European Journal of Psychology of Education
1999, Vol. XIV, nº 1, 57-69

Individual differences in school mathematics performance and feelings of difficulty: The effects of cognitive ability, affect, age, and gender

Anastasia Efklides
Maria Papadaki
Georgia Papantoniou
Gregoris Kiosseoglou
Aristotle University of Thessaloniki, Greece

The aim of the study was to identify possible individual differences effects on school mathematics performance and feelings of difficulty (FOD). Cognitive ability (general and domain-specific), affect (anxiety and achievement need), age, and gender were considered the main sources of individual differences. The effect of the testing experience (i.e., the repeated exposure to the testing situation) was also taken into account. Two hundred forty three subjects, of both genders, from 13 to 15 years of age were tested with three task batteries: the cognitive ability, the affective battery and the school mathematics battery. Ratings of the difficulty of each of the mathematics items were also collected. A second testing of the affective battery, mathematical tasks and FOD was effected one year after the first. A series of path analyses and ANOVAs were performed on the data. It was found that ability directly influenced performance whereas both ability and affect influenced FOD. Feelings of difficulty were also influenced by performance. Age differentiated FOD only at the 2nd testing. Gender interacted with both person and task characteristics and had an effect on FOD but not on performance.

As indicated in the title, this paper deals with individual differences in school mathematics. It summarises the main findings of a research project which was reported in Efklides, Papadaki, Papantoniou, and Kiosseoglou (1997, 1998). The distinct feature of this project was the emphasis it placed not only on performance but on subjective experience, in this case feelings of difficulty (FOD) experienced in relation to the mathematical tasks solved. From this point of view, our project aimed to show the relevance of individual differences (ID) research to the study of online experience and self-regulation, as mediated by cognitive and affective factors.

This research was supported by Aristotle University research grants.

Indeed after decades of research on individual differences there seems to be increasing discontent among psychologists as to what new this kind of research can offer to our understanding of performance (Calfee & Curley, 1995; Undheim, 1994). Individual differences research has even less to say about human experience and the ideas, appraisals or feelings one experiences when dealing with specific problems. This is so because ID research is studying general person characteristics, such as intelligence and personality traits, whereas it is often the actual task situation that determines outcome variables such as performance and experience.

This kind of criticism leads to two kinds of response: the first is to abandon ID research and focus on the other factors that presumably affect students' performance and task-related experiences; the second is to continue ID research and integrate it in designs that involve other potentially important factors, such as task characteristics. In this way one may get a more complete picture of the complex interactions of the factors influencing human performance and subjective experience. The second approach was adopted in this study.

A fundamental problem one faces in this kind of integrative work is the reconciliation of general person characteristics with task-specificity. This is not a problem if one assumes that person characteristics directly influence task-related performance and experiences. It is, however, a problem if we take into account the differentiation of general person characteristics according to the domain they refer to. In this case, the effects of general person characteristics on behavior may be indirect or even non-existent. The problem becomes even more complicated if we accept an even finer level of differentiation, namely the task level. If we are able to delimit the effects of the various levels of generality of the factors influencing performance and experience, then we may become able to understand better the sources or the nature of variation among individuals.

Boekaerts (1995) have underscored the need for differentiating affective constructs as to their scope or generality. Boekaerts pointed out that affective variables function at three levels of generality (LG), namely the superordinate, the middle, and the subordinate level. Variables at the superordinate level correspond to the student's "inclination to engage in scholastic learning"; at the middle level they correspond to the "student's tendency to react in a favorable or unfavorable way to particular domains of knowledge", and variables at the subordinate level tap the student's "selective sensitivity to specific learning situations" (p. 166).

A similar differentiation of LG can be found in intelligence research. All recent conceptualizations of intelligence agree that cognitive abilities vary in scope. Thus there is general cognitive ability at the top of a hierarchy of specialized or more narrow abilities (these also involve domain-specific abilities) and at the bottom there are even narrower factors, which are task-specific factors. Task performance is influenced by all the above factors (Demetriou & Efklides, 1994; Gustafsson, 1984). Thus, in both the affective and intellective domains one may distinguish three LG, namely the superordinate or general level, the middle or domain-specific level, and the subordinate or task-specific level.

Adoption of the above conceptual framework allows the identification of effects of higher order intellective and personality variables on the lower order ones. A second, even more important issue that can be investigated within this framework is the possible feed-back and feed-forward effects (Ford, 1995) of general person characteristics and task-specific performance and experiences. That is, how current performance and experiences influence general person characteristics in the short and in the long run. In order to identify these effects, the design of the study needs to be longitudinal.

A third issue that can be investigated within an integrative, LG, longitudinal design, is the identification of possible interaction between knowledge acquisition and general person characteristics. Knowledge acquisition is related to age, in the sense that older children have longer school instruction and, consequently, more knowledge in the various school subjects and expertise (the term "expertise" is used here to denote the dimension of knowledge or skills availability to a person in relation to a specific knowledge domain). Increasing age and growing expertise may have an effect on performance and related experiences, such as feelings of difficulty, but it may also interact with general person characteristics, since previous research has shown, for instance, that anxiety interacts with practice (Heinrich &

Spielberger, 1982). This may also be true for other personality traits. Furthermore, it is not clear up to now how general intelligence and domain-specific abilities interact with growing expertise in a domain. Finally, gender which is another source of ID besides expertise may also interact with general person characteristics and influence performance and feelings of difficulty.

To investigate the above issues the following study was implemented. There were two testing waves. In the first testing wave there were, first, measures of general cognitive ability (GCA) and general mathematical ability (GMA); second, measures of anxiety trait (Atrait), anxiety state (Astate), need success (nSuc), and fear of failure (fFail); third, measures of performance on school mathematics tasks and feelings of difficulty (FOD). The affective measures were taken both before the mathematical testing (1st wave pretest affect) and after it (1st wave posttest affect). In the second testing wave, there were measures of performance and FOD on the same mathematical tasks, as well as measures of all the above mentioned affective variables after completion of the mathematical testing (2nd wave posttest affect).

The results of the above study have been presented analytically in Efklides, Papadaki, Papantoniou, and Kiosseoglou (1997, 1998). In this presentation we concetrate on the three issues stated above, namely (a) the effects of higher order intellective and affective variables on lower level ones and on performance and FOD; (b) the effects of performance and FOD on current and future affect such as anxiety and achievement need (nAch); and (c) the effects of age (or expertise) and gender on performance and FOD.

The specific hypotheses tested in relation to each of the above issues were:

1) In the cognitive ability domain: General cognitive ability will influence general mathematical ability, because the second is more specific than the first. The effect of GCA on performance will be indirect via GMA, to the extent there is a strictly hierarchical organization of cognitive abilities. General mathematical ability, in turn, will influence task-specific processes and performance. There was no prediction as to the effects of GCA and GMA on FOD, because there is no previous study to our knowledge testing this kind of effects. However, since FOD are products of task-specific processing, the prediction was that they would be influenced by performance factors.

2) In the affective domain: The hypothesis was that, at the *pretest*, higher order affective variables will influence lower order variables. This is so, because the pretest measure of affect reflects the organization of the affective system as it exists before one enters a specific performance situation. Therefore it will represent the presumed hierarchical organization and top down effects. However, at the *posttest*, the relation will be in the opposite direction, because it is the subordinate level affect which is influenced by actual task experiences, and this information is fed back into higher-order affect.
   Expressly, at the pretest Atrait was predicted to influenc Astate (as related to mathematics) and this, in turn, to influence fFail to the extent fFail is considered an emotional response more closely related to actual task-processing. Need success, as a general orientation would also influence fFail in the context of nAch. At the posttest, the opposite direction of effects was expected because of the possible feedback effects of performance and FOD on fFail, and via fFail to nSuc, Astate and Atrait.

3) Increasing age and growing expertise in mathematics, as students move to higher grades and learn more, should improve performance and lower FOD for two reasons: first, increased knowledge should facilitate performance and eliminate sources of difficulty; second, it should lower anxiety and increase nSuc, thus facilitating task achievement.
   However, expertise and practice (through repeated testing) make one better aware of actual task demands. Therefore there should be an interaction of expertise with testing and task.

4) Finally, gender should interact with Astate and influence performance and FOD since girls experience higher anxiety in the case of mathematics.

Method

Participants

Two hundred forty-three (out of 299 in the first testing wave) students of 7th, 8th, and 9th grade were tested in the two testing waves; the second testing took place one year after the first. There were 81, 86, and 76 students in the 7th, 8th, and 9th grade cohort, respectively. Of them, 119 were girls and 124 boys.

Tasks. Participants were tested with four batteries of tasks and questionnaires. These were the General Cognitive Ability Battery, the General Mathematical Ability battery, the School Mathematics battery, and the Affective battery. Analytic description of the tasks can be found in Efklides et al. (1997, 1998).

General Cognitive Ability (GCA) was assessed with a battery of inductive tasks, because, as mentioned above, fluid intelligence has been identified in the past as inductive ability (Gustafsson, 1984).

The domain-specific ability, namely the *General Mathematical Ability* (GMA), was assessed with a battery of three tasks (Demetriou, Platsidou, Efklides, Metallidou, & Shayer, 1991), which according to the theory of Experiential Structuralism (Demetriou & Efklides, 1987, 1994) underlie mathematical competence. The first of the tasks addressed *arithmetic operations*, the second *algebraic notions*, and the third *proportional reasoning*.

The *School Mathematics* battery involved (a) the *Basic Mathematical Notions Test* (BMNT) and (b) the *Grade-Specific Mathematical Notions Test* (SMNT). The BMNT battery included 16 tasks, representing decimals, fractions, algebraic operations, percentage, and geometry. They were of three levels of difficulty: easy, moderate and difficult (see Efklides et al., 1998). The SMNT tasks were selected from the mathematics curriculum of the 7th and 8th grade, and were administered to the 7th, and 8th and 9th grades respectively.

The *Affective* battery involved, first, the Spielberger Test Anxiety Inventory (TAI) (Spielberger, 1980), which gives a score of General Test Anxiety and two more specific scores representing Worry and Emotionality. It is assumed to tap Atrait. Second, the Cognitive Interference Questionnaire (CIQ) (Sarason, Sarason, Keefe, Hayes, & Shearin, 1986), presumably tapping Astate, and specifically, the Worry aspect of it. Third, the Achievement Motivation Scale (Nygard & Gjesme, 1973), which gives one score for nSuc, representing the positive aspect of nAch, and one score for fFail, representing the Avoidance of Failure motive.

Feelings of difficulty represented the on-line, subjective experience of task complexity. Students were required upon completion of each of the school mathematics tasks to rate the difficulty of the task on a 4-point scale, ranging from 1: not difficult at all, 2: a little difficult, 3: quite difficult, to 4: very difficult.

Results and discussion

In order to test the hypotheses stated above and delimit the relations underlying affect, cognitive ability, performance, and subjective experience in the two testing waves, a series of path models were applied. The EQS statistical program was used (Bentler, 1993). The path model depicting, first, the relations underlying affect, cognitive ability (GCA and GMA), performance and FOD on the BMNT tasks, were presented in Efklides et al. (1998). This model differentiated performance and FOD according to task difficulty [easy (E), moderate (M), difficult (D)]. In this analysis the whole sample was represented. The fit indices of the model were: $\chi^2(266)=283.423$ $p=.221$, Comparative Fit Index (CFI)=.993. The model is shown in Figure 1.

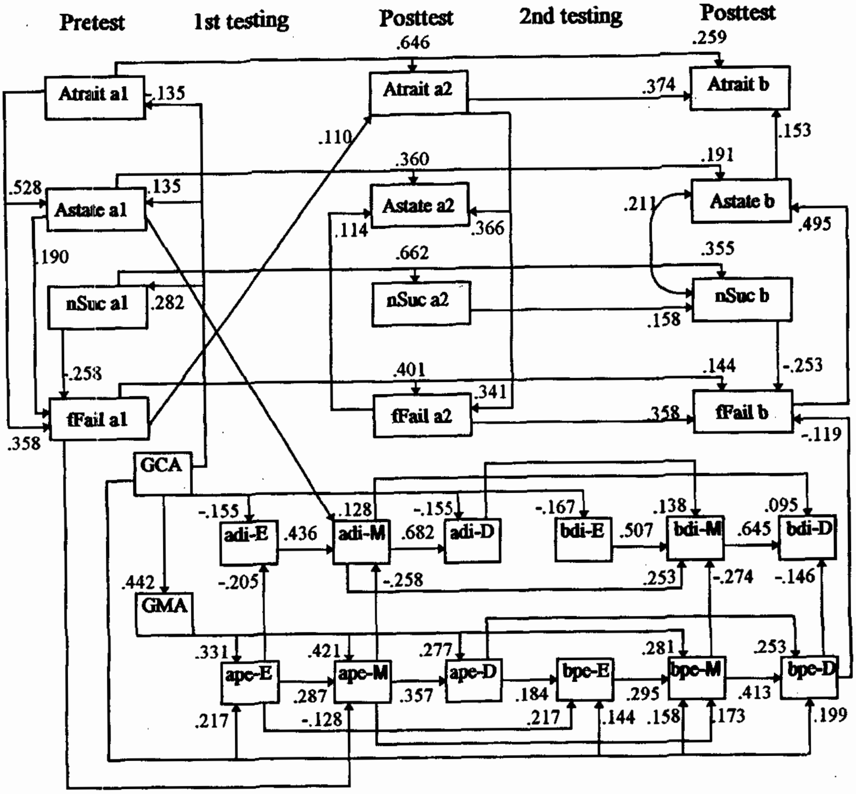

Figure 1. The path model involving the whole sample (adapted from Efklides, Papadaki, Papantoniou, & Kiosseoglou, 1998. European Journal of Psychology of Education)

Note. The meaning of the symbols is:

a1: pretest on the 1st testing wave; Atrait: anxiety-trait; a2: posttest on the 1st testing wave; Astate: anxiety-state; b: 2nd testing wave; nSuc: need success; GCA: general cognitive ability; fFail: fear of failure; GMA: general mathematical ability; ape-E: performance on the BMNT easy tasks for the 1st testing wave; ape-M: performance on the BMNT medium difficulty tasks for the 1st testing wave; ape-D: performance on the BMNT difficult tasks for the 1st testing wave; bpe-E: performance on the BMNT easy tasks for the 2nd testing wave; bpe-M: performance on the BMNT medium difficulty tasks for the 2nd testing wave; bpe-D: performance on the BMNT difficult tasks for the 2nd testing wave; adi-E: feelings of difficulty on the BMNT easy tasks for the 1st testing wave; adi-M: feelings of difficulty on the BMNT medium difficulty tasks for the 1st testing wave; adi-D: feelings of difficulty on the BMNT difficult tasks for the 1st testing wave; bdi-E: feelings of difficulty on the BMNT easy tasks for the 2nd testing wave; bdi-M: feelings of difficulty on the BMNT medium difficulty tasks for the 2nd testing wave; bdi-D: feelings of difficulty on the BMNT difficult tasks for the 2nd testing wave.

For the testing of the expertise effects, a second path model will be presented, including the scores of both the BMNT and the SMNT tasks. This model was based on the scores of the 9th-grade cohort and it is used here as an example of the changing relations between intellective and affective factors, on the one hand, and performance and FOD on the other as domain-specific knowledge increases. Similar models regarding the 7th- and 8th-grade cohorts are reported in Efklides et al. (1997). The fit indices of the model were: $\chi^2(184)=215.892$ $p=.054$, CFI=.960 and is shown in Figure 2. The results will be presented in the order of the hypotheses stated above.

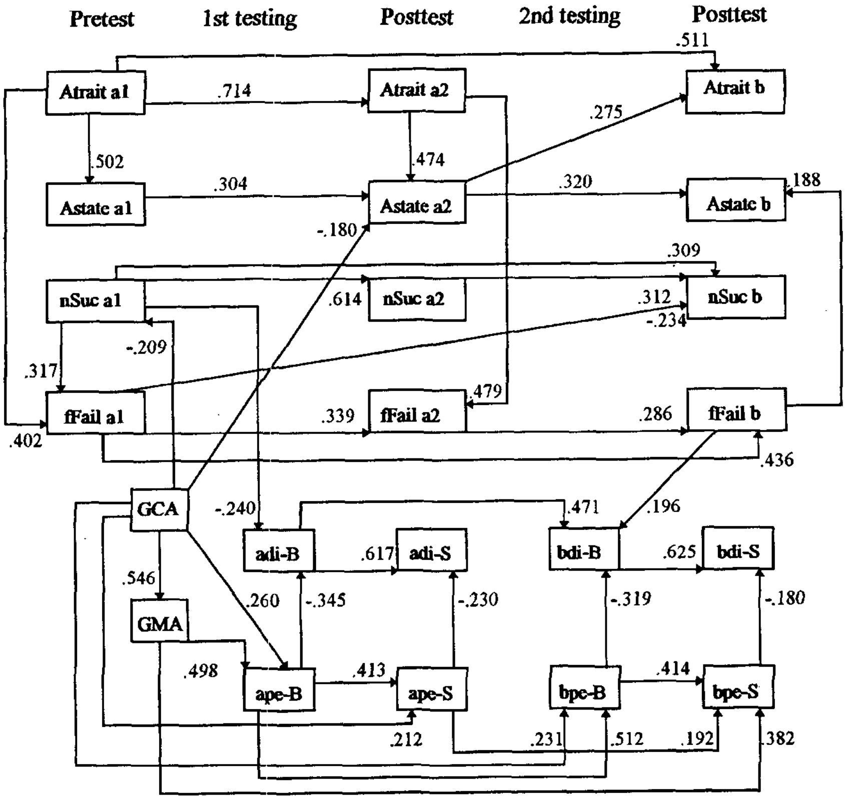

Figure 2. The path model involving the 9th grade cohort (adapted from Efklides, Papadaki, Papantoniou, & Kiosseoglou, 1997. American Journal of Psychology)

Note. The meaning of the symbols is:

a1: pretest on the 1st testing wave; Atrait: anxiety-trait; a2: posttest on the 1st testing wave; Astate: anxiety-state; b: 2nd testing wave; nSuc: need success; GCA: general cognitive ability; fFail: fear of failure; GMA: general mathematical ability; ape-B: performance on the BMNT for the 1st testing wave; ape-S: performance on the SMNT for the 1st testing wave; bpe-B: performance on the BMNT for the 2nd testing wave; bpe-S: performance on the SMNT for the 2nd testing wave; adi-B: feelings of difficulty on the BMNT for the 1st testing wave; adi-S: feelings of difficulty on the SMNT for the 1st testing wave; bdi-B: feelings of difficulty on the BMNT for the 2nd testing wave; bdi-S: feelings of difficulty on the SMNT for the 2nd testing wave.

Effects of GCA and GMA

As shown in Figure 1, general cognitive ability (GCA) influenced general mathematical ability (GMA), but the effects of GCA on performance were not only via GMA, as predicted in Hypothesis 1. There were direct effects of GCA on performance on the easy tasks in the 1st testing wave and on the easy and moderate difficulty tasks in the 2nd testing wave. The effects of GMA were on all categories of tasks in the 1st testing wave and on the moderate difficulty tasks in the 2nd testing wave. In a sense, there was an inversion of the effect of GCA and GMA from the 1st to the 2nd testing.

This is an important finding because it suggests that general intelligence is used for different purposes than domain-specific ability. General cognitive ability is probably used for the access and assembly of existant general knowledge and skills, whereas domain-specific ability is used for the accessing of the specific concepts, relations, and procedures required for the processing of the particular tasks. Once this has been achieved, that is in the 1st testing, there is no immediate need for the use of GMA unless there are task-specificities which need to be considered. This was the case of moderate difficulty tasks. They were within students' grasp but still had properties not fully understood. Students' increased experience with mathematics allowed them to better understand these task properties and thus use the specialized knowledge structures required. This conclusion is also supported by the effects of GMA shown in Figure 2. General mathematical ability influenced the BMNT in the 1st testing wave and the SMNT in the 2nd testing wave.

It is most interesting that GMA had no effect on FOD. It was GCA and task- specific performance that influenced feelings of difficulty. Specifically, GCA had a low but significant negative relationship with FOD on easy and difficult tasks in the 1st testing and with the easy tasks in the 2nd testing (see Figure 1). These effects are only partly in line with GCA's effects on performance, because they are limited mainly to the easy tasks; only in one case was GCA related to difficult tasks (in the 1st testing wave). This finding suggests that the greater the accessibility of general knowledge and skills the less intense are FOD. This relation of GCA with FOD was not significant in the case of 9th grade students (as shown in Figure 2), where the effects on FOD were more affective.

Indeed, FOD is a very complex phenomenon, because, as shown in Figures 1 and 2, it is also influenced by performance and affect. These effects, nevertheless, are much weaker than the interrelations between the FODs reported on tasks of varying difficulty. This means that FOD are relative in nature and product of inferential processes that take into account various cues related to task processing, such as task and effort interaction (Johnson, Saccuzo, & Larson, 1995; Weaver & Bryant, 1995) or strategy use (Rellinger, Borkowski, Turner, & Hale, 1995). Thus in the case of high difficulty tasks in the 1st testing (see Figure 1) subjects based their judgement of task difficulty on GCA and on FOD of the moderate difficulty tasks rather than on actual performance on the tasks. The relationship with performance was established in the 2nd testing, when the difficult tasks were no more new. In this case FOD was determined both in terms of FOD of moderate difficulty tasks and of task-related factors rather than GCA.

Effects of affective variables

As shown in Figures 1 and 2 at the pretest anxiety trait (Atrait) influenced anxiety state (Astate) and fear of failure (fFail). Fear of failure was also influenced by Astate and need success (nSuc). All these effects were in line with Hypothesis 2, because superordinate and middle level affect influenced lower order affect, namely fFail. The expected inversion of the direction of effects from lower order to higher order variables was clearly confirmed only in the case of fFail, which influenced Astate. There was no direct effect of fFail on Atrait and nSuc. Finally, there were effects of Astate on Atrait, but these were not consistent. These results imply that subordinate level affective variables, such as fFail do not directly feed back on general person characteristics. The road is through middle level affect, that is Astate.

As regards the effects of affective variables on performance and FOD, it was found that there was no direct effect of higher order affect (Atrait, Astate, and nSuc) on performance. Their effect was indirect through fFail (see Figure 1), which influenced performance on moderate difficulty tasks. This effect is in line with achievement motivation theory (McClelland, Atkinson, Clark, & Lowell, 1953) which claims that tasks of moderate difficulty are the ones that create tendency to avoid failure. However, this effect was weak in comparison to cognitive ability (GCA and GMA) effects.

The effects of affect on FOD were quite different. There was a low but significant direct effect of Astate on FOD of moderate difficulty tasks (as shown in Figure 1) and a direct effect of pretest nSuc on FOD on BMNT tasks in the 9th grade cohort (Figure 2). What is worth noting in this cohort is the fFail effect on FOD on the same BMNT tasks in the 2nd testing. This finding suggests an inversion of the tendencies of achievement need along with testing. Specifically, the 15-year-olds entered the achievement situation confident that they could succeed but one year later they realized that there were still notions and tasks they could not handle. This realization raised their fear of failure and this in turn made their FOD estimations higher.

In so far as the possible feedback effects of performance and FOD on affect is concerned, it was found that it was performance that influenced fFail (see Figure 1) and not FOD, as one would expect. This finding suggests that performance factors lead to two kinds of response: one emotional (that is fFail) and one of feelings, such as FOD, which are more metacognitive in nature. These two forms of response do not interrelate at least in the short run.

Finally, Figures 1 and 2 present interesting evidence as regards the feed-forward effects of the 1st-testing on the 2nd-testing affect. It was found that posttest affective measures were related to the respective pretest measures both in the first testing and in the second. However, there are some other effects which indicate effects of subordinate or middle level variables on superordinate ones. As shown in Figure 1 pretest fFail directly influenced posttest Atrait in the 1st testing. As shown in Figure 2 pretest fFail directly influenced 2nd testing nSuc, and first year posttest Astate influenced 2nd testing Atrait. These findings add further corroboration to the findings regarding the influence of posttest fFail on Astate, and of Astate on Atrait. Therefore, it can be concluded that the affective system maintains both stability and change over time. Stability is indicated by the relatively strong relations of 2nd year affect with the corresponding first year affect, whereas change is indicated by the effects of lower level affect on general person characteristics such as Atrait and nSuc.

Effects of age and expertise

We now come to the third hypothesis which regards the possible age effects on performance and FOD. A series of path analyses investigating the intellective and affective effects on performance and FOD in each of the three age groups/cohorts were presented in Efklides et al. (1997). These analyses showed, that although the basic pattern of relations between cognitive ability (both GCA and GMA) affect, performance, and FOD was stable across the three age groups/cohorts, there were also differentiations between them. Specifically, as students grow older and gain expertise in a domain (thus leading to better performance) this influences the effects of GCA and affect on performance and the FOD reported, as well as the structure of students' affective system.

Efklides et al. (1998) investigated the effects of cognitive ability, anxiety trait and age on performance and FOD through a series of ANOVAs. In this case subjects were divided into high and low GCA, and high and low Atrait groups within each age group/cohort. These analyses showed that age affected performance, but it did not affect FOD. There were also interactions of age/cohort with testing and task difficulty. Specifically, as regards performance the 7th-grade cohort improved in the 2nd testing mainly in the easy tasks, whereas the 8th-grade cohort in all tasks. The 9th-grade cohort improved in all tasks but to a lesser extent than 8th-graders (see Figure 3). This finding suggests that 9th-graders were at a stage of relative stability as regards basic mathematical notions, whereas 7th graders despite the fact that they had been taught the BMNT notions they had not assimilated the new knowledge. Teaching made a difference basically for 8th graders.

However, despite the changes of performance due to age/expertise effects there was no age effect on FOD, as mentioned above. This suggests that changes of FOD are slower and to a certain extent independent of age and expertise. This is understandable if we recall the multitude of factors that directly or indirectly influence FOD. There was nevertheless an age/cohort by testing interaction and an age/cohort by task difficulty interaction. In this case 7th and 8th graders tended to increase their FOD ratings in the 2nd testing more than 9th graders. The only exception was in the case of easy tasks, where 9th graders gave similar ratings to those of 7th graders (see Figure 4).

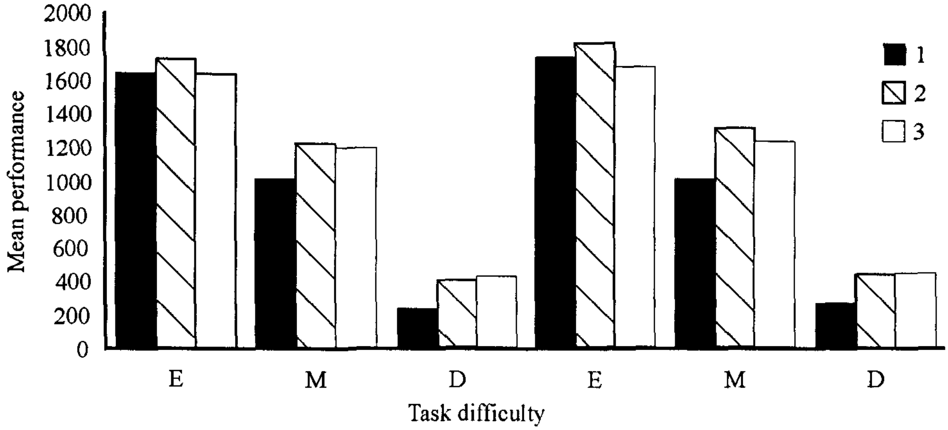

Figure 3. Mean performance scores as a function of grade, task difficulty and testing (adapted from Efklides, Papadaki, Papantoniou, & Kiosseoglou, 1998. European Journal of Psychology of Education)

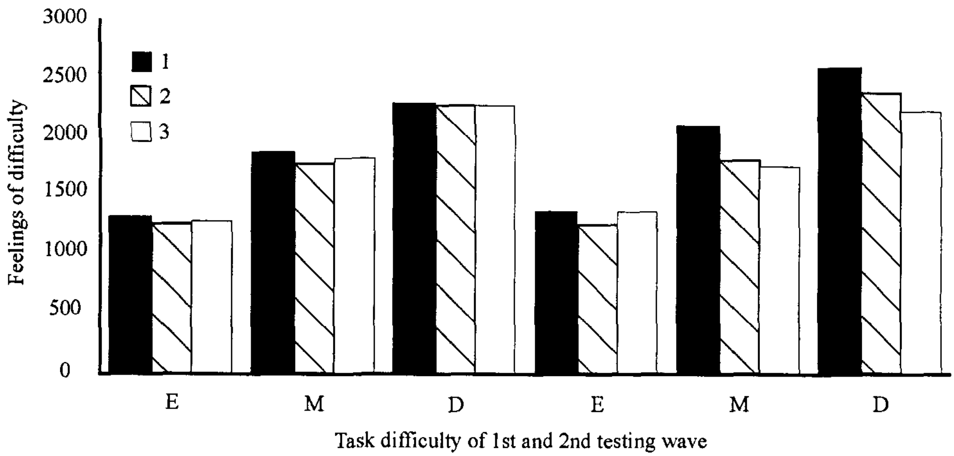

Figure 4. Feelings of difficulty as a function of grade, task difficulty and testing (adapted from Efklides, Papadaki, Papantoniou, & Kiosseoglou, 1998. European Journal of Psychology of Education)

Furthermore, in the 2nd testing FOD were more differentiated among cohorts than in the 1st testing. It can be concluded then that age and the associated expertise, which acts at the cognitive level, contributed to better performance as regards moderate and high difficulty tasks but it did not differentiate significantly FOD, which are influenced by cognitive and non-cognitive factors. It is important to note, however, that the experience one has with a task or similar tasks does make a difference for FOD, independenly of age, because makes one better aware of the pecularities of the task and one's reaction to them.

Effects of gender

The effect of gender on performance and on FOD was investigated in Efklides et al. (1998). Girls reported significantly higher Atrait than boys. The same difference was found in the case of Astate and fFail but not in nSuc. This finding confirms previous ones (Fennema, 1989) showing increased Atrait and mathematics-related anxiety state. However, despite their increased anxiety girls did not differ from boys in performance and there was a marginally significant effect in FOD. There was also an interaction of gender with Astate, testing and task difficulty, which indicated that girls were more variable in their responses than boys. It can be concluded then that gender at least in this age range, did not have any major effects on performance and FOD on school mathematics.

Conclusions

The research project presented above aimed to identify the effects of LG of person characteristics, as well as of age/expertise and gender on performance and FOD related to school mathematics. Task difficulty and repeated testing were also taken into account.

One of the basic findings was that the concept of levels of generality (LG) is critical for differentiating the effects of general person characteristics on performance and subjective experience. The most important finding of this study was that higher order constructs, such as GCA, Atrait, and nSuc, do not necessarily exert their effects through the hierarchically lower--order constructs. Besides these indirect effects, there were also direct effects of higher level constructs on either performance or FOD; this suggests that the various LG serve different functions; in other words, higher order constructs are not mere abstractions of lower order factors and they cannot be reduced to them. Consequently, situational or even domain-specific factors cannot explain all the variance observed in performance or subjective experience and we need to integrate constructs of superordinate level along with lower level ones into our accounts of human variability.

Our study also showed that longitudinal research is important in order to understand, firstly, how person characteristics themselves change in the long run and, secondly, how the situational demands on them change. We found that current performance as well as acquisition of new knowledge and skills associated with increasing age and instruction influences in the long run lower order affect and this in its turn influences middle and even superordinate level affect. However we were not able to identify long-term effects of FOD on affect. This needs to be further investigated.

We also found that a higher order construct may be called in when the task or situation demands it, for instance when the task is new or very difficult; but when the person becomes familiar with the task he/she does not need the same higher order construct in order to process the task anymore and moves to an even higher or lower level construct, depending on the function that serves the situation best.

A third important finding was that FOD is relative in nature and determined by the estimated difficulty of related tasks. They are also influenced by performance, cognitive ability and affect. These results indicate that on-line, task-related experiences such as FOD are distinct from both cognitive and affective person characteristics or emotions. Therefore in a model of self-regulated learning we should be aware that on-line subjective experience is conveying complex messages, incorporating information about the person's past and present encounters with the task. Furthermore, on-line task-related experiences form dynamic systems that have as epicenter the task but are independent from it. They flow and change along with task solution (Efklides, Petropoulou, & Samara, 1997). This very nature of on line experiences explains why in our study we did not find any direct and immediate feedback effect of FOD on affective variables. It is probable that only after they have been repeated a lot of times they become clearly part of the person's self awareness in relation to the task at hand and part of his/her concept of the self that influences affective responses. This, however, has to be proven by future research.

To sum up it is our conviction that individual differences research has a lot to offer in the integration of our knowledge regarding the dynamics of performance and subjective experience, particularly in relation to the self-regulation process.

References

Bentler, P.M. (1993). *EQS: Structural equations program manual.* 2nd edition. Los Angeles, CA: BMDP Statistical Software.

Boekarts, M. (1995). The interface between intelligence and personality as determinants of classroom learning. In D.H. Saklofske & M. Zeidner (Eds.), *International handbook of personality and intelligence* (pp. 161-183). New York: Plenum.

Calfee, R.C., & Curley, R.G. (1995). Intellective and personality factors of literacy. In D.H. Saklofske & M. Zeidner (Eds.), *International handbook of personality and intelligence* (pp. 143-159). New York: Plenum.

Demetriou, A., & Efklides, A. (1987). Experiential structuralism and neo-piagetian theories: Toward an integrated model. *International Journal of Psychology, 22*, 679-728.

Demetriou, A., & Efklides, A. (1994). Structure, development, and dynamics of mind: A meta-piagetian theory. In A. Demetriou & A. Efklides (Eds.), *Intelligence, mind, and reasoning* (pp. 75-109). Amsterdam: Elsevier.

Demetriou, A., Platsidou, M., Efklides, A., Metallidou, Y., & Shayer, M. (1991). The development of quantitative--relational abilities from childhood to adolescence: Structure, scaling, and individual differences. *Learning and Instruction: The Journal of the European Association for Research on Learning and Instruction, 1*, 19-43.

Efklides, A., Papadaki, M., Papantoniou, G., & Kiosseoglou, G. (1997). The effects of cognitive ability and affect on school mathematics performance and feelings of difficulty. *The American Journal of Psychology, 102*, 225-258.

Efklides, A., Papadaki, M., Papantoniou, G., & Kiosseoglou, G. (1998). Individual differences in feelings of difficulty: The case of school mathematics. *European Journal of Psychology of Education, 13*, 207-226.

Efklides, A., Petropoulou, M., & Samara, A. (1997, August). Metacognitive experiences before, during, and after problem solving. In A. Efklides (Chair), *Metacognitive experiences and their role in cognition.* Invited symposium conducted at the 7th European Conference for Research on Learning and Instruction, Athens, Greece.

Fennema, E. (1989). The study of affect and mathematics: A proposed generic model for research. In D.B. McLeod & V.M. Adams (Eds.), *Affect and mathematical problem solving: A new perspective* (pp. 205-219). New York: Springer Verlag.

Ford, M. (1995). Intelligence and personality in social behavior. In D.H. Saklofske & M. Zeidner (Eds.), *International handbook of personality and intelligence* (pp. 125-142). New York: Plenum.

Gustafsson, J.-E. (1984). A unifying model for the structure of intellectual abilities. *Intelligence, 8*, 179-203.

Heinrich, D.L., & Spielberger, C.D. (1982). Anxiety and complex learning. In H. Krohney & L. Laux (Eds.), *Achievement, stress, and anxiety* (pp. 145-165). Washington, DC: Hemisphere Publishing Corp.

Johnson, N.E., Saccuzo, D.P., & Larson, G.E. (1995). Self-reported effort versus actual performance in information processing paradigms. *Journal of General Psychology, 122*, 195-210.

McClelland, D.C., Atkinson, J.W., Clark, R.W., & Lowell, E.L. (1953). *The achievement motive.* New York: Appleton Century-Crofts.

Nygard, R., & Gjesme, T. (1973). Assessment of achievement motives: Comments and suggestions. *Scandinavian Journal of Educational Research, 17*, 39-46.

Rellinger, E., Borkowski, J.G., Turner, L.A., & Hale, C.A. (1995). Perceived task difficulty and intelligence: Determinants of strategy use and recall. *Intelligence, 20*, 125-143.

Sarason, I.G., Sarason, B.R., Keefe, D.E., Hayes, B.E., & Shearin, E.N. (1986). Cognitive interference: Situational determinants and traitlike characteristics. *Journal of Personality and Social Psychology, 51*, 215-226.

Spielberger, C.D. (1980). *Manual for the Test Anxiety Inventory*. Palo Alto, CA: Consulting Psychologists Press.

Undheim, J.O. (1994). Taking stock of what there is: The case of cognitive abilities. In A. Demetriou & A. Efklides (Eds.), *Intelligence, mind, and reasoning* (pp. 29-44). Amsterdam: Elsevier.

Weaver, C.A., & Bryant, D.S. (1995). Monitoring of comprehension: The role of text difficulty in metamemory for narrative and expository text. *Memory and Cognition, 23*, 12-22.

Le but de cette recherche était d'identifier d'éventuels effets des différences individuelles sur les performances scolaires en mathématiques ainsi que sur le sentiment de difficulté (SDD). Les principales sources de différences individuelles prises en considération étaient: l'aptitude cognitive (générale et propre au domaine), les affects (anxiété et besoin de réussite), l'âge et le sexe. L'effet de l'expérience elle-même (i.e., la participation répétée à la situation expérimentale) a également été pris en compte. 243 sujets des deux sexes, âgés de 13 à 15 ans, furent soumis à trois séries cle tests: tests d'aptitude cognitive, tests affectifs et tests de connaissances scolaires en mathématiques. Un jugement sur la difficulté (SDD) de chacune des tâches mathématiques était également recueilli. Une deuxième application de la batterie des tests affectifs, des tests de connaissances en mathématiques et du SDD a eu lieu un an après la première. Une série d'analyses de parcours ainsi que d'analyses de variance ont permis de constater que l'aptitude cognitive influence directement la performance, alors que l'aptitude et les affects influencent ensemble le sentiment de difficulté. Cette dernière variable est également influencée par la performance. L'influence de l'âge sur le SDD n'est apparu qu'à la deuxième passation. Le sexe, en interaction avec les caractéristiques des personnes et des tâches, a un effet sur le SDD mais pas sur les performances.

Key words: Affect, Cognitive ability, Feelings of difficulty, Individual differences, School mathematics

Received: June 1998

Anastasia Efklides. School of Psychology, Aristotle University, 540 06 Thessaloniki, Greece, Tel: 0030-31-997374, Fax: 0030-31-997384, E-mail: efklides@psy.auth.gr.

Current theme of research:

Relations between online task-related feelings and performance.

Most relevant publications in the field of Psychology of Education:

Efklides, A. (1997). Training domain-specific abilities. In J.H.M. Hamers & M.Overtoom (Eds.), *Inventory of european programmes for teaching thinking* (pp. 55-57). Utrecht: Sardes.

Efklides, A. (1997). *Psychology of thinking* (in greek). Athens: Ellinika Grammata.

Efklides, A. (1998). The role of cognitive abilities and affect in math and science learning (in spanish). In S. Castaneda (Ed.), *Evaluation and fostering of the teaching of intellectual development in science, arts, and technics. International perspective in the XXI century threshold* (pp. 265-298). Mexico: Facultad de Psicologia, UNAM.

Efklides, A. (in press). Training domain-specific abilities: The case of experiential structuralism. In J.H.M. Hamers, J.E.H. Van Luit, & B. Csapo (Eds.), *Teaching thinking skills* (pp. 105-130). Lisse, The Netherlands: Swets & Zeitlinger.

Maria Papadaki. School of Psychology, Aristotle of University of Thessaloniki, 54006, Thessaloniki, Greece, Tel: 0030-31-997374, Fax: 0030-31-997384, E-mail: efklides@psy.auth.gr.

Georgia Papantoniou. School of Psychology, Aristotle of University of Thessaloniki, 54006, Thessaloniki, Greece, Tel: 0030-31-997374, Fax: 0030-31-997384, E-mail: efklides@psy.auth.gr.

Grigoris Kiosseoglou. School of Psychology, Aristotle of University of Thessaloniki, 54006 Thessaloniki, Greece, Tel: 0030-31-997374, Fax: 0030-31-997384, E-mail: efklides@psy.auth.gr.