Consistentie van aanpakgedrag

Een procesdiagnostisch onderzoek naar acht aspecten van hoofdrekenen

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SUMMARY

CONSISTENCY OF APPROACH BEHAVIOR

A process-assessment research into eight aspects of mental arithmetic

A recurrent theme throughout this book is the relationship between personality and learning. The problem of consistency lies at the heart of the book. In personality psychology, research into the problem of consistency is primarily carried out with respect to personality characteristics or traits. In this book we deal with the consistency of approach behavior, i.e., cognitive and metacognitive processes. We pose ourselves the following questions:

- To what extent are students consistent in their approach to different learning tasks or different problems within a task domain, and
- is the variability in approach behavior determined more by differences between tasks or problems, or by individual differences between students?

Chapter 1 deals with the problem of consistency. The personality-psychological and the psychodiagnostic backgrounds of cross-situational consistency are discussed, and examined in relation to the relevance of the above-mentioned consistency issues. Chapter 2 presents a general operational definition of the concept of approach behavior. In Chapter 3 this operational definition is applied to the task domain of mental arithmetic (addition and subtraction up to 100). Chapters 4 through 8 contain a report on research into (the consistency of) approach behavior in mental arithmetic. Chapter 9 (Epilogue) discusses results produced by this study which can be used in future research into the consistency of approach behavior in different learning-task domains. In addition, the initial impetus is given for a process-consistency approach to personality.

The following is a summary of the dissertation, divided into three sections:
(1) operational definition of the concept of approach behavior, (2) initial impetus for a process-consistency approach to personality, and (3) report on an empirical study of approach behavior in mental arithmetic.

1 OPERATIONAL DEFINITION OF THE CONCEPT OF APPROACH BEHAVIOR

Approach behavior is a 'fuzzy concept' that provides information on how students handle a (learning) task. 'Approach' or 'approach behavior' refers to cognitive and metacognitive processes which take place when students are engaged, for instance, in working out a sum, taking a dictation, or reading a text. In this study, an operational definition is developed for facilitating objective description and measurement of approach behavior in its totality for different learning tasks. This operational definition is based upon:
(1) the three-part interaction-model of activity psychology,
(2) concepts used by Gal`perin, and
(3) practical process assessment and dynamic assessment procedures.
Three-part interaction-model
This book is based on the theoretical framework of activity psychology (Vygotskij, Leont’ev, Gal’perin). The interaction-model of activity psychology is a three-part model consisting of the components Situation, Person and Approach (see figure 1.1). The model shows that, when a student is confronted with a task situation, a certain approach will result from the interaction between student and situation. At first glance, the model may appear trivial, but closer consideration reveals this not to be the case. Most cognitive-psychological interaction-models contain only two components: person and situation (or environment). The three-part nature of this model indicates that approach behavior is a separate category. Approach behavior neither belongs to the personality of a student, nor to the situation. Approach behavior (or more general human activity) — the middle member of the three-part model — forms the process through which the subject interacts with the surrounding world of objects.

The interaction-model of activity psychology can be regarded as a model of classroom learning (De Corte et al., 1974) as well as a model of personality (Witzlack, 1977) or of development (Vygotskij, 1978). The model facilitates research into issues dealing with the complex interaction between the model’s three components, i.e.:
(1) task situation, containing the following distinctions:
   - type of task domain (mental arithmetic, correct spelling, reading comprehension, etc.)
   - (type of) problems within that task domain
(2) student personality, containing, for instance, the following distinctions:
   - classification according to skill level
   - classification based upon intelligence
   - classification based upon (present or absent) prior knowledge
   - classification according to the methods by which the students are instructed
   - classification according to gender
(3) approach behavior, containing the following distinctions:
   - attention
   - orientation
   - automatization
   - flexibility
   - insight
   - consciousness
   - control.

Gal’perin
According to activity psychology, human activity consists of externally observable, practical actions as well as mental actions. In order to describe the actions which make up approach behavior, we have chosen the concepts used by the Russian educational psychologist P.J. Gal’perin (see Haenen, 1993). Gal’perin (1969) makes a distinction in the first place between:
(1) orienting actions (‘how am I going to approach this sum?’)
(2) executive actions (actual calculation of the sum), and
(3) control actions (‘is this the right answer?’).
Secondly, Gal’perin distinguishes six properties or parameters for describing actions, namely:
(1) level (mental, perceptive, verbal, and material actions)
(2) degree of abbreviation
(3) degree of mastery
(4) degree of generalization
(5) degree of insight, and
(6) degree of consciousness.
On the basis of a literature study regarding the approach behavior of students with learning problems, we here add the following three properties, namely:

(7) degree of independence
(8) degree of flexibility, and
(9) lack of attention.

Finally, we describe the actions performed by a student in terms of:

(10) the nature of the task-specific operations.

We can now describe the orienting, executive and control actions performed by a student in solving a problem in terms of the above-mentioned ten properties of activity. This description produces 24 indices for what we have called the aspects of approach behavior.

**Process assessment and dynamic assessment**

In our research, in order to determine the various aspects of approach behavior, we have made use of procedures taken from practical process assessment. In process assessment (or qualitative assessment), actions performed by a student are retrieved by combining data originating from retrospection with data originating from behavior observation (Van Parrenen, 1981). Combining data from these two different sources is often found in practical diagnostics, but rarely applied in scientific research.

In dynamic assessment, the student is helped or given instruction in order to determine the degree of independence of the student's activity: can a student who is unable to perform a certain activity spontaneously manage to do so when aided by an adult? Dynamic assessment can be regarded as the determination of 'the zone of proximal development' (Vygotskij, 1978). In Chapter 1 the process assessment and dynamic assessment strategies are compared with traditional achievement testing.

The relevance of the general operational definition of approach behavior developed in this book can be summarized in three points:

- the operationalisation facilitates (future) research into the issue of cross-situational consistency of approach behavior across different learning task domains (see section 2 of this summary).
- the operationalisation can serve as an 'overarching theory' (Schön, 1983) for process assessment in different learning task domains.
- the operational definition can be used within one learning task domain for research into domain-specific consistency problems and for research into the relationships various approach aspects of approach behavior have with one another (see section 3 of this summary).

**2 INITIAL IMPETUS FOR A PROCESS-CONSISTENCY APPROACH TO PERSONALITY**

One of the as yet unresolved fundamental issues in personality psychology is the person/situation controversy: to what extent is behavior determined by personality characteristics, by the properties of situations, or by person/situation interactions? A related, and sensitive issue in assessment is whether, when dealing with a student with learning problems, one should set up and test diagnostic hypotheses regarding personality traits relevant to learning (such as intelligence and cognitive style), or situation characteristics (such as the didactic method used) or interactions between the two (Sundberg, 1977). In the classic psychometric approach, judgments regarding students' personality traits are based on the administration of standardized psychological tests. In the (more modern) behavioral approach to assessment, the tendency is to limit oneself to situation specific judgments based on direct observation of a given learning
behavior (Shapiro, 1987). The two approaches, viewed theoretically, are at odds with one another and do not do justice to the variety and complexity of the phenomena. On the one hand are students whose action repertoire reveals fundamental shortcomings. Such students demonstrate an adverse approach to all sorts of school tasks; that is, they have an inadequate work attitude that is more or less interiorised in their personality. On the other hand, however, are children who merely demonstrate domain specific deficiencies in one or a few subjects.

In Chapter 9 of this study, an initial impetus is given to what we have called a process-consistency approach to personality. Conclusion of a certain personality characteristic is based on determining the degree of consistency of approach behavior across different learning tasks. This diagnostic decision procedure is, as it were, diametrically opposed to the reasoning in which behavior in a given classroom situation is predicted on the basis of a psychometric test score.

If we have determined that Sylvia demonstrates a great deal of consciousness in approaching an arithmetic task, a reading task, and a spelling task, then we may state that Sylvia’s personality is characterized by a high degree of consciousness.

If we have diagnosed a lack of insight in Karl’s approach to an arithmetic task, a reading task, and a spelling task, then we may state that Karl’s personality is characterized by a lack of insight.

If Erica demonstrates a lack of attention in approach behavior with regard to all sorts of arithmetic problems, but works intently at other learning tasks, then we may state that a lack of attention does not typify Erica’s personality but, rather, that the lack of attention is situation specific: it remains confined to one task domain, namely arithmetic.

Determining the degree of consistency of approach behavior is important in diagnosing learning problems because the more different learning task domains there are in which a student demonstrates the same inadequate approach, the less a plan of treatment can restrict itself to task specific subject deficiencies. In such instances, diagnostic hypotheses must also be formulated and tested regarding the fundamental shortcomings in the action repertoire and their possible causes.

The proposed process-consistency approach makes use of common processes in various learning tasks in order to describe aspects of the personality structure. Cattell indicates a similar approach when stating: "The objective location and measurement of common processes (...) is practically unrepresented in psychological research at the present time. (...) Despite this methodological neglect it is obvious that processes, for example, typical processes of learning (...) are important structures. They are structures in the sense of recurrent patterns of behavior, but even less than traits are they to be considered as definable entirely in the individual. They are joint structures in the individual and his physical environment" (Cattell, 1979, p. 33). In the same vein, Bem states in the framework of the person/situation controversy: "Our fundamental scientific task is to convert observations of particular persons behaving in particular ways in particular situations into assertions that certain kinds of persons will behave in certain kinds of ways in certain kinds of situations, that is, to construct triple typologies or equivalence classes - of persons, of behaviors, and of situations - and to fashion theories of personality that relate these equivalence classes to one another" (Bem, 1983, p. 566). The process-consistency approach suggested here reveals similarities to the 'act frequency approach to personality' propagated by Buss and Craik within the psychology of personality (Buss & Craik, 1986).

A number of conceptual, methodological, instrumental and empirical conditions must be met in order to conduct research into the cross-situational consistency of approach behavior across different learning task domains. This dissertation hopes to provide a contribution to the facilitation of such research.
3 EMPIRICAL RESEARCH INTO EIGHT ASPECTS OF MENTAL ARITHMETIC

In Chapter 3, the developed general approach behavior concept (see section 1 of this summary) is elaborated upon for the task domain of mental arithmetic. This produces two instruments:

1. the Leiden Diagnostic Arithmetic Approach Test (Dutch abbreviation LDRT) and
2. a prior knowledge test for the LDRT.

These instruments were used to conduct a descriptive study among elementary school students.

Instruments and variables

Leiden Diagnostic Arithmetic Approach Test

The LDRT (Van der Heijden, 1988c) is a process-diagnostic instrument for assessing what, in arithmetic didactics, is called handy and flexible mental arithmetic. The test is administered individually and consists of 48 mental arithmetic sums (addition and subtraction up to 100) in formula form (see Appendix 4.2). On the basis of standardized retrospective questions and behavior observation, scores are produced for the following eight aspects of approach behavior in mental arithmetic:

1. Lack of attention
2. Orientation (handy arithmetic)
3. Solution procedures
4. Automatization
5. Flexibility
6. Insight
7. Consciousness
8. Control.

In addition, the LDRT produces two achievement-variables: a correct/incorrect score and a reaction time score.

Prior knowledge test for the LDRT

The prior knowledge test for the LDRT produces two scores for general prior knowledge necessary for mental arithmetic up to 100:

1. reading and writing numbers, and
2. knowledge of the place value system.

In addition, this test produces three scores for specific preconditions for handy arithmetic.

Additional instruments

Finally, two standardized arithmetic achievement tests were taken by the students, a vocabulary test (index for verbal intelligence), and Raven’s Coloured Progressive Matrices (index for nonverbal intelligence).

Appendix 4.6 contains the variable names, with an explanation in English of their meanings.

Subjects

The study was conducted among 174 elementary school students at the end of second grade. The average age of the students was eight years and three months. Tables 5.1 to 5.6 (Chapter 5) contain a description of the research group. Although no attempt was made to provide a representative sampling, the average level of arithmetic achievements in our group did not differ from the general population of second grade students in The Netherlands.
Description, reliability and validity
Tables 5.7 to 5.9 (Chapter 5) contain information regarding the descriptive values, reliability and validity of the two LDRT achievement-variables. Tables 5.10 to 5.15 contain information regarding the five prior knowledge scores. Tables 5.16 to 5.37 contain descriptive values of the eight approach-variables. The results on reliability (Table 5.38) and validity (Table 5.39) of the approach-variables, express a satisfying reliability and validity.

Results
Table 6.5 (Chapter 6) contains the correlations between the approach-variables and the LDRT achievement-variables. Tables 6.6 and 6.7 contain results of multiple regression analyses of approach-variables and achievement variables. Table 6.11 contains the results of bivariate analyses between the approach-variables. Tables 6.13 to 6.16 explore the multivariate relationships between approach-variables. Gender differences are explored in Tables 6.18 to 6.27. The results of the following domain-specific consistency questions are presented in Chapter 7:

- To what extent, within the task domain of mental arithmetic, do students demonstrate consistency in aspects of approach behavior in different (types) of sums?
- Is the variability in approach aspects determined more by the differences between the (types of) sums or more by the individual differences between students?

The two consistency questions stated above are answered both for approach variables on separate sums (item scores) as well as for over 3 to 4 sums of same type aggregated approach variables. For aggregation over type of sums, the sums of the LDRT were classified according to three criteria (see Tables 4.2 and 4.3 for this classification):
(I) addition/subtraction; with and without carrying over (four types)
(II) degree of difficulty (three types)
(III) eight types of so-called handy-arithmetic sums.
In addition, consistency analyses were conducted among distinguishable sub-groups of strong and weak arithmetic students (Table 7.23). (See: Lamiiel, 1987; Paunonen & Jackson, 1986b).

Conclusions and discussion
The following conclusions are drawn and discussed in Chapter 8:

Consistency
- The group of students studied by us demonstrate, on the whole, a high degree of consistency in approach behavior.
- The variability in approach behavior is, in general, determined more by individual differences between students than by differences (in type and level of difficulty) between sums. The opposite situation is found in only one aspect of approach behavior for one specific type of sum.
- Differences are more often found between individual student's inherent approach behavior, rather than that different approach behaviors are elicited by different (types of) sums and sums at different levels of difficulty. In addition, however, a number of interesting substantive differences were found between the (types of) sums.

On the basis of these results we may state that the three-part interaction-model has fulfilled a useful function in the conceptualization of the consistency problem because, in the model, the variability in approach behavior is regarded as being determined by two distinguishable factors, namely, the student characteristics and the characteristics of the problem situation.
In the discussion section we contend that the high degree of consistency found here can be interpreted as inflexibility: Students tend to use the same solution methods regardless of the type of problem at hand. On the basis of these results, we demonstrate that this type of inflexibility is linked to relatively low achievements in mental arithmetic, while, on the other hand, a flexible approach is linked to relatively higher achievements.

**Central aspects: consciousness - control - automatization**

- Consciousness, control and the degree of automatization are shown to form the central aspects of approach behavior in mental arithmetic.

The importance of consciousness and control (metacognition) for mental arithmetic using formula sums which students have relatively much experience is particularly striking. On the whole, little attention has been paid to these aspects of approach behavior in scientific research into mental addition and subtraction. The research results are discussed against the background of theories regarding consciousness, automatization, metacognition, control and metacontrol (Shiffrin & Schneider, 1977; Brown, 1979; Flavell, 1979; Leont’ev, 1979; Baars, 1988; Van Haneghan & Baker, 1989; Kaptelinin, 1992).

Handy arithmetic, orientation and the functioning of knowledge

- Handy-arithmetic problems are, on the average, approached by students in a handy fashion in (only) 30% of the cases; 70% of the students follow a standard approach, in spite of the fact that more than 85% of the students later admit to finding the handy approach easier.
- A handy approach to problems signifies a considerable increase in efficiency in mental arithmetic.
- The research shows that, depending upon the complexity of the specific knowledge to be activated, a variety of forms of handy arithmetic can be distinguished.
- The fact that students approach handy-arithmetic problems in a handy fashion in only 30% of the cases can only partially be attributed to shortcomings in prior knowledge.
- The discrepancy in our results between (1) the (small) degree to which problems are approached in a handy fashion and (2) the (large) degree to which students do possess the task-specific preconditions to a handy approach can only be explained if one allows the presence but non-functionality of the task-specific knowledge in a relatively large group of students.

The conclusion must alas be drawn that the students’ education has not led to the habit of first analyzing a problem before beginning the calculations: a ‘mathematical attitude’ or ‘disposition to higher order thinking’ (Resnick, 1987) is conspicuously absent here.

**Arithmetic approach, arithmetic skills and intelligence**

- The arithmetic achievements can be predicted reasonably well based upon the collective distinguished aspects of approach behavior.
- The arithmetic approach is not related to verbal intelligence (vocabulary).
- The arithmetic approach behavior has a surplus value above and beyond the non-verbal intelligence (Raven IQ) when predicting arithmetic skills (See Appendix 8).

**Aggregation**

The following conclusions are discussed against the background of the problem of aggregation in scientific arithmetic and personality research (Mischel & Peake, 1982; Epstein, 1983; Lamiell, 1987; Siegler, 1987).
On the one hand, aggregation of item scores can be useful in connection with an increase in data stability but, on the other hand, relevant information may be lost through such aggregation.

Data averaged over a number of strategies may not accurately reflect the characteristics of any strategy; averaging of data may distort conclusions regarding certain aspects of performance.

Consistency indices of approach behavior in mental arithmetic, calculated across the entire group of students, cannot be interpreted (in terms of probability) at the level of the individual student.

The last conclusion supports Lamiell’s standpoint, to wit: "Unless they are perfect, the reliability and validity coefficients (and other aggregate statistical indices such as omega square ratios, generalizability coefficients, etc.) generated by individual differences research have no legitimate interpretation of any kind whatsoever at the level of the individual" (Lamiell & Trierweiler, 1986, p. 475).

**Gender differences**

- The girls were somewhat lower achievers than the boys in mental arithmetic.
- The girls demonstrated a lower level of automatization (the girls counted on their fingers more than the boys did, for instance)
- The girls demonstrated a lesser degree of consciousness than did the boys.
- In problems involving three terms (for example, 18+15+5=? and 13+15-13=?), the girls did not orientate themselves as much; that is, the girls more often approached such problems according to standard methods.
- The differences in achievement found between boys and girls can be explained by the differences between the genders in approach behavior.

When viewing the above results, one must keep in mind that the research was not conducted using a representative sampling. The results are discussed against the background of research into gender differences in arithmetic and mathematics achievement (Friedman, 1989). In the dissertation, a number of social, motivational and emotional factors are propounded in explanation of the gender differences found here (Fennema, 1989; Lester et al., 1989; Tavecchio et al., 1991; Braun, 1992). The above results offer points of departure for decreasing gender differences in arithmetic achievement by means of educating a more adequate approach behavior.
Consistentie van aanpakgedrag

Drie onderwerpen komen in dit boek aan de orde:

AANPAKGEDRAG BIJ HOOFDREKENEN
174 eindvierde-groep-basisschoolleerlingen werden individueel onderzocht met de Leidse Diagnostische Rekenaanpak Test. Acht aspecten van het hoofdrekenen (optellen en aftrekken tot 100) werden in kaart gebracht:
- aandacht
- handig rekenen
- oplossingsprocedures
- automatisering
- flexibiliteit
- inzichtelijkheid
- bewustheid
- controle.
In dit boek worden vragen beantwoord over:
- de consistentie van het aanpakgedrag
- de verbanden tussen aanpak, prestaties en intelligentie
- het verband tussen de aanpakaspecten onderling
- verschillen tussen jongens en meisjes.

AANPAKGEDRAG IN VERSCHILLENDE TAAKDOMENEN
Daarnaast maakt de operationalisatie toekomstig onderzoek mogelijk naar de mate van algemeenheid versus vakspecificiteit van cognitieve en metacognitieve processen.

AANPAKGEDRAG EN PERSOONLIJKHEID
In het boek wordt een aanzet gegeven voor een proces-consistentie benadering van persoonlijkheidseigenschappen. Hierbij gaat het om de vraag in hoeverre er bij leerlingen sprake is van basale tekorten in het handelingsrepertoire of van vakspecifieke deficiënties.
Wanneer leerlingen een ongunstige aanpak vertonen bij allerlei schooltaken kunnen we zeggen dat de ongunstige werkhuizing in hun persoonlijkheid is geïnterrioriseerd. Het diagnostiseren van de mate van interiorisatie is van belang voor de behandeling van leerproblemen.