Research since 1976 on Affective Student Characteristics*

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In 1978, Ed Begle died in Palo Alto leaving a book unfinished that was about to become a main reader in mathematic education Until 1976, Begle had gathered any piece of information on empirical investigations in this field, prepared dozens of bibliographies and reviewed the literature. His conclusions on almost all topics of mathematics instruction were edited post mortem by his colleagues [Begle, 1979], standing as the compressed knowledge of one of the most eminent math educators of our time.

Begle's book is not only a summary, but finishes with a long list of questions, and points to lines of research worthwhile being undertaken and others probably fruitless, not adding much to our understanding of teaching and learning mathematics. Some that are discussed intensively by Begle involve "student variables". The present article deals with those student characteristics which Begle called "affective", namely anxiety, mathematics attitudes, motivation, personality, school attitudes, self-concept, and test anxiety, and their impact on mathematics learning and achievement as they are investigated in empirical studies since 1976.

Summing up the scientific knowledge in 1976 Begle concludes that the "survey of student variables provokes mixed reactions". Though quite a remarkable amount of empirical research with regard to these variables had been conducted in the preceding decade the results were by no means conclusive In particular the correlations between some affective variables and mathematics achievement ranged from "considerable" to "none", and the quality of the relationship, in particular the problem "which causes which", remained unclear.

Before taking a deeper look at each variable and the research since 1976 some more general remarks are wanted. The line of research since and probably because of Begle's book has changed in several respects.

- Several studies and projects have been conducted to develop and evaluate intervention programs with the intention to increase self-concept, attitudes and motivation or to decrease school anxiety respectively [Ammons, 1975; Bagley, 1977; Barke-Stein, 1976; Brody, 1974; Crumpton, 1978; Dumke/Heidbrink, 1980; Fontana-Durso, 1976; Friesen, 1977; Hatfield, 1977; Kulm, 1977; Marquez, 1977; Parcarella, 1977a, b; Robitaille *et al.*, 1977; Scheer, 1977; Tapp, 1978; Waller, 1976]. The starting point is not necessarily the same for all these studies; some argue for a positive change of the affective variable in question because of its causal relationship with mathematics achievement, while others follow Begle's argument, saying that "positive attitudes toward mathematics, even if they do not correlate at all with achievement, would be intrinsically desirable. Efforts to find ways to improve attitudes should be encouraged" [Begle, 1979, p. 99].
- The rationale of the studies has shifted in so far as the correlation between one affective variable and math achievement is no longer the main point of interest but the relationship between the affective variables, between these variables and modes of instruction, and, finally, between the variables and stages of the learning process [Bellamy, 1976; Birkel/Straub, 1977; Bozar, 1977; Carey, 1978; Cohen, 1977; Gilbert, 1977; Heymann, 1978; Johnson, 1977; Lissmann, 1977; Logiudice, 1970; Marjoribanks, 1976, 1977; McIntire/Drummond, 1977; Peterson, 1977; Pitiyanuwat, 1977; Simons *et al.*, 1975; Weinert *et al.*, 1975; Whitaker, 1977]
- The amount of empirical research seems to have decreased in favour of more theoretical endeavour reconceptualizing the underlying constructs in a way specific for mathematics instruction [Ames, 1976; Gauthier/Yarworth, 1980; Jopt, 1977, 1980; Loose/Unruh, 1976; Lorenz, 1979, 1980; Robinson, 1976].

The following will not summarize those studies which are "follow ups" confirming or disconfirming previous research already cited by Begle, but is restricted to what seem to be promising lines for future research. Begle's categorization of the affective variables is adopted for this purpose.

Anxiety and test anxiety

Correlational studies on anxiety and mathematics achievement seem to be infertile and questionable since research in general psychology has shown that the relationship is non-linear; it partakes rather of an inverted U-shape. Though these findings are not limited to mathematics learning but apply to all subjects and cognitive tasks they were mainly established and confirmed in mathematics A certain level of "arousal" seems to be necessary and optimal for achievement, but beyond a certain critical value the achievement drops again [Morris *et al.*, 1978; Suydam, 1975].

Begle's categorization of anxiety and test anxiety is equivalent to the state and trait-anxiety distinction Analytic research on the differential effects of these anxieties showed that trait-anxiety only indirectly influences math achievement via state-anxiety, the latter having direct impact on learning in general and the problem solving process in particular [King *et al.*, 1967; Sepie/Keeling, 1978]. State anxiety, exceeding a critical value, prevents the generation of hypotheses in problem solving tasks [Fransson, 1977; Whitaker, 1977]

Unfortunately for empirical research, the effects of anxiety on achievement may be reduced by the higher effort undertaken by highly anxious students, something that can hardly be held constant or partially out in an empirical design

Mathematics differs from other subjects as students' anxiety level is higher then elsewhere [Fennema/Sherman, 1977]. Typical differences in anxiety between the sexes favouring boys [Tobias/Weissbrod, 1980] are reported in several studies, a problem which led the NSF to support research on its causes and possible remedial strategies. These projects are still being conducted and only partially published [Fox *et al*, 1977; Fennema/Behr, 1980].

State anxiety seems to be directly related to another affective variable, namely the students' self-concept of his ability in mathematics High self-esteem of one's own task-specific ability reduces anxiety and vice versa, the (negative) correlation being quite considerable [Suydam, 1975; Lorenz, 1980]. A change towards a cognitive point of view in future research on affective variables may lead to the conclusion that self-concept is not only an indicator of anxiety but the prior construct [Lorenz, 1979].

State anxiety and motivation relate in a similar way, high anxiety reducing the motivation to undergo mathematical tasks whereas low anxiety increases the willingness to "try at least" [Culler/Holahan, 1980]. The same holds true for the anxiety-attitude relationship, high anxiety decreasing the positive attitude for mathematics [Suydam, 1975].

Some research studies considered the effects of teachers on anxiety and mathematics achievement. It is obvious and well known that teachers differ in the amount of anxiety their instructional style produces. But as is shown in these works teachers even differ in the way student anxiety affects mathematics achievement: that is, in one class the negative effect of anxiety on test results may be high whereas the influence of intelligence and creativity is low, while in another class the effects are the other way round [Heymann, 1978]. It seems it would be fertile to study the teaching behaviour leading to high/low anxiety impacts on mathematics achievement for its practical value. It might be unnecessary to let students undergo anxiety reducing programs (such as systematic desensibilization) but rather train teachers in behaviours identified by empirical evidence

The influence of anxiety on achievement seems to diminish as students progress in a content area [Simons *et al.*, 1975]. When the instructional unit is presented in a hierarchical order (which it normally is) the high influence of anxiety on learning decreases whereas the influence of intelligence, being low at the beginning, increases reciprocally [Weinert *et al*, 1975] It is not clear yet if this result obtained in elementary arithmetic is generalizable over age and mathematical content.

School attitudes and mathematics attitudes

What has been said on anxiety holds true for attitudes as well. School attitudes are too much a global construct to be directly attached or influential to any specific behaviour like mathematics achievement [Ames, 1976].

School attitudes are built up out of attitudes toward the several subjects and more or less their (weighted) average [Michaels/Forsyth, 1977]. The relationship between school attitudes and mathematics attitudes is thus not overwhelming and the correlation with mathematics achievement cannot be more than moderate [Marjoribanks, 1976, 1977; Robinson, 1976].

Mathematics attitude, as Begle mentioned, improves slightly from fourth to sixth grade and declines afterwards. The inverse linkage with anxiety towards mathematics might explain this fact and could possibly be due to sex specificities [Suydam, 1975; Aiken, 1976; Fennema/Sherman, 1977].

The causal relationship between attitudes and achievement has hardly been investigated since 1976 [Begle, 1977; Bozar, 1977; Hatfield, 1977; Pitiyanuwat, 1977; Quinn, 1978], partly due to some theoretical reconceptualizations of the underlying constructs and reorientations within the associated sciences (mainly general and cognitive psychology; see below).

Self-concept

Theoretical assumptions confirmed by a considerable amount of data show that the self-concept as a well defined construct does not exist [Torshen, 1976] but should be split into several parts each related to task-specific activities or situation-specific contexts [Bettchen *et al.*, 1976] Not only may a student assess his mathematics ability as different from his English or science ability, but he may even be better in arithmetic than in geometry [Jopt/Ermshaus, 1977] To evaluate the relationship between task- or content-specific self-concept and achievement a diversity of self-concept measures has been constructed [Bridgeman/Shipman, 1978; Oanh/Michael, 1977].

Research findings show that the mathematics self-concept is built up in an analogous way to concept formation [Lewis, 1976; McIntire/Drummond, 1977]: success and failure lead the student to tentative hypotheses about his own ability to cope with difficult tasks [Andrews, 1975; Raberger, 1976]; these hypotheses are tested in future activities and get stable over time [Calsyn/Kenny, 1977]. Several points should be mentioned:

- The student's assessment of his mathematics ability depends on the achievement of his reference group, e.g. his classmates [Ammons, 1976]. Quite different achievement outcomes in an elementary and a special school could correspond to the same self-concept as the levels calling a result success or failure are dissimilar [Herber, 1976; Rheinberg/Enstrup, 1977]. This could partly explain the relatively moderate correlations between self-concept and achievement in field studies that do not take the class as the unit of analysis [Roger *et al*, 1978].

- Data from studies in general psychology confirm the close relationship between self-concept and persistence at difficult tasks. These findings, though not astonishing at all, are important as they relate cognitive with behavioral phenomena and elucidate the mechanisms between these two. High self-esteem leads the student to invest more effort when failing at a mathematical problem because additional effort seems reasonable and promising to cope with the task. Low self-concept, on the other hand, leads to a persistence drop as success seems to be out of reach even with additional exertion. The construct that links self-concept and persistence is "effort calculation" [Culler/Holahan, 1980; Lorenz, 1979; Jopt, 1980; Henson, 1976]
- Anxiety and motivation as well as attitudes are related to self-concept, though in different ways. Attitude seems to be a mere affective correlate of the student's cognitive assessment of being successful in certain content areas [August *et al.*, 1975; Kulm, 1980]. Anxiety can be conceptualized as the fear of failing at a task, a content, or a subject implying a cognitive calculation of the perceived ability and assumed (subjective) task difficulty. If a student assesses his mathematics ability to be low his fear of failing rises [Lorenz, 1979; Birkel/Straub, 1977]

  The same applies to motivation regarded as hope for success [Eisenhard, 1977]. Anxiety and motivation both influence the student's willingness to persist at difficult tasks [Cohen, 1977]. Persistence as a behavioral construct directly relates to mathematics achievement [Jopt, 1977, 1980].

Personality

There is little research evidence on personality factors beyond Aiken's summary of 1976. Personality characteristics related to mathematics achievement, like high sense of personal worth, responsibility, high social standards, and freedom from withdrawing tendencies, should be regarded as indicators or correlates of *general* achievement motivation. There is no hint in the research literature of any of these factors being specific for mathematics, and no theoretical conceptualization leading to such an hypothesis [Dumke/Heidbrink, 1980]. This might partly explain the absence of empirical research endeavours in this topic since 1976.

There is, of course, some knowledge about those personality traits which are regarded as specific cognitive competencies, for example cognitive styles. There are close correlations between the dimensions of field-dependence/independence and mathematics achievement (highest for arithmetic and geometry) as well as between impulsivity/reflectiveness and mathematics performance favouring reflectiveness [Radatz, 1979]. But little has been added to our knowledge in this area since Begle's book [Friedrich, 1976; Lissmann, 1977].

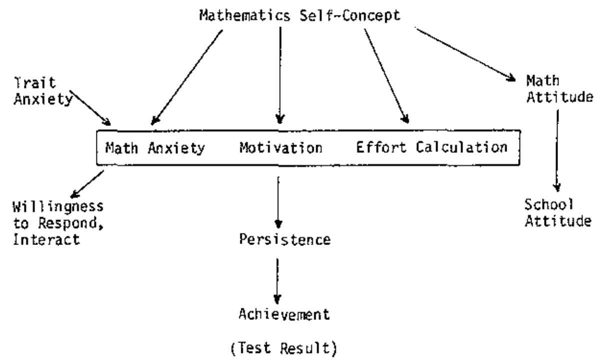


Figure 1
Process model of affective student variables

Perspective

The model outlined in the foregoing (see Figure 1) might thus establish a theoretical frame to explain the mechanisms between the affective variables discussed by Begle. A lot of crucial points still remain for future research. Studies have to be rather subtle to enlighten the differential relationships between these variables and their correspondence to mathematics achievement. A simple linear causality seems unrealistic in the light of the data and does not meet the complexity of classroom interaction and affective and cognitive student variables [Peterson, 1977]. A more systematic (=ecological) approach including teacher behaviour and content area is needed [Luce/Hoge, 1978; Lorenz, 1980]

One of the crucial points in future research will be the development of alternative research methods and techniques to illuminate the process character of mathematics learning and teaching, only partially studied in the last five years.

The need for content-specific instruments measuring the affective variables discussed in this article might show (and some research evidence already does) that these variables are not constant over time, not even from one day to the next. These findings conflict with the researcher's need for reliability and they limit the results in their external validity to specific contents, classes, and even situations. Still they may increase the practical value of fundamental research in mathematics education.

Mathematics education is not yet a scientific discipline with regard to its own methodology and instruments [Bromme *et al.*, 1980]. It still relies heavily on theoretical concepts discussed and studied in related fields. Affective student variables as described in this article are more or less arbitrary selections of factors emerging from studies in educational psychology and personal psychology. By taking over the results of related sciences one adopts their theoretical shortcomings as well. In the author's view personal psychology especially seems to be a dead end with respect to mathematics instruction, leading to well planned studies (and doctoral degrees) on the one hand but adding little to our understanding of mathematics learning Begle/Gibb [1980] criticized this kind of scientific endeavour as "making bricks" instead of "building edifices of knowledge"

Begle/Gibb's perspective of future research in mathematics education is too recent to have an impact on the studies discussed in this article. But there is some research undertaken in fields which, at this moment, seem quite far away but are nevertheless fruitful for our discipline. Problems of learning, in particular of building up cognitive structures and available memory in specific situations, are studied in cognitive psychology and artificial intelligence, converging in something like "cognitive science". Fortunately, mathematical situations and mathematics learning are the main topics in this field (because one center is at MIT in connection with Papert's Logo-Project).

Evidently, the structure of the problems to be solved calls for clinical investigation and observation, longitudinal studies with individuals, and the idiosyncratic influence of their (affective and cognitive) "variables" on the learning *process* and the foundation of meaning [for an example see Lawler, 1981] This type of research resumes the Piagetian tradition ("structure building" as research problem and clinical method), partly lost in mathematics education or converted to correlational field studies. (Ginsburg and Erlwanger are rare exceptions; that's why they seem to be the most cited authors of the last decade.)

A reorientation in mathematics education seems necessary, and Shumway's book [1980] is a good start If mathematics educators are looking beyond the borders of their discipline, the author would point in the direction of AI and cognitive science.

Bibliography

Adrian, M M , The relationship of self-concept of ability science and mathematics achievement and the operative comprehension of reading content. *DAI 39A,* 1978, 764

Aiken, L R , Update on attitudes and other affective variables in learning mathematics *Review of Educational Research 46,* 1976, 293-311

Ames, R , *An epistemological analysis of the teaching and learning of attitudes.* Paper at the AERA meeting, San Francisco, 1976

Ammons, J D , A study of the effects of nonpromotion and promotion as related to achievement and self-concept of elementary school students East Texas State University, Doct. Diss., 1975, *DAI 36 A,* 1976, 5011

Anderson, L W., *Using the Rasch Model to measure change in academic self-concept resulting from instructional and curricular innovations* Paper at the AERA meeting, San Francisco, 1976

Andrews, D L , The perception of significant others and its relationships to children's self-concept development and school achievement. Georgia State University, Doct Diss., 1975, *DAI 36 A,* 1976, 4337

Andrews, G R./Debus, R L Persistence and the causal perception of failure: Modifying cognitive attributions *Journal of Educational Psychology 70,* 1978, 154-166

August, G J./Rychlak, J F./Felker, D W., Affective assessment, self-concept, and the verbal learning styles of fifth-grade children *Journal of Educational Psychology 67,* 1975, 801-806

Bagley, S.L , A comparison study of seventh grade student achievement and attitude under two different junior high school organizational patterns. *DAI 38 A,* 1977, 1321-1322

Barke-Stein, J A , A study of self-concept in the elementary school using different methods of group counselling. Brigham Young University; *DAI 37 A,* 1976 798

Beck, M D , What are pupils' attitudes toward the school curriculum? *Elementary School Journal 78,* 1978, 9, 73-78

Begle, E G., *Critical variables in mathematics education: Findings from a survey of the empirical literature* MAA & NCTM, 1979

Begle, E.G /Gibb, E G , Why do research? In: Shumway, R J (Ed), 1980, 3-19

Bellamy, W K , The relationship between self-concept and attitude towards school, and an individualized instructional mathematics program University of Southern California, Doct Diss., 1975, *DAI 36 A,* 1976, 7145-7146

Bettchen, C /Winne, P H /Wideen, M F , *Self-concept: Generalizability of the construct and its relation to achievement.* Paper at the AERA meeting, New York, 1977

Birkel, P./Straub, G., Zur Abhängigkeit der Leistungserwartung von Klassenarbeiten von bisherigen Leistungen und den Persönlichkeitsmerkmalen Prüfungsangst, Intelligenz und Geschlecht *Zeitschrift für empirische Pädagogik 2,* 1977, 59-82

Bozar, R M , A comparative study of attitude toward school, intellectual achievement responsibility, and achievement in mathematics of fourth grade students in open and traditional classroom instructional programs in selected schools in Dekalb County, Georgia *DAI 37 A,* 1977, 4833-4834

Bridgeman, B./Shipman V C , Preschool measures of self-esteem and achievement motivation as predictors of third-grade achievement *Journal of Educational Psychology 70,* 1978, 17-28

Brody, M.B., The effect of rational-emotive affective education on anxiety, self-esteem, and frustration tolerance Temple University, Doct Diss., 1974, *DAI 35 A,* 1974, 3506

Bromme, R *et al*, Review of E G Begle's critical variables in mathematics education *Zentralblatt für Didaktik der Mathematik 12,* 1980, 16-23

Calsyn, R J./Kenny, D A , Self-concept of ability and perceived evaluation of others: Cause or effect of academic achievement? *Journal of Educational Psychology 69,* 1977, 136-145

Carey, J F O , The relationship between attitude toward school, sex, intelligence, and academic achievement *DAI 39 A,* 1977, 2824-2825

Cohen, M , Interest and its relationship to problem-solving ability among secondary mathematics students *DAI 37 A,* 1977, 4929

Cranford, H R , A study of the effects of computer-assisted instruction in mathematics on the achievement and attitude in pupils in grades five and six in a rural setting *DAI 37 A,* 1977, 5660

Crumpton, S D , A mathematical anxiety reduction project *DAI 38 A,* 1978, 5310

Culler, R.E./Holahan, C J , Test anxiety and academic performance: The effect of study-related behaviors. *Journal of Educational Psychology 72,* 1980, 16-20

Dumke, D./Heidbrink, H., Auswirkungen unterschiedlicher Förderung auf die Persönlichkeitsstruktur lernschwacher Schüler *Psychologie in Erziehung und Unterricht 27,* 1980, 1-9

Eisenhard, W B., A search for the predominant causal sequence in the interrelationship of interest in academic subjects and academic achievement. *DAI 37 A,* 1977, 4225-4226

Fennema, E./Behr, M J , Individual differences and the learning of mathematics. In: Shumway, R J (Ed), 1980, 324-355

Fennema, E /Sherman J , Sex-related differences in mathematics achievement, spatial visualization and affective factors *American Educational Research Journal 14,* 1977, 489-494

Fontana-Durso, B., The effects of behavior modification on locus of control, self-concept, reading achievement, mathematics achievement, and behavior in second grade children. St John's University, Doct Diss , 1975, *DAI 36 B,* 1976, 4197-4198

Fox, L H /Fennema, E /Sherman, J , *Woman and mathematics: Research perspectives for change* NIE Papers in Education 8 Washington, D C., 1977

Fransson, A., On qualitative differences in learning: IV – Effects of intrinsic motivation and extrinsic test anxiety on process and outcome *British Journal of Educational Psychology 47,* 1977, 244-257

Friedrich, C., Untersuchung über den Zusammenhang zwischen Schulleistung und Persönlichkeitsfaktoren. *Zeitschrift für erziehungswissenschaftliche Forschung 10,* 1976, 30-45

Friesen, V E , The relationship of affective and cognitive variables to achievement and attitude under lecture-discussion and computer-assisted instruction *DAI 37 A,* 1977, 4095

Gauthier, W J Jr./Yarworth, J.S., Conceptual and methodological considerations in self-concept and participation in school activities reanalyzed *Journal of Educational Psychology 72*, 1980, 167-169

Gilbert, C D , A study of the interrelationship of factors affecting sixth grade students in respect to mathematics. *School Science and Mathematics 77*, 1977, 489-494

Hart, K.M , Mathematics achievement and attitudes of nine and ten-year olds, effects of mathematical games and puzzles. *DAI 37 A*, 1977, 4932

Hatfield, M M , A longitudinal study comparing the effects of two instructional methods on attitudes toward and achievement in mathematics *DAI 37 A*, 1977, 4841-4842

Henson, R , Expectancy beliefs, ability, and personality in predicting academic performance. *Journal of Educational Research 70*, 1976, 41-44

Herber, H.-J , Der Einfluß der schulischen Leistungsbeurteilung auf die Lernmotivation und ihre praktischen Implikationen *Erziehung und Unterricht 126*, 1976, 86-97

Heymann, H W , *Lehr-Lern-Prozesse im Mathematikunterricht*. Stuttgart: Klett-Cotta, 1978

Hunkler, R., The relationship between a sixth-grade student's ability to predict success in solving computational and statement problems and his mathematics achievement and attitude *School Science and Mathematics 77*, 1977, 461-468

Jacob, J F , The effects of individualizing instruction by the use of multisensory multi media learning centers on reading and arithmetic achievement of inner-city children *DAI 37 A*, 1977, 5586

Johnson, G W., A study of cognitive and attitudinal interactions in seventh grade mathematics. *DAI 37 A*, 1977, 7008-7009

Jopt, U J., Anstrengung aus psychologischer Sicht *Neue Unterrichtspraxis 6*, 1977, 346-354

Jopt, U J , Leistungsmotiv und naivpsychologische Fähigkeitswahrnehmung bei Schülern. *Zeitschrift für Entwicklungspsychologie und pädagogische Psychologie 12*, 1980. 75-87

Jopt, U J /Ermshaus, W , Wie generalisiert ist das Selbstkonzept eigener Fähigkeit? Eine motivationspsychologische Untersuchung zur Aufgabenabhängigkeit der Fähigkeitswahrnehmung. *Zeitschrift für experimentelle und angewandte Psychologie 24*, 1977, 578-601

King, F J /Heinrich, D L./Stephenson, R.S /Spielberger, C D , An investigation of the causal influence of trait and state anxiety on academic achievement *Journal of Educational Psychology 68*, 1976, 589-594

Kulm, G., The effects of two summative evaluation methods on achievement and attitudes in individualized seventh-grade mathematics *School Science and Mathematics 77*, 1977, 639-647

Kulm, G., Research on mathematics attitude In: Shumway, R.J (Ed). 1980, 356-387

Latuszek, P /Borchert, J., Persönlichkeitsdimensionen von Haupt – und Sonderschülern. Ergebnisse von Selbst – bzw. Fremdbeurteilungen *Psychologie in Erziehung und Unterricht 26*, 1979, 17-28

Lawler, R W., The progressive construction of mind. *Cognitive Science 5*, 1981, 1-30

Lewis, P , *Significant others, self-concept of ability, and achievement* Paper at the AERA meeting, San Francisco. 1976

Lissman, U., Wechselwirkung von Schülermerkmalen und schulischen Leistungen. *Zeitschrift für empirische Pädagogik 1*, 1977, 28-48

Logiudice, J.F., The relationship of self-esteem, test anxiety, and sixth grade students' arithmetical problem solving efficiency under variant test instructions St. John's University, Doct Diss., 1970, *DAI 31 B*, 1970, 2995

Loose, K D./Unruh, R., An analysis of interaction of anxiety, aspiration levels and ability derived from ecological systems theory Paper at the AERA meeting, San Francisco, 1976

Lorenz, J.H., *Selbstkonzept und Attribuierungen im Mathematikunterricht* Stuttgart: Hochschul Verlag, 1979

Lorenz, J.H., Teacher-student interactions in the mathematics classroom: A review. *For the Learning of Mathematics* 1, 1980, 14-19

Luce, S R /Hoge, R D , Relations among teacher rankings, pupil-teacher interactions, and academic achievement: A test of the teacher expectancy hypotheses *American Educational Research Journal 15*, 1978, 489-500

Marjoribanks, K , School attitudes, cognitive ability and academic achievement. *Journal of Educational Psychology 68*, 1976 653-660

Marjoribanks, K., Affective and environmental correlates of cognitive performance. *Journal of Educational Research 71*, 1977, 639-647

Marquez, A A , The effect of individualized instruction on academic growth and attitudes toward school in low achieving sixth grade students. *DAI 37 A*, 1977, 7641-7642

Marx, R W , *Teacher judgements of students' achievement and attitudes*. Paper at the AERA meeting, San Francisco, 1976

McBride, C C /Rollins, J H , The effects of history of mathematics on attitudes toward mathematics of college algebra students *Journal for Research in Mathematics Education 8*, 1977, 57-61

McIntire, W./Drummond, R J., Multiple predictors of self-concept in children. *Psychology in the Schools 14*, 1977, 295-298

Michaels, L A./Forsyth, R A., Construction and validation of an instrument measuring certain attitudes toward mathematics *Educational Psychological Measurement 37*, 1977, 487-492

Morris, L.W./Kellaway, D S /Smith, D H , Mathematics anxiety rating scale: Predicting anxiety experiences and academic performance in two groups of students. *Journal of Educational Psychology 70*, 1978, 589-594

Oanh, N T /Michael, W B., The predictive validity of each of ten measures of self-concept relative to teachers' ratings of achievement in mathematics and reading of Vietnamese children and of those from five other ethnic groups *Educational and Psychological Measurement 37*, 1977, 1005-1016

Ohlson, E./LaMonte/Mein, L., The difference in level of anxiety in undergraduate mathematics and non-mathematics majors. *Journal for Research in Mathematics Education 8*, 1977, 48-56

Pascarella, E T , Interaction of motivation, mathematics preparation, and instructional method in a PSI and conventionally taught calculus course *AV Communication Review 25*, 1977, 25-41 (a)

Pascarella, E T., Student motivation as a differential predictor of course outcomes in personalized systems of instruction and conventional instructional methods *Journal of Educational Research 71*, 1977, 21-26 (b)

Peterson, P L , Interactive effects of student anxiety, achievement orientation, and teacher behavior on student achievement and attitude *Journal of Educational Psychology 69*, 1977. 779-792

Pitiyanuwat, S , Relationship among attitudes, beliefs, achievement intentions and achievement behavior in mathematics *DAI 37 A*, 1977, 681

Quinn, D.W , The causal relationship between mathematics achievement and attitude in grades 3 to 6: A cross-lagged panel analysis *DAI 39 A*, 1978. 3433

Raberger J , Die Schulleistung und ihre Beziehung zur Selbsteinschätzung des Schülers *Erziehung und Unterricht 126*, 1976, 251-259

Radatz, H., Some aspects of individual differences in mathematics instruction *Journal for Research in Mathematics Education 10*, 1979, 359-363

Rheinberg, F /Enstrup, B , Selbstkonzept der Begabung bei Normal – und Sonderschülern gleicher Intelligenz: Ein Bezugsgruppeneffekt *Zeitschrift für Entwicklungspsychologie und Pädagogische Psychologie 9*, 1977, 171-180

Rheinberg, F /Schmalt, H D./Wasser, I., Ein Lehrerunterschied, der etwas ausmacht. *Zeitschrift für Entwicklungspsychologie und pädagogische Psychologie 10*, 1978, 3-7

Robinson, M L , Attitudes and achievement: A complex relationship ERIC ED 111 678, 1976

Robitaille, D F /Sherrill, J M./Kaufman, D.M , The effect of computer utilization on the achievement and attitudes of ninth-grade mathematics students *Journal for Research in Mathematics Education 8*, 1977, 26-32

Rogers, C M /Smith, M D /Coleman, J M., Social comparison in the classroom: The relationship between academic achievement and self-concept *Journal of Educational Psychology 70*. 1978. 50-57

Rubin, R.A./Dorle, J /Sandidge, S , Self-esteem and school performance. *Psychology in the Schools 14*, 1977, 503-507

Scheer, J K , Effects of supplemental diagnostic/prescriptive teaching on mathematics achievement, attitude and self-concept. *DAI 38 A*, 1977,

Sepie, A C./Keeling, B , The relationship between types of anxiety and underachievement in mathematics *Journal of Educational Research 72*, 1978, 15-19

Shumway, R J. (Ed.), *Research in mathematics education* NCTM, Reston Virginia, 1980

Simons, H./Weinert, F E./Ahrens, H.J , Untersuchungen zur differential-psychologischen Analyse von Rechenleistungen. *Zeitschrift für Entwicklungspsychologie und pädagogische Psychologie 7,* 1975, 153-169

Stedman, M E./Breen, M J . Teacher interest and pupil attitudes *Educational and Psychological Measurement 37,* 1977, 1091-1094

Stuart, H.L , A study of factors related to the mathematics achievement of eighth-grade students in the public schools of St Tammany Parish, Louisiana, *DAI 39 A,* 1978, 2115

Suydam, M N., Research of some key non-cognitive variables in mathematics education *Schriftenreihe des IDM 4,* 1975, 105-135

Tapp, B.C., The effect of an individualized mathematics laboratory approach on the self-concept and achievement of low achievers in a Semi-Rural Junior High School *DAI 38 A,* 1978, 6512

Tobias, S./Weissbrod, C., Anxiety and mathematics: An update *Harvard Educational Review 50,* 1980, 63-70

Torshen, K P , *Self-concept. An examination of structure* Paper at the AERA meeting, San Francisco 1976

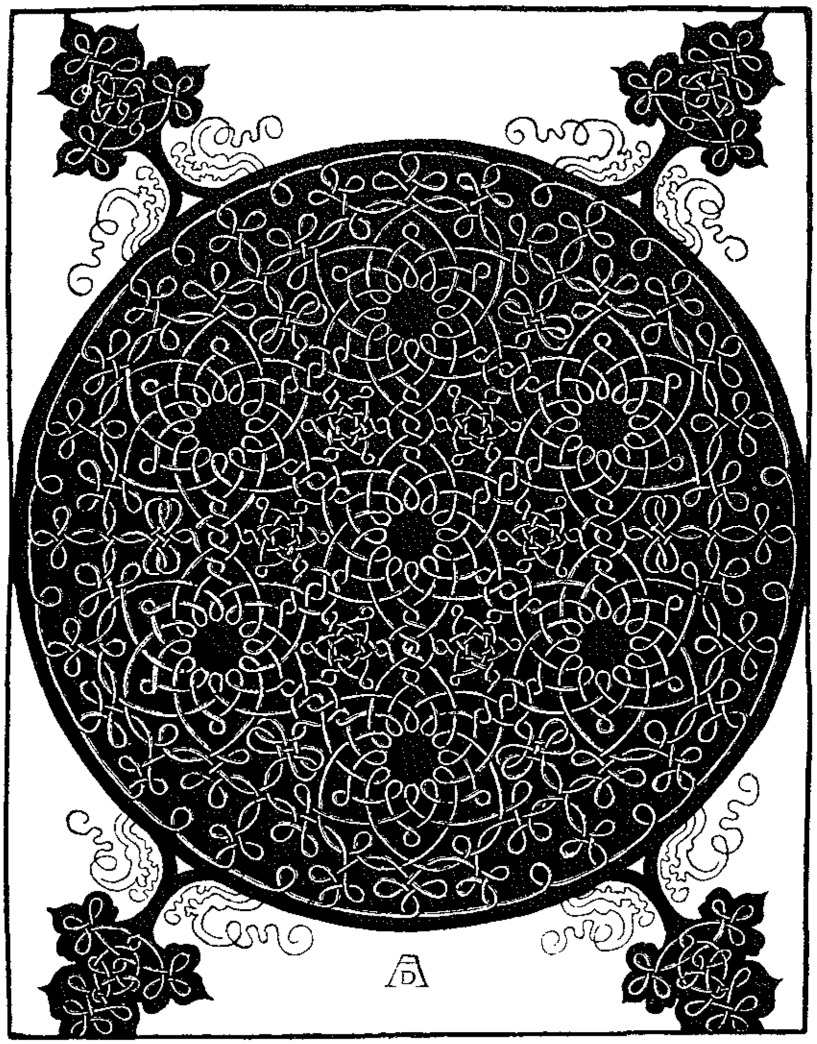
Wallen, T B., Differences in mathematics achievement anxiety, and self-esteem between individualized (plan) and traditional instructional settings. Northern Illinois University, Doct Diss , 1975, *DAI 36 A,* 1976, 6571-6572

Weinert, F.E./Simons, H./Ahrens, H J , Der direkte Einfluß kognitiver und motivationaler Bedingungen auf Schulleistungen In: W.H. Tack (Ed.): *Bericht über den 29. Kongress der deutschen Gesellschaft für Psychologie in Salzburg 1974,* Göttingen: Hogrefe 1975, 215-219

Whitaker, D R , A study of the relationships between selected non-cognitive factors and the problem solving performance of fourth grade children *DAI 37 A,* 1977, 6392

Winne, P H./Walsh, J , Self-concept and participation in school activities reanalyzed. *Journal of Educational Psychology 72,* 1980, 161-166

Wolff, L.S , The influence of two types of classroom examinations on level of learning and test anxiety in tenth year mathematics. *DAI 83 A,* 1977, 748-749



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