# USING ORAL EXAMS AS AN ASSESSMENT METHOD IN ENGINEERING COURSES

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TEDU
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# DEEPER UNDERSTANDING OF THE SUBJECT?

- Most engineering courses are assessed by written exam papers that mainly require mathematical answering.
- How much emphasis is put on the descriptive questions in an engineering exams?

# OUTLINE

- Communication Skills for 21st Century Engineer
- ORAL EXAMS – RESERVATIONS ABOUT THE PROs and CONs
- Oral Exam: Advantages + Disadvantages
  - For the student and the examiner
- A case study: TEDU ME SOLID MECHANICS COURSE
  - A rubric for the oral assessment
- Discussion and possible suggestions?

# COMMUNICATION SKILLS (ORAL + VISUAL) FOR THE 21ST CENTURY ENGINEER

- "Communication skills" is one of the 11 key components required by an undergraduate program in ABET (*Baum, E., 2000, Engineering accreditation in the USA*).
  - Needs to be incorporated into the curriculum instead of a stand-alone subject!
- English is accepted as the most widespread language in the world and cited as the major language of science (*Kitao K., 1996, Why do we teach English?*)
- Oral communication is a "LEARNABLE SKILL" (*Polack-Wahl, J.A., 2000, It is time to stand up and communicate*)
- Engineering profession relies on clear communication of visual forms (drawings/diagrams…) → Processing complex information through graphical means.
- EQ (emotional intelligence) means motivation, self-awareness, self-regulation, empathy and social skills → need to be incorporated into student education
  - IQ falls short without EQ! (*Salovey, P. and Meyer, J.M., 1998, Emotional Intelligence*)

# ORAL EXAMS – RESERVATIONS ABOUT THE PROS AND CONS

- Students get intimidated when it comes to oral exams
  - Is it the presentation part??
  - Is it the preparation part??
- ORAL EXAMS NEED APPROPRIATE DESIGN: The examiner needs to very carefully prepare to maximize available time!
- ORAL EXAMS NEED APPROPRIATE ADMINISTRATION:
  - The examiner needs to very carefully prepare to minimize bias!
  - The examiner needs to familiarize the students with the process to decrease anxiety

# ADVANTAGES FOR THE STUDENT

# GIVES DIRECT FEEDBACK/"SELF-CORRECTING NATURE":

IMMEDIATE DIAGNOSIS AND CORRECTION OF ANY MAJOR MISCONCEPTIONS

# THINKING OUT LOUD:

A STUDENT WILL START A RESPONSE, AND THEN, EVEN BEFORE THEY HAVE COMPLETED THEIR INITIAL THOUGHT, WILL SEE A BETTER WAY TO LOOK AT THE PROBLEM AND LOGICALLY WORK THEIR WAY TO A CORRECT ANSWER FROM A NEW STARTING POINT.

# ENCOURAGES IN-DEPTH PREPARATION:

THE UNIQUE ANXIETY ASSOCIATED WITH BOTH PUBLIC SPEAKING AND TESTING CAN PROVIDE A POWERFUL IMPETUS FOR STUDENT PREPARATION

# CREATES COMMUNICATION OPPORTUNITY:

STUDENTS GET A CHANCE TO ORALLY CONVINCE THE EXAMINER THAT THEY KNOW THE MATERIAL

# VALUABLE PRACTICE FOR FUTURE PROFESSIONAL ACTIVITY:

ADVANTAGE IN ORAL INTERVIEWS AND FUTURE JOB-RELATED PRESENTATIONS

# NO ANTICIPATION:

STUDENTS APPRECIATE THIS AS IT REMOVES THE PERIOD OF UNCERTAINTY BETWEEN WHEN THE TRADITIONAL EXAMINATION TAKES PLACE AND WHEN THE MARK IS GIVEN

# PSYCHOLOGICAL SIDE:

STUDENTS DO NOT WANT TO PERFORM POORLY IN SUCH A PERSONAL SITUATION, THUS THEY PREPARE MUCH BETTER!

(THE «PERSONAL COMPONENT» HELPS THE STUDENTS WHO LACK MOTIVATION IN PARTICULAR)

# ADVANTAGES FOR THE EXAMINER/INSTRUCTOR

# CLEAR COMMUNICATION:

THE DIALOGUE FORMAT DECREASES MISCOMMUNICATION IN BOTH QUESTIONS AND ANSWERS.

NON-VERBAL (PARALINGUISTIC AND VISUAL) CUES AID INTERPRETATION OF STUDENT RESPONSES.

IDENTIFIES AND DECREASES ERROR VARIANCE DUE TO GUESSING.

# CORRECT/DIRECT ASSESSMENT:

MEASUREMENT OF STUDENT ACHIEVEMENT IN CONSIDERABLY GREATER DEPTH AND BREADTH IS POSSIBLE THROUGH FOLLOW-UP QUESTIONS, PROBES, ENCOURAGEMENT OF DETAILED CLARIFICATIONS

# RESISTANT TO PLAGIARISM:

STUDENTS MUST EXPLAIN CONCEPTS USING THEIR OWN WORDS.

"SPEECH IS ONE WAY IN WHICH INDIVIDUALS HELP TO FORM THEIR OWN PEDAGOGICAL IDENTITIES. IT HAS AN AUTHENTICITY THAT WRITING CANNOT POSSESS"

*Barnett, R., 2007. A will to learn: Being a student in an age of uncertainty.*

# -ZERO- CHEATING:

EXCELLENT TOOL TO AVOID CHEATING IN THE EXAMS (IF THAT IS AN ISSUE…)

# REDUCED GRADING STRESS:

MORE «FRONTLOAD», LESS «BACKLOAD»

# THINKING OUT LOUD:

## EXAMINE THE STUDENTS' THOUGHT PROCESSES

# ALLOW FOR INSTRUCTOR GROWTH:

## PRECIOUS TIME FOR MENTORING

# DISADVANTAGES

# TIME

Oral exams require an instructor to set aside anywhere from 15 to 60 minutes to meet with each student.

# TIME - POTENTIAL SOLUTION

- Using oral exam as a part of the assessment (i.e. Asking part of the exam to be presented).
- Asking for graduate student help.

# STUDENT RESISTANCE AND INEXPERIENCE

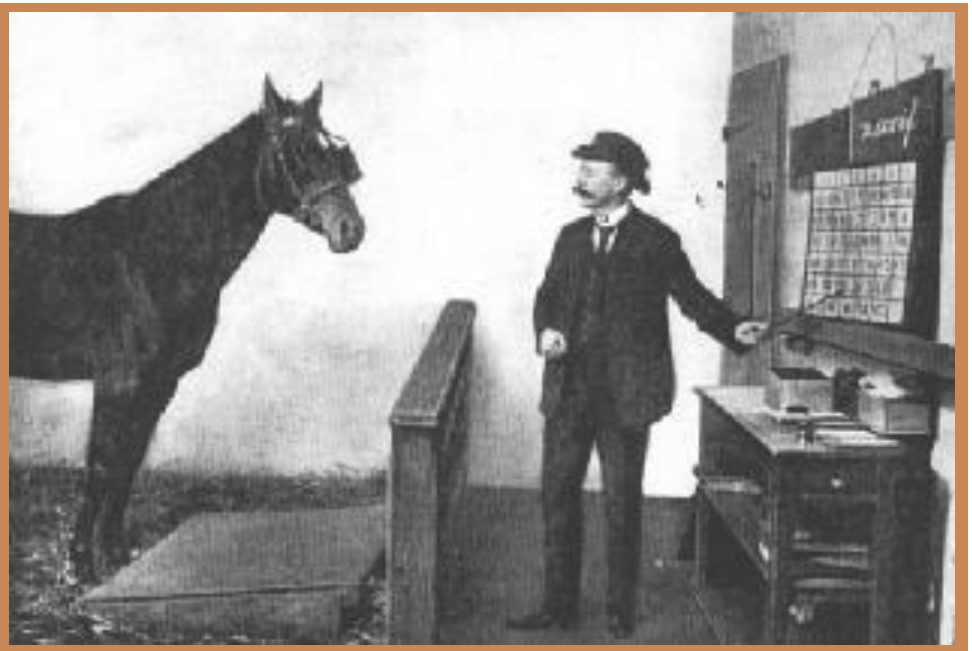
- Public speaking can cause considerable anxiety for students.
- Might unfairly favour the extrovert and confident student.

# STUDENT RESISTANCE AND INEXPERIENCE - POTENTIAL SOLUTION

- Distribute grading info (rubric) and inform well before the exam about all the details.
- Prearrange "standard" questions and how to deal with typical students' problem responses; "pilot" training simulations.
- Take time to establish open, non-threatening atmosphere for testing.
- Electronically record oral exams for more detailed evaluation later.

# "CLEVER HANS" PHENOMENON:

- The counting horse: Kluge Hans stamping its hoof!
- A form of involuntary and unconscious cueing.
- However, engineering courses are less open to simple cues…



# SUBJECTIVE GRADING/BIAS:

Compared to usual formats like multiple choice, short answer, or problem solving, oral exams require more discretionary judgment when grading

# BIAS - POTENTIAL SOLUTION:
## A «PERFECTLY DESIGNED» GRADING RUBRIC

Jamie Douglas and Rachel Knighten developed a rubric for engineering mechanics course in University of Wisconsin - Fox Valley;

Jamie Douglas, Ph.D., assistant professor of engineering, and Rachel Knighten, Ph.D., associate professor of world languages, were honoured with the Kaplan award for their collaborative effort to design and implement oral exams as an alternate learning assessment in an engineering mechanics course. By offering another kind of examination instead of traditional pen-and-paper tests, Douglas and Knighten were able to demonstrate a positive impact on student learning.

| | 1 | 2 | 3 | 4 | 5 | Multiplier |
|---|---|---|---|---|---|---|
| **Vocabulary / Terminology** | Unable to use proper technical terminology to discuss problem and solution | Unsure of proper terminology | Student needs to be prompted to clarify, is unaware of specialized technical terms | Generally uses proper terminology to describe problem, may need some support but generally knows proper technical terms | Uses proper terminology to describe problem, includes specialized vocabulary specifically related to topic | 0.3 |
| **Content** | Unsure of how to work problem. Unable to draw and label correct figures. Unable to determine or recall equations. | Frequent prompting to draw figures and/or help with determining which equations to use to solve problem | Needs prompting to draw or label correct figures and/or arrive at the proper equations. | Draws and labels correct figures and uses correct equations, uses equations out of order or in an illogical sequence | Draws correct figures, uses correct equations in logical sequence | 1.5 |
| **Solution** | Needs frequent prompting to arrive at correct answer with correct number of significant digits and units. Makes multiple sign errors or sine/cosine errors. | Needs frequent prompting to arrive at correct answer with correct number of significant digits and units. Makes sign error or sine/cosine errors. | Needs some prompting to arrive at correct answer with correct number of significant digits and units. May make sign error or sine/cosine errors. | Arrives at correct answer with correct number of significant digits and units with minimal prompting. | Arrives at correct answer with correct number of significant digits and units. | 1.4 |
| **Organization / Command of Problem** | Student is unable to explain or understand the problem-solving method or the meaning of the problem's answer. | Student cannot explain problem solving-process clearly, needs prompting to understand the process and/or meaning of the problem's answer. | Student cannot explain problem solving-process clearly, or appears to rely on memorization of problem solving methods to explain. | Student provides some insight into problem solving-process and can explain significance of answer. | Student can explain problem-solving process and explain the meaning of the answer. | 0.5 |
| **Effort & Motivation** | Student fails to communicate beyond bare minimum. | Student struggles to communicate, relies on instructor to fill-in gaps. | Student needs assistance. Answers questions willingly; elaborates with prompting. | Student participates willingly in the interview, may need some guidance. Elaborates with little or no prompting. | Student engages listener and shows initiative during the interview. | 0.3 |

# CONTENT (x 1.5)

| | | | | |
|---|---|---|---|---|
| **Unsure** of how to work problem.<br>**Unable** to draw and label correct figures.<br>**Unable** to determine or recall equations.<br>**1** | **Frequent prompting** to draw figures and/or help with determining which equations to use to solve problem<br>**2** | **Needs prompting** to draw or label correct figures and/or arrive at the proper equations.<br>**3** | Draws and labels **correct** figures and uses correct equations, uses equations out of order or in an **illogical sequence**<br>**4** | **Draws correct figures, uses correct equations in logical sequence**<br>**5** |

# SOLUTION (x 1.4)

| | | | | |
|---|---|---|---|---|
| **Needs frequent prompting** to arrive at correct answer with correct number of significant digits and units. **Makes multiple sign errors** or sine/cosine errors. | **Needs frequent prompting** to arrive at correct answer with correct number of significant digits and units. **Makes sign error or sine/cosine errors**. | **Needs some prompting** to arrive at correct answer with correct number of significant digits and units. May make sign error or sine/cosine errors. | **Arrives at correct answer** with correct number of significant digits and units **with minimal prompting**. | **Arrives at correct answer with correct number of significant digits and units**. |
| 1 | 2 | 3 | 4 | 5 |

# ORGANIZATION / COMMAND OF PROBLEM (x 0.5)

| | | | | |
|---|---|---|---|---|
| Student is **unable to explain or understand the problem-solving method** or the meaning of the problem's answer. | **Student cannot explain problem solving-process clearly**, **needs prompting** to understand the process and/or meaning of the problem's answer. | Student cannot explain problem solving-process clearly, or appears to **rely on memorization** of problem solving methods to explain. | Student **provides some insight** into problem solving-process and **can explain significance of answer**. | **Student can explain problem-solving process and explain the meaning of the answer.** |
| **1** | **2** | **3** | **4** | **5** |

# VOCABULARY/TERMINOLOGY (x 0.3)

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| **Unable to use proper technical terminology** to discuss problem and solution | **Unsure of proper terminology** | **Student needs to be prompted** to clarify, is unaware of specialized technical terms | **Generally uses proper terminology** to describe problem**, may need some support** but generally knows proper technical terms | **Uses proper terminology to describe problem, includes specialized vocabulary specifically related to topic** |

# EFFORT AND MOTIVATION (x 0.3)

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Student **fails to communicate beyond bare minimum**. | Student **struggles to communicate**, relies on instructor to fill-in gaps. | **Student needs assistance**. Answers questions willingly; elaborates with prompting. | **Student participates willingly in the interview, may need some guidance.** Elaborates with little or no prompting. | **Student engages listener and shows initiative during the interview**. |

# CONTENT AND SOLUTION

| | 1 | 2 | 3 | 4 | 5 | Multiplier |
|---|---|---|---|---|---|---|
| Content | Unsure of how to work problem. Unable to draw and label correct figures. Unable to determine or recall equations. | Frequent prompting to draw figures and/or help with determining which equations to use to solve problem | Needs prompting to draw or label correct figures and/or arrive at the proper equations. | Draws and labels correct figures and uses correct equations, uses equations out of order or in an illogical sequence | Draws correct figures, uses correct equations in logical sequence | 1.5 |
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# OTHER FACTORS

| | 1 | 2 | 3 | 4 | 5 | Multiplier |
|---|---|---|---|---|---|---|
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| Effort & Motivation | Student fails to communicate beyond bare minimum. | Student struggles to communicate, relies on instructor to fill-in gaps. | Student needs assistance. Answers questions willingly; elaborates with prompting. | Student participates willingly in the interview, may need some guidance. Elaborates with little or no prompting. | Student engages listener and shows initiative during the interview. | 0.3 |

| | 1 | 2 | 3 | 4 | 5 | Multiplier |
|---|---|---|---|---|---|---|
| Vocabulary / Terminology | Unable to use | | | Generally uses proper | | 0.3 |
| Content | figures. Unable to determine or recall equations. | equations to use to solve problem | the proper equations. | out of order or in an illogical sequence | sequence | 1.5 |
| Solution | Needs frequent prompting to arrive | Needs frequent | | | nt | 1.4 |
| Organization / Command of Problem | explain or understand the problem-solving method or the meaning of the problem's answer. | solving-process clearly, needs prompting to understand the process and/or meaning of the problem's answer. | problem solving-process clearly, or appears to rely on memorization of problem solving methods to explain. | Student provides some insight into problem solving-process and can explain significance of answer. | Student can explain problem-solving process and explain the meaning of the answer. | 0.5 |
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**Highest possible oral exam grade:**

$$(0.3 + 1.5 + 1.4 + 0.5 + 0.3) \times 5 = 20$$

**Lowest possible oral exam grade:**

$$(0.3 + 1.5 + 1.4 + 0.5 + 0.3) \times 1 = 4$$

# CASE STUDY

Fall 2015 TEDU ME Course:

ME 241 Introduction to Solid Mechanics

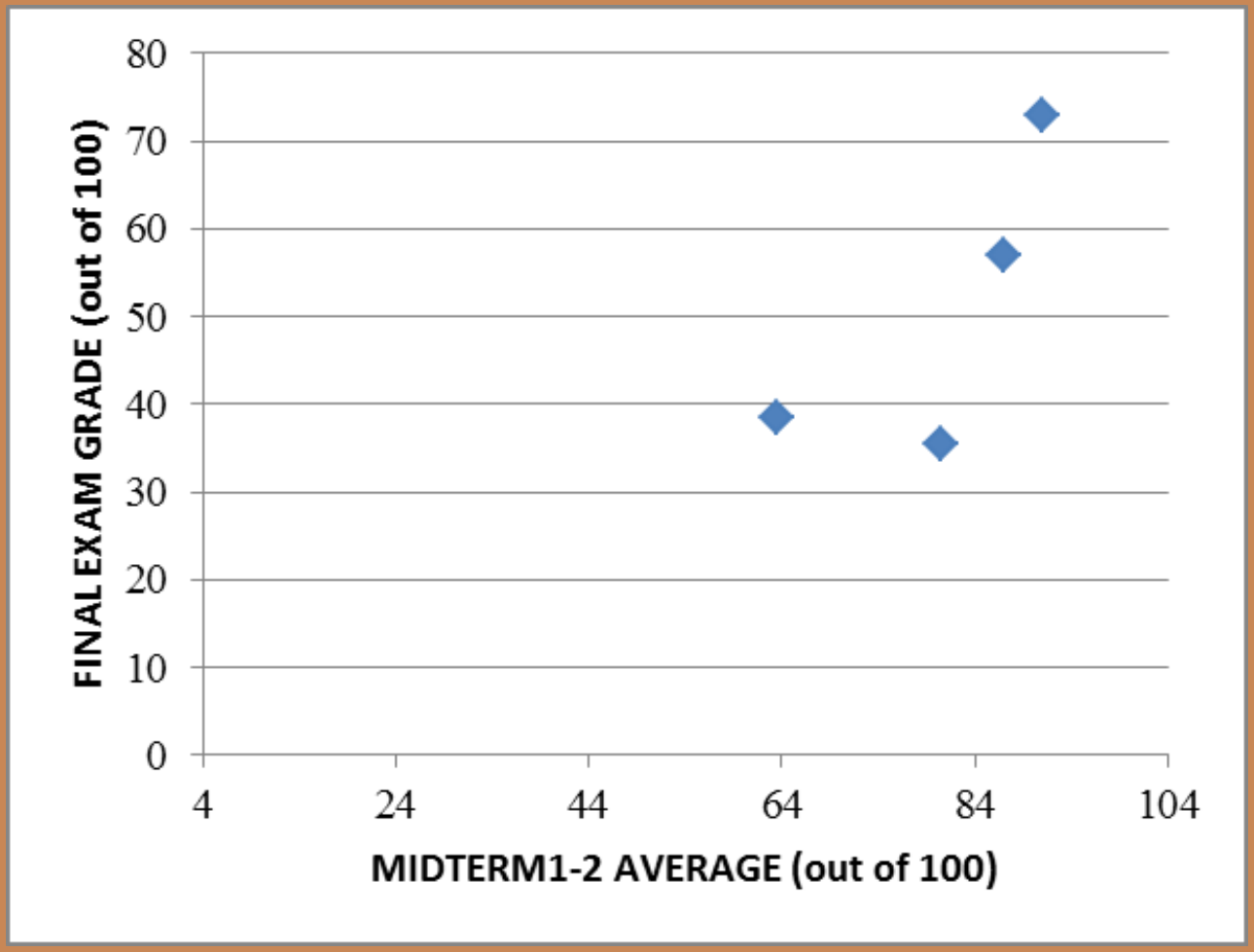
# ASSESSMENT TECHNIQUE DETAILS

- Two midterm exams were given in the form of "oral examinations" and the final exam was a classical type written exam (3-hr long).
- In each of the oral exams, students were given 3 questions:
  1. 15 minutes of brain-storming time.
  2. Solve the questions on the board (15 minutes each question; in total 45 minutes).
     - Grading:
       1. The oral part: 75 % of their midterm grade
          - » depending on many factors;
            a. how much the instructor had to interfere
            b. how well they presented their work
       2. The write-up of the solutions was required:
          - » 30 minutes were dedicated to the write up.

# MY GOALS FOR THE ORAL MIDTERMS WAS…

- Increase students' comfort with explaining a solution method
- Test (while teaching) how to use appropriate technical language and ability to organize the problem solving method
- Choose to interfere with the solution process to use it an opportunity to teach the students while identifying misconceptions or areas of weakness

# WORKED WELL!


80
70
60
50
40
30
20
10
0
FINAL EXAM GRADE (out of 100)
4
24
44
64
84
104
MIDTERM1-2 AVERAGE (out of 100)

# FEEDBACK FROM THE STUDENTS

| Did the oral quizzes help you ... | Yes | Unsure | No |
|---|---|---|---|
| ... explain your approach | 4 | 0 | 0 |
| ... work under pressure | 3 | 0 | 1 |
| ... identify a problem or error you had with a problem | 4 | 0 | 0 |
| ... identify a mistake that you make multiple times | 3 | 0 | 1 |
| ... set-up problems | 4 | 0 | 0 |
| ... use correct terms and language to describe problems | 4 | 0 | 0 |
| ... improve technical communication skills | 3 | 1 | 0 |

# CONCLUSION

- Oral assessment technique falls under the category of "**active learning**"
  - Students learn based on inquiry and presentation
  - Students engage in "cooperative learning" as they practice together.
- It's always good to keep a balance between different forms of examination; oral, written, projects to fight the possible disadvantages of oral exams.

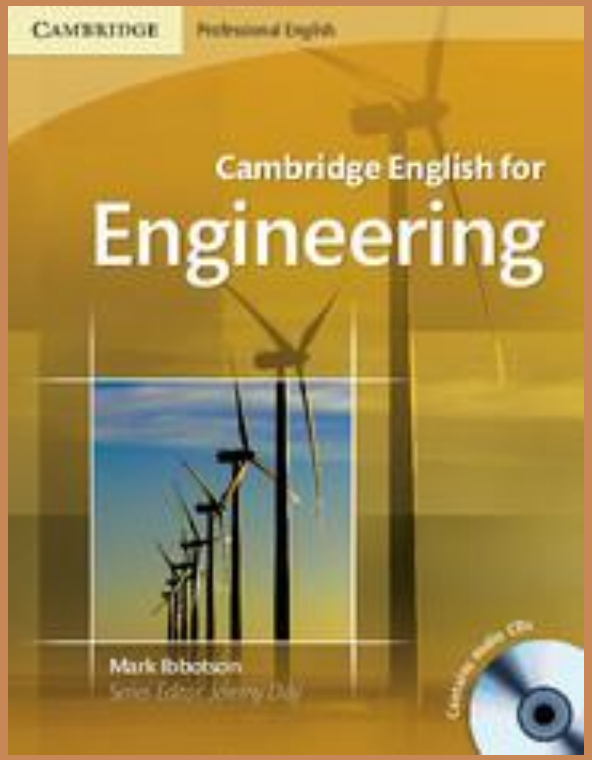
# FUTURE DIRECTIONS WITH THIS STUDY

- Apply a «modified version of this approach to the next batch of TEDU ME students (# > 4!!)
- Research on how well do we integrate English language in our undergraduate courses?

  *Collaboration with ELS!*

  - Do the students get a chance to practice/improve their English/presentation skills in English throughout undergraduate education?
    - We cannot expect miracles from their English prep year!
    - Continuous education is required:
      - Ask your students to take “ENG 204: Professional Communication Skills in English (*i.e.* as a “free elective” course)

# Can be found in the TEDU library!




# RESOURCES


- University of Pittsburgh “Speaking in Disciplines”
- Jamie Douglas, Rachel Knighten, Using Oral Quizzes in an Engineering Mechanics Course, Proceedings, The 2014 ASEE North Midwest Section Conference, October 16-17, 2014, Iowa City, IA, USA.
- Bairan, A. and B.J. Farnsworth, "Oral Exams: An Alternative Evaluation Method," *Nurse Educator*, 22, Jul/Aug 1997, 6-7.
- Dressel, J.H., "The Formal Oral Group Exam: Challenges and Possibilities-The Oral Exam and Critical Thinking," Paper presented at the Annual Meeting of the National Council of Teachers of English (81st, Seattle, WA, November 22-27, 1991).

# MORE RESOURCES


- Bech Jensen, Bogi. "Oral Assessment in Engineering Education," International Journal of Electrical Engineering Education, 2010.
- Donnell, J.A., B.M. Aller, M. Alley, A.A. Kendrowicz, “Why Industry Says That Engineering Graduates Have Poor Communication Skills: What the Literature Says,” American Society of Engineering Education, 2011.
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- Sayre, E. "Oral Exams as a Tool for Teaching and Assessment," Teaching Science, 2014.