A Meta-analysis of Mathematics Teachers of the GIFT Program Using Success Case Methodology

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The ICMI-ICIAM Discussion Document (DD), *Educational Interfaces between Mathematics and Industry*, states that "…mathematics is said to be used almost everywhere. However, these uses are not generally visible except to specialists." The GIFT program is one whose goal is to bridge this gap through substantive projects which bring practicing math teachers into industrial ("real world") projects during the summer, have them integrate their new experiences back into their classroom, and add flexibility (Section 1.1 of DD) to the thinking of their students. The point of this evaluation research is to see, using Success Case Methodology, whether the goals of the program that we see informally being achieved are supported by data. We will use any "unanticipated consequences" from this analysis to improve the GIFT program, expand the analysis to science projects, and, motivated by DD, lay the groundwork for future GIFT-related projects.

Introduction to the study

The ICMI-ICIAM Discussion Document, *Educational Interfaces between Mathematics and Industry*, talks about "…the intimate connections between mathematics and industry" and, for example, then says that "…mathematics is said to be used almost everywhere. However, these uses are not generally visible except to specialists." The GIFT program is one whose goal is to bridge this gap through substantive projects which bring practicing middle and high school mathematics teachers into industrial projects and then have them integrate their new experiences back into their classroom. Because of time constraints, teachers without firsthand knowledge cannot provide mathematical situations which involve "real life problems." The last sentence of 1.1 in the Discussion Document is especially in agreement with our approach; to wit, "In other words, learners should be equipped for flexibility in an ever-changing work and life environment, globally and locally." From the GIFT experience, the flexibility should change the teachers' outlook and, ultimately, the outlook of their students. The last four of the bullets of the *What are the aims of the Study?* and the last two of *Why is there a need for this Study?* fit well with the goals of the GIFT program. The issues of sections 8 (Curriculum and Syllabus issues) and 9 (teacher training) of the discussion document fits well with regard to the goals of the GIFT project.

The present work lays the groundwork for future projects motivated by the discussion document. The results of the present meta-analysis will ultimately be used as a basis for further analysis in a long term project using a variety of methods for both math and science teachers.

Introduction to the GIFT program

In a commitment to providing first hand connections between classroom activities and real world applications, the Georgia Intern-Fellowships for Teachers (GIFT) initiated in 1991 by the Georgia Institute of Technology is a collaborative effort between industry and education. GIFT provides mathematics, science, and technology teachers in grades six through twelve (students between 12 and 17 years old) 'real life' experiences in the applications of those disciplines. Over time, GIFT has placed 1,515 teachers into summer internship positions of 4-7 weeklong in corporate and university research laboratory settings. From the beginning, participants in GIFT benefited from internships provided by long term industry partners such as UPS, Georgia Power, Cisco, and EMS Technologies; and more recently by partners Nordson Corporation, Solvay Pharmaceuticals, CIBA Vision, Gwinnett Hospital System, RFS Pharma, Optima Chemicals, PCC Airfoils, and Stiefel Laboratories and General Electric. We know anecdotally that these internships have contributed to teachers having increased content knowledge and enhanced teaching practices based on evidence based experiences and now move towards an in-depth analysis. Programs like GIFT are sometimes referred to as "externship" programs.

GIFT is designed with the following goals:

- Provide industry mentors an efficient method of identifying and selecting teachers interested in participating in internships,
- Quickly orient teachers to industry work environments, and mentors to K-12 workplace culture,

- Provide participants (teachers and mentors) support throughout the summer by assigning small groups of teachers to a master-teacher facilitator,
- Assist teachers with creating an "Action Plan" for implementing summer experiences into the classroom or more generally applying the GIFT experience in the classroom,
- Provide support for Action Plan implementation in the classroom through visits by GIFT staff,
- Foster the development of an extended professional community of learners, and
- Encourage extended partnerships for communication and collaboration between teachers and industry mentors and pass that approach on to the students of the GIFT teachers.

Logistics of the GIFT program

To participate in GIFT, sponsors from industry or a university submit an on-line survey which includes a position description describing the nature of the summer work, a list of the skills required of the teacher, and a letter of intent for participation. The teachers complete an on-line application that includes information about their background, courses they have taught, their technology skills and their geographical preference for work locations. GIFT uses information from the sponsor and teacher databases to coordinate the matching of skills with the preferences of both. Sponsors are given access to applications of teachers who meet their job requirements. Sponsors then interview prospective applicants and select a teacher to hire for the summer. Approximately 150 teachers from in Georgia, U.S. apply to the program each year, with a current average placement of 80 teachers per summer.

Once the sponsorships are arranged, each GIFT teacher works with two people. One is a mentor from the industry whom we call an (industry) mentor or sponsor and the second is a facilitator. A facilitator is generally an experienced teacher who has served as a GIFT intern in previous years or a college professor with significant grades sixth through twelfth experience. Facilitators provide guidance in the development of interns' Action Plans, assess the Action Plan, and make recommendation on the allocation of state granted Professional Learning Units (PLUs), a requirement for teachers in the State of Georgia.

Rationale for the study

Research suggests that the quality of the teaching workforce is the single most important factor in predicting student achievement (Darling-Hammond & Ball, 1997). "Quality" has many dimensions, however. Effective teachers must have a solid knowledge of academic content, a high mastery of different pedagogical techniques, an understanding of student developmental issues and different ways of learning, and a strong sense of professionalism. Teachers also must have a satisfactory answer to the inevitable question by students—"When am I ever going to use this"? Other than student learning or developmental issues, industrial workplace environments are in the unique position of being able to help teachers develop their strengths in most of these categories through summer internships. When teamed with facilitators, industry mentors can provide motivated teachers summer experiences that show the uses of math skills in industry, that increase the teacher's content knowledge, and that provide new teaching strategies.

These experiences also provide teachers with first-hand knowledge about how industrial scientists actually approach problems, how they design experiments, how they interpret data, how they communicate orally and in writing, and how they come to and implement workplace solutions. And, in perhaps the most powerful effect of all, the teachers' sense of professionalism from these experiences has a continuing influence on them. In that regard, the GIFT program provides teachers an opportunity to connect classroom activities to real world applications and vice versa.

The point of this evaluation research is to see, using Success Case Methodology, whether the goals of the program that we see informally being achieved are, in fact, supported by data. In addition, we will use any "unanticipated consequences" from this analysis to improve the GIFT program regardless of teacher instructional specialty as long as the insights are transportable to other disciplines.

The purpose of this study is to document the success cases of GIFT mathematics teachers in industrial workplace environment. We identified 23 mathematics teachers, each of whom worked in industrial workplace environment, to construct individual cases. This approach will help us to uncover patterns and develop themes across cases (Yin, 1994). The case studies document the prior experiences, knowledge, and beliefs these mathematics teachers brought to the program, as well as how those factors interacted with their learning from the program and from their own teaching experiences.

The Aims of the Study

It is hoped that this study will broaden the awareness of mathematics teachers and other educators with regard to industrial work place environment and needs with respect to education. In addition, we hope to explore the relationship between mathematics teachers and industrial workplace environment, and the impact of GIFT program on industrial work place environment. We anticipate having first results in March, 2010 in time to report to the ICMI/ICIAM meeting.

Study Design

The Success Case Evaluation Method (SCM)

Brinkerhoff (2003) originally developed the Success Case Method (SCM) to evaluate the impact of interventions on business industry goals. It is a simple process that combines analysis of outstanding groups with case study and story-telling. The primary goal of the model is to assess how well an organizational intervention is working by focusing on extreme (that is, both "success" and "unsuccess") groups (Coryn, Schroter & Hanssen, 2009). It is a way of exploring whether and how well an initiative is working. Furthermore, it is designed to identify the contextual factors that differentiate successful from unsuccessful cases. The stories are supported with evidence to confirm their reality. According to Brinkerhoff (2003);

> A success story is not considered valid and reportable until we are convinced that we have enough compelling evidence that the story would 'stand up in court'…if pressed we could prove it beyond a reasonable doubt .

The core questions of the SCM approach are:

- What is really happening?
- What results are being achieved?
- What is the value of the results?
- How can it be improved?

Although SCM has been used to evaluate training initiatives and new work methods, it has also been used in educational setting to determine the reasons that influence the academic achievement of minority students (Coryn et al. 2007). More recently, SCM has been proposed as an alternative approach to reexamine causal relationships when more scientifically rigorous designs are not practical and not feasible (Brinkerhoff, 2005 ; Shriven, 2006a). SCM is a five step procedure:

1) Focus and plan the SCM
2) Create an impact model

3) Survey all program recipients to identify success and nonsuccess cases
4) Interview a random sample of success and nonsuccess cases and document their stories
5) Document findings, conclusions, and recommendations

According to Coryn (2007), in step one, the researcher needs to determine the focus of the SCM study that can be used for both formative and summative reasons. In step two, the cases are identified as high ("success cases"), moderate (average cases) and low ("unsuccess cases"). The survey method usually is used to identify cases. We are now in the process of constructing the required survey. In step four, these identified cases are used to create a sampling strata that represents both success and unsuccess cases. Therefore, SCM method is an analysis of extreme or outlier cases where independent evidence is sought to support claim of success or failure. Next, the underlying reasons for success and unsuccess cases are investigated using a semi-structured interview method that searches for an explanation from a random sample of extreme cases. In final step, the SCM findings, conclusions and explanations are put together across all cases. Furthermore, the final report is usually presented as a meta- analysis of success stories.

Why SCM method?

In order to learn from GIFT's program impact and to explore the impact of leadership improvement on industrial work place environment, an evaluation methodology was needed. SCM is a valid method to evaluate the GIFT program because it allows the researcher to assess the past efforts in a particular program (Coryn et al., 2009). It is particularly useful as an evaluation method for GIFT because it allows for an in-depth exploration of (1) what impact it is having on mathematics teachers (2) what are the specific barriers that exists in industrial workplace environment that GIFT mathematics teachers encountered. The result of using the SCM is that it can be used to understand and evaluate the effectiveness and impact of GIFT mathematics teachers. Applying SCM to historical data will provide insight for the evaluation through other methods of the GIFT program.

The Developed Impact Model

At the core of the SCM approach, the following Impact Model will be followed:

Capability → Critical Actions → Key Results → Organizational Goals

Capability: What new or improved capabilities were acquired as a result of participation in GIFT?

Critical Actions: What the participants did with the new or improved capability?

Key Results: What did the mathematics teachers achieve?

Organizational Goals: How did the results achieved affect goals of the GIFT program and industrial work environment?

With the SCM method, we will be able to assess the GIFT program with these four categories. In other words, we will assess to what extent the GIFT intervention program developed improved capabilities, and then resulted in improved actions in industrial workplace environment, and whether those actions helped the industrial work environment. Furthermore, we will investigate how those achieved results affected the overall program goals. We will gather information to support this impact model through a combination of survey(s) and interview(s) as well as data verification(s). This research will be also a case study of "stories" as these are compelling ways to demonstrate improved leadership.

The participants for this study will consist of 23 mathematics teachers who did a total of 26 internships and were in the program at least one of the summers of 2007, 2008, and 2009. Demographically, 14 are high school teachers and 9 are middle school teachers. There were African American (16), Caucasian (6) and one Asian-American in the sample. In addition, 17 of them are female and 6 male. Their numbers represent 14 suburban, 6 urban and 3 rural school districts. To assess the program impact, we will interview the teachers about their experience in industrial working environment, and ask them to complete a survey about their experiences with the program.

This proposed study will examine 23 mathematics teacher cases (here, case refers to per internship experience) to determine what impact GIFT is having in the industrial workplace environment. Furthermore, we will identify the barriers to the work. It is possible that we may re-construct our own version of an *Impact Model* based on the information that will be found in the cases while we are analyzing each of the 23 cases. An SCM study results, typically, in two immediate ways. One is "in-depth stories of documented business impact that can be disseminated to a variety of audiences with the company." and a second "Knowledge of factors that enhance or impede the impact of training on business results." (Brinkerhoff & Dressler, 2002).

According to Brinkerhoff (2003), in some cases, the researchers view the logic differently than what had originally written, and they can change some components of the model for consistency across the models. It is important to emphasize that this method allows us to evaluate many cases across the state, and not just cases that are considered successful.

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