Theory of Sustained Optimal Challenge in Teaching and Learning

Shaheen Ahmed

1868 150 YEARS 2018

Minnesota State University Mankato

- Bloom suggests teaching 90% of the materials
  - to achieve mastery learning
- In practice, students move up to the next level just by learning
  - 70% (author's current department)
  - 60% (author's current university)
  - 40% (author's undergraduate institute)
  - Even only 33% (author's institution from grade 1 to 12)
- The exposure to the advanced level topics
  - prioritized more than the mastery learning
    - in many education systems

- How much material?
- What is the difficulty level?
- What is mastery?

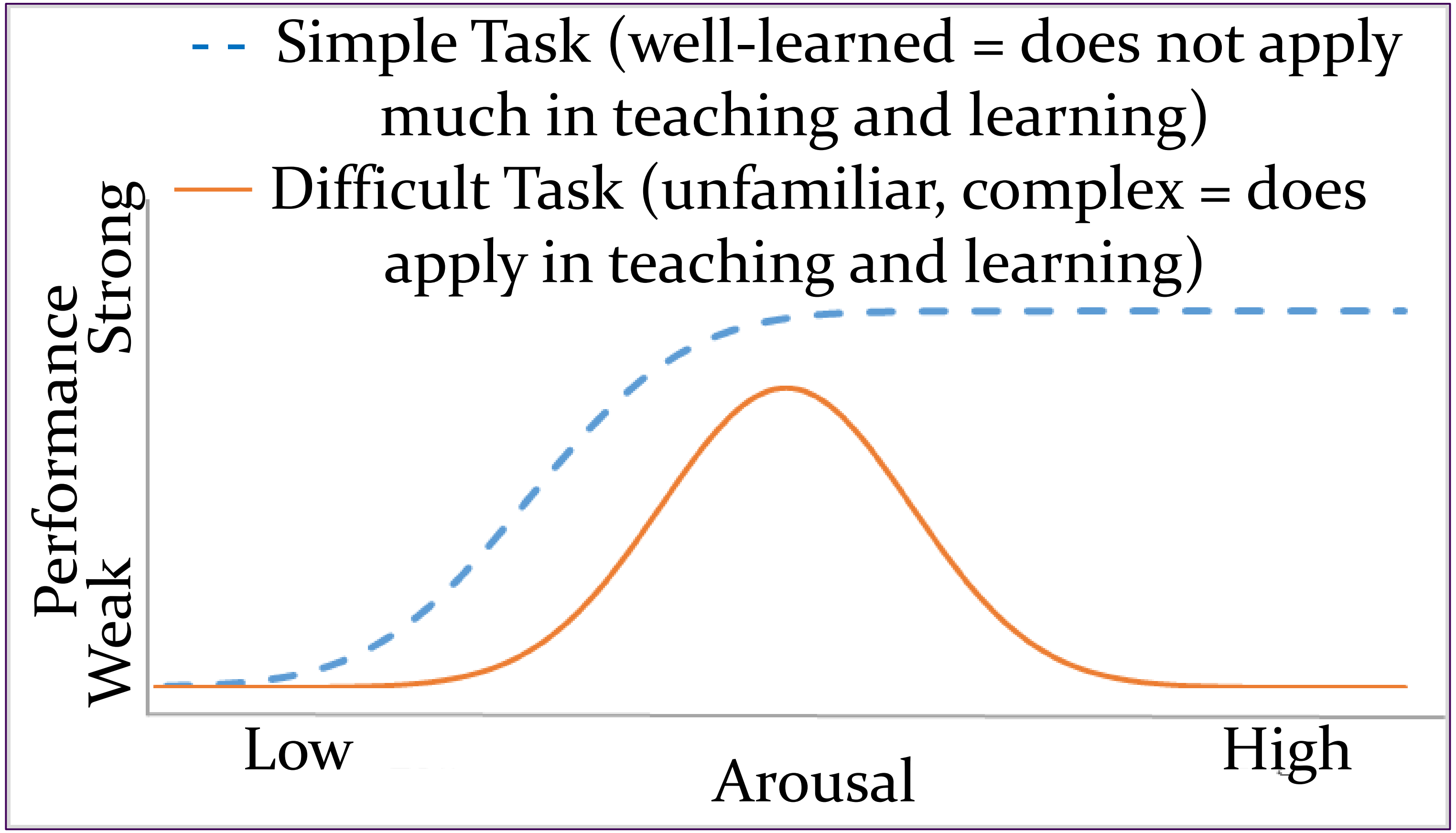
- The following is an excerpt from the learning outcomes of a course

“Student should be able to apply anthropometry to design, redesign, develop, and evaluate workstations.”

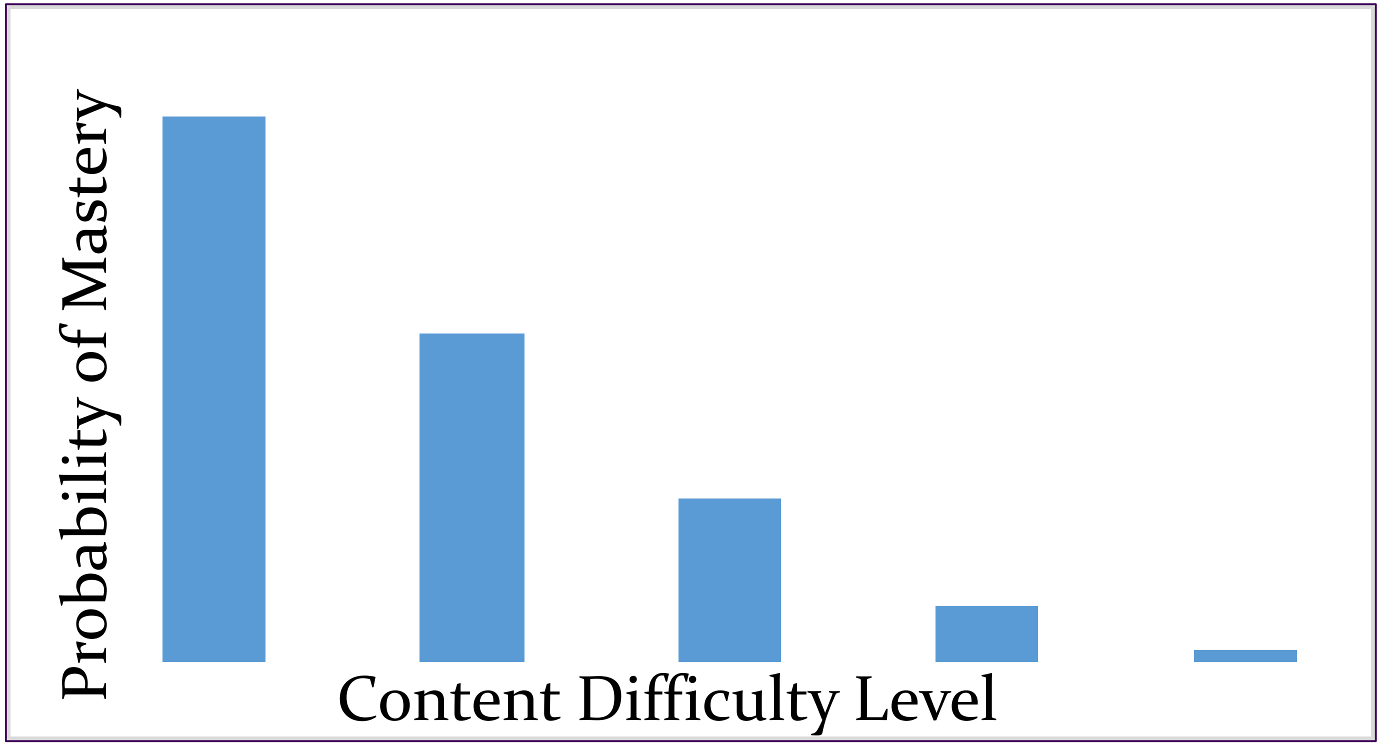
- To what breadth and depth should we go?

- Yerkes-Dodson law
  - Arousal vs Performance
- Teaching & Learning
  - Mostly difficult task
  - Unfamiliar & Complex
- Optimal arousal

Students' Aptitudes = Instructors' Expectations

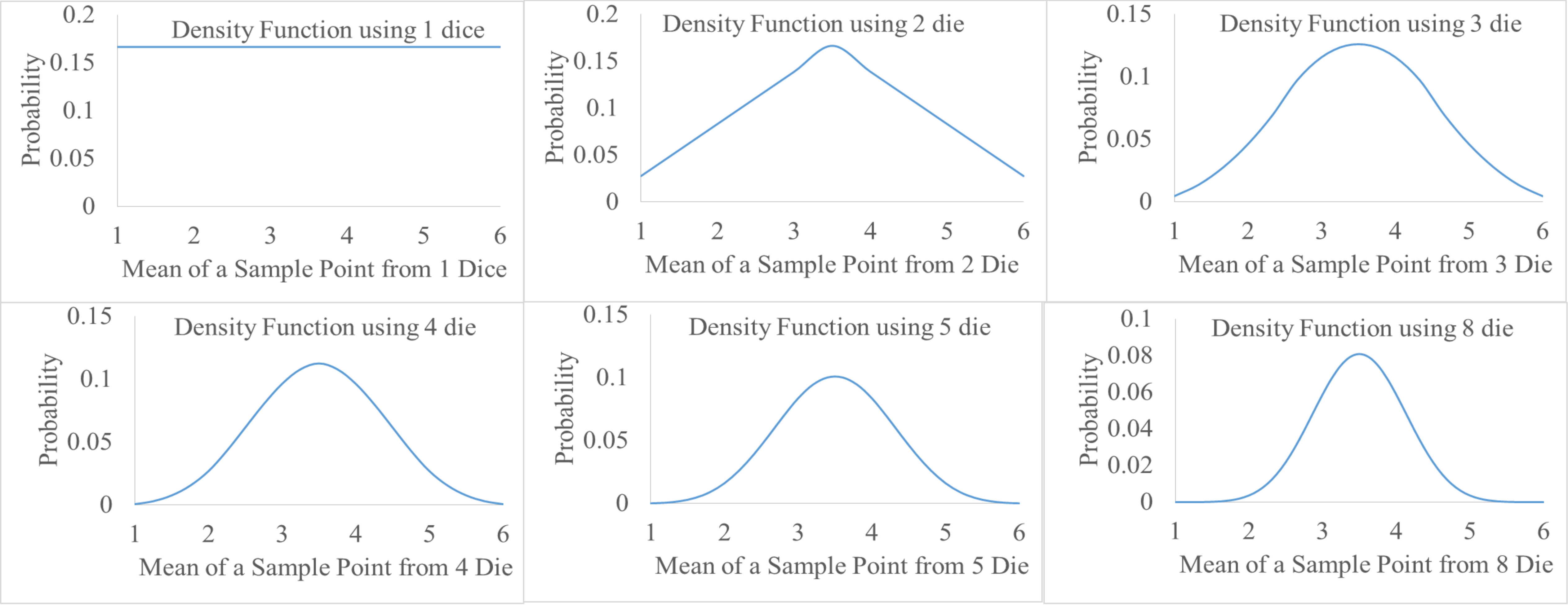


- Should we teach
  - 100%
    - Students: learned 100%
  - 90%
  - 70%
  - 60%
  - 33%
  - 10-20%
    - Students: Learned Nothing!



- To avoid too many easies or difficulties
  - Normal (Gaussian) distribution of difficulty levels
    - to match students' aptitude levels
      - to achieve optimal performance

- How do we keep the challenge Normally distributed?
- Central Limit Theorem,
  - *"The distribution of mean or sum from a large sample of a sufficiently large number of identical and independent random variables will be approximately normally distributed regardless of their original distributions."*
- Multiple assessment points?
  - Normally distributed content difficulty level
    - to achieve the optimal challenge
      - for most students



Density Function using 1 dice
Probability
0.2
0.15
0.1
0.05
0
1 2 3 4 5 6
Mean of a Sample Point from 1 Dice
Density Function using 2 die
Probability
0.2
0.15
0.1
0.05
0
1 2 3 4 5 6
Mean of a Sample Point from 2 Die
Density Function using 3 die
Probability
0.15
0.1
0.05
0
1 2 3 4 5 6
Mean of a Sample Point from 3 Die
Density Function using 4 die
Probability
0.15
0.1
0.05
0
1 2 3 4 5 6
Mean of a Sample Point from 4 Die
Density Function using 5 die
Probability
0.15
0.1
0.05
0
1 2 3 4 5 6
Mean of a Sample Point from 5 Die
Density Function using 8 die
Probability
0.1
0.08
0.06
0.04
0.02
0
1 2 3 4 5 6
Mean of a Sample Point from 8 Die

- 10-13 assessments
  - 3-credit hour course
    - semester system
- Adjusting the difficulty level
  - based on the performance in the previous topics.
    - Poor performance
      - too difficult
    - High performance
      - too easy
- Mid-semester student feedback
  - Making sure, we don't lose them too early

- Applying the sustain optimal challenge theory
- A wide range of multidisciplinary courses taught
  - Undergraduate
    - Introductory Statistics
    - Mechanics of Materials
    - Fluid Power
  - Undergraduate/Graduate
    - Quality Management Systems
    - Human Factors and Ergonomics
  - Graduate
    - Design of Experiments

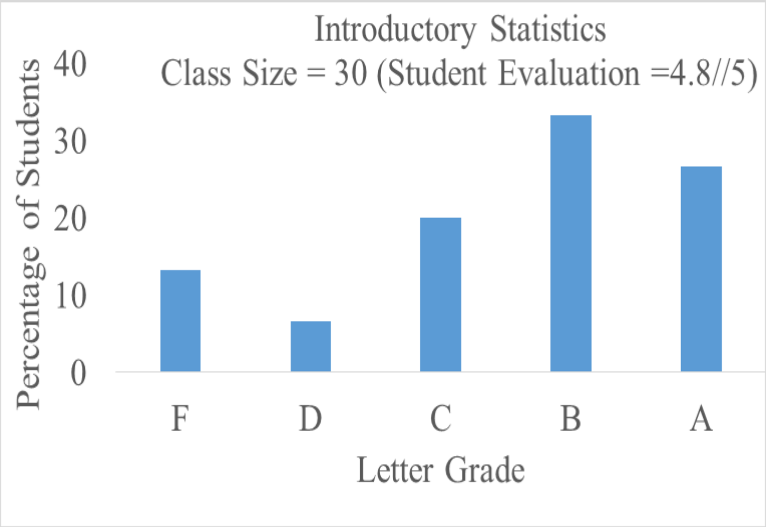
Normality test (Chi-Square) on the grade distributions

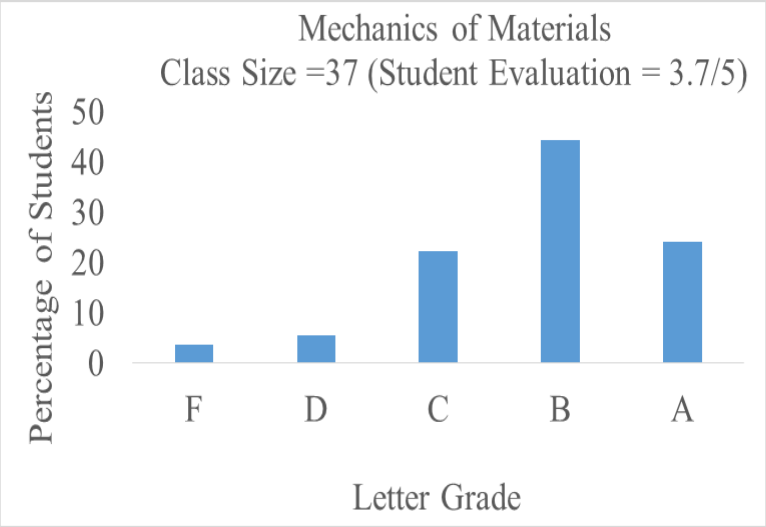
Normal	Mean Grade	p-value
Introductory Statistics 1st	85	0.014
Introductory Statistics 2nd	84	**0.005**
Mechanics of Materials 1st	80	0.440
Mechanics of Materials 2nd	79	0.269
Quality Management Systems 1st	80	0.138
Quality Management Systems 2nd	78	0.020
Human Factors & Ergonomics 1st	82	0.129
Design of Experiments 1st	90	**0.008**

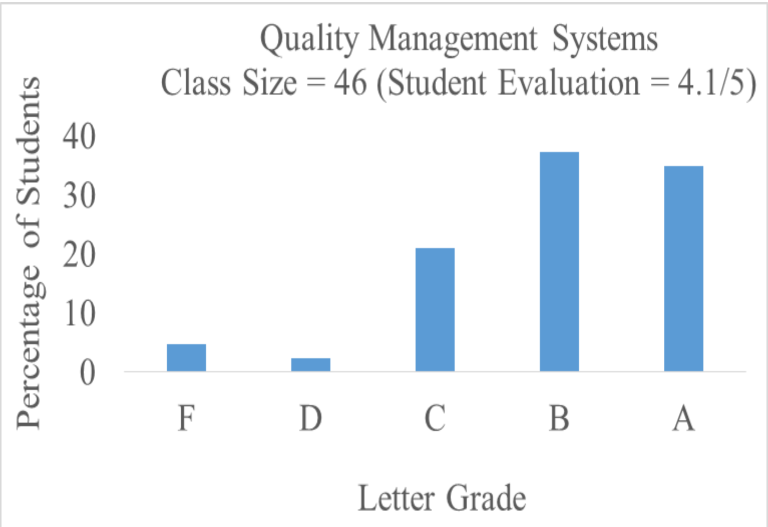
*Bold faced p-values indicate non-normal data with a significance level of 0.01. 1st = Fist Time Taught, 2nd = Second Time Taught. Influential points were removed before testing.

RESULT THEORY OF SUSTAINED OPTIMAL CHALLENGE IN TEACHING AND LEARNING

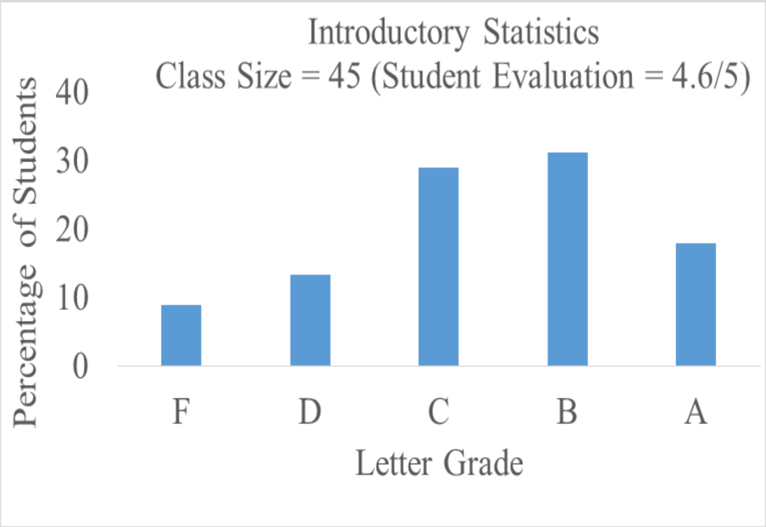
First Time Taught

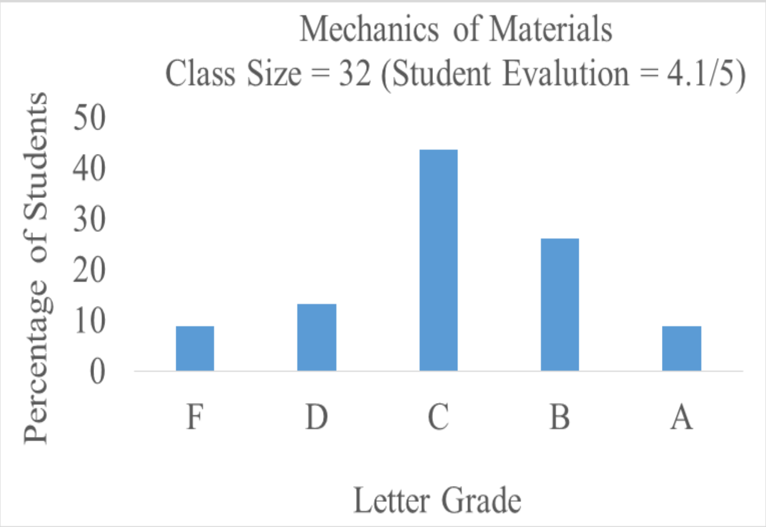


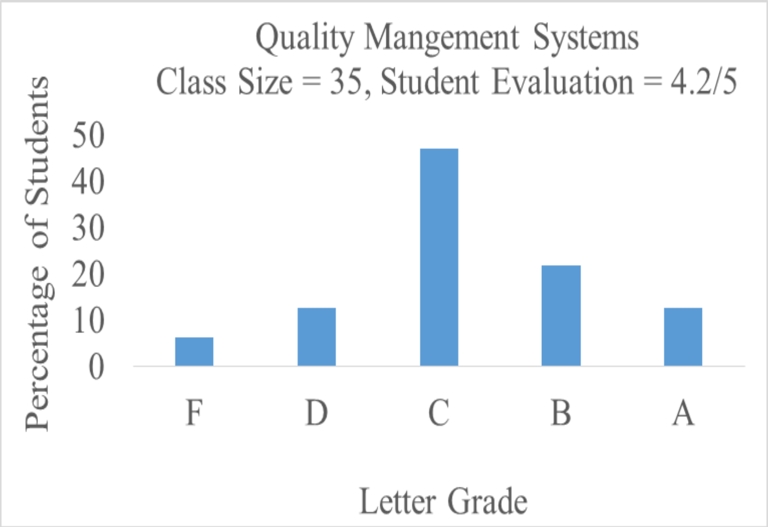




Second Time Taught







- The mean student evaluations = 4.25/5
- Most frequent positive feedback
  1. instructor is knowledgeable
  2. instructor really cares for us
  3. focus on student learning
  4. problem solving step by step
  5. learned a lot from this course
  6. very effective use of class time
  7. approachable and easy to talk
  8. good response to students' questions
  9. fair grading
  10. clear expectation
  11. small deadlines.

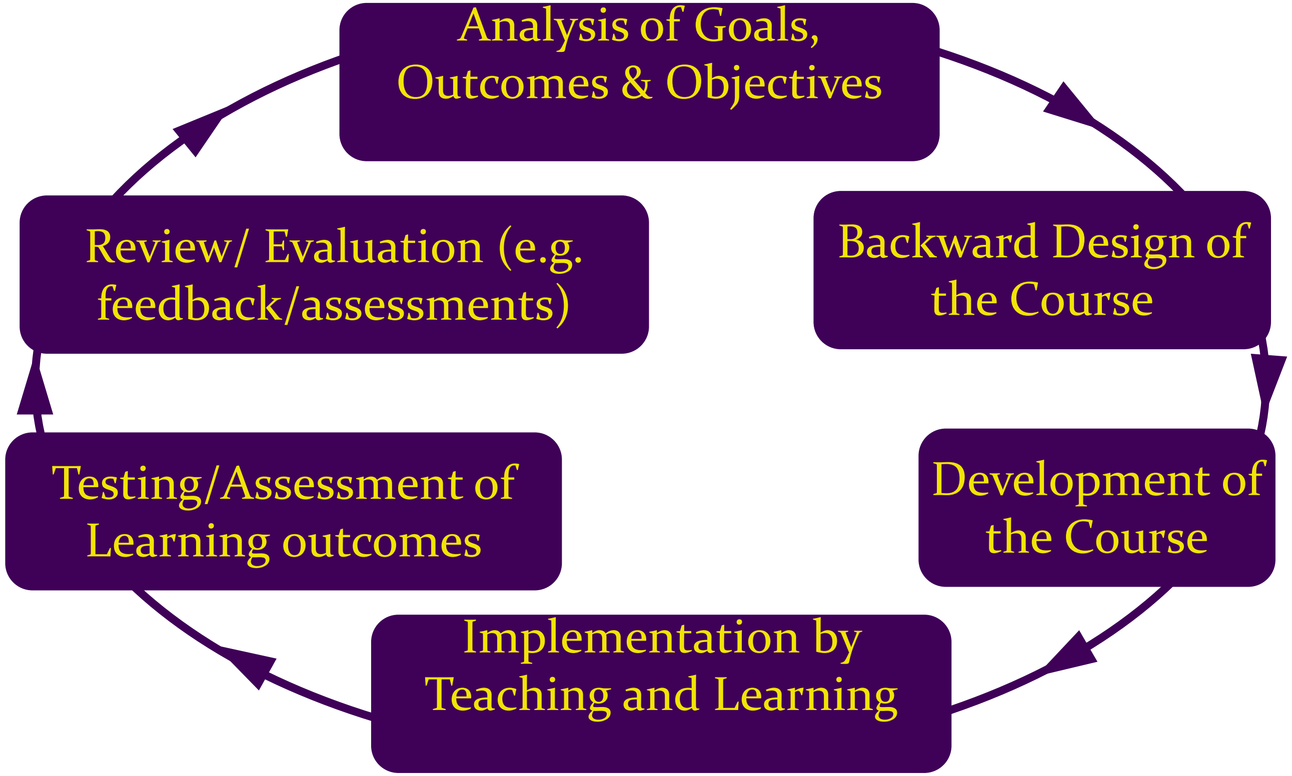
- Theory of the Sustained Optimal Challenge has helped student learning primarily in three ways

1. Frequent Assessments and Feedback in a Consistent and Timely Manner for Continual Improvement

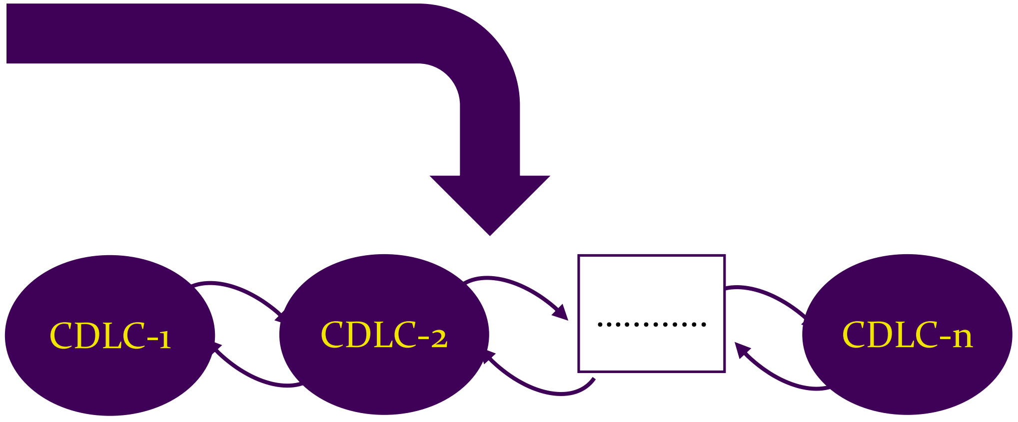
2. Matching the Instructors' Expectations with the Students' Aptitudes

3. Significant Reduction in Variation in Student Learning

- Frequent Assessments and Feedback in a Consistent and Timely Manner for Continual Improvement

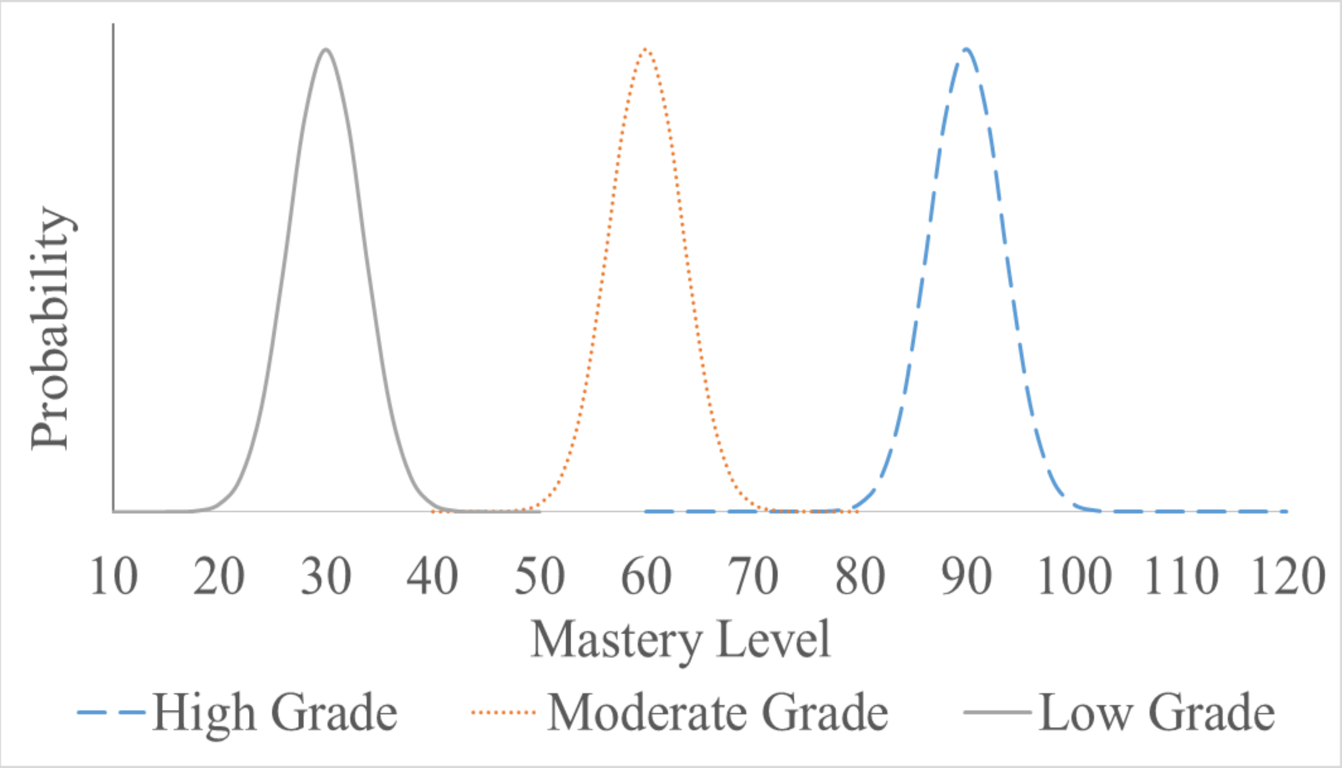


Course development life cycle (CDLC)

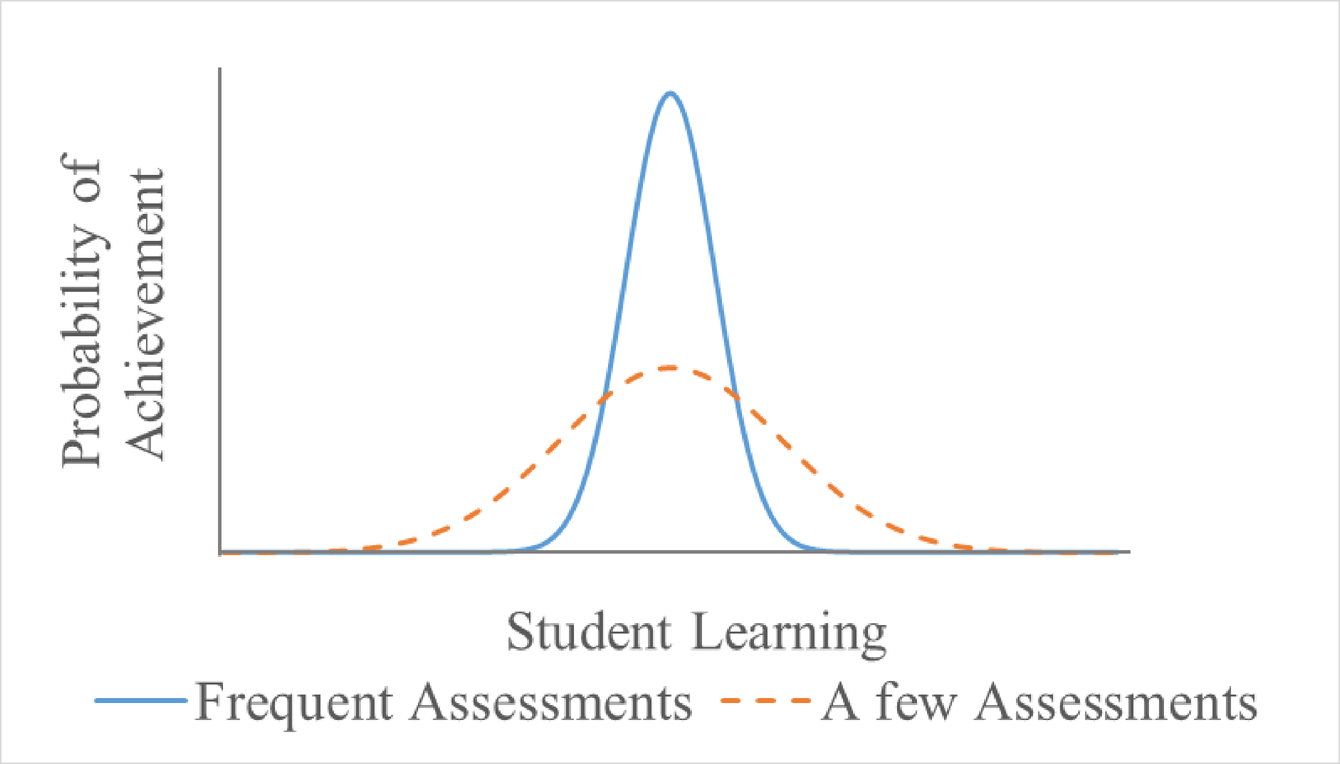


Continual improvement in every assessment period applying the theory of sustained optimal challenge.

- Matching the Instructors' Expectations with the Students' Aptitudes
  - The distribution of grades for 6 out of 8 courses
    - Observed to be normal
      - As expected from the central limit theorem
  - Sounds like a random assignment of grade!
    - The author is not suggesting any mean grade
    - Grade must reflect learning
    - The mean grade/challenge could follow the institution policy in the Theory of Sustained Optimal Challenge



- Significant Reduction in Variation in Student Learning
  - As the number of assessment points increase, the distribution converge from flatter to a narrower Normal distribution.



Limitation

- Adjusting the content difficulty level over the course of learning
    - Independent random variables?
- The assessment process may not be compared to a fair die
    - Take-home tests
        - Not a random variable any more!
- Each student (if not identical twins) with distinctive aptitudes
    - Identical random variables?
- The learning outcomes have not been compared to the courses taught using the theory of sustained optimal challenge and other methods of instruction.

Conclusion

- This research presented a theory to challenge students optimally over the course of teaching and learning
- The theory suggests that frequent assessments and regular feedback help students' learning primarily in three ways
  1. continual improving over the course of teaching and learning
  2. matching the instructors' expectations with the students' aptitudes
  3. finally, reducing the variation in student learning.
- The instructor will be able to set the depth of the contents and the speed of instructions to prepare students to cope with the future challenges in the higher education or the workforce.

Thank You!