use collaborative didactic procedures to stimulate self-regulation</td>
</tr>
<tr>
<td></td>
<td>1.3. Include psychometrically valid indicators to evaluate learning progress</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Managerial</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>3.4. Concentrate teacher coaching on those pupils most in need of this</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>
Gifted pupils differ from other pupils in, for example, initial or entry level of development or learning competence, magnitude of learning steps, degree of self-regulation during learning, and use of meta-cognitive strategies (King et al. 1985; Goleman 1995; Bearne 1996; Kerry and Kerry 1997). Pedagogical equity will be demonstrated then when all young children are supported differently but effectively at home, in nursery school and onwards (Gardner 1961). ‘Cognitive load theory’ focuses on cognitive processing and the organisation of information using instructional designs (Paas, Renkl, and Sweller 2003; van Merriënboer, Kirschner, and Kester 2003). In line with this theory, Kalyuga et al. (2003) demonstrated that instructional designs which were effective with inexperienced learners had a negative effect when used with more experienced learners. At the beginning of nursery school, already a pupil’s entry characteristics should therefore be used to connect play activities and instructional lines, to improve the pupil’s functioning (see also Bennathan and Boxall 1966; Mooij 1999). Lubinski (2004, 34) used the term ‘appropriate developmental placement’ to indicate the adjustment of the curriculum at a pace commensurate with the learning of gifted pupils.

Moreover, creation and mutual control of pro-social relationships between all persons in school is important to positively coordinate social comparison processes and their effects. In particular instructionally supported collaboration between pupils in small groups may enable more motivating and more self-regulated learning processes and outcomes (Kirschner 2002). Increasing pupils’ self-regulation also increases the possibilities for teachers to assist or coach the pupils who most need the teachers’ expertise or support. Systemic integration of these various strategies to improve development and learning can be expressed in a differentiated multilevel structure with various types of learning processes and effects for different types of learners, across different types of situations (see also Cronbach 1983). Table 1 reflects these aspects in the third conditional dimension containing guidelines specified according to strategies to improve development and learning.

The systemic approach as modelled in Table 1 is theoretically in line with, for example, the ‘schoolwide enrichment model’ (Renzulli 1990; Renzulli and Reis 2000). The model presented also agrees with outcomes of research concerning ‘non-graded classes’ (see Westberg and Archambault 1997; Lloyd 1999) and academic and social-emotional effects of educational acceleration (e.g. Gross 1992, 2004; Mooij 1992, 1999; Robinson 2004; Rogers 2004). Furthermore, the design can preventively assist ‘twice-exceptional pupils’ – that is, gifted pupils with one or more special needs (Moon and Reis 2004).

When operating together, the three conditional dimensions in Table 1 are assumed to improve education and pupils’ learning processes and effects in a systemic multilevel way. The whole set of guidelines conceptualises a general educational model assumed to promote multilevel contextual learning processes, for different types of pupils. The model represents theoretical design conditions to transform a traditional age-based or less differentiated educational system into a differentiated, ICT-based, instructional managerial system. The expectation is that gifted pupils learning according to such systemic preventive conditions will do better than gifted pupils in traditional education, in particular because the self-regulatory capacities of gifted pupils can be used more, and better, in the improved systemic conditions. Different steps were taken to enable concrete specification and implementation of this model in practice.

Method

Development of prototypes

In a first step, research has to develop a prototype of the PDKS and a prototype of relevant ICT. Then, in collaboration with research, teachers can further develop and implement these prototypes in educational practice. Collaboration between different users like teachers, school staff,
developers and researchers is assumed to raise both quality and validity of innovation processes (Kensing, Simonsen, and Bødker 1998; Clark and Estes 1999; Blumenfeld et al. 2000; Remillard 2000). Wilson (1999, 13) stated that use-oriented strategies ‘increase the likelihood of successful implementation because they take the end use into account at the beginning design stages’.

The PDKS prototype was developed mainly in 2003 and consisted of seven hierarchically structured competence domains and sub-domains. The domains concerned respectively: language, general cognition, social-emotional performances, mathematics, physical-medical aspects, general psychological characteristics, and motor activities. The prototype reflected a multi-disciplinary classification based on concepts and sub-concepts including skills and sub-skills, to be measured by reliable and valid instruments if available. Examples are given below.

While using the potential functions of the PDKS prototype, a first prototype of Internet-based software was developed in 2003–2004 (see guidelines 2.1–2.5 in Table 1). The prototype was named DIMS because of the diagnostic, instructional, managerial, and systemic (DIMS) functions of the software (see http://www.dims.nl). The PDKS prototype was integrated into the DIMS prototype: see further the results below.

### Pilot implementation

In the Netherlands, nursery school for pupils aged 4–6 is integrated with primary school for pupils aged 6–12. From 2003–2005, research collaborated in a pilot with one Dutch nursery/primary school located in a middle-sized city in the eastern part of the country. The school was just founded in a new suburb characterised by a relatively high socio-economic level of inhabitants. At the beginning of 2003, the school had about 25 pupils. Expectations were that this number would increase to about 700 in some five years. The selection of this school and its willingness to cooperate were based also on the perception that, because of the low initial number of pupils, the school had opportunities to co-develop an improved educational system.

The pilot teacher of this school was also functioning as a special needs coordinator and was facilitated for about two days a week. Meetings between this teacher and the researcher took place about every three weeks, to inform the teacher and to coach her school innovation activities according to the conditional differentiation features presented in Table 1. The teacher informed and involved the school team. After about one year, specific results were visible in the pedagogical-didactic school characteristics and the flexible cognitive and social integration of gifted pupils, their curricular activities, and their learning processes.

### Results

#### Prototypes of PDKS and DIMS

The global structure and content of the prototype PDKS was discussed and checked with the pilot teacher. This resulted in hierarchical conceptual orderings which were integrated in DIMS and can be used in educational practice. An example is the ordering with respect to arithmetic competence concepts throughout pre-school and primary school. Global concepts at the highest level represent successively: arithmetic with numbers up to and including 10; then 20; then 100; numbers above 100 including adding and subtracting; multiplying and subtracting; numbers above 1000 and doing arithmetic by estimation; arithmetic by using a calculator. This conceptual ordering reflects learning processes common to most of the pupils. According to research (see Meijer 2003) and the pilot teacher, pupils with special educational needs (SEN) require much more refined conceptual structuring, diagnostics and exercises on these issues, whereas pupils gifted in this area learn the arithmetic processes usually without explicit school assistance. To make this individual or group differentiation diagnostically more concrete where indicated,
teachers or – if allowed – pupils can use the PDKS and DIMS prototypes to relate specific concepts and learning activities or tasks to these global concepts, to construct specific instructional lines at any level of difficulty. Moreover, administrative information about a pupil or teacher can be included, stored, or presented. Both gifted and SEN pupils can then get educational support at their own levels of competency, although they may reside in the same class. Learning activities or tasks are represented either symbolically or textually in DIMS; they are usually carried out by the pupils in three-dimensional practice. This instructional managerial support better fits the development potentials of young pupils and also reduces the number of computers required per classroom.

Furthermore, it was necessary to implement an instrument to screen entry characteristics of children of about four years old, to check the level of initial performance (see also guideline 3.1 of Table 1). After such a check, gifted pupils can, for example, move on immediately to higher level learning processes, to be confronted with really challenging learning tasks or activities. Requirements were that the screening instrument could be used with all children; by an infant day care teacher when the child is about to leave the day care centre to go to nursery school; by parents at the child’s intake into nursery school; and by a nursery school teacher after the child’s first months in this school. A psychometrically reliable instrument (see Mooij 2000) was used to estimate the level of competency in various domains by comparing the child’s behaviour with that of same-age peers on various items per scale. The questionnaire was integrated in DIMS and can measure behaviour domains with respect to, respectively: social interaction/communication; general cognition; language proficiency; pre-arithmetic proficiency; emotional-expressive competency; sensory-motor competency; and expected educational behaviour. The scale results can be indicated by different scores. For example, a first score represents the population norm for these children; a second score indicates the parents’ information about their child’s performance compared with age-mates; a third one is the comparable score from the nursery school teacher about the child; and a fourth score is based on the mean of the teacher’s scores of the children in this child’s class. If either the parents or the teacher score at the extreme end in one or more domains, this is a sign for detailed communication and, if desired, specific diagnostic tests.

Implementation and further development in practice

Implementation of both PDKS and DIMS started with the use of the screening procedure in the pilot school. Both parents and teachers first had to get accustomed to this intake, which took several months. But then they agreed that the screening helped them in getting a clearer view of a child’s entry characteristics. Moreover, a common frame of reference was established and this facilitated communication about the child (see Cornell et al. 1994). The outcomes per domain 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. Gifted children were next assigned activities at a much higher level and could then select tasks by themselves at this level, whereas low ability or special educational needs (SEN) children were given immediate specific support in the same class, if desired, and were able to select tasks at the level of competence relevant to them. New play and learning materials had to be introduced because it now became clear that differences between pupils were much more evident than was accounted for with the traditional materials. The teachers became more interested than before in creating different types of small groups of pupils because this organisational feature seemed to provide better conditions to foster and control pro-social and effective relationships between pupils. The screening thus helped them to become more conscious in using flexible individual, small group, and school conditions to improve cognitive and social aspects of learning processes with various types of pupils.
Because of the many changes, the pilot teacher’s attention became focused on the main pedagogical-didactic development and less on the use of ICT. This is made concrete in information written by this teacher in December 2003, at the end of the first year of the pilot. According to the teacher, the school then uses a child-oriented curriculum which is based on three general rules throughout the whole organisation, for gifted and non-gifted pupils. The general rules are:

1. Take care that the child’s inside feelings are OK; reflective discussions are good instruments to realise 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’s inside comfortable and efficient.

With respect to tasks and activities that may be part of the weekly task schedule of a pupil, at first the teacher places a pupil at a specific instructional or competence level. Following this, the general rule is that pupils themselves choose another pupil to cooperate with on the basis of the competencies of the other pupil. The choice of another pupil may depend on the specific area of competence, so more partners can be chosen by the same pupil. In other words, each pupil is usually included in some small collaborative groups of pupils. The formulation for executing tasks or activities is:

- What do you want to do? Make a choice for yourselves.
- Why do you want to work on this task or activity?
- How are you going to do that?

A work-plan of a pupil can be designed by the pupil for a longer period 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 with skills and goals to realise with each pupil. To coordinate these possibly different plans, intensive collaboration exists between the pupil, the parents, and the school. If necessary, external professionals are included. Evaluation of the input of external professionals is conducted regularly.

Learning arrangements for gifted pupils

Giftedness is assumed by the teacher by using information from three different sources: the screening of each child’s entry characteristics by parents and teacher; other potentially relevant information from parents or the day-care centre; and observation of the pupil’s daily behaviour in school. In the teacher’s coaching of a gifted pupil the instruction is:

- If something does not succeed, formulate for yourself what or where the problem is;
- Try to estimate what or where the cause is;
- What exactly is the problem?
- After 20 seconds you ask assistance from another pupil or from the teacher.

Moreover, one parent comes weekly to the nursery/primary school to play a challenging social game with the gifted children, with a focus on collaboration in particular. The school applies the self-chosen activities of the gifted pupils in the planning scheme of the school. This ‘enrichment’ involves the pupils’ wishes in the planning and future organisation of activities throughout school.

In December 2003, the teacher supplied information about three young pupils who were assumed to be gifted. These pupils were not tested to check for one or more domains of giftedness. The first pupil is a girl called Henna (date of birth 21/06/1997). She is attending a class of pupils
made up of school years 2, 3 and 4. The pilot teacher describes this girl and her learning arrangements as follows.

When this girl started to visit school she was not open, but shy. She readily made contact with two other girls. Soon her advanced development compared to the other pupils became clear. Acknowledgement of her relative progress resulted in acceleration, among other things. At this moment she is attending class 4, she likes to play and dance with her two friends from class 3. She is fond of working with a girl from class 4. She is very independent, is very good in organisation and knows what she wants. Her drive to develop is enormous.

In a reflective discussion we will have to clarify how she feels and what she likes to do. She is allowed to choose what she does, and with whom. She and her workmate will collaboratively make a plan, to sketch what they are going to do and what the requirements are. The result is a working plan for a couple of weeks. The teacher will coach this plan with respect to content and execution. Additionally, the teacher will also provide advice where necessary. The plan may refer to all types of competence domains.

The second pupil is a boy named Jack (date of birth 22/02/1997). At first he had attended another school but because of some problems he had changed school. He also attends classes 2, 3 and 4. The pilot teacher gives the following information.

He likes to play alone or with younger children, does not or hardly ever initiates contacts with adults. He likes to go his own way completely, exploring things, reading and so on. He does not like arithmetic, it is difficult for him and he has to write much. He also states this in his reflective discussion. He loves working with three-dimensional construction materials, the computer, and reading. It is important for Jack to ask for help timely if something does not succeed. Jack will choose a task with somebody else, determine criteria and make a plan. Another possibility is that Jack and Henna construct a plan with respect to arithmetic to work on together in the next time. The teacher will advise and look after the curriculum. Where necessary the teacher will enrich the regular curriculum.

The third pupil is a boy called Daniel (date of birth 14/04/1997). He is also attending classes 2, 3 and 4. His characteristics and learning arrangements are described as follows.

An expressive child, open and spontaneous. In particular in the beginning Daniel had a restriction of interest, mainly focused on dinosaurs. He constantly looks for contacts with everybody, adults, elder and younger children. He is very verbal. He can become very angry if something is not successful, somebody is not nice to him, or the teacher is not around for some moments. From a motor point of view (fine and global) he has support of a motor therapeutist at school. His motor behaviour may be a problem sometimes in his performance. Adaptations in quantity of training or other types of performance may be used in school.

Tools to assist arithmetic may be necessary now and then, to extend strategies to a higher level. He has many plans. His weekly scheme of activities will be completed with many additional activities. Important with Daniel, as we see it, is to work on a realistic picture he has to make of himself. A reflective discussion with him and his parents will have to assist Daniel to better understand his behaviour and how to self-regulate his own behaviour. Daniel is still offered the whole Alphabet once a month. He learns daily and one month later we check his learning progress. In collaboration with another pupil, Daniel will make a plan that directs activities he likes to work on.

The three gifted pupils can thus work at their own levels of competency, in close collaboration with self-chosen partners. From a personality point of view the children seem to differ considerably, but this does not need to play a problematic role. The teacher closely coaches or advises the children both individually and in small groups. She also enables much self-regulation according to the individual work-plan of each child, and compensates when necessary with the school’s work-plan. She was able to formulate exactly where each pupil’s level of competence was in the various school subjects and related these levels to global concepts used in the PDKS prototype. However, no explicit development of instructional lines in DIMS had taken place; she needed more facilities and research support to realise this.
Self-regulation of learning

At the end of the pilot the teacher reflected that registration, differentiation, and monitoring activities were becoming a heavy burden. She acknowledged that it was either necessary to draw upon the supportive ICT system or to slow down the individualised learning provisions because of the rapidly increasing number of pupils. More teachers of the school were then involved in discussing the potential advantages and disadvantages of either choice. Main discussion points were relationships between characteristics of the PDKS as used in the school to order learning activities or tasks including assessment of progress, and the various possibilities to adequately support responsible self-regulation of gifted pupils in particular by using DIMS.

The discussions stimulated further explications of aspects of competency-based learning of pupils, as experienced by the teachers. For example, as a pupil exerts more control over his or her own learning processes, the degree of ‘self-regulated learning competence’ increases, which motivates realisation of the next learning tasks (see also van den Boom et al. 2004). Competency-based learning can then be characterised by: estimation of difficulty level of learning tasks followed by selection of tasks; various types of support or coaching of learning; and assessment of learning results according to specific criteria or norms, followed by selection of next or other tasks. Increasing relevant possibilities for self-regulation or learner-control in these successive stages may function as prerequisites for motivated and effective, or competent, next learning steps (see van Merriënboer 1999). The PDKS and DIMS can be interpreted then as possibilities or tools to ‘scaffold’ specific learning processes for specific learners, which can be changed or modified with respect to the support of, for example, the teacher or peers. The goal is to enable and challenge a pupil to self-regulate their own learning processes in responsible ways (see Wood, Bruner, and Ross 1976; Rosenshine and Meister 1992). Learning can be interpreted then as dealing with a pupil’s cognitive, behavioural, and attitudinal characteristics of task selection, coaching, and assessment followed by next task selection, and so on. In this ‘learning cycle’ the control of a learner in terms of self-regulation of learning can increase by, for example, a gradual change from control by others (i.e. the teacher or curriculum), via control by the learner him- or herself, to assistance or ‘tutoring’ of other learners (i.e. peers), to increase their control of learning. Moreover, each learning cycle is dependent 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 type of learning situation. Self-regulation thus assists in performing learning cycles, to increase the learner’s competencies when he or she is dealing with relevant environments.

A model reflecting this self-regulation of successive learning cycles is presented in Figure 1.

Figure 1 illustrates a 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 ‘done by or dependent on others’ via ‘by the learner him- or herself’ to ‘assisting the learning of peers or other learners’. The ‘self-regulation process’ in the centre of Figure 1 clarifies that selection, coaching, and assessment are coordinated systemically and dynamically, to realise smooth functioning of and growth in efficiency of the relevant competencies. What is optimal, however, has to be worked out or decided upon in the interaction between education/teacher and learner. Scaffolding can be interpreted as the handing over of learning responsibilities or control as done ‘by others’ to as done ‘by the learner him- or herself’, including being a coach or assistant to peers or other learners. In practice, self-regulation respectively scaffolding for ‘gifted’ pupils will differ much from comparable processes for ‘regular’ pupils. However, ‘gifted’ pupils will also differ considerably from one another (see the three pupils described above).
Discussion

The research question asked for the design and development of education that fits and further supports the development potential, actual competencies, self-regulatory capabilities, and learning styles of gifted pupils. Information from four types of educational interventions on gifted pupils showed that in particular compacting and acceleration may have positive cognitive or intellectual effects. Specific attention should, however, be given to family, teacher, and peer support, to compensate for possibly negative social comparison or group-related effects on specific self-concepts and corresponding motivation and achievement. It was expected that systemic, preventive combination of such intervention measures would make them more effective and more sustainable.

This combination was designed by using three conditional dimensions: differentiation of learning materials and procedures, integration by and use of ICT support, and strategies to improve development and learning. These dimensions were related to diagnostic, instructional, managerial, and systemic aspects of learning processes (see Table 1). The relationships were expressed in guidelines to change or transform education from a traditional age-based system into a more flexible, supportive system for various types of pupils. The modelled guidelines also imply the creation of learning arrangements that provide for more self-regulation for gifted pupils than traditionally occurs.

In the period 2003–2005, a pilot was carried out in a newly initiated Dutch nursery/primary school. During the pilot years, the number of pupils in school increased to about 170. The goal of the pilot was to further develop and implement the design in collaboration with teachers in practice. The results were concentrated in prototypes of structured competence domains (PDKS) and supportive software (DIMS) that support the screening of the entry characteristics of four-year-old pupils and the follow-up systemic support by adequate play and learning processes. Pupils were enabled to collaborate according to their own choices in small groups, at specified achievement levels according to the PDKS, and at their own levels of competence. DIMS was used regarding
the identification of a learner’s entry characteristics and instructional clarifications, but not yet with respect to learning processes. At the end of the pilot, in particular the potentials of the PDKS to order learning activities or tasks including assessment of progress and possibilities to support responsible self-regulation of gifted pupils by using DIMS were discussed with the teachers involved.

The school innovation indicates that, after three years of development, the systemic guidelines are realised partly in the learning processes of gifted and other pupils. Teachers and parents screen the entry competencies of the target four-year-olds using a suitable psychometrically controlled instrument. The children then receive more systemic and – if necessary – more immediate diagnostic and instructional support than they would normally receive. In addition, the communication and degree of cooperation with infant day-care teachers, parents, and youth-care service have increased considerably. This results in more preventive information for the design of instructional lines and self-regulatory learning for individual or small groups of pupils.

A first conclusion is that it seems indeed possible to design and improve early education according to the three conditional dimensions as modelled in Table 1. The concept PDKS links multilevel curricular, learning, and behavioural competence concepts and relevant measures for different types of learners, at different levels. Essential from motivational and psychological points of view are the differentiated evaluations and assessments of learning progress – that is, assessment with respect to one’s own individual progress, relative to a small group, the class, school, or age group (see also Marshall and Drummond 2006). In a qualitative observation study in a Swedish primary school, Bergqvist and Säljö (1998) also verified that instructional, organisational, and evaluation differentiation were related in age-integrated classes. As suggested in the present pilot results, such differentiation is necessary in particular for pupils scoring initially much higher or much lower than their peers in one or more domains of competence (see also Collier 1994). In this respect, the pilot teacher and her colleagues did a great job in the design and execution of these differentiated features throughout the nursery/primary school.

Second, further within-school development will occur when additional aspects of the PDKS and related learning materials and procedures are incorporated into the DIMS programme in particular. Increased availability of valid materials and effective self-regulation procedures for learners, teachers, managers, other professionals, and parents, will presumably exert a cumulative effect and stimulate further adoption (see Finn-Stevenson and Stern 1997; Mangione and Speth 1998). In particular the early self-regulation of gifted pupils seems possible but also essential to let them realise their potentials and competences. Important is which development decision the pilot school will take next. In the meantime, other nursery/primary schools decided to start with the use of the screening procedure of entry characteristics in August 2006. Collaboration with more schools will of course increase the possibilities for realisation of the guidelines developed in Table 1 (see also Kemp 2000; Johnsen et al. 2002).

Third, gifted pupils, but also other pupils like those with special educational needs, really need the systemic prevention type of education as elucidated in Table 1 (Mooij 1999; Kliewer et al. 2004). Supportive evidence for such an approach is given by, for example, the ‘Dynamic Scaffolding Model’ of teacher development which can be integrated in and across schools (Matthews and Foster 2005; see also Griffin and Beagles 2000). It seems that such support – if available – could aid the pilot project teachers’ decision to continue. This would require organisational and financial provisions by either the school board or educational support instances.

Fourth, as Blumenfeld et al. (2000) have observed in conjunction with comparable research, educational transformation requires the realisation of bottom-up improvements by both local and national institutions with innovation, assessment, research, and policy tasks at different educational levels (see also Baker, Bridger, and Evans 1998; Earle 2000). In this respect the situation in the Netherlands is not easy to handle (see Mooij and Smeets 2006). However, the more schools
and institutions adopt this transformation procedure, the greater its impact and the easier it will be to empirically demonstrate the efficiency and effectiveness of the preventive guidelines in Table 1 compared with traditional education or intervention measures.

Notes on contributor
Prof. Dr. Ton Mooij is a professor for educational technology at the Open University of the Netherlands (Heerlen) and a senior researcher at the Radboud University/ITS (Nijmegen).

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