CHAPTER FIVE

The Relationship Between Talent and Flow in Mathematics

Mathematical ability and flow were the key variables in a study involving four cohorts of talented adolescents enrolled in an accelerated math program. On the basis of previous research, several hypotheses were tested: (1) that mathematical ability and intrinsic motivation, operationalized as the experience of flow, would be significantly related, (2) that extrinsic motivation would not be related to ability, (3) that subjective competence and ability would be related, but task enjoyment and ability would not, and (4) that there would be no relationship to gender. This chapter begins by examining the pertinent descriptive statistics regarding aptitude and motivation and then analyzes their relationship.

Mathematical Ability

Due to the nature of the selection process, each of the studies explicitly controlled for ability. Admission to the program was determined by qualifying scores, consequently very few students with Scholastic Aptitude Test scores in math (SAT-M) lower than 420 participated. Table 5.1 presents the average math scores and combined math and verbal scores for the students who participated in the program. There were no significant differences for boys and girls during any of the years.

Table 5.1 SAT-M Descriptive Statistics for Talent Search Math Students

Year	N[a]	Mean SAT-M	s.d.	Min.	Max.	Mean SAT-M+V[b]	s.d.
1992-93	55	477	45	360[c]	590	844	79
1993-94	75	487	53	360	680	864	88
1994-95	63	497	62	410	720	855	94
1995-96	73	501	68	410	720	858	100

[a] Numbers differ from enrollment due to missing scores
[b] Combined means for math and verbal scales
[c] Some students with scores below the threshold of 420 were admitted on the recommendation of a school official.

An increase in the math scores over the four years corresponds to an increase of 130 points in the scores of the highest ranking students who were enrolled. Although this may imply a trend, during the pilot study year (1991) average ability was almost 500, a sign that the distribution of ability fluctuates but does not necessarily increase year after year.

To place the math ability of these students in perspective, a comparison was made between the 1995 enrollees and those who did not enroll but who participated in the talent search conducted in DuPage County that year (n = 1,037). Since high ability was a requirement for admission, a significant difference from the talent pool was expected.

The mean for the program qualifiers that year was 501 compared to 381 for the rest of the talent search population (*t* value = 14.99, $p < .001$). The probability that one of the sixth graders who took the SAT would qualify for a class was .30, almost one chance in three. To be an average student in the program with an SAT-M score of 500 situated one at the 92nd percentile for talent search participants.

Because of this explicit selection on ability, other variables expected to correlate, such as motivation, were incidentally subjected to the same selection effects. If it happens that flow is related to ability--which seems to be the case--variance in flow may be attenuated due to the restriction on SAT scores. Therefore, to obtain a more accurate picture of the relationships between ability, motivation and performance, procedures to compensate for selection effects inherent in drawing from the top one percent of a standard normal population were incorporated in the subsequent analyses (the procedures are found in Lord & Novick, 1968, pp. 142-146).

Two out of the four years during which observations were made, there was no significant correlation between the mathematical and verbal subscales of the SAT. Only during 1992 and 1995 they were significantly correlated ($r = .384$, $p < .01$ and $r = .294$, $p < .025$, respectively). Comparatively, among the students in the 1995 county talent search population, the relationship between mathematical reasoning and verbal reasoning was significant as well ($r = .385$, $p < .001$). Yet in spite of this relationship, analyses demonstrated that the scale for mathematical reasoning explained more variance in achievement by itself than in combination with the verbal reasoning scale, therefore, verbal ability was dropped from further consideration.[1]

Mathematical Motivation

Exploratory factor analyses were performed on the flow questionnaires from each administration of Forms A, B and C.[2] The replications yielded two factors each with eigenvalues greater than 1: subjective enjoyment and competence, termed *task enjoyment* and *cognitive ease* in the present research. Except for the final year (when additional items were included to measure perceived ability), a one-factor solution was deemed the most conceptually meaningful for measuring the effects of flow. This was decided on the basis of Thurstone's (1947) principles of simple structure, as numerous variables loaded on two or more factors and there were few variables with zero or near-zero loadings.

The scale for flow that was used ranged from a possible low of -1 (all entropy) to +1 (all negentropy). As reported in Chapter 4, Cronbach alphas for this index clustered between .81 and .93, indicating that the composite was internally consistent. Table 5.2 provides the descriptive data on flow for each of the four years. The assumption that population variances for flow were equal and that scores were normally distributed were upheld.

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1. In sixteen quarters, SAT-V correlated significantly with grades only twice.

2. In all, there were 12 administrations of the flow questionnaires (not including the one used in measuring flow in the talent search pool). Initial principal-components factor analyses were followed by varimax rotation.

It may be observed that flow measured at the mid-point of the year was always lower than at the beginning. Students tended to enter with confidence and feelings of high affect--feelings that would diminish as the challenges of the program were encountered. During the first two years the scores rebounded by the end-point, in 1994-95 and 1995-96, feelings related to intrinsic enjoyment of math continued to decline. These changes indicate an effect probably due to instructional experiences. In-depth analysis of this phenomenon is set aside until chapter 7.

Table 5.2 Means, Standard Deviations, Minimum and Maximum Values for Flow[a]

Year	Mean	s.d.	Min	Max
92 Flow A	0.322	0.375	-0.531	0.938
92 Flow B	0.286	0.404	-0.909	0.909
92 Flow C	0.324	0.428	-1.000	0.938
93 Flow A	0.480	0.299	-0.844	1.000
93 Flow B	0.362	0.309	-0.326	0.864
93 Flow C	0.397	0.301	-0.938	1.000
94 Flow A	0.420	0.267	-0.361	0.861
94 Flow B	0.296	0.302	-0.432	1.000
94 Flow C	0.271	0.380	-0.688	1.000
95 Flow A	0.421	0.335	-0.702	0.921
95 Flow B	0.363	0.317	-0.451	1.000
95 Flow C	0.323	0.368	-0.809	0.924

[a] Flow A was measured before the start of instruction on week 1, Flow B was measured on week 15 and Flow C on week 30 at the end of the program.

Talent and Flow

Consistent with the pilot study, talented students demonstrated an interest and enjoyment of math as measured by the flow construct. In this respect they stand out from adolescents of lesser ability. Using data from the 1995 county-wide talent search, students who took the SAT and qualified for math classes were compared with non-qualifiers in terms of reported flow (n = 820; not all 1,037 participants were given flow questionnaires). As Table 5.3 indicates, qualifiers derived significantly more flow from mathematical activity. Two sub-indices for flow were also markedly different: qualifiers reported more enjoyment (negentropy) and less stress (entropy) prior to taking the exam. The higher the average ability of the group of students, the more prominently subject matter was enjoyed, an observation concordant with Steinkamp and Maehr (1983). Supposedly, the magnitude of the differences would be even greater in a population not selected on high ability.

Table 5.3 ANOVA Comparison of Flow Indices for Math Qualifiers and Non-qualifiers (Data source: 1995 County-wide Talent Search)

Index	Qualifiers (n=231) Mean (s.e.)	Non-qualifiers (n=589) Mean (s.e.)	F
Flow	0.410 (.022)	0.241 (.014)	41.102***
Negentropy	0.713 (.011)	0.637 (.007)	36.682***
Entropy	0.303 (.014)	0.396 (.009)	30.146***

*** p < .001

With the scale for flow that was used, a score of zero signifies a balance between enjoyment and those factors such as boredom and frustration which detract from it.[3] Recalling Table 5.2, the average math enjoyment index scores ranged between 0.271 and 0.480 for students in the talent search classes, indicating proportionately more negentropy than entropy which is comparable to the sample of qualifiers in Table 5.3 (flow = 0.410).

Due to the selection of students at the 95th percentile or higher in terms of their ability, correlations between flow and ability were adjusted to compensate for the attenuation. For example, in 1992 the standard deviation of the SAT-M for students enrolled in classes was 45, normally 100 in a standard population. To obtain a more accurate picture of what the relationship between ability and its correlates would be in a population not selected on ability, correlations were adjusted accordingly (Lord & Novick, 1968).

A rather obvious nexus between ability and flow is suggested by Table 5.3. As expected, a significant zero-order correlation was found, supporting the hypothesis that ability and flow are related. In the more divergent county talent population, SAT-M scores ranged from 220 to 750 (s.d. = 78.6). Under these less restricted circumstances the correlation between SAT-M and Flow A was .252, $p < .001$, *df* 788.[4] Adjusting the correlation to the expected standard deviation for ability, an r value of .281 was obtained.

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3. Raw scores for negentropy and entropy were each scaled to range from 0 to 1, respectively. Equally weighted, the entropy scale was then subtracted from the negentropy scale.

4. Thirty-two cases deleted due to missing or incomplete data.

Table 5.4 Zero-order Correlations between Ability and Flow

		SAT-M	SAT-M[a]
1992	Flow A	0.505***	0.656***
	Flow B	0.387**	0.529***
	Flow C	0.451***	0.600***
1993	Flow A	0.208	0.281*
	Flow B	0.100	0.137
	Flow C	0.003	0.004
1994	Flow A	0.170	0.215
	Flow B	0.293*	0.363**
	Flow C	0.266*	0.331*
1995	Flow A	0.030	0.036
	Flow B	-0.035	-0.042
	Flow C	0.109	0.132

[a] Correlations adjusted for attenuation on ability

* $p < .05$ ** $p < .01$ *** $p < .001$

When correlations between ability and flow were computed in each of the four annual groupings, the results were inclined to be positive but inconsistent (Table 5.4). The largest correlations occurred during the 1992 study (SAT-M & Flow A = 0.505, Flow B = 0.387, Flow C = 0.451, all significant at or below the .005 level). During the following year, the correlations were 0.208, 0.100, and 0.003, respectively, none significant (refer to left side of Table 5.4). Correlations were adjusted to account for attenuation in ability. Following this adjustment, correlation coefficients were somewhat more pronounced (right side of Table 5.4). Only during the first and third years did the most able students also tend to be the most intrinsically motivated. The inconsistencies may be due to sampling sizes, reasons why students decided to enroll in the program, and the fact that intrinsic interest depends on factors other than ability. The average correlation between ablity and the four Form A samples was 0.297, which is comparable to 0.281 found in the larger talent population, providing more assurance about the validity and size of the association.

Intrinsic and Extrinsic Motivation

As these figures suggest, talented students are not exclusively motivated by enjoyment. They are affected by extrinsic pressures to perform as well. Theoretically, flow is not the opposite of extrinsic motivation; its fundamental contrast is to states of boredom, anxiety and apathy. It may be possible to be motivated intrinsically and at the same time embrace extrinsic reasons for the choices one makes (Amabile, et al., 1994). One or the other orientation may tend to dominate, however.

To see if this was the case, contrasts between intrinsic and extrinsic motivation were included in the 1995 questionnaires. Prior to taking the county-wide SAT exam, students were asked to rank items pertaining to their interest in math: earning good grades, competition with other students, preparing for a career, math is interesting in itself, and math is not interesting. Depending on which item individuals ranked first, students were identified as extrinsically motivated (the first three items listed), intrinsically motivated or amotivated. The majority of students (68%, n = 536) selected one of the extrinsic items as the most important reason for their interest in math. The intrinsic item was selected first by 207 students (26%); 48 of those tested indicated they were not interested in math (6%). Of the extrinsic items, “earning good grades in math interests me” was ranked first most often (41%, n = 323).

Table 5.5 ANOVA Comparison of Average Rank and Standard Errors for the Motivational Orientations of Talent Search Qualifiers and Non-Qualifiers[a] (Data source: 1995 County-wide Talent Search[b])

Orientation	Qualifiers N = 208		Non-Qualifiers N = 541		F
	Ave. rank	*s.e.*	*Ave. rank*	*s.e.*	
Good Grades	**2.22**	(0.08)	**1.90**	(0.05)	13.192***
Intrinsic Interest	2.23	(0.09)	2.60	(0.05)	12.981***
Competition	2.76	(0.08)	3.00	(0.05)	6.686**
Career Prep	3.07	(0.10)	2.92	(0.06)	1.897
Amotivation	4.70	(0.08)	4.32	(0.05)	15.443***

[a] Qualifications based on SAT-M scores equal to or greater than 420.
[b] 71 cases deleted due to missing or incomplete data.

** $p < .01$ *** $p < .001$
Note: Highest ranked categories are listed in bold type.

Similar to the findings for flow, higher-ability students were more likely to rank intrinsic interest higher. The average SAT-M score for intrinsically oriented individuals was 405, compared to 373 for those who showed an extrinsic preference (one-way ANOVA, F = 22.702, $p < .001$). Table 5.5 shows that most orientation items were significantly different depending on students' level of ability. Students who qualified to take math classes still ranked good grades as highly motivating (2.22 on a scale from 1 to 5), but a higher proportion of non-qualifiers ranked grades number one (1.90), a difference with an F value of 13.192 ($p < .001$).[5] Moreover, qualifiers ranked intrinsic interest higher than non-qualifiers (2.23 vs. 2.60, F = 12.981, $p < .001$). A predominant

5. The lower the number the higher the ranking.

interest in earning good grades and an intrinsic interest math were equally represented among qualifiers (ratings of 2.22 and 2.23). Among non-qualifiers, intrinsic interest was ranked significantly less important than grade-oriented interest: 2.60 vs. 1.90, $t = -9.516$, $p < .001$). Amotivation was ranked last by both groups, but the significant group difference (F = 15.443, $p < .001$) indicates that qualifiers (4.70) ranked this item dead last more often than non-qualifiers (4.32).

Table 5.6 Zero-order Correlations for Motivational Orientation, Ability and Flow (Data source: 1995 County-wide Talent Search)

Orientation	SAT-M	Flow A
Good Grades	-0.175***	-0.052
Competition	0.088	0.028
Career Prep	-0.098	-0.006
Intrinsic Interest	0.181***	0.483***
Amotivation	-0.159*	-0.442***

* $p < .05$ *** $p < .001$ (Bonferroni probabilities)

It was hypothesized that extrinsic motivation and ability would not be related. However, the data indicates a negative relationship between ability and an extrinsic interest in grades. Zero-order correlations for math ability and motivational orientation in the county-wide talent population confirm that students who were interested in getting good grades tended to do less well on the math portions of the SAT (Table 5.6). Given the size of the sample, the correlation, albeit not large, was highly significant ($r = -0.175$,

$p < .001$, $df = 665$).[6] Correlations were not significant between ability and the less-highly ranked extrinsic factors. The null hypothesis between ability and extrinsic motivation was rejected in the case of the most common extrinsic choice, grade interest, but accepted for competition and career preparation. When students' abilities are lower, they seem to be more concerned about getting better grades. Perhaps those students possessing more ability were less occupied with earning good grades because they were already getting them. Consequently, they were able to turn their attention to more immediate, intrinsic reasons for being interested in math. This is not to imply that good grades were unimportant for qualifiers, after all, a slight majority of them ranked grades as their number one interest. But it does indicate to a significant extent that higher ability correlates positively with intrinsic interest in math and negatively with extrinsic interest.

Partial correlations revealed that an interest in math grades and an intrinsic interest in math were independently related to ability. Controlling for interest in grades, and using correlations adjusted for attenuation, ability and intrinsic interest were positively correlated ($\beta = 0.164$, $p < .001$); controlling for intrinsic interest, the correlation between ability and extrinsic interest in grades was negative ($\beta = -0.157$, $p < .001$). A similar independent relationship was found when this measure of intrinsic orientation was replaced by flow in the regression equation: ability was positively correlated with flow ($\beta = 0.265$, $p < .001$), but negatively correlated with a focus on grades ($\beta = -0.189$, $p < .001$), a finding that is examined in more depth in Chapter 6. As predicted by theory,

6. The unadjusted correlation was -0.156, $p < .0001$. Cases deleted due to missing or incomplete data = 153.

flow and intrinsic interest were highly correlated (*r* = .462, *p* < .001), but not correlated with any of the extrinsic orientations (Table 5.6).

Turning to those students who qualified for math classes, among those who enrolled in 1995, intrinsic and extrinsic orientations were equally represented. Forty-nine percent of Math A, B and geometry students rated intrinsic interest in math highest (n = 36); this was followed by grades (22%), competition (16%), and career aspirations (10%). As each of these three is a variant of interest external to the task, 48% of the students selected extrinsic motivation as their primary orientation (n = 35). The remaining 3% indicated no reason to be interested in math (n = 2). First year and second year students in the program did not differ in their motivational orientations; neither did boys and girls.

Qualifiers who enrolled in math classes ranked intrinsic interest the highest (1.91 on a scale from 1 to 5), followed closely by an interest in earning good grades (2.07). For eligible students who did not enroll, this order was reversed (Table 5.7). Qualifiers who enrolled in classes ranked intrinsic reasons for math interest higher than qualifiers who did not enroll (nearly a significant difference: F = 3.729, *p* = .055). Since there could be many reasons why qualifiers did not enroll (bad night of the week, distance, expense, comparable classes at school, etc.), it is remarkable that a difference in terms of interest came even this close to having statistical significance.

Table 5.7 ANOVA Comparison of Motivational Orientations for Talent Search Qualifiers Who Enrolled in Math Classes and Those Who Did Not

Orientation	Enrolled		Not Enrolled		F
	N = 44		N = 165		
	Ave. rank	*s.e.*	*Ave. rank*	*s.e.*	
Intrinsic Interest	**1.91**	(0.19)	2.31	(0.09)	3.729

Good Grades	2.07	(0.17)	**2.25**	(0.09)	0.869
Competition	2.67	(0.18)	2.79	(0.09)	0.359
Career Prep	3.17	(0.27)	3.06	(0.14)	0.122
Amotivation	4.91	(0.13)	4.64	(0.07)	3.195

Note: Highest ranked categories are listed in bold type.

To describe better the differences that correspond to intrinsic/extrinsic orientations, a nominal variable, "orientation," was created to distinguish types of motivation. Using one-way analysis of variance, the two groups were compared to determine whether they were equal in terms of flow, math ability, and several other indicators of enjoyment and motivation. The two students who comprised the amotivated group were excluded from this phase of the analysis.

Table 5.8 summarizes a number of the significant differences that were found in terms of orientation. Intrinsically oriented students reported almost twice as much flow as students who were extrinsically motivated (.601 compared to .307)--the same result was found among the students who participated in the 1995 talent search screening, cf. Table 5.6. As the year progressed, however, students' experiences of flow corresponded less and less with their initial orientation (a phenomenon examined in Chapter 7).

Table 5.8 ANOVA Comparisons of Motivational Orientation on Flow, Ability and Achievement (Data Source: 1995 Talent Search Classes)

Dependent Variable	Intrinsic Orientation (n=36)	Extrinsic Orientation (n = 35)	F

Flow A	0.601[a]	0.307	20.479***
Flow B	0.478	0.272	7.378**
Flow C	0.384	0.246	1.874
Subject Matter Preference	1.611	0.687	18.546***
SAT-M	520	488	3.535
GPA	3.27	2.85	5.539*

[a] Figures in these columns are least squares means
* $p < .05$ ** $p < .01$ *** $p < .001$

One of the more striking contrasts between the two groups was their preferred views of mathematics. Those who were intrinsically motivated tended to view math as a *favorite* subject, whereas those in the extrinsic group saw it as an *important* subject. In its connection with interest, importance seems to be derived from the long-term utility of math as a means to prepare for a career, as a pursuit pleasing to others, as a way to earn recognition, etc., and not as an end itself, that is, the immediate enjoyment of doing math. This distinction helps to illustrate differences in task reward bias described by Reumann (1986): extrinsically motivated students found long-term goals more rewarding. Intrinsically motivated students found short-term goals such as enjoyment more rewarding. There was no difference in terms of ability, although the average SAT-M score of the intrinsic group was over 30 points higher.[7] The performance difference, however, was significant (F = 5.539, $p < .025$), confirming the expectation that grade point averages (GPAs) depend to some extent on intrinsic motivation, an effect examined in greater detail in Chapter 6.

7. Cf. Table 5.4.

Task Enjoyment and Cognitive Ease

Using data from the 1995 county-wide talent search, factor analysis clearly identified two factors which satisfied the criteria for simple structure. The first of these, task enjoyment, was comprised of 11 conceptually related items: several variables pertaining to enjoyment of math, happiness, wanting to do math rather than having to do it, wishing to be doing nothing else other than math (if given a choice), and being unaware of distractions or boredom. Six items loaded on cognitive ease: feelings of control and confidence that work would turn out well, a sense that challenging work was easy to do, being unaware of frustration, stress, or having to struggle to do well in math. In terms of other motivational research, this factor shares much in common with perceived competence. For students enrolled in the 1995 math classes, partial correlations showed cognitive ease to be related to their subjective ratings of ability (r = 0.484, $p < .001$), whereas task enjoyment was not (r = 0.066, *n.s.*). Even though factorially distinct, enjoyment and ease were found to be significantly correlated: $r = .557$, $p < .001$.

On the basis of earlier research (e.g., Schiefele & Csikszentmihalyi, 1995; Valås & Søvik, 1993), it was hypothesized that cognitive ease and ability would be related, but not ability and task enjoyment. Regression analysis showed this not to be the case. Table 5.9 summarizes the results. Both factors derived from flow ‘predicted’ ability independently; in fact, task enjoyment was slightly the better predictor. While a causal relationship cannot be determined from these findings, they do support the hypothesized connection between ability and the experience of cognitive ease in doing math. The findings do not support the hypothesis that intrinsic task enjoyment and ability are unrelated, however. Just as flow was found to be related to ability, both of these factors derived from it are related to mathematical talent.

Table 5.9 Regression Results for Task Enjoyment and Cognitive Ease on Mathematical Ability (Data source: 1995 County-wide Talent Search)

Independent Variable	*r*	Standard Coefficient (β)	*t*
Task Enjoyment	0.264[a]	0.180	4.25***
Cognitive Ease	0.251	0.151	3.56***

[a] Regression based on correlations adjusted for attenuation in SAT-M
*** $p < .001$ $R^2 = .09$

Gender and Flow

For students enrolled in the talent search classes, only once did girls in the talent search program report more entropy in math than boys. This occurred at the beginning of the 1993 term (F = 4.259, $p < .05$). But the effect was not long-lasting: by the time flow was measured at mid-year and again at the end, there were no longer any gender differences. Unlike similar studies of talented students (e.g. Schiefele & Csikszentmihalyi, 1994), analysis of variance provided no evidence that boys in these classes showed a stronger interest in mathematics than girls. But this may be a result of studying a population restricted in terms of its ability.

Table 5.10 ANOVA Comparisons of Gender on Flow, Motivational Orientation and Ability (Data source: 1995 County-wide Talent Search)

Dependent Variable	Boys (n=456)	Girls (n = 352)	F
Flow	0.322	0.244	9.945**
Negentropy	0.671	0.642	6.245*
Entropy	0.349	0.396	9.207**
Intrinsic Interest	2.47[a]	2.54	0.661
Extrinsic Interest	2.03	1.95[a]	1.207
SAT-M	391	367	18.346***

[a] The lower the number the stronger the preference
* $p < .05$ ** $p < .01$ *** $p < .001$

In the county-wide talent population boys enjoyed significantly more flow than girls: 0.322 compared to 0.244, F = 9.945, $p < .01$ (Table 5.10). Girls encountered more entropy and less pleasure in doing math. In terms of intrinsic versus extrinsic motivations, however, the differences were only slight. On this basis, talented boys and girls differed more in regard to intrinsic differences associated with flow, not in regard to their intrinsic versus extrinsic motivational orientation.

Looking more closely at the differences in flow in terms of gender (Table 5.11), two-way analysis of variance indicates that girls experienced the same task enjoyment as boys (F = 0.001, *n.s.*) but significantly less of the cognitive ease factor (F = 9.100, $p < .01$). This is not due to the fact that proportionately more boys demonstrated more aptitude. Even in groups selected on comparable levels of ability, girls felt less confident about their abilities than boys. Similar findings have been reported in Benbow (1988), Eccles, (1985), and Fox, et al. (1985).

Table 5.11 Summary of ANOVA Comparisons of Gender and Ability on Cognitive Ease and Task Enjoyment (Data source: 1995 County-wide Talent Search)

	F-values	
Effect	Cognitive Ease	Task Enjoyment
Gender	9.100**	0.001
Ability[a]	17.604***	24.704***
Gender x Ability	0.339	0.184

[a] Two groups: Math qualifiers vs. non-qualifers
** $p < .01$ *** $p < .001$

Discussion

While the connection between ability in math and intrinsic motivation has been demonstrated before (e.g., Gottfried, 1985), this is the first empirical study to show a relationship between mathematical ability and flow. In theory, such a relationship was thought to exist but was never tested explicitly (Csikszentmihalyi, personal correspondence, March 12, 1997). The most convincing support for this claim comes from students tested in the 1995 county-wide talent search. This group possessed enough diversity in its talent to illumine differences in the experience of flow even without adjusting correlations for attenuation in ability. Moreover, among the math qualifiers who met at the college--the top 8% of the top 5% of district youth in terms of their talent-

-two out of the four cohorts evidenced that a significant relationship exists between talent and flow, attenuation notwithstanding.

Another theoretical assumption for which this study provides support is that flow and intrinsic motivation are related orthogonally. Again using the 1995 talent search sample as evidence, flow correlated with intrinsic motivation but not with extrinsic motivation.[8] This finding helps to substantiate the claim made earlier in this dissertation that flow is a special case of intrinsic motivation, that its opposite is entropy, not extrinsic goals such as earning good grades which persons find rewarding. Although the experience of flow may be more favorable in the case of persons who find doing math rewarding for reasons intrinsic to math such as discovery, this does not exclude persons whose interest in math is extrinsic from experiencing flow. Supposedly, if the conditions are right (goals, feedback, and a balance between challenges and skills), flow may occur no matter how extrinsically persuaded an individual may be. It may prove to be that these serendipitous episodes of flow help individuals eventually to shift from an extrinsic to an intrinsic orientation.

It was also found that ease in doing math helps to explain perceived competence and that both are related to demonstrated ability. Partly because a relationship between flow and ability was never shown before, it was hypothesized that ability and task enjoyment would not be related. This hypothesis was not supported; enjoyment was significantly related to talent, which, of course, accords with the correlation between flow and talent. Just as it makes sense to expect more able students to experience more ease in doing math, it should be acknowledged that with greater ability comes greater subjective enjoyment. If they lack adequate skills, it is unrealistic to expect students to enjoy math for intrinsic reasons. In that case, extrinsic motivations may play the more important role. The challenge for educators, discussed in the final chapter, is how to recognize when and how to shift from an emphasis on extrinsic rewards to more intrinsic ones.

Since enjoyment and ability are related--just as perceptions of ease in doing math and ability are--the question remains, “when controlling for ability, how much of future achievement can be attributed to motivation?” Opinions on this vary widely, from Krutetskii (1976) who claimed that motivation makes up for lesser ability, to Gottfried (1985) whose study suggested that intrinsic motivation depends on ability. The present findings would indicate that ability is the determining factor in regard to motivation. Whether intrinsic motivation operates independently in predicting achievement and talent development or whether it is just a function of ability is examined in the next chapter.

Finally, in groups of varying ability it is probable that boys will experience more flow than girls--unless the girls happen to have the greater skills. The present study found that girls who qualified for math classes reported significantly more enjoyment and ease than boys who did not qualify. Even though flow experiences seem to be determined primarily by ability, gender definitely played a role in regard to perceptions of competence. Controlling for level of ability, girls felt less in control of their work and less confident that their work would turn out well.

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8. Extrinsic motivation is usually conceptualized and shown empirically (as it was here) to be diametrically opposed to intrinsic motivation

Is it plausible that the difference in perceived competence, which does not depend on ability, is due to some inherent motivational response unique to boys or girls? Some support for this comes from Ekstrom's (1994) analysis of gender in high school mathematics. Her findings suggest that boys in particular are attracted to math for its utility, in other words, extrinsic rewards. Mickelson (1989) described a rival hypothesis: that girls are more motivated by social approval and extrinsic rewards, boys by a desire for mastery and intrinsic rewards. The present findings support neither possibility. Boys and girls exhibited the same orientations to math: those who qualified for classes tended to focus on intrinsic rewards, non-qualifiers on extrinsic factors such as grades. More likely, gender motivational differences are due to enculturation and educational treatment, for instance, the extent to which teachers support students' feelings of self-determination (Valås & Søvik, 1993), different expectations that teachers have regarding boys and girls and math (Ekstrom, 1994), or the types of opportunities that are made available to boys versus girls (Mickelson, 1989; Torrance, 1965).