# Facing the realities of "high-stakes" testing while keeping science and engineering outreach alive

Keith Williamson[1], Hassan Ndahi[2], Sharon Waters[3], Laura Nelson[4]

[1]East Carolina University/ [2]Old Dominion University/[3]Tidewater Community College/ [4]Portsmouth City Public Schools

## Abstract

This paper discusses the impact of *high-stakes* testing on the K12 outreach experiences of science and engineering graduate students. As the use of accountability systems continue to evolve as a basis for measuring the performance of schools, there is a threat to meaningful science and engineering outreach since teachers often use the results of *high-stakes* assessment as their primary reference point for evaluating the merit of innovative teaching practices and career induction experiences for students. We found that science and engineering outreach activities combined with teacher professional development seminars and a socio-constructivist framework for teaching provide an effective approach for limiting the use of accountability systems as the sole reference for success. Similarly, the approach helped teachers cope with the pressures of *high-stakes* testing while conducting professional experimentation to change their attitudes and beliefs about science and engineering topics. Specifically, the use of graduate students as content-resources in classrooms creates a collaborative environment that encourages teachers to avoid tendencies to narrow curriculum standards and spend large amounts of instructional time preparing students for *high-stakes* tests.

## 1. Introduction

For decades, the main strategy for engineering outreach involved activities designed to motivate and attract students using the wonder and excitement inherent in the processes of design and discovery. Typically, matters related to curriculum alignment were left to the classroom teacher and university faculty involved in the outreach. Beginning in the 70s, the importance of statewide and national accountability testing in the U.S. has risen steadily. In the reauthorization of the Elementary and Secondary Education Act (ESEA), *No Child Left Behind*[1] the federal government signaled a further increase in the use of accountability systems to measure student performance. In effect, the *NCLB* mandates that schools meeting accountability standards be given bonuses[2] and schools not meeting these goals first be given assistance then later sanctions such as loss of crucial state or federal funding. This emphasis on the preparation for and the results of accountability tests has changed the school environment for partnerships between university faculty and classroom teachers. For struggling schools, assistance often involves intervention in terms of new leadership designated as "turn-around specialists" to reverse organizational behavior patterns believed to contribute to the failure to meet accountability standards. In some schools, these specialists exacerbate teacher turnover,



*Proceedings of the 2005 American Society of Engineering Education Annual Conference & Exposition*

curtail outreach activities in preference for curricula tightly bound to test objectives and extra-curricula programs such as "Saturday School" to provide as much instructional time as possible preparing students for accountability tests[3]. A study[4] on the impact of one such accountability system showed that 97 percent of the 78 teachers surveyed increased instruction in tested objectives while 75 percent stopped teaching topics that were not included on the test. In many schools, the topics that are often left out provide important contexts for helping students attach the personal meaning necessary for science and mathematics activities to lay the foundation for early career induction experiences in engineering and related fields.

This shift towards accountability and away from context presents a new challenge for engineering outreach. The new reality requires engineering faculty to be more mindful of how outreach activities support teacher professional development, particularly teacher knowledge, interests, and development goals in topics related to engineering. One innovative approach for connecting teacher needs to engineering outreach is to partner graduate students from engineering and sciences with classroom teachers. Teachers and K12 students benefit from having a "role model-expert" or "role model-content resource" in the classroom for up to 20 hours per week, and graduate students build critical communications skills while developing an appreciation for the day-to-day challenges of nurturing the next generation of science and engineering professionals. In the current article, we report on our experiences with the National Science Foundation's *Graduate Teaching Fellows in K-12 Education (GK-12) Program.*

The *GK12* program at Old Dominion University[*] is based on a constructivist approach for learning as an active and continuous process where students take information from the classroom and construct personal interpretations and meanings based on prior knowledge and experience.[5-6] In this model, *graduate fellows* approach fourth and fifth grade classrooms from the constructivist perspective that social interactions within the classroom create learning experiences that incorporate knowledge as a shared commodity among members of the community.[7-8] In this sense, *graduate fellows* as "role model-experts" or "role model-content resources" leverage the social interactions within the classroom environment to produce apprentice situations where 4th and 5th grade students as novices engage in the same problem solving activities as graduate students in the role of experts.[4]

## 2. University outreach to local public schools

To ensure that the *GK12* program was relevant to both teachers, K12 students and graduate fellows, the school district and university project team set the following performance criteria: (1) graduate students should understand and be able to manage the social environment in 4th and 5th grade classrooms; (2) teachers should know how to integrate graduate fellows as effective content resources "experts"; (3) university faculty should understand teachers' professional development needs and provide related support for teachers. To meet these criteria, five professional development seminars were established throughout the school year to prepare graduate fellows for the classroom environment and engage disciplinary faculty in teacher professional development. The

[*] Award# 0139336 Engineering Graduate Fellows and Master Teachers for Grades 4-5

five seminars (listed in Table 1) were developed to: (1) help broaden teachers' content knowledge in science, engineering and mathematics; (2) provide graduate fellows with an overview of teaching pedagogy and management strategies for $4^{th}$ and $5^{th}$ grade classrooms; (3) provide an opportunity for graduate fellows and teachers to interact and exchange ideas as experts in their fields, and; (4) provide a forum to discuss how reflective practice should inform education theory.

| Title | Time/ Instructor |
|---|---|
| Seminar I: Managing Inquiry and Social Interactions in the Classroom | Fall / District Science Supervisor |
| Seminar II: Mini-Economy Model | Fall/University, Economics Faculty |
| Seminar III: Gender Perspectives in Science & Engineering | Fall/ University Psychology Faculty & Virginia Space Grant Consortium |
| SeminarIV: Applied Mathematics – Educated Guesses | Spring / University Mathematics Faculty |
| Seminar V: Engineering Problem Solving | Spring/ University Engineering & Occupational /Tech Studies Faculty |

Table 1. Professional Development Seminars for teachers and graduate fellows

One of the underlying themes of the *GK12* project is to transform the university's culture to view outreach to public schools as an integral part of graduate education, and as a necessary step in ensuring that the nation produces a well-trained and educated population for excellence in science, engineering and mathematics innovation.[9] Consequently, in developing the teacher-graduate fellow professional development seminars, a multi-disciplinary faculty team of faculty PIs were selected from at least one department in four of the University's colleges including Business, Education, Engineering and Science. The goal was to broaden faculty participation as much as possible. Similarly, participation by graduate fellows from multiple science and engineering disciplines expanded the network of faculty participating in additional roles as research advisors.

## 3. Results and Discussion

To gage the success of the seminars and the impact of graduate fellows in the classroom, we tracked school improvement data for the first two years of the project and used a 5-point Likert scale to compare general impressions from teachers and graduate fellows on how they saw the challenges of engaging students and the perceived barriers to testing new ideas (professional experimentation) in the classroom. The Likert scale varied from 1 (strongly disagree) to 5 ( strongly agree).

Figures 1-3 show student achievement data and responses from 7 teachers and 14 graduate fellows. Figure 1 summarizes a comparison of the different perceptions of the school environment among teachers and graduate fellows. The goal was to compare how closely graduate fellows' impressions matched teachers' impressions on factors that influence how $4^{th}$ and $5^{th}$ grade students derived personal meanings from the mathematics and science activities developed as a result of our project activities. These factors included (a) students' behavior; (b) students' prior knowledge, (c) relevance of project activities to students' personal experience, and; (d) scheduling of mathematics and science activities during the school day. Figure 2 shows student achievement on state accountability tests for science. Figure 3 shows graduate fellows' and teachers' responses on their general impressions on three factors that influence their willingness to try new ideas in the classroom. These factors included: (a) school resources; (b) administrative support, and; (c) parental support.

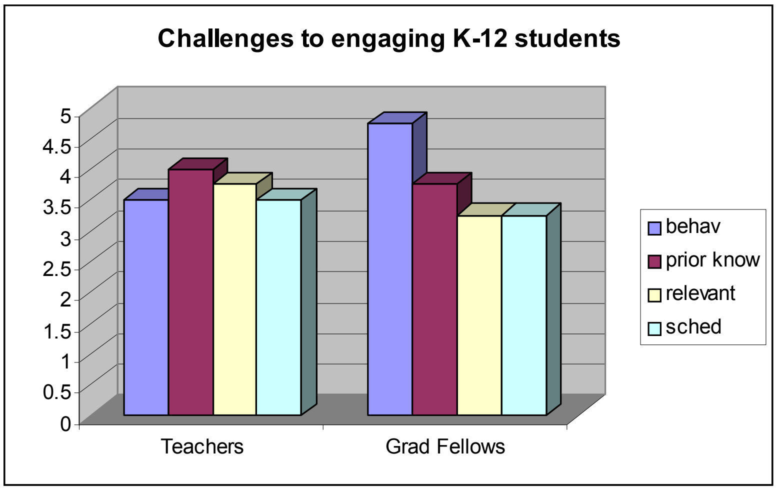


Figure 1. Teacher and graduate fellows responses on engaging K-12 students

In Figure 1,graduate fellows' impression of the challenges to student engagement were consistent with teachers' impressions except for challenges related to student behavior. One possible explanation for this difference in perspective on the significance of behavior as a challenge to engagement could be influenced by graduate fellows' role identity in the classroom. This role identity[10] has to do with the way graduate fellows see themselves in the classroom and the personal biographies they bring to it. Since *at-risk* students are the majority in our partners schools, these results suggest that impressions of student behavior might be shaped by how graduate fellows negotiate the tensions between "authoritative discourse" – the dialogue that defines graduate fellows' roles in fulfilling curriculum goals – and "internally persuasive discourse" – the dialogue that defines what graduate fellows' believe about *at-risk* students and struggling schools.[11]

One aspect of helping graduate students better understand the K12 environment is to help them confront the difference between their perspectives and the perspectives of experienced teachers who understand the complexities of teaching children placed *at-risk* because of social and economic barriers. The seminar on managing social interactions and inquiry was important for helping graduate fellows establish a framework for engaging students and developing perspectives on how social factors such as poverty, family breakdown, substance abuse, violence, and homelessness affected classroom behavior. In shaping these perspectives, the seminar on managing social interactions helped graduate fellows better understand the work of teachers of *at- risk* students, and helped them draw distinctions between working *with* instead of *on* teachers' deficits as perceived by student achievement on accountability tests. The seminar prepared graduate fellows for the subjective task of developing personal meanings for important questions such as: What does it mean to teach *at-risk* students? And, how can school-based and university-based educators collaborate to explore innovative approaches for teaching and supporting these *at-risk* students?

This context for personal meaning set the framework for graduate fellows to help 4$^{th}$ and 5$^{th}$ grade students develop personal meaning from the mathematics and science activities developed for the project. One innovation that emerged from this joint search for personal meaning is a *Standards of Learning Science (SOLS) Baseball* activity developed by one of our graduate fellow- teacher teams. The activity integrates elements of economic game theory and positive interdependence[12] to help students learn science facts that prepare them for the state's accountability exam. Since adopting the *SOLS Baseball* game, student achievement at some of our partner schools have shown dramatic gains. In some cases, improvements reversed steep declines in scores from previous years, as indicated in Figure 2. Although it is difficult to claim that all the gains have been the result of the GK12 Program and activities such as *SOLS Baseball*, the results in Figure 2 offer encouraging insights.

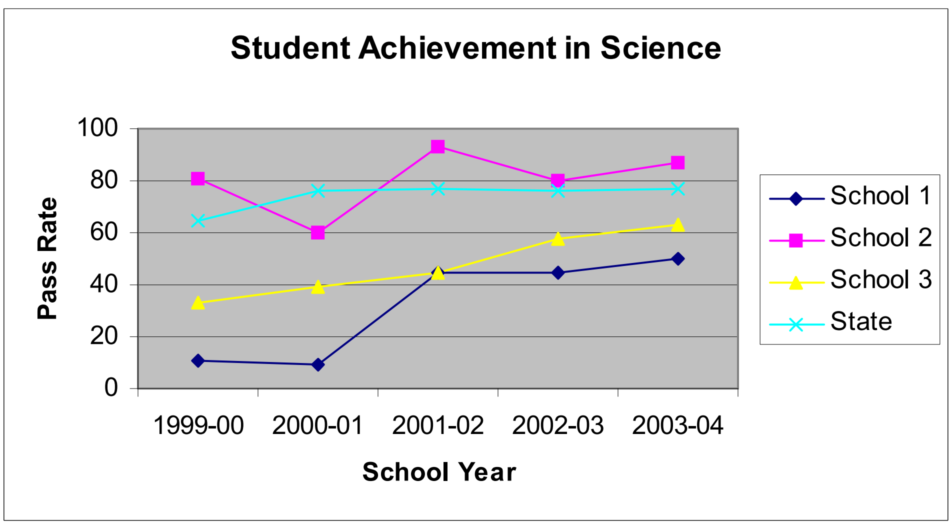


Figure 2. Student achievement in science for three G4-5 partner schools

Results from our survey of the graduate fellows' perception of the barriers to professional experimentation was very different from classroom teachers as shown in Figure 3. Specifically, teachers' and graduate fellows' perceptions of resources differed based on how they perceived the resources provided to the school. Discussions during the seminars revealed that although some teachers held negative views of the resources provided as part of the state's intervention program, they did not believe these interventions interfered with their willingness to try new ideas in the classroom. In sharp contrast, graduate fellows saw these interventions as limiting teachers' professional experimentation; however, graduate fellows saw more value in the resources provided by intervention than teachers. These differences in perspective warrant further study, particularly since both graduate fellows and teachers shared similar perspectives on *teacher change* as involving changes in attitudes, beliefs, and classroom practices that influence learning outcomes.[13-14] Teachers suggested that the state's intervention programs and the resources provided with them were based wholly on perceived deficits in teachers' knowledge and skills while graduate fellows tended to see these resources mostly in terms of monetary value. Some teachers argued that these resources ignored the real problem facing *at-risk* students. They echoed district wide concerns[15] that *at-risk* 4th and 5th grade students often arrive at school hungry, without enough sleep or unprepared because they were baby-sitting siblings instead of studying. Although the goal of the state's intervention program was to affect changes in teachers' knowledge and beliefs and consequently changes in classroom practice and higher student achievement, teacher and principals reflected research findings[14] that such intervention programs often neglect social factors and follow misleading models for teacher professional development. Within the school district, there were several different types of intervention depending on the perceived level of need at a particular a school. Some schools were assigned partnership teams made up of teachers from successful schools outside the district

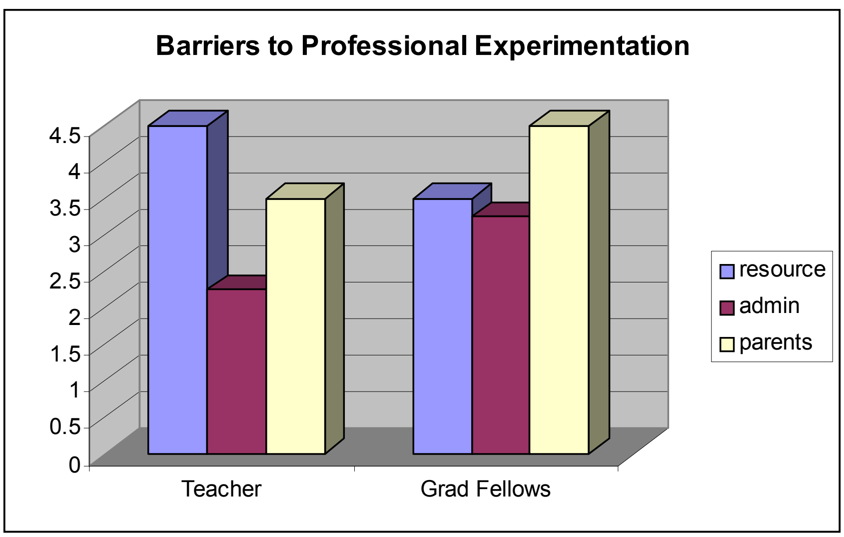


Figure 3. Teacher and graduate fellows responses on barriers to experimentation

while others were put under the more aggressive watch of an auditor who provided recommendations and followed up periodically to make sure recommendations were being adopted. Another possible explanation for the different perspectives on the barriers to experimentation is the wide variation in intervention models (each of the three schools had a different intervention model) and the different effect each intervention model had on student achievement. Graduate fellows who experienced more successful interventions reported that these partnerships succeeded because they were based on trust and the sharing of innovative strategies. On the other hand, graduate fellows who experienced more troubled interventions reported that these partnerships failed because the relationships lacked trust and were filled with excessive criticism. Despite these varied experiences with intervention partnerships, the exposure deepened graduate fellows' interest in teacher change literature[14] and broadened their perspectives on how significant changes in teacher beliefs and attitudes influence professional experimentation and the desire to "field test" new ideas and evaluate these ideas in terms of student learning outcomes beyond those measured by accountability tests.

Besides the insight on teacher experimentation, the results also suggest that GK12 graduate fellows developed a framework for teacher professional development that put *change in teacher's classroom* practice as the first step in the teacher change process.[13] This perspective suggests that changes in classroom practice leads to changes in student learning outcomes and finally changes in teacher's beliefs and attitudes. While more elaborate models exist,[14,16] this perspective provides an adequate framework for helping graduate fellows assess their role in the teacher change process. In the current project, graduate fellows spent the entire school year in 4th and 5th grade classrooms gaining experience and providing direct input into classroom practice. Much of what graduate fellows and the teachers themselves reported and the collaborative framework with graduate fellows as "in-class content resources" for teachers[17] support classroom experimentation that help teachers integrate science and engineering outreach and University/K12 partnerships into strategies to improve student achievement on state accountability tests.

## 4. Conclusions

The GK 12 program allow interactions between expert and novice in schools labeled *at-risk* due to complex social and economic barriers including poverty and a history of low student achievement. Collaboration between graduate fellows and teachers in these schools are vital for reversing poor student achievement and helping teachers sustain role identities that withstand the emotional burdens of preparing for, administering and receiving the results of *high-stakes* tests.

## 5. Bibliography

1. U.S. Congress. (2001) *No child left behind act of 2001.* Washington D.C.
2. Boardman, A. and Woodruff, A. (2002) "Teacher change and high-stakes assessment: what happens to professional development?" *Teaching and Teacher Education*, 20, 545-557
3.Wall, D. (2000) "The impact of high-stakes testing on teaching and learning: can this be predicted or controlled?" *System* Vol. 28
4. Moore, W. (1994) "The devaluation of standardized testing: One district's response to a mandated assessment" *Measurement in Education* 7(4) 343-367
5. Von Glasterfeld, E. (1995) "A constructivist view of teaching" In *Constructivism in Education* (Eds Steffe, P. and Gale, J.) Lawrence Erlbaum Publishers, Hillsdale, N.J.

6. Jarvinen, E. ( 1998) “The Lego/Logo Learning Environment in Technology Education: An Experiment in a Finnish Context” *Journal of Technology Education* 9(2)
7. Konold, C. (1995) “Social and cultural dimension of knowledge and classroom teaching” In *Constructivism in Education* (Eds. Steffe, P. and Gale, J.) Lawrence Erlbaum Publishers, Hillsdale, N.J.
8. Rogoff, B. (1990) *Apprenticeship in thinking: Cognitive development in social context.* Oxford University Press, N.Y.
9. The U.S. Commission on National Security/ 21st Century (2001) *Roadmap for National Security: Imperative for Change*
10. Friesen, D., Finney, S., and Krentz, C. (1999) “Together against all odds: towards understanding the identities of teachers of at risk students” *Teaching and Teacher Education* ,5, 923-932
11. Britzman, D. (1991) *Practice makes practice,* State University New York Press, N.Y.
12. Williamson, K., Land, L., Butler, and Ndahi, H. (2004) “A structured framework for using games to teach mathematics and science in K12 classrooms” *The Technology Teacher,* 11, 15-18.
13. Guskey, T. (1986) “Staff development and the process of teacher change” *Educational Researcher, 15(5),* 5-12
14. Clarke, D. and Hollingsworth, H. (2002) “Elaborating a model for teacher professional growth” *Teaching and Teacher Education,* 18, 947-967
15. Gruss, M. (2003) “Three Portsmouth schools fail: students can be tutored” *The Virginian Pilot,* August 16th.
16. Cobb, P., Wood, T. and Yackel, E. (1990) “Classrooms as learning environments for teachers and researchers” In *Constructivist views on the teaching and learning of mathematics* (Eds. Davis, R.B., Mayey, C., & Noddings, N..) National Council of Teachers of Mathematics, Reston, VA.
17. DeGrazia, J, Sullivan, J., Carlson, L., & Carlson, D. “A K12/University Partnership: Creating Tomorrow’s Engineers” *Journal of Engineering Education,* (90), 4, 557-563.

## AUTHORS’ BIOGRAPHIES

Dr. Keith Williamson is an Associate Professor in the Department of Technology Systems at East Carolina University. He received his Ph.D. in Mechanical Engineering from Tufts University. He is the Principal Investigator on the GK12 project and has received numerous awards for teaching and research. Dr. Williamson’s current research is focused on University/K12 partnerships and thermo-mechanical processing. He was previously on the faculty in the Department of Mechanical Engineering at Old Dominion University.

Dr. Hassan B. Ndahi is an Associate Professor in the Department of Occupational and Technical Studies at Old Dominion University. He received his Ed.D in vocational and technical education at Oklahoma State University. Dr. Ndahi has worked on numerous research projects as PI and Co-PI. His research interest include professional development, design and technology, production technology and distance learning.

Sharon C. Waters is the Grants Officer and Assistant Professor at Tidewater Community College in Norfolk, Virginia. She received the Master of Fine Arts degree in Cinema from the University of Southern California and is currently a Ph.D. candidate at Regent University. A Research Advisor on the National Science Foundation's GK-12 project and the Board Chair for GK-12 partner, CHROME (Cooperating Hampton Roads Organizations for Minorities in Engineering), Ms. Waters current research interests are the influence of media portrayals of scientists, engineers, and technology workers on women and underrepresented minorities and the public understanding of science.

Laura J. Nelson is the Director of K-12 Science Education for Portsmouth Public Schools in Portsmouth, VA. She earned a Bachelor's degree from Wheaton College, MA in Biology/Chemistry and a Master's degree from Old Dominion University, VA in Educational Leadership and Supervision. She has been the recipient of many awards for teaching, supervision, and curriculum and instruction. Recently, she was awarded a Mathematics and Science Partnership Grant through the Virginia Department of Education that unites five public school districts, five public and private universities and colleges, and the Virginia Space Grant Consortium. Laura Nelson's focus is to promote STEM partnerships between the K-12 community and the colleges/universities.