Beliefs, Motivation, and Achievement in Mathematics: A Cross-National Perspective*

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The poor performance of American children in school mathematics has been a topic of national concern for at least the last decade. Our children consistently perform at or near the bottom among highly industrialized nations in international comparisons (Garden, 1987; McKnight, Crosswhite, Dossey, Kifer, Swafford, Travers, & Cooney, 1987). Monographs such as A Nation at Risk (National Commission on Excellence in Education, 1983) have highlighted the risks to economic growth and national security that arise from our failure to educate our children adequately in mathematics. These admonitions, however, have apparently had little effect on achievement levels; recent studies indicate that Americans are continuing to fall behind. (Stevenson, Chen, & Lee, 1993).

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In contrast, children in Asia excel in mathematics. Japanese children are continuously ranked at or near the top in international comparisons, and recent studies have also indicated that Chinese, Taiwanese, and Korean children also perform exceptionally well.

Why do American children perform so poorly, and why do Asian children perform so well? In part, factors related directly to schools and schooling appear to play an important role. For example, the school year is about two months longer in most Asian countries than in the United States. Moreover, Asian teachers on average devote more of the school day to mathematics than American teachers. Researchers have also suggested that Asian instructional techniques and curricula facilitate children's learning of mathematics (Stevenson & Stigler, 1992).

Although school-related factors obviously are important, I believe that they cannot provide a complete explanation for the excellent mathematics performance of Asian students and the poor performance of American students. Differences in achievement levels must be considered from a perspective that emphasizes the values that underlie education. Children's motivation to work hard and perform well in school is determined in part by culturally based beliefs about influences on performance and the value of effort.

This chapter presents evidence that American parents and children are more likely than their Asian counterparts to believe that school performance, particularly in mathematics, is substantially influenced by innate ability. In contrast, Asian children and their parents are more likely to believe that performance is influenced primarily by effort. In addition, American parents express greater satisfaction with their children's academic performance than Asian parents. These differences could play an important role in the observed achievement differences.

The first section of this chapter is a brief overview of a series of studies that has focused on school achievement and motivation in Asian and American elementary school children. The second section presents the findings of interviews with parents and children regarding achievement-related beliefs. The third and fourth sections consider, respectively, the implications and origins of the differences in belief systems.

OVERVIEW OF THE RESEARCH

Most of the research presented here comes from a series of studies of Japanese, Chinese, Taiwanese, and American elementary school children (Stevenson, Lee, Chen, Stigler, Hsu, & Kitamura, 1990; Stevenson, Lee, & Stigler, 1986; Stevenson & Stigler, 1992; Uttal, Lummis, & Stevenson, 1988). Detailed description of the methods of these studies has been published elsewhere and thus is not included here (see Stevenson et al., 1990). The research has included achievement tests in reading and mathematics, a detailed battery of intellectual ability tests, and interviews with children, their mothers, and their teachers. More than 10,000 children have been tested, and over 1000 mothers and children have been interviewed in each country. Extensive efforts have been made to ensure that the tests and interviews are culturally appropriate. For example, all test items and interview questions have been developed simultaneously in the different languages by child development experts who are fluent in at least two of the languages (Chinese, English, and Japanese).

The results of the achievement tests have been consistent with previous cross-national comparisons; American children have performed much worse than their Asian counterparts. The present studies have also added some important new information. For example, the results have revealed that achievement differences emerge early in elementary school. Japanese students perform substantially better than American students, even at first grade. In addition, the present studies have revealed that the excellent performance of Asian children is not limited to highly industrialized nations such as Japan. Stevenson, Lee, Chen, Lummis, Stigler, Fan, and Ge (1990) found that students in mainland China also excel in mathematics, even though the Chinese schools are often overcrowded by American standards (the number of students in a class often exceeds 40), and relatively little money is available for maintaining schools or purchasing materials.

The results of the intellectual abilities tests have also invalidated one common explanation for the superior performance of Asian children in mathematics. It is often suggested that Asian children are more intelligent in general, or that they possess a genetic advantage in mathematics (Lynn, 1982). However, children in all cultures performed comparably on the intellectual ability tests. No consistent differences emerged that favored Asian children (Stevenson et al., 1986; Uttal et al., 1988). The remainder of this chapter is devoted to developing the argument that although intellectual ability per se does not play a role in the cross-national differences in achievement, what parents and children believe about intellectual ability and school performance may play a critical role.

BELIEFS, MOTIVATION, AND LEVEL OF SATISFACTION

What cultural factors may underlie the large differences in achievement levels? The interviews of parents and children revealed several important cultural differences in beliefs that may be partly responsible. In addition, differences emerged in mothers' ratings of their children's abilities and mothers' satisfactions with their children's performance. These are discussed in turn.
Beliefs About Influences on Achievement

The interviews have revealed that American mothers are more likely than their Asian counterparts to believe that innate ability strongly influences children’s academic achievement. For example, American mothers were significantly more likely to disagree with the following statements: “People have the same amount of math ability,” and “Any student can be good at math if he or she tries hard enough.” Mothers were asked to use a scale that ranged from 1 (strongly disagree) to 7 (strongly agree). The ratings of American mothers were significantly lower for both questions. American mothers particularly disagreed with the suggestion that people tend to be born with the same amount of ability (mean ratings were approximately 2 on the 7-point scale). Japanese and Chinese mothers were significantly more likely to agree with these statements or to hold neutral beliefs (Lee, Ichikawa, & Stevenson, 1987).

The answers of American mothers to several other questions were consistent with the focus on innate ability. American mothers agreed significantly more than Japanese or Chinese mothers with the statement, “Your child was born with his or her mathematics ability.” Similarly, American parents believed that long-term predictions can be made about a child’s future scholastic achievement. Mothers were asked, “When in a child’s life does it become possible to predict how well children will do on achievement tests that will be given at the end of high school?” Only 10% of the Chinese mothers answered “elementary school,” but 38% of the American mothers gave this response. If parents believe that school performance is determined by innate ability, then they may think that achievement patterns will stay the same across the school years.

Within each culture, children’s beliefs generally were consistent with those of their mothers. American children believed more than their Asian counterparts that innate ability strongly influences achievement. Perhaps the most compelling demonstration of this difference is children’s responses to questions regarding the diagnostic value of tests for determining how much natural ability a person has. Taiwanese, Japanese, and American children were asked how strongly they agreed with the following statement, “The tests you take can show how much or how little natural ability you have.” Japanese children, in particular, strongly disagreed with the statement, but American children tended on average to agree with it.

Children were also asked to rate how much they agreed with the statement, “Everybody in your class has the same amount of ability in math.” American children on average were significantly more likely than Asian children to disagree with this statement. American children also disagreed more than Asian children with the statement, “The best students in the class always work harder than the other students.”

Estimates of Ability

A second, consistent difference between Asian and American respondents concerns estimates of ability. Americans rate themselves as more talented and as having more ability than do Asians.

Mothers were asked to rate their child’s overall intelligence, learning ability, verbal expression, and reasoning skills. On average, parents in all three countries thought their own child was above average. This finding is reminiscent of Garrison Keillor’s description of Lake Wobegon, an imaginary town created for a popular radio show, as a place where “all the children are above average.” Keillor recognized that mothers everywhere think that their own children are better than the rest (Stevenson & Stigler, 1992). American mothers, however, displayed the greatest positive bias; their ratings were significantly higher for all questions than those of Japanese or Taiwanese parents. That is, American parents consistently thought their children had more ability in school-related domains than did Asian parents (Stevenson et al., 1990).

Children’s estimates of their abilities were consistent with those of their mothers. Students were asked to answer questions such as, “If you were to rank all the students in your class from the brightest to the most stupid, where would you put yourself?” The response scale ranged from 1 (“most stupid”) to 7 (“the brightest”). Like their mothers, students in all countries thought of themselves as above average. Moreover, the ratings of American students were significantly higher than those of Japanese or Chinese students. American students also thought of themselves as significantly more talented in mathematics and as having significantly more potential for future achievement (Stevenson et al., 1990).

Expectations and Satisfaction with Performance

The interviews also revealed that American mothers were consistently more satisfied than their Asian peers with their child’s scholastic performance, even in mathematics. This is surprising given the poor overall performance of American children.

Parents were asked to rate on a 3-point scale how satisfied they were with their child’s performance, ranging from 1 (not satisfied) to 3 (very satisfied). More than 40% of the American mothers were very satisfied, but less than 10% of the Asian parents were very satisfied. In contrast, less than 10% of the American mothers, but over 20% of the Asian mothers, said that they were very dissatisfied.

Possible relations between mothers’ satisfaction and children’s level of achievement were revealed in a series of questions that were
posed to American and Chinese mothers. Respondents were asked to assume that their child was given a mathematics test, and that the average score was 70. Parents were then asked, "What score do you expect your child would receive?" and, "What score would you be satisfied with?" The expected scores were similar; American mothers on average thought that their child would receive an 82, and Chinese mothers expected an 85. However, there was a dramatic difference in the scores that parents would find satisfactory: American mothers said, on average, that they would be satisfied with a score ($M = 76$) that was below what they expected their child to receive, whereas Chinese mothers would only be satisfied with a score ($M = 94$) that was substantially higher than the expected score. The answers to these questions provide strong evidence that differences in level of satisfaction could affect parents' motivation to encourage their children to perform well in school mathematics. Chinese parents will not be happy until their children improve, but Americans will accept scores that are even lower than what they expect their child to receive.

Even more specific evidence is available to document the relation between children’s level of achievement and parents’ level of satisfaction. Asian mothers tended on average to express dissatisfaction if their child's performance was only slightly below the average performance of children at his or her grade level. In contrast, American mothers only expressed dissatisfaction if their child’s performance was substantially below the average for his or her peers. Similarly, Asian parents expressed satisfaction with their child’s performance only if it was above that of other children at the same level; American parents were satisfied with below-average performance (Lee, Ichikawa, & Stevenson, 1987). American parents also thought that their children had fewer problems in mathematics. Crystal and Stevenson (1991) found that only 10% of American mothers thought that their children had problems in mathematics. In contrast, 24% of the Asian parents thought that their children had problems.

Once again, children generally agreed with their parents. American children thought that they were doing quite well in school; they rated their performance significantly higher than did Japanese or Chinese students. American children said that they liked mathematics and felt that they had few problems with it.

These results raise the question of why Americans are so satisfied with relatively poor performance. Stevenson and Stigler (1992) suggest that American parents of elementary school children have little basis for specific evaluation of their child’s progress in school. Grades are used less commonly in elementary school than in higher grades, and parents may not receive enough information to make a realistic assessment of their child’s performance.

There may also be a second, important reason for American parents’ overly optimistic evaluations of their children’s performance: The higher evaluations may be a consequence of a belief system that stresses innate ability over effort. If parents believe that their children’s performance is determined largely by genetic factors, then they may also believe that there is relatively little that can be done to improve a child’s level of performance. A negative evaluation may be taken as evidence that there is something wrong with the child (i.e., low ability) rather than something wrong with the amount of effort that the child extended on the particular task or assignment (Weiner, 1985). Being satisfied with poor performance, then, may be a form of self-protection. Americans may prefer to be satisfied with mediocre work than to think of their children as lacking in ability. This suggestion is an extension of the classic principle that people are likely to hold beliefs that protect their own sense of self worth (see Larrick, 1993). If poor performance is taken as evidence of lack of ability, then the person’s self worth is directly affected.

**POSSIBLE CONSEQUENCES OF CROSS-NATIONAL DIFFERENCES IN BELIEF SYSTEMS AND LEVELS OF SATISFACTION**

How might the differences in American and Asian belief systems be related to achievement differences? There are several possible relations, but all center on the theme that attributions of innate ability and low levels of satisfaction may combine to foster a situation in which relatively little time and effort is devoted to mathematics.

If parents believe strongly that achievement in mathematics is determined largely by innate ability, then they may have little incentive to encourage their children to work hard. Taken to an extreme, a strong belief in innate ability may lead parents to take a rather cynical view regarding the value of effort: If a child has a lot of ability, he or she doesn't need to work hard. Conversely, if a child lacks ability, then hard work may be a waste of time.

One finding that is consistent with this interpretation concerns the amount of time that children devote to homework. American students consistently do less homework than their Asian counterparts. This difference was statistically significant even at first grade, but was more compelling at fifth grade. For example, the average American fifth-grader spent about four hours per week on homework. In contrast, Japanese fifth-graders spent about six hours and Taiwanese fifth-graders spent 11 hours (See Chen & Stevenson, 1989; Stevenson & Stigler, 1992).

Another less obvious, but potentially quite important consequence of a belief system that favors innate ability concerns the role of mistakes in
children's education. Children's errors can give teachers an important opportunity to alert other students to potential problems that they may encounter and to help students gain insight into the correct approach to the solution. However, if mistakes are taken as evidence of low innate ability, then publicly discussing an error can be a humiliation to a young child. This attitude can rob the entire class of the opportunity to prevent mistakes in their own work before they arise (Stevenson & Stigler, 1992).

The possible consequences of the American focus on genetic explanations are particularly troubling in regard to mathematics achievement. Perhaps more than any other school subject, mathematics requires precisely those things that attributions to innate ability are likely to reduce: diligence, attention to homework, and a willingness to learn from mistakes. To succeed in mathematics, children must not feel that difficulties mastering individual concepts or problems reflect directly on underlying ability. Moreover, children must realize and accept that the payoff for hard work may not be immediately obvious. Adopting this kind of perspective is probably difficult when the underlying cultural belief is that failure in school mathematics is evidence of a lack of innate, genetic ability, and that relatively little can be done to improve one's level of ability.

**ORIGINS OF BELIEF SYSTEMS**

The final section of this chapter addresses the origins of belief systems about the nature of intelligence and achievement in Asia and the United States. Why do Asian parents and children emphasize effort, and why do Americans emphasize innate ability?

In Asia (and particularly in China), beliefs focusing on effort appear to be related to long-standing cultural traditions, which are to some extent rooted in the writings and teachings of Confucius. Confucius wrote, for example, that "In teaching there should be no distinction of classes." (as quoted in Legge, 1966, p. 235). In addition, Chinese children are taught that to improve the material or social world, one must begin with self-improvement. In Chen and Uttal's (1988) words, Asian educational philosophy "has emphasized that societal improvement must begin with self-improvement. The Confucian doctrine was cultivate yourself, regulate your family, govern well your state, then order well the kingdom" (pp. 353-354). In sum, Asian children are taught that self-improvement is both possible and important, and that effort is to key to realizing one's potential.

The American emphasis on innate ability is, at first glance, rather surprising. American cultural values have traditionally emphasized hard work and diligence. Yet there is a strong competitor to the traditional American emphasis on effort: genetic determinism. This perspective, which has been adapted from biology and psychology, posits that human attributes are largely determined by innate factors, and that evolutionary selection controls the expression of these traits (Lerner, 1992; Lewontin, Rose, & Kamin, 1984). In Lerner's (1992) words:

Genetic determinism is the belief that the primary cause of behavior lies in the evolutionarily-shaped, hereditary process of individuals. The basis of a person's behavior and development is said to lie in the genes. And because society is nothing more than a collection of individuals, evolutionarily-based hereditary mechanisms create and drive society too. (p. xviii)

The popularity of genetic determinism has waxed and waned during the past 50 years. It was quite popular in the early half of this century. For example, almost as soon as intelligence tests were invented, researchers began to study the genetic origins of IQ. They assumed that racial and ethnic differences in IQ were attributable directly to biological differences. The popularity of genetic determinism declined somewhat during the 60s, when there was a strong belief that human intelligence could be improved dramatically by rectifying social problems such as poverty. Programs such as Head Start were engendered within a belief system that emphasized environmental enrichment.

Genetic determinism has recently become quite popular again, bolstered in part by new genetics techniques, such as more specific gene mapping. At the same time, advances in behavioral genetics and the availability of an increasingly large body of research on the similarity of twins reared apart (see Plomin, 1986) has helped to increase the popularity of genetic determinism in psychology. Research is currently underway that is aimed at identifying genetic components of numerous and wide-rangi phenomenon of interest to social scientists, including sexual orientation, chemical dependence, various personality traits, and even criminal behavior. The results of these studies, even if they are reported by the researchers as preliminary and tentative, often receive tremendous coverage in the press. It seems that hardly a week goes by without a report that a gene has been discovered "for" a particular trait, disease, ability, and so forth. Genetic and reductionist explanations abound for almost all aspects of human behavior. It is perhaps quite easy for parents and educators to get the message that genetics matters most. Thus, it should not be surprising that American parents believe that genetics highly influences the school achievement of their children.

The prevailing message that genetics matters most may be particularly appealing in regard to understanding and improving mathematics achievement. In part, the emphasis on genetic explanations for mathematic-
ics achievement may stem from the fact that poor mathematics performance is much more accepted in the United States than poor reading performance. When confronted with a problem that requires mathematics knowledge, it is not uncommon for a person to laugh and say, "I never was very good at math." In contrast, it is not socially acceptable to say, "I never was very good at reading." Clearly, Americans believe that reading is more important than mathematics. Our research supports this claim; for example, American parents have consistently rated reading achievement as more important than mathematics achievement (Stevenson & Stigler, 1992). Even though illiteracy remains a problem, most adults in the United States are relatively more competent at reading than at mathematics.

How might the American focus on reading be related to genetic explanations for mathematics achievement? The answer may be that being good at math, unlike reading, is perceived as something special, something that distinguishes a person from others. Because relatively few Americans are good at mathematics, American adults may be more aware of individual variation in mathematics achievement than in reading achievement. Consequently, they may perceive mathematics achievement as something that requires a special ability.

My point in discussing the new interest in genetic explanations for human behavior is not to criticize the entire enterprise. Certainly all of human behavior and personality is affected by our genetic makeup, and it is critically important to identify these influences. The danger arises when it assumed that genes directly determine, rather than influence, complex phenomena such as personality and school achievement (Lerner, 1992). Too many people, including perhaps the average American parent, assume that the identification of a genetic influence means that relatively little can be done to influence a given phenomenon (Lickliter & Berry, 1990). Once a genetic explanation is suggested, the search for other influences is often curtailed or halted. Insufficient attention is given to the complexity and importance of interactions between genetics and environment and to the possibility of influencing the course and direction of these interactions.

The dangers of overly simplistic models of the relation between genes and complex behavior have been pointed out by numerous authors, including Lewontin et al. (1984) and Lerner (1992). Taken to an extreme, genetic determinism can be used to justify racism, sexism, and even genocide (Lerner, 1992). There is also a more subtle danger that may be directly relevant to attempts to understand the causes of the poor school performance of American children. Focusing on genetic explanations may lead parents and students to give up much too quickly on the potential for achievement. In Stevenson's (1992) words:

Americans are much more likely to point to the limitations imposed by an assumed level of innate ability. This belief has potentially devastating effects. When parents believe success in school depends for the most part on ability rather than effort, they are less likely to foster participation in activities related to academic achievement. (p. 73)

This argument is not meant to imply that Japanese or Chinese culture is free of concepts of innate ability. Indeed, many Americans are often surprised and appalled that Japanese government or business officials sometimes use genetic or even racist explanations for American educational or social problems. Japanese citizens apparently are quite willing to appeal to genetics to account for differences between members of different societies. However, the present results suggest that these explanations are less likely to be used when the focus is on differences within their own society.

In sum, my suggestion is that the American belief in the strong role of innate ability arises from and reflects the interest of scientists in genetics and genetic explanations for biological and psychological phenomena. This interest arose in the earlier portions of this century, when psychologists and educators began to relate the newly defined intelligence quotient with presumed racial and ethnic differences. The search for genetic explanations predominates in the popular press, and the public seems to have assumed that genetics is to a large part responsible for school achievement.

**CONCLUSION**

By now, the poor school achievement of American children is old news. What is less well-known, however, is that our beliefs about the causes and nature of school achievement may, at a subtle and general level, contribute to the problem. This chapter has demonstrated two consistent differences in Asian and American beliefs and values regarding education. First, American parents are more likely than Asian parents to believe that achievement is determined largely by innate ability. Second, even though American children consistently fall behind in international comparisons, their parents are quite satisfied with their scholastic performance. Taken together, these factors may play an important role in the overall low level of achievement in school mathematics; they may reduce children's motivation to devote much time and effort to topics such as mathematics that require it.

The claims regarding possible relations between belief systems and achievement are speculative at this point, and more research obviously is required. It is impossible at this stage to prove conclusively that the American emphasis on innate ability is, in part, responsible for the lower
levels of mathematics achievement. Further research is needed to determine more specifically the nature of the relation between beliefs and achievement in different cultures. Most research thus far has been based on survey and correlational methods. It may now be possible, based on hypotheses developed from the research reported here, to develop more rigorous experimental tests, using methods that are commonly employed in research on beliefs and attributions (see Weiner, 1985).

The results of the present research have implications for attempts to improve the mathematics achievement of American children. Many educators and government officials have expressed interest in adopting Asian curricula or instructional techniques for use in the United States. The assumption seems to be that if it works in Asia, it can work here. The current results reveal why this putative assumption may not be true; Japanese and Chinese success in mathematics is supported by a system of historically based cultural beliefs. Adopting techniques out of context is unlikely to help unless we also consider how values and beliefs influence education in the countries that are being used as models for attempts to improve achievement here.

Finally, the results highlight the need for further consideration of how the current focus on biological and genetic explanations influences children's development and school achievement. As we learn more about how our genes influence our behavior and development, we must be careful not to give parents and educators the idea that hereditary directly determines exactly how well a child will do in school. The identification of genetic influences should not lead American parents to abdicate their fundamentally important role of influencing their children's development and scholastic achievement. Perhaps by focusing on what we can change and less on what we cannot, we could help children at all levels of intelligence perform better.

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