AC 2009-885: THE TECT WORKSHOP: RAISING HIGH-SCHOOL TEACHERS' AND GUIDANCE COUNSELORS' SELF-EFFICACY IN COUNSELING STUDENTS ABOUT ENGINEERING CAREERS AND MAJORS

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The TECT Workshop: Raising High School Teachers and Guidance Counselor Self-Efficacy in Counseling Students about Engineering Careers and Majors

Introduction

The United States faces a serious shortage of scientists, engineers, technologists, and mathematicians because high school students, especially those from underrepresented groups, are increasingly losing interest in these subjects [1]. Reversing this trend requires promoting science, technology, engineering and math (STEM) subjects and professions in a more socially relevant, real-world context and recognition of the differences in learning styles and self-efficacy between males, females and minorities [2, 3, 4]. As STEM teachers and school guidance counselors are a primary catalysts for introducing students to engineering and technology subjects and careers, the **T**eaching **E**ngineering to **C**ounselors and **T**eachers (TECT) professional development workshop has been developed by the University of North Carolina at Charlotte (UNC-Charlotte) to strengthen the way in which high school teachers and counselors approach the integration of engineering based materials into their courses and counseling.

The TECT workshop, a National Science Foundation (NSF) funded proof-of-concept project, incorporates the well-established STEM model of hands-on problem-based learning to improve student learning and comprehension. To reinforce this approach, the TECT workshop makes use of existing engineering related student summer camps to conduct concurrent teacher and counselor in-service education and promote best practices that reach across the diversity of student learning styles and interests. In the TECT workshops, the teachers and counselors interact with students in the summer camps, learn new engineering and pedagogical content, and participate in teaching selected summer camp activities.

To date, three TECT workshops have been held that have included a total of 29 STEM teachers and 15 guidance counselors from 24 local area high schools. This paper first presents the framework for the project and discusses some of the innovative materials and content developed. Finally, the paper concludes with some of the results and findings that demonstrate the workshop's potential to significantly increase participants' self-efficacy in counseling students about engineering careers and majors.

The Challenge: Bridging the Engineering Awareness Gap

According to Thomas L. Friedman, in *The World is Flat: A Brief History of the 21st Century*, America now imports foreigners to do the scientific work that its citizens no longer want to do or even know how to do [5]. Nearly one in five scientists and engineers in the United States is an immigrant, and 57 percent of doctoral candidates in engineering are foreigners [6]. In 2004, women only comprised 10% of the tenured/tenure-track faculty in U.S. engineering colleges, minorities only 5.3% [7].

In addition, the NSF report *Women, Minorities, and Persons with Disabilities in Science and Engineering: 2000* states that, although some progress has been made at all levels of education and employment, women are still less likely to choose careers in science and engineering [8].

Additionally, the numbers and percentages of minorities in engineering related careers are decreasing [9]. If left unchecked, these trends will jeopardize the country's economic future; therefore, more effective action is required to expand the pool of scientists and engineers by increasing the numbers of high school graduates who are interested in engineering and, in particular, finding innovate ways to attract more women, minorities, and persons with disabilities [10].

This effort requires us to teach more of our youth about the importance of science and technology in our rapidly changing, rapidly shrinking world. However, this becomes a formidable challenge as 90% of society at large indicated that they were not very well informed about the engineering profession [11]. Therefore, it is not surprising then that many high school students do not choose to pursue engineering careers. This lack of awareness and its impact is highlighted by a study performed by the Maui School System which reported that significantly more females than males indicated they would enroll in more math and science classes ***if*** there were good job opportunities associated with math and science [12], indicating that females were not aware of the extensive opportunities in STEM careers.

For most high school students, the primary exposure to technical professions comes from their STEM classroom teachers and/or their guidance counselors. However, a study performed by Ferris State University indicated that 51% of high school students felt that ***no one*** within their high school had been helpful in providing career advice or guidance [13]. A study at the New Jersey Institute of Technology indicated that, while counselors may have positive attitudes towards engineers and discuss engineering as a possible career with their students, they lack rudimentary knowledge about engineering careers [14]. Other studies have shown that girls are actually "tracked away" from math and science careers by both teachers and counselors [15].

Teachers tend to have higher expectations for boys than for girls, especially in the area of math and science. These lowered expectations translate into less rigorous instruction for girls compared to boys [16]. Current research indicates that many female high school students feel that career counselors have discouraged them from taking math courses [17]. In addition, counselors tend to promote engineering only to their very best and brightest female students while at the same time encouraging academically average male students to consider engineering majors [2].

Because of these and other observed failures in our STEM education system, the National Science Board identified the following priorities for ensuring a world-class education in STEM fields for all Americans [18]:

- Strong public support for the value of STEM education for all students and citizens,
- A high quality teaching workforce,
- Appropriate opportunities to learn for all students,
- Effective guidance counseling on STEM education and careers, and
- Assessment tools that reinforce learning in STEM fields.

The TECT Workshop Model

In response to this call to improve STEM education and to raise student awareness of engineering careers, the TECT project was developed with the following goals in mind:

GOAL 1: *Improve* STEM educational programs and career guidance counseling in high schools within the Charlotte, North Carolina region through enhanced STEM-based teacher professional development workshops focused on engineering.

GOAL 2: *Enlarge* the pool of technical and diversity trained teachers and counselors within the Charlotte, North Carolina region by recruiting and training mentors to conduct TECT-based training within their own school districts.

GOAL 3: *Broaden* the diversity of students engaged in STEM educational programs and opportunities in high schools within the Charlotte, North Carolina region.

The key component of the 3-year NSF funded proof-of-concept TECT project is a one week long professional development workshop for high school STEM teachers and guidance counselors. The focus of the workshops is to teach the participants about engineering while training them in hands-on techniques and classroom practices that can be used to overcome latent gender and minority based biases that STEM teachers and counselors bring to the classroom [2, 19]. If teachers are to be effective in stimulating student interest in engineering, they must be knowledgeable in the technical areas themselves [20]. In addition, we need to increase the information about engineering careers that school counselors give high school students. Moreover, the engineering topics and profession need to be presented in a socially relevant context [2, 3, 4].

In order to reinforce the concepts presented, the TECT workshops have been integrated with engineering focused student summer camps currently being hosted by UNC-Charlotte as part of a separate NSF project. The summer camps are used as a vehicle to allow the TECT participants the opportunity to experience the diversity of students within the engineering camps, observe the hands-on activities and classroom techniques used during the camps, and to practice skills learned in the TECT workshop. The capstone practicum for the TECT workshop requires the teacher participants to prepare a lesson plan incorporating a hands-on engineering activity and delivering the lesson to the summer camp students while the counselor participants conduct a group career counseling session with the summer camp students.

At the conclusion of the workshop, participants are required to develop formal work plans describing the engineering content and activities they intend to incorporate into their classrooms or counseling during the course of the next semester. A one day follow-up meeting with all participants is held at the end of the semester in which participants are asked to report and critique their experiences in completing their work plans and incorporating TECT concepts into their classrooms.

The learning objectives, describing what participants should be able to do by the end of the TECT workshop, are outlined in Table 1.

Table 1
Learning Objectives for TECT Workshop

1. ***Articulate*** the importance of K-12 engineering education.
    a. Recognize the nation-wide shortage of engineers and technologists.
    b. Describe the overall decline in students entering engineering related majors.
    c. Characterize the demographics of students entering engineering related majors.
2. ***Explain*** engineering career opportunities within a global and societal context.
    a. Identify and contrast the engineering disciplines as outlined by ASEE.
    b. Relate the changing roles and skills of the engineer-of-the-future.
    c. Outline academic preparation requirements and available academic pathways.
3. ***Critique*** the impact of diversity in promoting engineering careers.
    a. Recognize student differences in career and identity development.
    b. Identify and evaluate differences in student learning styles.
    c. Assess the need to improve the self-efficacy of marginalized students.
4. ***Formulate*** lesson plans incorporating engineering content that support North Carolina Standard Course of Study objectives.
    a. Correlate specific academic discipline topics to related engineering content.
    b. Identify and access available K-12 engineering education resources.
    c. Evaluate the effective use of competitions and team building activities.
    d. Plan, complete and evaluate an assigned hands-on engineering activity.

To achieve these learning objectives, the workshop is presented in a series of modules that range from an introduction to the general field of engineering to pedagogical strategies best suited for teaching engineering concepts to specific coverage of the major sub-fields on engineering. In addition, modules are included that address student diversity and learning styles. Separate breakout sessions specifically tailored to the informational needs of the guidance counselors have also been developed. The overall outline of the workshop is shown in Table 2.

Each of the discipline specific modules contains one or more discipline related hands-on activities that participants complete. Participants were provided strategies for tying the activities into a variety of North Carolina Standard Course of Study requirements for high school level STEM courses. Low cost projects using common supplies and materials were deliberately chosen to ensure that cost was not a barrier to implementation into the normal public school classroom. Projects include K'nex and/or file folder bridges, windmills made from drinking straws, dismantling discarded cell phones, electronic bread boards, and sprinkler systems values and piping to create artificial heart values, etc. The modules were scheduled to run concurrently with the same discipline module being presented in the student summer camps. This provides the participants with the opportunity to observe additional hands-on activities and classroom strategies. In the windmill activity, teachers and students actually work as teams to complete the exercise. In addition, TECT participants are expected to deliver a lesson plan developed as part of the biomedical engineering module to the summer camp students as part of a teaching practicum.

Studies have shown that any effective pre-college outreach program geared towards increasing diversity in engineering must [2, 19]:

1. Promote awareness of the engineering profession;
2. Provide academic enrichment to participants;
3. Address teacher effectiveness; and
4. Support the educational system of the participants.

The TECT project has been structured to meet these criteria through its integrated career guidance training, teacher development, and integration with student summer camp activities. The research hypothesizes that this mix of diversity awareness based teacher professional development training coupled with improved career guidance counseling training will provide a necessary foundation to increase the number and diversity of students entering STEM related fields.

Table 2:
TECT Workshop Outline

Section 1: Setting the stage for the TECT workshop
- Module 1: Workshop Welcome & Opening

Section 2: Establishing the theoretical foundation for the TECT workshop
- Module 2: Classroom & Student Diversity
- Module 3: Collaborative and Active Learning Strategies

Section 3: Exploring Engineering Disciplines
- Module 4: A Day in the Life of an Engineer
- Module 5: Engineering Profession Overview and Academic Pathways
- Module 6: Biological and Biomedical Engineering Overview & Activity
  - Module 6B: Math & Science Connections: Biomedical (Teachers)
  - Module 6C: Exploration of Engineering Related Career Guidance Materials (Counselors)
- Module 7: Civil & Construction Engineering Overview
  - Module 7B: Math & Science Connections: Bridges (Teachers)
  - Module 7C: STEM Careers & Motivation (Counselors)
- Module 8: Mechanical Engineering Overview & Activity (Combined with Summer Camps)
  - Module 8B: Math & Science Connections: Windmills (Teachers)
  - Module 8C: Attributes and Traits of Successful Engineers (Counselors)
- Module 9: Electrical & Computer Engineering Overview
  - Module 9B: Math & Science Connections: Electric Circuits (Teachers)
  - Module 9C: Profiles in Engineering (Counselors)

Section 4: Teacher & Counselor Practicum
- Module 10A: Teacher Practicum with Summer Camps (Teachers)
- Module 10B: Strategies to Generate Interest in Engineering (Counselors)
- Module 11: Critique and Open Discussion of Teacher Practicum & Counselor Strategies

Section 5: Workshop Follow-up Activities
- Module 12: Engineering Related Educational Resources (computer lab)
- Module 13: Post-Workshop Action Plans
- Module 14: Engineering Outreach & JETS Clubs Activities
- Module 15A: Additional Math & Science Connections (Teachers)
- Module 15B: Counselor Focus Group Discussion with Summer Camps (Counselors)
- Module 16: End of Workshop Open Discussion & Evaluation

Section 6: Post-Workshop Feedback & Reinforcement

Research Methodology

Three TECT workshops have been conducted to date, one during the summer of 2007 and two during the summer of 2008. The combined workshops have included a total of 29 STEM teachers and 15 guidance counselors from 24 local area high schools representing seven school districts. Table 3 provides a breakdown of some of the group demographics. As part of the project, each participant receives a $500 stipend upon their successful completion of the 5-day workshop and a $100 stipend upon completion of the one day follow up meeting.

Table 3:
2007& 2008 TECT Workshop Participant Demographics

Female	61%
Male	39%
White	63%
African-American	36%
Tenure of service:	2 years to 30 years (median 6.5 years)

To evaluate the effectiveness of the workshop materials, two surveys were administered to the workshop participants. The first was a multi-cultural awareness survey adapted from a study conducted by Ponterotto, et al. [20]. The second survey focused on the participants' perception of engineering; the survey was adapted from a study of counselors' attitudes and knowledge about engineering at the New Jersey Institute of Technology [14]. The surveys were administered both prior to and at the completion of the workshop in order to assess any changes in attitudes or perceptions created by the workshop. The attitude towards engineering survey (ATES) was also administered during the one-day workshop follow up meeting. This paper reports on only some of the results from the ATES survey.

The ATES has three primary measures: 1) the Attitudes to Engineering Scale, 2) a Counseling Efficacy measure, 3) a Knowledge of Engineering Careers measure plus a short demographic section. The Attitudes to Engineering Scale measures opinions about stereotypes of engineers and engineering, the skills necessary for engineering, the perceived rewards of becoming and engineer, and what engineers actually do. The Counseling Efficacy measure is a self-report of teachers' and counselors' working knowledge about information sources to help prepare students for a career in engineering and the extent to which they actually encourage students to study engineering. The Knowledge of Engineering Careers measure is a multi-part, open-ended question designed to measure how much counselors know about different types of engineers.

The Attitudes to Engineering Scale has 26 items that ask workshop participants to indicate the degree to which they agree or disagree with statements about engineers and engineering as a career using a five point Likert-type scale. The Counseling Efficacy measure has 13 items that ask participants whether they have or know where to find specific kinds of information necessary to prepare students for a successful career in engineering, what types of careers they suggest to students who excel in math and science, and whether they specifically encourage students to pursue engineering. The Knowledge of Engineering Careers measure asks counselors to name five different types of engineers and to give an example of the work each type of engineer does.

An ANOVA procedure with a 95% confidence level was used to compare the pre-workshop and post-workshop survey results in order to determine whether or not any statistically significant changes in participants' awareness and perception towards engineering occurred due to the workshop. A MANOVA procedure was planned to compare the post-workshop follow up meeting survey results with the survey results from the workshop in order to assess the persistence of any changes in attitude over time. However, only 59% of the participants were able to return for the follow up meeting and the remaining population sample size was deemed too small to yield any valid results.

Results and Lessons Learned from the TECT Workshop

The survey data for all three workshops were aggregated and the results of the statistical analysis are reported in Table 4. An alpha level of $p = 0.05$ was used as a significance criterion for the statistical tests. The *F* factor is the result of the one-way analysis of variance and the *P-value* is the probability of the change occurring by chance. The reported changes are statistically significant when the *F* factor is greater than *F critical* or the *P-value* is less than *p*.

As can be seen, the change in overall attitude towards engineering was statistically significant for the combined group as well as for math teachers and guidance counselors although it was not significant for science and technology education teachers. This is likely a result of science and technology education teachers having a greater prior awareness of engineering due to the closer relationship of their fields to engineering topics. However, the increase in the participants' engineering-related counseling self-efficacy was statistically significant for all groups.

Table 4

2007 & 2008 TECT Workshop Impact on Participant's Attitude towards Engineering

ANOVA Statistical Analysis of Pre-workshop and Post-workshop Responses (p = 0.05)

Survey Component	*F*	*P-value*	*F critical*	*significance*
Overall Attitude Towards Engineering				
Combined *(n=41)*	26.759	1.67E-06	3.960	significant
Math Teachers *(n=12)*	10.558	3.68E-03	4.301	significant
Science Teachers *(n=8)*	3.831	7.06E-02	4.600	not significant
Tech Ed Teachers *(n=8)*	3.733	7.38E-02	4.600	not significant
Counselors *(n=13)*	9.159	5.83E-03	4.260	significant
Engineering Counseling Self-Efficacy				
Combined *(n=41)*	83.210	5.06E-14	3.960	significant
Math Teachers *(n=12)*	33.400	8.17E-06	4.301	significant
Science Teachers *(n=8)*	30.816	7.14E-05	4.600	significant
Tech Ed Teachers *(n=8)*	5.618	3.27E-02	4.600	significant
Counselors *(n=13)*	34.982	4.21E-06	4.260	significant

The change in the 5-point Likert mean scores is reported in Table 5. Changes in mean scores ranged from 0.254 to 0.393 for the overall attitude towards engineering. Technology education teachers had the smallest change, again probably due to the close relationship between technology education and engineering topics. Counselors, on the other hand, showed the largest increase in scores which is an indication that their initial awareness of engineering may be less than desired considering their important role in counseling students about engineering.

Table 5
2007 & 2008 TECT Workshop Impact on Participant's Attitude towards Engineering
Changes in 5-point Likert Scale Mean Scores by Participant Discipline on ATES (p = 0.05)

Survey Component	5-point Likert Mean Scores			*statistical significance*
	Pre-Workshop	*Post-Workshop*	*Change*	
Overall Attitude Towards Engineering				
Combined *(n=41)*	1.908	1.572	0.336	significant
Math Teachers *(n=12)*	1.926	1.612	0.314	significant
Science Teachers *(n=8)*	1.880	1.524	0.356	not significant
Tech Ed Teachers *(n=8)*	1.796	1.542	0.254	not significant
Counselors *(n=13)*	1.976	1.583	0.393	significant
Engineering Counseling Self-Efficacy				
Combined *(n=41)*	2.802	1.623	1.179	significant
Math Teachers *(n=12)*	3.064	1.718	1.346	significant
Science Teachers *(n=8)*	2.837	1.404	1.433	significant
Tech Ed Teachers *(n=8)*	2.649	1.625	1.024	significant
Counselors *(n=13)*	2.633	1.669	0.964	significant

Changes in mean scores ranged from 0.964 to 1.433 on the engineering counseling self-efficacy component. This essentially one point or larger improvement on a 5-point Likert scale is very large and is indicative that participants' left the workshop feeling much more confident about talking with and counseling their students about engineering majors and careers. Even the technology education teachers showed improvement despite the fact that most technology education curriculum is already tied closely to engineering subjects. The improvement in engineering related counseling self-efficacy is the most significant result of the workshop as the hypothesis of the project is that this increased awareness and counseling self-efficacy will translate into high school teachers and guidance counselors motivating more students to pursue engineering majors. Whether or not this impact on students occurs due to the TECT workshop still must be established through more rigorous longitudinal studies that are beyond the scope of the current project.

Anecdotal evidence of the potential of the TECT workshop to affect this change was provided by a high school math teacher that attended one of the 2008 workshops. Using skills and methods developed at the TECT workshop, the teacher revised a pre-algebra level course by incorporating several engineering related activities tied to the mathematical concepts being covered. Before beginning the activities, the teacher talked to the students about engineering and asked them how many were interested in being an engineer. None raised their hands. After completing the activities, the teacher surveyed the students and received the following responses:

- *"Engineering would have been a fun field for me because we would've learned more from it." (female)*
- *"Yes I would consider engineering as a career because it's more than sitting and its hands on to making and designing."(male)*
- *"I think engineering would be a fun field, but it's too much math."(female)*
- *"I think it would be fun but difficult."(female)*

- *"I do think engineering would be a fun field because I like putting my mind to work to create something."(female)*
- *"I would like to be an engineer because if it's as fun as the project is it would be really exciting."(female)*
- *"Yes I think engineering would be fun but it would be a little hard."(female)*
- *"Engineering would be a really fun field because you get to use your imagination to create things."(male)*
- *"It would be a fun field but hard."(male)*
- *"I would like to be an engineer because I'm going to be a nurse." (female)*

Positive feedback concerning engineering improved from 0% positive to 45.5%. Positive feedback from females was 46.7% and from males 42.9%. This occurred in basically a remedial level math course with students that had limited prior positive experiences with math and technical subjects and demonstrates the potential of TECT-related teacher training to impact students. Of course, whether or not any of these particular students ultimately pursue engineering majors remains an open question.

Another example was the case of a female student who expressed interest in studying medicine but after learning about biomedical engineering from their guidance counselor, decided to pursue engineering as a major instead. Without the TECT workshop, such an occurrence would have been unlikely as the counselor admittedly knew little about bio-medical engineering prior to attending the workshop. Additional anecdotal feedback from teachers and counselors on how they have used their TECT training to positively impact students' awareness and perceptions of engineering could be reported except for space limitations within this paper.

Conclusions

Preliminary results from the TECT project indicate that the workshop increased participants' positive attitudes towards engineering and improved their self-efficacy in counseling their students about engineering majors and careers. Anecdotal feedback received from participants indicate that they have been able to use the TECT training to positively impact students' awareness and perceptions of engineering Additional workshops are planned for the summer of 2009 in order to further validate the model and results. Of course, any long term impact from the TECT workshop still needs to be proven and verified. Particularly, whether or not the TECT model has any verifiable impact on increasing both the number and diversity of students pursuing engineering and technology related majors.

As a proof-of-concept project, the TECT project will be evaluated to determine its potential effectiveness and long term viability. If the workshop proves effective, strategies for expanding the project and developing its sustainability after NSF funding has expired will be explored. However, pending final results, we believe the integrated mix of diversity awareness based teacher and counselor professional development training and the summer engineering camps provides a necessary foundation to increase the number and diversity of students entering STEM related fields.

References

1. Clark, J.V., *Minorities in Science and Mathematics: A Challenge for Change,* Virginia Parent Information and Resource Center, 2000.
2. Baum, Eleanor, "Recruiting and Graduating Women: The Underrepresented Student", *IEEE Communications Magazine*, December 1990, pp. 47-50.
3. Extraordinary Women Engineers Project, "Extraordinary Women Engineers Final Report, April 2005", National Science Foundation Grant No. EEC-0438810.
4. Zuga, K.F., "Addressing Women's Ways of Knowing to Improve the Technology Education Environment for All Students", *Journal of Technology Education*, Vol. 10, No. 2, 1999, pp. 57-71.
5. Friedman, T.L., *The World is Flat: A Brief History of the 21st Century*. New York: Farrar, Straus, Giroux, 2005.
6. Chubin, D.E., May, Gary S., and Babco, E.L. *Diversifying the Engineering Workforce*, Journal of Engineering Education, January 2005, p 73-86.
7. Engineering Workforce Commission of the American Association of Engineering Societies, *Engineering and Technology Degrees*, 1973-2003.
8. National Science Foundation, *Women, Minorities, and Persons with Disabilities in Science and Engineering: 2000,* Arlington, VA. 2000. (NSF00-327).
9. Milbourne, L.A., *Encouraging Girls in Science and Math,* The ERIC Review, Vol. 6, Issue 2
10. Kowalenko, K., *Increasing Diversity in America's Science, Engineering, and Technology Fields,* The Institute, IEEE, Dec., 2000.
11. Davis, L.A. and Gibbin, R.D., Editors, "Raising Public Awareness of Engineering", National Academy of Engineering, 2002, 108 pages, ISBN: 0-309-08624-8.
12. Maui Economic Development Board, Inc. Women in Technology Project, "Assessment Report Part Two – The Maui County High School Technology Survey", Kihei, Maui, 2001.
13. Career Institute for Education and Workforce Development, *Decisions Without Direction: Career Guidance and Decision-Making Among American Youth*, Hurley, D. and Thorp, J. editors, Ferris State University, 2002. http://www.constructmyfuture.com/pdf/dwd_report.pdf
14. Gibbons, S.J., Hirsch, L.S., Kimmel, H., Rockland, R., Bloom, J., "Counselors' Attitudes and Knowledge About Engineering", *Proceedings of the International Conference on Engineering Education*, July 21 – 25, 2003, Valencia, Spain
15. American Association of University Women Educational Foundation, "Shortchanging Girls, Shortchanging America", Washington, D.C., 1991.
16. Sadker, M. and Sadker, D., "Failing at Fairness: How America's Schools Cheat Girls", New York: Scribner, 1995.
17. National Research Council (NRC) Center for Education (CFE); NRC Committee on Science and Mathematics Teacher Preparation (CSMTP), *Educating Teachers of Science, Mathematics, and Technology: New Practices for the New Millennium,* National Academy Press (NAP), 2001.
18. National Science Board, *America's Pressing Challenge – Building a Stronger Foundation*, Arlington, VA. 2006 (NSB-06-02)
19. May, G.S. and Daryl, E.C., "A Retrospective on Undergraduate Engineering Success for Underrepresented Minority Students", *Journal of Engineering Education*, Vol. 93, No. 1, 2003, pp. 1-13.
20. Ponterotto, J.G., Burkard, A., Rieger, B.P., Grieger, I., D'Onofrio, A., Dubuisson, A., Heenehan, M. Millstein, B., Parisi, M., Rath, J.F., and Sax, G., "Development and Initial Validation of the Quick Discrimination Index (QDI), *Educational and Psychological Measurement, 55*, 1016-1031, Dec. 1995

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