CHAPTER EIGHT

Implications of Task Enjoyment in Math

By now the reader should be aware that the two most prominent findings in this dissertation are (1) students who experience the task enjoyment of flow perform better in mathematics and (2) students who are involved in more complex classrooms retain this flow. Before generalizing that more complex experiences on a regular basis in school will foster improved motivation and higher achievement, a task that remains is to arrive at a sound interpretation of the findings. In this final chapter, several of the more salient implications are examined along with the contributions this research makes in terms of motivational theory and educational practice, and questions that have not been answered.

As expected, achievement was found to be positively related to intrinsic motivation as measured by the construct of flow. Other investigators have noted similar results before (e.g., Csikszentmihalyi, Rathunde, & Whalen, 1993; Schiefele & Csikszentmihalyi, 1994, 1995), but the present investigation and its replications are unique in two respects: the subjects were talented seventh and eighth graders, as opposed to talented high schoolers, and a distinction was made between cognitively-oriented and affectively-oriented attributions.

Talent and Flow in Adolescence

In terms of flow-related research, this study makes a contribution by focusing on the experience of younger adolescents. Previously, the most relevant data pertained to talented students in grades nine through twelve. Sufficient evidence has accumulated, however, including data from the present study, to conclude that by the time youth reach high school, their motivation for school work may be significantly less intrinsically oriented than it once was (e.g., Eccles & Midgely, 1989). The middle school years have been shown to be critical in this regard. For this reason, it is imperative to develop a more comprehensive picture of learning and motivation during the period of intrinsic motivation's greatest decline.

Admittedly, the findings may be limited because the subjects possessed remarkable talent for their age. The effect of ability in math on their experience cannot be underestimated. First, talent and flow were found to be significantly related. This was always assumed, but until now it remained empirically elusive. When a wide enough spectrum of mathematical ability is examined, there can be no mistake that less precocious students experience flow less often. The chances of having a flow experience in math increase with ability, which is stated by theory: "When challenges and skills are relatively high and well matched..." (Csikszentmihalyi, 1993, page 181).

During the four years of Study I, about 10% of the fast-paced math students experienced as much or more entropy than negentropy, an indication that this minority did not experienced much flow in math. In the 1995 county-wide SAT screening, 25 of the 261 students who earned qualifying scores, again almost 10%, reported as much or more entropy as negentropy. A larger percentage (19%) of the 730 non-qualifiers that same year claimed not to have more negentropy than entropy. This suggests that as many as 90% of the math qualifiers and 81% of the non-qualifiers may have experienced flow to some extent while engaged in math, presumably still a higher frequency than one would find in a normal population; however, no comparative data are available.

Because of restricted variance in the fast-paced programs, the relationship between flow and ability was at times hard to detect. Only during two of the four years studied were the most talented students also the most likely to experience flow. This seems to indicate that flow depends on *sufficient* not necessarily maximum ability; all the students seem to have possessed enough talent to experience flow.

An analysis of the 1995 county-wide SAT data found that the greatest difference between students in terms of flow occurred when SAT-M 420 (not recentered) was treated as a threshold. Below this threshold students reported 34% more entropy than students whose scores were higher (F = 25.599, $p < .0001$), and correspondingly less negentropy. It must be stressed that no absolute number is known at which, once it is reached, flow starts to happen. There is still a good chance that individuals below SAT-M 420 still experience flow, but conditions are more favorable when ability is higher.

In terms of their motivational orientation, more able students were likely to be interested in math for intrinsic rather than extrinsic reasons such as earning good grades, competition, or preparing for a career. Because these differences were statistically significant among students selected on high ability to begin with, in a normal population of youth differences due to ability might even be more manifest.

Ability does not account for all the variance in flow, only 12% on the average in the four years of Study I.[1] Subjective matter preferences, personal history and personality

[1] Based on correlations adjusted for attenuation in ability.

factors may help to explain further why students fail to find much enjoyment in a subject for which they have adequate capabilities. These possibilities remain to be researched.

Changes in Flow

Like most students their age, participants in the fast-paced math program tended to experience less intrinsic enjoyment as the school year progressed. Perceptions of flow generally declined the same way that attitudes and satisfaction with school and academic subjects do as students enter middle school (e.g., Yamamoto, Thomas, & Karns, 1969). Students in grades six through eight increasingly adopt an extrinsic "have to" attitude

Table 8.1 Comparisons of Flow at Weeks 1 and 30 (paired samples t tests)

A. Above Average Flow A Groups

Year	(n)	Flow A	Flow C	*t*
1992-93	(27)	0.625	0.583	0.731
1993-94	(41)	0.687	0.514	4.216***
1994-95	(37)	0.595	0.378	3.954***
1995-96	(39)	0.667	0.402	4.823***

*** $p < .001$

B. Below Average Flow A Groups

Year	(n)	Flow A	Flow C	*t*
1992-93	(25)	-0.016	0.105	-1.301
1993-94	(32)	0.255	0.257	-0.038
1994-95	(26)	0.191	0.109	1.166
1995-96	(24)	0.132	0.209	-1.002

toward school (Eccles, Wigfield, Reuman & Mac Iver, 1987). A similar situation occurs among talented students in terms of the flow they experience.

The greatest losses in the subjective pleasures of math were experienced by individuals who reported the most flow initially. Except for 1992-93, the decrement after being in the program 30 weeks was significant (Table 8.1). Unexpectedly, students who reported less than average levels of flow at the beginning of the year tended to post slight gains in flow by the end of the year (none were statistically significant).

Two observations may be made in this regard. Those who experienced the most intrinsic enjoyment stood to lose the most. In 1992 for example, students experiencing less than average amounts of flow reported more entropy than negentropy at week 1. Theoretically, they had no flow to lose.

The slight gains in enjoyment that were made in three of the four years among these students may be due to a number of factors, but based on the data that is available a determination cannot be made. It is possible that the experience of joining a group of talented peers to study math on a more challenging level may have resulted in more subjective enjoyment, which some students mentioned when interviewed. Specifically, they seemed to appreciate the faster pace of instruction and the chance to explore more difficult subjects, made possible by not investing much time rehashing materials already mastered. Those whose flow declined may also have appreciated this, but other factors may have come into play that produced a net loss. What these overshadowing factors might be is difficult to tell; the only available insights come from Study III, the effect of classroom complexity, discussed below.

One might think that ability would contribute to the amount of flow that was retained, since greater skills ought to help prevent frustration. Students with above average talent in the program (relative to others enrolled) tended not to retain their enjoyment any better.

Complexity of Instruction and Changes in Flow

From observational data gathered during 1993-94, significant instructional differences were found which help to explain changes in flow. In this context, classroom complexity was shown to be an effective guide for identifying instructional practices that affect student motivation. As discussed in Chapter 7, several complex structures combined to bring about profound differences in students' experiences of flow: formats which allowed for greater self-determination and interaction between students, and types of problems that required the use of higher cognitive processes. Students who reported loss of flow tended to belong to classes that did not provide as consistent an exposure to more complex task structures. Students who reported gains or marginal losses tended to be involved with these types of tasks more often.

Whereas none of these more complex features of classroom experience may be solely responsible for a significant impact on intrinsic enjoyment, the additive effects were quite impressive. Recitation, for instance, tended to lessen students' interest because it was associated with lower-level cognitive demands, sets of problems selected by the teacher and review of material. It did not facilitate interaction between students, and perhaps more importantly, it left less time for complex activities such as discussion, individual seatwork and student presentation in which harder problems, student choice and interaction were prominent. In light of these findings, teachers may be advised that the most economical delivery systems to present material (lecture, demonstration) and to check on comprehension (recitations) also undermine intrinsic motivation by restricting students' self-determination and control.

The intent of the present research was to test the viability of a model of classroom complexity. Having obtained conceptually meaningful results, additional research is encouraged not only in the context of gifted education but regular math classes as well. Whether or not greater complexity supports intrinsic interest among students of less ability or whose predominant motivation is grades or other extrinsic means cannot be determined from the data. Moreover, intrinsic versus extrinsic orientation was not measured at the time of the observations. Nor were gender differences interpretable because only a few girls belonged to each class. Therefore, a valuable supplemental study would address both gifted and regular middle school math classrooms, incorporating students' motivational orientations along with experiences of flow in light of the complexity of classroom structures, tasks, and gender.

Talent, Flow, and Achievement

It was hypothesized that the best predictor of achievement would be demonstrated ability in math. But when controlling for flow, ability measured by SAT math reasoning scores was not clearly superior. In fact, it could be argued that flow was better, predicting grade point averages three out of four years when controlling for ability. When controlling for flow, ability was found to predict GPA two years out of the four.

Although flow was the more consistent independent variable, ability accounted for a greater proportion of the variance in performance when it happened to predict it. The hypothesis that achievement would be predicted independently by math ability and flow was supported. Each factor explained 11% of the variance in grade point averages. Obviously, a lot of variance is not accounted for, possibly teacher effects, subjectivity in grading, and so on. These are concerns to be controlled in any follow-up investigations. None of the variables measured during the 1993-94 classroom observations contributed to a better explanation of the grades that were earned. As it is, regardless of other effects, both flow and ability helped significantly to explain variation in achievement.

It should be noted that the math reasoning scale of the SAT *used separately from the verbal scale* accounted for more variance than flow. When math and verbal scores were combined, as they sometimes are in programs to identify qualifiers, flow was clearly the better predictor of achievement. This finding questions the advisability of using both sets of SAT scores as a basis for selecting students for fast-paced classroom math instruction.

Relevant to the discussion introduced in the opening chapter on how to encourage students to do better, to work harder, is the finding that the combination of flow and math ability promotes higher achievement in math. Individuals whose motivation was extrinsic earned lower grades on the average than those who were motivated by the enjoyment of math.

On this basis, it may be allowed that doing better in math is not merely a question of working harder, but of enjoying the work. At the same time, it must be kept in mind that enjoyment as defined by flow involves more than experiencing a good time: it is serious task involvement in which challenging work seems surprisingly easy to accomplish. The enjoyment of flow is related to this perception of ease, the ability to concentrate deeply without apparent effort, to forget about one's self for a while, to realize suddenly that hours have passed in what seems like only minutes. Consequently, for its own sake flow encourages people to engage in even more challenging work the next time (Massimini & Carli, 1988).

The results obtained in Chapter 6 suggest that when intrinsic motivation declines, achievement depends mostly on tested ability. It could be argued that a significant loss of intrinsic motivation might not drastically affect the accomplishments of talented individuals. Unless they stopped trying altogether, they could probably pass the course on the basis of ability alone. But if they were to remain intrinsically motivated, it was demonstrated that the resulting achievements could be higher, by as much as a letter grade.[2]

The Relationship between Cognitive and Affective Factors in Flow

The case for making learning experiences enjoyable is further supported by the finding that students feel better about their abilities when involved in enjoyable tasks. The data suggests this may be especially true for girls. Too numerous to list are the studies that posit self-efficacy or perceived competence as the heartbeat of achievement motivation (Aiken, 1970; Atkinson, 1957; Bandura, 1977; etc.). From the present study it appears this cognitive domain is moderated by affective experiences *but not the other way*

[2] Cf., Table 6.4.

around. Theoretically, this suggests that task enjoyment is the more primal impulse; in a manner of speaking, it primes the pump. While an explanation for this phenomenon already exists in the construct of flow and was examined in Chapter 6, it is a dynamic that invites further study and replication.

As Study III suggests, task complexity affects flow. Looking more closely at two factors of flow, cognitive ease and task enjoyment, complexity was found to be related significantly with changes in enjoyment but not cognitive ease. Students exposed to more complex structures experienced more enjoyment as the year progressed (r = 0.286, $p < .05$, df = 47). On the other hand, the correlation between complexity and cognitive ease was not significant (r = -0.024, *n.s.*), indicative that more complex, interactive formats, higher cognitive challenges and more novel problems had little effect on the ease with which tasks were perceived. That is, for talented students more complex tasks did not make math seem harder, but it did make the experience more enjoyable. Not only did complex task experiences facilitate higher levels of flow and better liking of learning activities, but to a lesser extent, students liked their teachers more and performed better academically (cf. Table 7.6).

Motivation and the Goals of Education

Synthesizing Studies II and III, complex learning experiences helped talented students to realize more intrinsic enjoyment in math, and even though they were talented enough to excel in the subject matter, their accomplishments depended significantly on flow. The performance differences were even more vivid when comparing students' reasons for pursuing math. Students whose interest in math was intrinsic to the subject accomplished work that earned them A's as opposed to the B's earned by extrinsically motivated students. By implication, talented individuals who were motivated extrinsically may not have performed up to their potential, since comparably gifted youth achieved more when they were motivated intrinsically, evidenced by the experience of flow.

If better work in mathematics is done by students who enjoy what they are doing, educational goals that fail to address motivation are incomplete. Others have made this claim before (Schiefele & Csikszentmihalyi, 1995; Winne & Marx, 1989), but as evidence continues to accumulate in its favor, the quality of students' affective experience is bound increasingly to be treated as a desired outcome of instruction. Without enjoyment, students do not progress as fast and as far (Csikszentmihalyi, et al., 1993), nor do the most able students perform as well.

Whether it was intended or not, an example of the progress in trying to incorporate intrinsic motivation in education may be seen in the language and the recommendations of the National Council of Teachers of Mathematics' (NCTM) curriculum standards for grades 5 to 8. In addition to the goal that students become mathematically literate, the standards affirm that "Mathematics...can be appreciated and enjoyed by all students" (1996, page 1). Although this brief statement merely alludes to intrinsic motivation, more importantly, the standards support this affirmation by instructional means that, as the present study has demonstrated, students can find subjectively rewarding.

The recommendations resemble the present findings in a number of ways. In terms of self-determination, students should be given opportunities to become active learners, engaged more fully in the process of learning. They should not have to rely on outside authorities such as a teacher or an answer key, but do their own reasoning. Teachers are encouraged to let students formulate their own problems and to raise questions stemming from personal interest. In terms of perceived competence, students are encouraged to become more confident in their ability to use mathematics and to make sense of new problem situations in their world. Consequently, teachers are urged to utilize more problems that integrate mathematical topics rather than to teach them in isolation. More complex means of communicating mathematical ideas are encouraged through discussion, writing, reading and listening rather than doing comparatively simple fill-in-the blank worksheets and answering questions that require only a yes, no, or number response, typical in recitation. In place of routine, one-step practice exercises, more complex, integrative open-ended problems and extended problem-solving projects are encouraged. Furthermore, students are to be challenged to build on their prior knowledge and experience, applying these in new and increasingly difficult situations.

As this dissertation found, these recommended practices can be beneficial in terms of flow. The activities that are suggested help to make learners more autonomous and self-confident, two pillars of self-motivation. More integrative activities also serve to raise the cognitive complexity of the work and involve students in more interactive instructional formats with more complex problems.

When the NCTM standards speak of the general goal that students learn to value mathematics,[3] it attempts to establish that value in extrinsic cultural, historical, and scientific contexts. On a more personal level, mathematics should also be known as an inherently enjoyable activity. The primary meaning or value of mathematics does not have to depend on what others have done with it or what it has done for others. The intrinsic value is that doing mathematics, in particular, having mathematical insights, is inherently pleasurable. Doing math can result in negentropy, which has its own personal, affective meaning. In practical terms, the type of instruction recommended by the NCTM standards would remain essentially the same. But in using more complex approaches, it should be assumed that math can be enjoyed for its own sake, not just its utility. The challenge for educators is to help their students find in math, according to the poet Sylvia Plath, "work-for-itself-as-its-own-reward" (Hughes & McCullough, 1982, p. 305).

Putting Classroom Complexity into Practice

Making the assumption that students can enjoy work for its own sake may help to insure that complex tasks are not unwittingly compromised by factors which undermine intrinsic motivation. Of these factors, unquestionably the hardest to avoid is the use of extrinsic rewards. As suggested by Study I, less talented individuals are more likely to be extrinsically motivated and experience less flow. Unless students become proficient in math to the point of not becoming frustrated with what might be considered above

[3] The five general goals articulated by the K - 12 standards for all students are: 1) that they learn to value mathematics, (2) that they become confident in the ability to do mathematics, (3) that they become mathematical problem solvers, (4) that they learn to communicate mathematically, and (5) that they learn to reason mathematically (National Council of Teachers of Mathematics, 1989).

average challenges, they probably will not find it highly enjoyable for intrinsic reasons. In that case extrinsic rewards will be required to attract one's attention to the point of attempting the activity. Albeit a minority, in this light some of the talented students were quite dependent on extrinsic rewards.

After all that has been said, it is hard not to imply that extrinsic means to motivate are less desirable. Truthfully, unless one is dealing with an exceptional group in which nine out of ten students have experienced flow in math, as was the case in the present research, extrinsic motivation is probably a necessity. In fact, it is probably unavoidable: even in this program grades had to be given to inform schools of students' progress. Without an interest in objects extrinsic to mathematical tasks, most students of average ability would not work at all and then achievement would really lag. Not to resort to extrinsic incentives to focus attention on a topic that students do not yet find interesting, or at least to regain order, even among motivated individuals, would be difficult indeed.

Therefore, if extrinsic rewards cannot be avoided, at least they should be used judiciously. Spaulding (1992) makes several good points about minimizing their negative impact on intrinsic motivation. When there is no intrinsic motivation to undermine, not only are extrinsic incentives necessary, they do little harm. In cases where students are self-determined and perceive themselves as competent, the way that extrinsic rewards are used can minimize undesirable effects. Like Deci & Ryan (1985), she recommends that an emphasis be given to the informative, not the controlling, nature of the reward. Grades, for instance, could be accompanied by descriptions about the quality of a student's work. Rather than making the only feedback the grade, the comments can direct a student to identify places where mistakes were made in order to avoid them next time. In order to facilitate flow, the more immediate the feedback, the better. Another way to de-emphasize the controlling nature of rewards may be to give students opportunities for choices as an outcome of on-task behavior. These strategies could be used with average and talented students alike, to foster more autonomy and competence.

When students make mathematical discoveries, extrinsic rewards are superfluous and probably ought to be avoided. Epiphanies of insight, feelings of control, the merging of action and awareness, the loss of self-consciousness, are potentially rewarding enough. For the talented students surveyed, oftentimes these discoveries came when they were working problems on their own, when no one else was around to reward them. In class, the discoveries were affirmed by being able to demonstrate a solution successfully. Because the work spoke for itself, all the teacher had to say was “nicely done!”

Another way that complex tasks may be compromised is through ambiguity. Students will be unable to attend to the task if they have to figure it out first. As studies of flow have shown repeatedly (Csikszentmihalyi, 1990), flow depends on clear goals. Individuals know what they must do. In introducing the use of more complex problems and formats, teachers should attend carefully to their directions; students must understand what to do.

Furthermore, challenges must be balanced with students’ abilities. When moderately novel problems were used in Study III, students retained their flow. When problems that were too difficult were used, entropy (frustration) increased. The capability of the students ultimately determined the effectiveness or extent of the complexity. A difficulty in generalizing the present findings to a normal population is that the outcomes depend to a large extent upon students who are highly proficient, who can assert themselves productively in a complex classroom. For this reason, research in the task structures of regular classrooms and the motivation of average students is needed.

In attempting to put greater complexity into practice even in gifted education, a number of obstacles are bound to be encountered. More time may be required than is presently allowed to do mathematics well, that is, to foster determined students. Because talent search classes met only once per week, sessions were relatively long, providing more time for discovery-type problems and extended student interaction.[4] Formats were utilized that would not be possible to such an extent in a regular 50-minute period. A typical discovery problem that was used here would require half the time available in most classes. Although complex problems tended to incorporate and synthesize a good deal of mathematical content coverage, to spend the majority of one class session on a single problem might not seem to most teachers an efficient or practical use of time.

In terms of classes held during the school day, more time may be required if similar approaches are to be adopted. Consideration may be given to longer periods of time, e.g., block scheduling, to allow for more interactive formats, student control and genuine problems. If this is not possible, there are probably housekeeping and non-mathematical tasks that may be eliminated or accomplished in less time.

[4] While two-and-one-half hours once a week seems to be adequate for many of the students in this research, a number of them complained it was not enough. A request that was not unusual was to meet twice as often in order to master more material.

The number of students in a classroom and the classroom composition that may have been conducive to more flow-supporting tasks may also make it difficult to put greater complexity into practice. Small class sizes was a luxury afforded by this particular program. As a result, students could contribute more to discussions, they could more easily get the attention of the class when they had something they wanted to present. On the other hand, during recitations there was practically no place to hide. With greater numbers of students in a room, it is harder to distribute participation in discussion evenly. To attract everyone's attention may be more intimidating and, in recitation, the chances that someone else will be called upon is greater.

Without question, the findings support alternative programs for talented students in math. The level of challenge needed to prevent their boredom would frustrate average students. While pairing up talented and average students might give the latter more informational feedback, it prevents students with the ability (and the motivational need) from going faster. The present findings also underscore the importance of social interaction made possible through group discussion and cooperative problem solving.

Since math qualifiers were relatively alike in terms of talent, individuals volunteered their ideas quite freely (whether they were correct or not)--something they might refrain from doing in a class of mixed abilities for fear of derision. For motivational reasons, talent grouping has merit. In heterogeneous classes, these same students might keep their ideas to themselves, thus sacrificing their ability to interact with others, to have their ideas affirmed or challenged.

To teach this way requires a fairly advanced grasp of mathematics and the ability to leave the textbook. Talent search teachers seldom found their discovery problems in the assigned text. Problems came from other sources including submissions by students. Teachers who pursued this type of problem were willing and able to 'go with the flow,' so to speak, reasonably confident in the students' ability and their own to find a solution. It was usually the case that someone's insight led others to an answer. But it was improvisational and success was not guaranteed. Occasionally, a problem stumped everyone and it had to be set aside so that other matters could be attended to.

Through appropriate classroom structures, it may be possible to preserve the intrinsic interest of more talented students. For the quality of student experience to become a higher educational priority, there will not only need to be guidelines for developing more complex classrooms, there will need to be opportunities for them to develop, all of which has implications for the amount of time made available, the number of students in a class, the curriculum, and so on--decisions which are not made in the classroom itself.

The small things that may be done in a classroom start with taking stock of current instructional practices. Are the goals clear? Who or what is the source of the feedback? Is the feedback informational or controlling? Is the feedback unambiguous? Are problems little more than practice drills? Could problems be more challenging? Are students interacting? How much recitation is being used? How much time is being spent on housekeeping? What activities do students enjoy? When students make discoveries how are they rewarded? These are questions which apply to all students, not just the ones who are the most able. Because curricular decisions affect student motivation, these are concerns that deserve attention.

In practice, extrinsic rewards believed to foster achievement are integrated into virtually any math class one chooses to observe. Grades, competition, recognition and emphasizing the value of math in preparation for a career all constitute incentives external to math activity. The decision to employ them may be well-intended: to get students to work harder. But just like the goal of national superiority in math and science, each is a decision which is pre-determined for students. In many ways, education as it exists deals a double dose of "extrinsicity:" most instructional decisions are imposed upon students and many of the methods used reward students for work that is not inherently mathematical. Except for the most talented, few probably find doing math rewarding in itself. Lacking reasons that are their own for doing math and having been raised on few rewards derived directly from mathematical activity, it is no wonder students lose interest, assuming they had it to begin with. Hope comes in the form of helping students find more personal rewards: “In the long run, it is enjoyment that motivates students to pursue knowledge beyond the minimum requirements” (Wong & Csikszentmihalyi, 1991, page 568). Now it may be added that task complexity adds to task enjoyment, at least it prevents its decline among talented adolescents, which in turn helps them realize more of their potential.