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# Department heads' perceptions of their influence on mathematics achievement in Singapore and the United States

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## Keywords

Mathematics, Schools, Leadership

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## Abstract

Heads of secondary school mathematics department were surveyed to assess their perceptions of how they influence and impact students' performance in mathematics. Survey results showed both agreement and discrepancy between what department heads perceived as actual and optimal activities to enhance instructional improvement, influence student achievement, and implement initiatives for change. The report concludes with a description of the pre-service and in-service programs.

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Recent research has documented the powerful influence of academic leadership in improving school programs (Bushher and Harris, 1999; Calabrese, 2002; Nir, 2003; Stoll and Fink, 1996). Particularly, effective schools possess leaders, such as Heads of Departments (HoDs), who make a significant and measurable contribution to the success of academic programs (Brown and Ruthersford, 1998; Bushher and Harris, 1999). In mathematics education, few programs have enjoyed the remarkable success of Singapore in the mathematics portions of the Third International Mathematics and Science Study (TIMSS) and its 1999 follow-up, TIMSS-Repeat or TIMSS-R (Kelly *et al.*, 2000; Mullis, 1997).

TIMSS was the largest, most comprehensive, and most rigorous international study of schools and student achievement ever conducted. In 1995, more than 40 countries participated in an assessment of mathematics and science achievement at the fourth, eighth and 12th grades. In 1999, TIMSS was replicated for students in grade eight and renamed TIMSS-R. TIMSS and TIMSS-R were designed to provide trends in the eighth grade mathematics and science achievement in an international context (Mullis *et al.*, 2000). Thirty-eight countries participated in TIMSS-R. Of these, 26 countries also participated in TIMSS at the eight-grade level in 1995. Also, 1999 marked 4 years since TIMSS was completed, and the population of students originally assessed as fourth-graders had by then advanced to the eighth grade. Thus, for 17 of the 26 countries that participated in TIMSS at the fourth grade, TIMSS-R provided information about whether the relative performance of these students had changed in the intervening years.

Although a number of publications have compared the TIMSS performances of Singapore and other Asian countries with western countries, there has been little research identifying the role of leadership at the departmental level in accounting for achievement differences (Turner and Bowlam, 1998; Wise and Bush, 1999). What work has been undertaken to establish how HoDs influence achievement has often analyzed this influence from a cultural perspective (Hannay and Ross, 1999; Hannay *et al.*, 2001). Effective departments usually presented a profile or



culture that was consistent with high performance on achievement measures (Harris *et al.*, 1995). As Bauersfeld (1998) noted, a departmental culture clearly cannot exist independently of the culture of the society that maintains the institution. Consequently, it may be more accurate to refer to the subculture of the department as the set of observable functions, structures, and developments that can be changed by the interventions of HoDs and other members of the department (Dellar, 1996).

Departmental and subsystem cultures impact achievement results for several reasons. First, mathematics department cultures stress mathematical knowledge and expertise, and secondary mathematics teachers regard themselves as essential, learning specialists. A further cultural value relates to the assignment of resources that can have considerable impact on efforts to improve achievement. Cultural differences of the larger community also impact mathematics achievement differences, and Cooney (2001) has remarked that perhaps the most interesting part of the story about high achieving students may well be the societal conditions that promote that achievement.

Singapore's educational system mandates 10 years of formal education with 6 years of primary school and 4 years of secondary school. As in the US, mathematics is a compulsory subject at all grade levels in Singapore schools and Singapore's Ministry of Education issues comprehensive syllabi that list desired learning outcomes along with instructional objectives (Singapore Ministry of Education, 2000). Comparable mathematical guidelines for US schools typically emanate from state or regional educational offices as well as from non-governmental organizations such as the National Council of Teachers of Mathematics (NCTM), the largest association of school mathematics teachers in the US. Singapore has closely-knit communities with high parental expectations in a culturally controlled educational system. As a result, the needs of students and the priorities of the culture are in concert, and department heads are apt to be strong-willed, loyal, task-oriented, and conservative (Zhang, 1994). On the other hand, schools in the United States are in diverse

school districts each with different educational resources and prerogatives. Consequently, the culture of school mathematics departments and the characteristics of American HoDs are more diversified than those of their counterparts in Singapore.

There is substantial evidence that the department head has great potential importance in influencing achievement differences (Harris *et al.*, 1995). To study HoDs' role in affecting teaching and learning, heads of secondary school mathematics department were surveyed to assess their perceptions of how they and their departmental culture influenced students' performance on measures of achievement.

A sample of 12 HoDs from secondary schools in Singapore and 12 HoDs from the United States were surveyed. The Singapore version of the survey forms were distributed to 12 HoDs who participated in a special sequence of courses for a Diploma Degree at the National Institute of Education (NIE) in Singapore during the academic year 2001-2002. The American version of the survey form was completed by 12 HoDs who were enrolled in mathematics education seminars in New England or in special institutes for enhancing algebraic thinking held in California during the summer of 2001. Although the Singapore and US HoDs voluntarily participated in the courses, seminars, and institutes in which they were surveyed, all the HoDs used their participation as a means of satisfying professional development requirements inherent to their positions. Consequently, the entire sample showed evidence of being skewed toward more professionally dedicated HoDs who volunteered to complete survey forms.

The survey forms were developed to explore the following broad questions.

- (1) What do HoDs in mathematics see as their contribution to the success of educational reforms and students' scores on international tests of achievement?
- (2) Can research describe the successful initiatives and obstacles experienced by HoDs in improving mathematics teaching and learning?
- (3) What do mathematics HoDs see as the optimum training for their positions?

Survey forms were distributed to and collected from 12 HoDs from each country during 2001. The survey questions were open-ended and focused on the HoDs' experiences and the impact they believe that they have on mathematics achievement. Further, HoDs were asked to respond to open-ended items detailing the preparation or special training needed by HoDs.

To understand the context influencing the roles of HoDs in both cultures, qualitative data were analyzed to identify the themes and patterns and whenever possible typical commentary from the HoDs were used to illustrate these themes and patterns. Survey findings and comparable TIMSS and TIMSS-R items were used to highlight the results from the analyses. The following are the highlights from the findings.

The sample of Singapore HoDs consisted of eight female and four males with an average of 12 years of teaching experience and 3 years experience as head of the mathematics department. Among the American HoDs, there were seven females and five males with an average of 18 years of teaching experience and 7 years experience as head of the mathematics department. These figures were somewhat less than those found in a study undertaken by Turner (1998a, b) in which 204 HoDs were surveyed and it was discovered that the average length of teaching experience was 21 years. Notably, only 10 percent of these HoDs in the Turner study were appointed to their positions with less than 12 years teaching experience.

Based on the Singapore HoDs' reports, the duration of mathematics classroom time per week ranged from about 180 to about 300 min. From the self-reports of the American HoDs, the duration of mathematics classroom per week ranged from 225 to 350 min.

The Singapore HoDs reported that they spent an average of about 18.1 h per week working on departmental issues outside of school, that is, after usual working hours. US department heads indicated that they devoted about 12.7 h per week outside of school to work on mathematics department concerns. Corresponding results based on the TIMSS findings showed that 60 percent of the Singapore teachers and 32 percent of the American teachers reported that they spent

more than 21 h per week outside the school day preparing for classes or grading exams.

Consequently, there appeared to be parallels here between the patterns shown in TIMSS and TIMSS-R data with respect to the duration outside the school day devoted to school issues between both teachers and HoDs. Particularly, Singapore teachers and HoDs devote more time to school issues outside of the school day than their American counterparts.

HoDs provided a variety of responses when asked how they and their departmental culture influenced the quality of achievement in mathematics. In Singapore, more than half of the respondents mentioned action plans, departmental goals, schemes of work, and the monitoring of departmental programs as keys influencing the quality of achievement. One HoD stated that "as an instructional leader the HoD influences quality by setting directions and bringing focus through targets set and programmes mounted". The majority of Singapore HoDs indicated that they influenced quality by target setting, supervision, setting examples, and encouraging sharing sessions during department meetings. American HoDs also provided diverse responses, but the majority mentioned school inservice programs coordinated with state and national standards, school improvement programs, and the mentoring of probationary teachers as important aspects of their and their department's cultural influence. One US department head put it this way, "I encourage teachers to attend workshops and conferences at both local and regional levels as well as suggesting effective resource materials to them. We are fortunate to have a supportive administration that provided funds for teachers to take advantage of professional development opportunities. I encourage faculty members to take advantage of these opportunities."

HoDs were also asked what they should do to influence the quality of learning in their department. Common responses to this question in Singapore related the need for the HoD to be a role model, an expert in the field, and a catalyst for transforming the department into a professional learning community. One HoD stated, "The HoD should have a vision for the department and encourage the faculty that we will be able to deliver the dream if we work

together as a team. The HoD also needs to capitalize on teachers' potential and to nurture and maximize teachers' potential." Some US respondents indicated that their major influences should relate to ensuring that administrators were educated about current reform issues in mathematics education and the need to adequately fund technology-based enhancements. One US HoD indicated that the HoD's influence should be felt in both directions: within the cultural milieu of the mathematics department and as the principal's main source of information about mathematics education.

Department heads were also asked about the initiatives they had implemented for improving achievement in their departments. The initiatives listed by Singapore HoDs in response to this open-ended question included: the infusion of IT and thinking skills into lessons, the implementation of professional sharing sessions (learning circles), better tracking of pupil performance, and the mentoring of weaker teachers by experienced teachers. When US HoDs responded to these items, no mention was made of developing departmental resource libraries. This finding reflects the earlier TIMSS-based results that 57 percent of Singapore secondary teachers relied on departmental lesson plans as compared to only 3 percent of their US colleagues. One US HoD from a large urban school noted that, "We have implemented initiatives to better integrate technology into the curriculum. We have also promoted integrative mathematics and science courses that are taught by teachers from both departments. These initiatives aimed to better capitalize on the connections between mathematics and other fields of study."

However this HoD, like the 11 other US HoDs, made no mention of planned or actual use of departmental lesson plans. To some US educators, the use of these shared instructional guides would likely detract from the culture of individual teachers' autonomy within the classroom that remains prevalent in the US (Cobb *et al.*, 1992). This cultural feature is generally not shared by Singapore educators, and particularly by the Singapore HoDs who were surveyed in this study.

As a companion question, the HoDs were asked what achievement-enhancing initiatives

they had successfully seen implemented in mathematics department. Mentoring, peer coaching and professional sharing of lessons and resources were mentioned by more than 80 percent of the Singapore HoDs. The US department heads also reported a wide range of successfully implemented initiatives. These included preparing students for regional mathematics competitions, parental support programs, pursuit of special funding opportunities for resource improvements, and activity-based learning programs. A HoD from California reported that, "I've seen a number of successful integrative initiatives that are successful because they connect mathematics to other parts of the curriculum, and due to this they gain and maintain widespread support."

With respect to the role of the HoD in enhancing achievement, almost half the Singapore HoDs related the importance of selecting suitable textbooks for the new syllabi as a means of enhancing achievement at their school. These respondents further indicated that when teachers were better prepared and equipped to implement change by the departmental culture, there was enhanced achievement at the school level. American HoDs saw their role in enhancing achievement both different and similar to their Singapore counterparts. US HoDs echoed reports from the Singapore HoDs about the importance of communicating policy changes and the need for faculty participation in implementing these policies. However, the majority of the US HoDs indicated that the impetus for change should originate from insights of the faculty. Four of the US HoDs also indicated that enhancing achievement required substantial support from parents and administrators as well.

Regarding what should be the role of HoDs in enhancing achievement, the majority of respondents from both countries reported that HoDs must ensure that teachers are comfortable with embracing changes in the educational system. Most of the US HoDs also indicated that HoDs must ensure that teachers are involved in the development of efforts to enhance achievement.

About one-third of the American HoDs indicated that to develop a sense of a shared culture in efforts to enhance achievement, teachers needed to be involved during the

earliest stages of these change efforts. One American HoD noted, "I feel that HoDs need to encourage teachers to become active members of NCTM (National Council of Teachers of Mathematics) and other groups that offer special academies to learn how to facilitate change." This HoD and three other US HoDs also noted that a number of senior teachers were less informed about the state and national standards for mathematics instruction. This finding supports the TIMSS and TIMSS-R results that when compared to their Singapore counterparts, substantially fewer US teachers were familiar with national curriculum guidelines, state curriculum frameworks, and local guidelines. In particular, American eighth grade teachers reportedly received less professional development than their counterparts who teach Secondary 2 classes in Singapore.

When asked about the preparation or special training they received prior to becoming department heads, all except three of the Singapore HoDs and all but two of the US HoDs indicated that they received some type of on-the-job training for their positions. One US HoD had this to say about his preparation before becoming department head, "Probably the best preparation for being a department head that I received came from our district mathematics K-12 coordinator who offered workshops on a variety of teaching topics as well as individual consultation about scheduling, resource management in mathematics departments." About half the Singapore HoDs and about one-third of the US HoDs indicated that their initial period of service as HoD was facilitated by supportive principals or vice-principals. When they were queried about what special training they should receive before becoming a HoD, the Singapore and American HoDs were unanimous in indicating that some type of basic leadership course on managing people and an instructional area should be taken. A majority of Singapore HoDs and two of the US HoDs emphasized the need for new HoDs to gain experience by working with or understudying an experienced HoD. One Singapore HoD related that, "It is very important for the HoD to know what the actual requirements and expectations for the position are."

With respect to the preparation or special training that the HoDs received after their appointments, all 12 Singapore HoDs reported completing the Diploma in Departmental Management (DDM). American and Singapore HoDs also provided a diverse listing of short courses and workshops that they had attended since becoming HoD, but none of the American HoDs reported completing a diploma in departmental management. Seven of the 12 Singapore HoDs and 11 of the 12 American HoDs also listed themselves as members of professional organizations in mathematics or mathematics education.

Concerning what preparation or special training HoDs should receive after their appointments, one-third of the HoDs from both countries related the need for initial and continued mentoring by more experienced colleagues. A majority of the respondents from both countries indicated that short, refresher courses should be offered to ensure that HoDs are updated on current developments. Particular topics that the Singapore HoDs felt should be covered in refresher courses included group dynamics, developmental supervision, and stress management. American HoDs also related the need for preparation or special training on resource and crisis management and how to conduct effective meetings. What follows is a summary of the study's conclusions based on the preceding findings.

Earlier research found that a number of TIMSS and TIMSS-R items were highly correlated with student achievement scores. These items included:

- (1) the amount of time outside the school day devoted to instructional issues by teachers and HoDs;
- (2) the use of departmental lesson plans; and
- (3) teachers' familiarity with national and local curricular guidelines.

Based on the findings of this study, there is evidence to support the contention that HoDs perceptions of the importance of these items within their mathematics department are related in a way that mirrors student achievement differences between Singapore and the USA.

Cultural differences are also prominent in the findings of this study. Particularly, the cultural differences between the countries manifest

themselves in the extent and nature of faculty efforts to enhance student achievement, while HoDs and the departmental cultures they create also impact mathematics achievement (Grouws and Lembke, 1996). The US HoDs in this study expressed a greater need to involve community members in efforts to enhance achievement, while Singapore HoDs often appeared to view community support for achievement-enhancing initiatives as a given commodity. The unique culture of the mathematics department also made itself evident in the HoDs' perceptions of their in-service needs for enhancing achievement. Glover and Miller (1999) found that the effectiveness of enhancement efforts depended upon the readiness of HoDs to embrace newer approaches as well as upon senior managers to empower HoDs to undertake changes within the departmental subculture. Notably, in this study, the HoDs from both countries commonly related their needs for better interpersonal, group and leadership skills – the essential components of endeavors to change the observable functions, structures, and developments that typically comprise a department's culture (Bauersfeld, 1998).

The conclusions that have surfaced from this qualitative, exploratory study give rise to a number of issues that concern mathematics educators in Singapore and the United States. From both conclusions and resultant issues, conjectures about instructional leadership and student achievement may be made, and these conjectures may be the impetus for further, in-depth research. Particularly, there is a growing consensus that mathematics education is a process of cultural interaction (Gerdes, 1998) and that HoDs are key to successful improvement efforts. As a result, it is important that university educators focus on developing among future mathematics teachers and future HoDs, an awareness of the cultural bases of mathematics achievement, as well as the potentially powerful role played by HoDs and other subject leaders in enhancing student achievement.

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