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Mathematical Achievement of High School Students Through Community Partnership: A Red Balloon Initative

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The vitality of any modern society depends on the mathematical literacy of its citizens. No longer necessary for just a few key decision makers, mathematics is the most important skill that we can pass on to the future generation. Mathematics, the language of science, economics, engineering, and computer science, must be a skill of the people. In the 21st century, the covenant of public education mandates that colleges and universities be responsible for developing this skill.[2] Unfortunately, the challenges within contemporary mathematics education are acute. The under-performance of American elementary, middle, and high school students on international standardized mathematics examinations has become a consistent element of the American educational landscape (Gonzales et al., 2008; Organisation for Economic Co-operation and Development [OECD], 2010). This deficiency can be seen at the collegiate level in the decreased mathematical readiness of incoming freshmen. In 2010, only 43% of all ACT-tested high school graduates met the Mathematics Readiness Benchmark (American College Testing Program, 2010). Lack of preparation in new college students translates into an increased need for remedial mathematics. At our institution, 28.2% of the incoming freshman class in 2010 required remedial placement for math skills. This percentage was up from 17.6% in 2009. These numbers are representative of an upward trend in remedially placed mathematics students at our institution (Forrest, et al., 2012).

The Mathematics Partnership Program (MaPP) seeks to counter this trend by redefining the role of the Mathematics faculty. As part of the Red Balloon Project, the Stockton College Mathematics Program has partnered with high schools of Southern New Jersey to create the Math Partnership Program.[3] MaPP manifests a philosophical shift in the pedagogical perspective of Stockton's Math Program. Previously, the Mathematics faculty understood their role as educators within the context of a four year experience; it was our responsibility to educate students from the time that they first enrolled until they graduated. We now view our role more holistically without a specific start and stop date. Indeed, if our goal is student learning, then it is our job to improve the mathematical education of potential students and to aid past students in their continuing education. By breaking down the traditional walls of the college experience, we are

extending our influence and responsibility beyond the artificial boundaries that existed previously. Our intent is to redefine the linear approach to college teaching into a full circle experience. We seek to engage both local high school teachers, many of whom are Stockton graduates, and their students, many of whom will soon be our students.

For too long, we have bemoaned the lack of student preparedness without addressing our role in their preparation. Framed under the initiatives of MaPP, we now accept a heightened responsibility towards the education of secondary school students. More specifically, MaPP seeks to improve the mathematical accomplishments of secondary school students of Southern New Jersey by improving the content knowledge of teachers. This focus leverages the strong correlation between the mathematical knowledge of instructors and the achievement of their students in mathematics courses. A significant body of research demonstrates this relationship in a concrete way (Ball, 1990; Goldhaber & Brewer, 1997a; Goldhaber & Brewer, 1997b; Monk, 1994; Rowan, Fang-Shen & Miller, 1997; Wenglinsky, 2000). In accomplishing its objectives, MaPP organically incorporates the ideals of the Red Balloon Project. MaPP increases engagement of both high school teachers and their students; MaPP is economically beneficial to both students and Stockton College; and MaPP utilizes technology to produce a community centric educational environment. We are committed to these ideals and are confident that the sturdy foundation provided by the Red Balloon Project will enable the continued success of our program

The Math Partnership Program (MaPP).

MaPP consists of three major components: an Annual Summer Workshop, initiated in summer 2011; a High School Precalculus for College Credit Program, instituted in the 2011-2012 school year; and a proposed series of Mini-Workshops running throughout the school year paired with a community wiki page.

Annual Summer Workshop. To support the continued mathematical development of our local high school teachers, MaPP instituted an annual summer workshop in 2011. Each summer, approximately 25 teachers from three local high schools participate in the workshop. In the pilot year, workshop participants were immersed in topics from undergraduate curricula with courses on advanced mathematics topics: Non-Euclidean Geometry, Abstract Algebra, and Advanced Calculus. This program successfully improved the content knowledge of participants; all but two of the participating high school teachers improved their scores on a pre-post content assessment. Feedback from the participants also demonstrated that the teachers benefited from the workshop. On a post-survey questionnaire,

the vast majority of respondents indicated that they had learned a great deal in the workshop and were interested in participating in other programs focusing on college-level mathematics.

While our Summer 2011 program was a success, we observed room for improvement. Participants wanted to see a closer connection between content knowledge and classroom teaching. Through conversation with high school teachers and their supervisors, we developed a program that emphasized this connection for summer 2012, thereby providing a more direct link between teacher skills and student achievement. In particular, we provided a forum for the investigation of topics relevant to the core curriculum standards for the state of New Jersey. The revamped workshop consisted of sessions discussing student misconceptions in Precalculus and Calculus, mathematical themes that connect from elementary through undergraduate education, the rationale supporting high school mathematics material, and the role of Precalculus in preparation for Calculus. Through this discussion, the community of local mathematics instructors formed a cohesive partnership. In describing the most successful aspects of the workshop, participants cited sessions aimed at group exploration of mathematical questions and discussions of the connections between undergraduate and secondary mathematics; these are precisely the topics that will improve student engagement in their classrooms. All but two of the participants either agreed or strongly agreed that their interactions during the workshop were beneficial and engaging. However, the most telling feedback was the simplest. In response to an open ended prompt, the vast majority of comments were extremely positive and supportive of the workshop's design; the improvement from summer 2011 was plainly evident. Engaging the high school teachers in building the workshop created an experience that will better serve the teachers and their students.

High School Precalculus Courses for College Credit. Among a subset of the teachers who are taking part in MaPP, we have implemented an initiative in which their students receive college credit for Precalculus taught under their direction. The Precalculus for College Credit component of our program is beginning its second year of implementation and has grown in participation and design. In its pilot year, three teachers, one from each of the participating schools, took part in the Precalculus for College Credit component of MaPP. In its second year, there are six teacher participants, and the course offerings now include Calculus in addition to Precalculus. This component of MaPP not only provides the teacher participants of the program with the opportunity and encouragement to execute their skills in the classroom but also demonstrates the Stockton Math Program's confidence in the partnership. Maintaining a working rapport with the

educators who are representing Stockton College at the high school level is of paramount importance to the process of continued engagement; it builds confidence in the skill base of the teachers, and it provides us with direct evidence of the impact MaPP has on their students.

Mini-Workshop Series and Wiki. Growth of the program and sustained engagement of the participants require a forum for sustained interaction. We are currently developing a model for the final component of our program that promotes continued conversation among the stakeholders. The proposed model includes the implementation of mini-workshops at participating high schools throughout the school year and the use of a wiki page that provides a networked knowledge base for our participants. The mini-workshop sessions are driven by mathematical questions from the teachers' classrooms. During the sessions, teachers will engage in mathematical exploration to understand better the mathematics they are teaching. The mini-workshops will counter the standard "expert model" that is prevalent in professional development seminars by focusing on a communal exchange of ideas. The ideas discussed in the mini-workshops will be compiled into a community-wide mathematics education wiki page, an informational web page that can be edited by the community it serves. The wiki will be the shared responsibility of the workshop organizers and participants. It will provide the teachers with a resource for finding answers to questions that occur in their teaching and will establish collaboration outside of the walls of a single high school. Most importantly, the wiki will continue the dialogue among all the stakeholders beyond the traditional forms of interaction.

MaPP as a Red Balloon Project

MaPP represents a pedagogical shift from the expert driven "sage on a stage" model to a networked model of communal knowledge. This perspective permeates each component of our program. MaPP is, at its heart, a community partnership (Forrest et al., 2012). It is from this scholarly point of view that MaPP addresses the three defining ideas of the Red Balloon Project, as articulated by Mehaffy (Mehaffy, 2010). In its design, MaPP is increasing student engagement in response to greater expectation of learning, responding to the strained economic times facing students and institutions alike, and redesigning the role of the faculty member based on 21st century advancements in technology.

Increased Engagement. Engaging students more effectively and producing greater learning outcomes are two significant goals of the Red Balloon Project that MaPP addresses. MaPP expands the audience engaged

by Stockton's Mathematics faculty beyond those currently enrolled at Stockton to include former students, our local high school teachers, and also future students, current high school students.

MaPP engages high school teachers by improving their mathematical content knowledge. Within the broad knowledge base of mathematical content, the focus of MaPP is dynamic, evolving based on the input of all stakeholders in the partnership. This dynamic nature is evident in the shift in the mathematical content of the summer workshops from the pilot year to the second year. Our shift in focus was a result of collaboration with the teachers and their supervisors as we collectively pursued an understanding of the relationship between undergraduate and high school mathematics content. Our collaboration has not only changed the content of the summer workshops, but also the very nature of our program. MaPP has quickly evolved into a fully formed partnership between Stockton College and the surrounding high school districts (Forrest et al., 2012).

MaPP engages high school teachers in mathematical inquiry, the process of questioning and understanding the truth of mathematical facts. MaPP does not provide the answers to all of these questions; no one has all of the answers and that would defeat the point. We seek simply to start the teachers on the path of exploration and to re-kindle the joy they once found in mathematical discovery. While mathematical inquiry may appear to be a solitary endeavor, collaboration and conceptual networking are essential to the process. The engagement inherent in mathematical exploration is exhibited in each component of MaPP. Within the workshop component, this communal mathematical investigation of high school content occurs directly. Via the wiki, mathematical inquiry is enabled as instructors can pose their questions to a network of peers. Within the Precalculus for College Credit component of our program, this exploration takes the form of discussion between collegiate and high school instructors bridging the mathematical gap between their educational environs. Mathematical inquiry permeates MaPP, engaging our community of educators.

The increased engagement of teachers intrinsically encourages greater engagement of their students. As teacher skills are strengthened through participation, so too are the skills of their students. Within MaPP, evidence of increased student engagement is particularly apparent in the Precalculus for College Credit component. The students in the program earned an average GPA of 3.3 in the course, and every student completed the course with a C or better. The students participating in the Precalculus for College Credit component successfully reached the deeper level of understanding of Precalculus required for Stockton credit. Through MaPP, the participating high school students were engaged at a collegiate level of learning.

Response to Economic Climate. The economic struggles facing public institutions have left colleges with the unenviable choice between raising tuition on students who are themselves facing economic hardships or cutting essential programs and services to offset the loss of funds. At Stockton College, we reject the premise that these are the only two options. Within the Precalculus for College Credit component of MaPP, we are reducing costs for students and increasing revenue for the college while providing a higher level of service in the process. This is the classic "win-win" situation. The students taking Precalculus within the context of MaPP pay $100 per college credit, a substantial savings in comparison to the usual cost per credit at Stockton College of $473. In addition, students do not incur any fees associated with matriculated status at the college and do not face any additional costs associated with travel or textbooks. The credits for this course appear as full college credits, and are transferable to any college or university.

While students are benefiting with regards to this financial agreement, Stockton College is also increasing revenue. Primarily, Stockton is generating income based on the four-credit contract with these students. This revenue has a great potential for growth as the program increases in numbers and as other college programs follow. The college is paying a small stipend to the faculty liaison working on this partnership, but for the most part this income is not offset by any financial output.

Beyond this basic addition of funds, Stockton is building equity with the surrounding community that will have potential economic benefits to the college in the future. By building a relationship with area high school students and their parents, we are creating a pool of future students. Students interact with faculty members in a positive experience that can only help to attract them to Stockton for their future education. MaPP also promotes a positive image of Stockton within the community, thereby increasing the community's goodwill towards the college and support of the college's outreach programs.

Adapting to Technological Age. With the advent of technology, there has been a dramatic shift in the way that students learn, and yet there has been little change in the way in which students are taught. Redefining the role of the educator in the 21st century goes beyond simply providing the student with technological tools in the educational process. MaPP is not simply proposing that we need more online courses to remain "current." Instead, we believe that the model for learning must be adapted to better fit the network of knowledge that now exists. At the heart of this shift is a communal approach to learning that is facilitated by technology (Mehaffy, 2010). Each aspect of MaPP encourages a partnership of shared learning and ideas, but this tenet is most evident within the mini-workshop and wiki component of our program.

The model for our mini-workshop sessions is straightforward. We provide a forum for teachers to raise their mathematical content questions to an organized community of mathematics instructors. While learning the answers to specific classroom questions is important, the main goal of these sessions is to engage interactively with teachers in the mathematical process in a communal setting. The basic tenets of our approach are grounded in mathematical inquiry and are fundamental to the ideas of the Red Balloon Project: we are smarter together than we are alone.

The wiki component of MaPP takes this philosophy one step further by disseminating the results of the mini-workshop discussions to all of MaPP's stakeholders and to other mathematics instructors. With the aid of this technological resource, we are expanding the conversation beyond isolated instances, to a more regular interaction. Our wiki allows MaPP to leverage our shared expertise to aid our community. The wiki provides a forum for this interaction, a resource for instructional learning, a record of the process, and a means for reaching a wider audience of mathematics instructors. With the wiki, MaPP takes advantage of the unique opportunity for cascading participation afforded by technology.

Outcomes

MaPP has produced positive results for local high school students, local high school teachers, the Stockton College Math Program, Stockton College as a whole, and the surrounding community. The partnership has engaged teachers in a variety of ways: by refreshing their mathematical content knowledge, by incorporating their vision into the program, and by enabling their voice in a community of mathematics educators. These gains for teachers translate to increased achievement for their students, as many students have met the challenge of the increased rigor presented in their Stockton credit bearing Precalculus courses. Increased engagement is not limited to these two groups, and the Stockton Mathematics faculty continue to learn from this partnership as it grows (Forrest et al., 2012). MaPP began with the modest goal of redefining the influence and responsibility of the math faculty to reach students beyond the formally defined four years of study. This program has evolved into a fully formed partnership that addresses each of the challenges delineated by the Red Balloon Project while redefining the role of the educator. With a focus on increased student engagement, MaPP is employing a teaching style that relies on the network of knowledge supported in this technological age in a way that is economically prudent. This partnership remains true to the covenant of public education by providing an excellent education to an ever widening audience as it addresses the public good.

Endnotes

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[2]"Historically, the covenant between public universities and the American people has been grounded in wide access, excellent curricula, research of value to people and communities, and public governance and financing" (Kellogg Commission on the Future of State and Land-Grant Universities [Kellogg Commission], 2000).

[3]The Richard Stockton College of New Jersey was established in 1971 with one comprehensive mission: provide an Ivy League quality education that is open and affordable to the masses. The Stockton plan was rooted in the philosophy that a college education ought to be a transformational experience (Daly, 2011). Although this was, arguably, not a new idea, Stockton's approach to this task was a fresh take on the existing model of higher education. Stockton was built on humanistic values that directly address the covenant that public education has with society. The most striking aspect of Stockton's design was its renewed commitment to the liberal arts experience. Stockton pioneered an innovative General Studies program arguing that "under emerging economic conditions of accelerating and unpredictable change, the breadth of education traditionally provided by the liberal arts might actually constitute the best possible career education" (Daly, 2011). This is no less true in today's uncertain economic climate. In a recently published book of essays detailing 40 years of the college's existence, the editors sum up the Stockton Experience as it applies to the future: "At a time when state funding is being cut and the public commitment to education is on the wane, we present Stockton College as a beacon of the values we hold. To paraphrase President Herman Saatkamp, education is a promise we make to the generations we never see. What will that promise be worth if we do not maintain our commitment to the kind of humanistic values on which Stockton College was founded?"

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