



Actively Engage Students Using More Personalized Approach in Programming Courses

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Outline

+ Background

- + Adaptive Learning
- + Bottleneck course

+ Adopted Technologies

- + Adaptive Learning, Flipped Classroom, SI
- + Team-based learning, Pair-Programming
- + Project-based Assignments

+ Affordability

- + OER Textbooks, zyBooks

+ Results

- + Assessment Findings
- + Student Feedback

Background – Adaptive Learning

Personalized Learning

Maintains a complete Learning Profile on all Items – not just content & instruction strategy; adapts & improves to enhance learning path & support retention & mastery

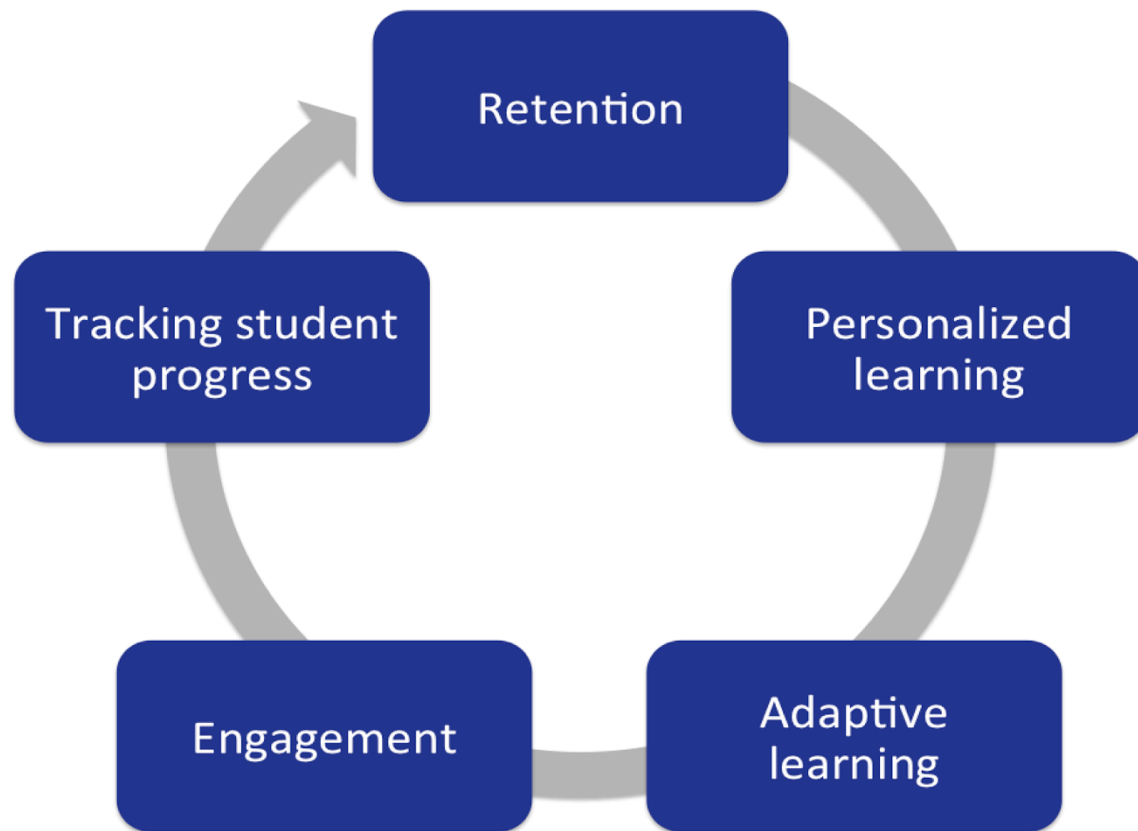
Adaptive Learning

Uses large data pools & analytics to continuously update the learning path by adapting content & instructional strategy in real time

Differentiated Instruction

Assessment to determine a fixed set of content and a fixed learning path

Background – Adaptive Learning (2)



Background – Course Characteristics

+ **Bottleneck Course: “Data Structures and Algorithms”**

- + Required core course
- + Prerequisite of 10 courses
- + Capacity: 35
- + 1st course for transferred students

+ **High DFW rate**

- + High Demand / Low Success
- + Some students have to repeat until pass

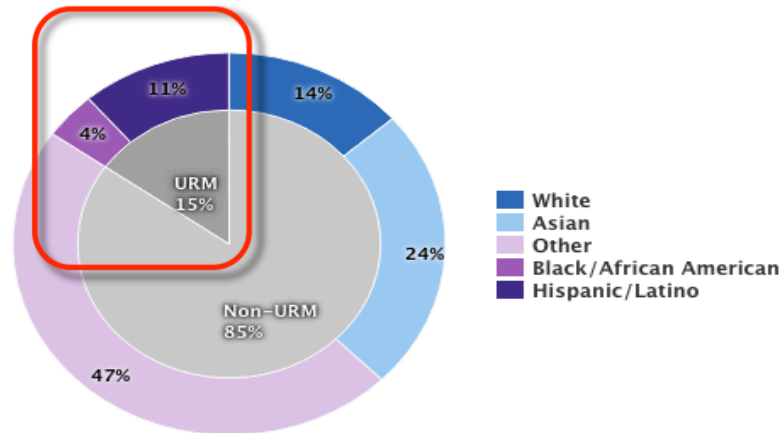
+ **Need Adaptive Learning**

- + Both undergrad and grad students taking the course
- + Some are advanced, and some need more help

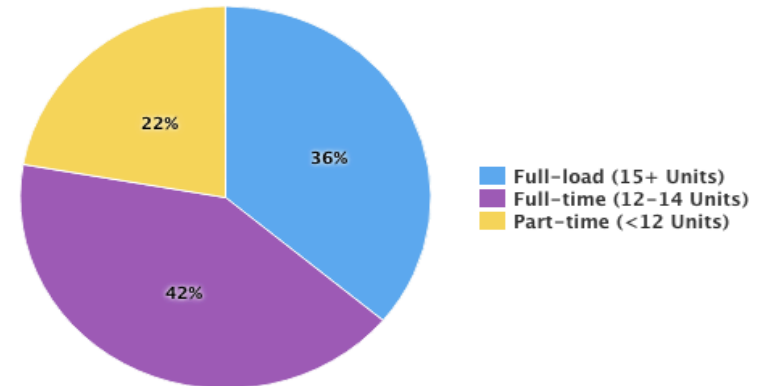
Background – Student Characteristics

Enrollment by Ethnicity

URM (Underrepresented Minority) and Non-URM (Non-Underrepresented Minority)



Undergrad Enrollment by Unit Load



Background – Student Characteristics (2)

TABLE I. UNDERGRADUATE STUDENT BODY PROFILE (FALL 2014)

Number of Students

Headcount: 12,242 Full Time: 10,663 (87%)

Gender (per headcount)

Men: 4,637 (38%) Women: 7605 (62%)

Racial/Ethnic Groups (% of undergrads)

Latino: 3,484 (28%)	Pacific Islander: 135 (1%)
Two or more races: 732 (6%)	Black/African American: 1,359 (11%)
Asian: 2,910 (24%)	Native American: 23 (<1%)
White: 2,309 (19%)	Unknown: 529 (4%)

Nonresident: 761 (6%)

Low Income Students 6,495 (61%)

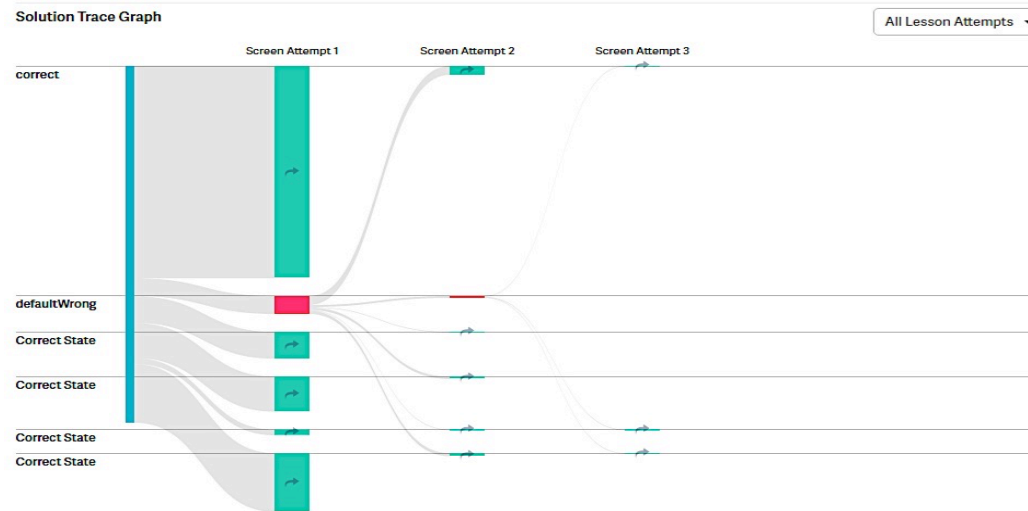
Mean Age of Students 24 years old

First Generation Students 5,930 (56.9%; 13.3% unknown)

Adopted Technologies – Adaptive Learning

+ Smart Sparrow

- + Adaptive Learning modules, address individual student needs
- + increase engagement, improve SLOs

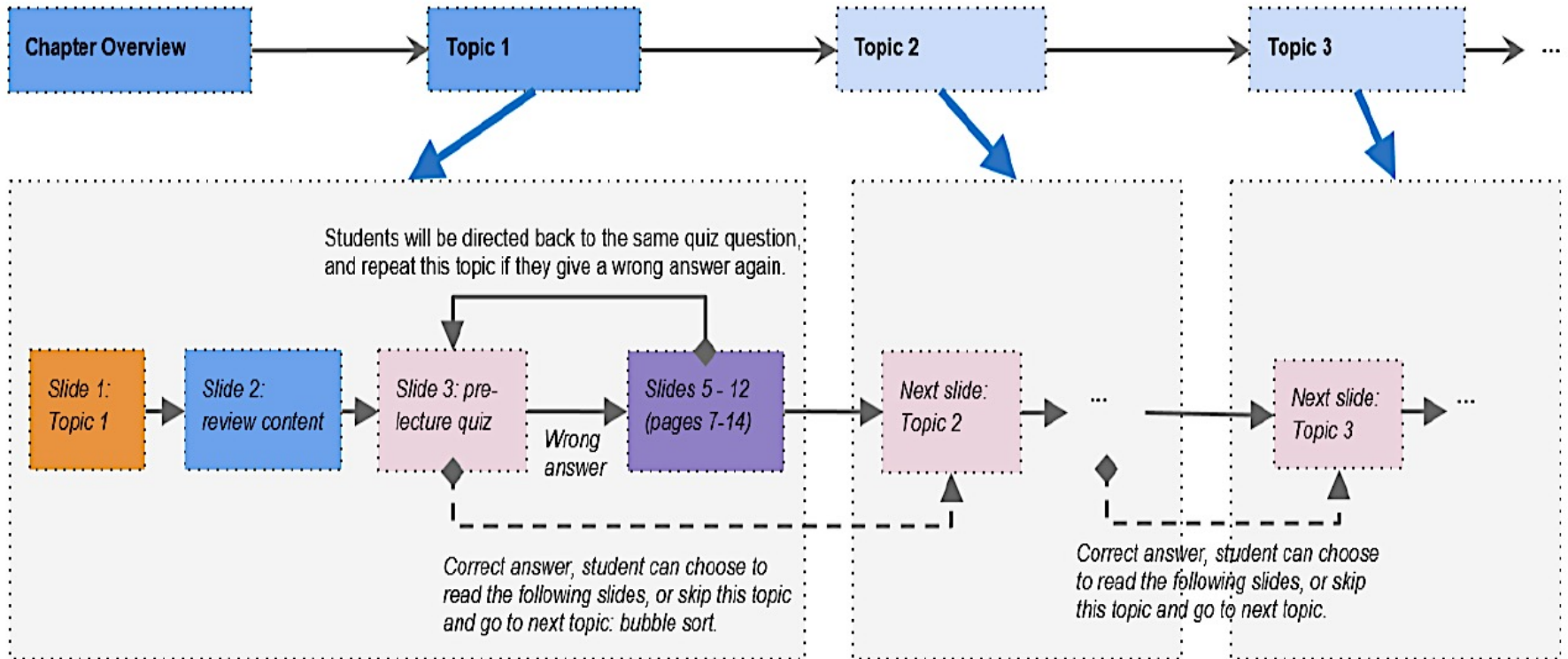


+ Blackboard: Adaptive Release

- + “Mark reviewed” to see the next

Adopted Technologies – Smart Sparrow

+ Design Flowchart of an Adaptive Lesson



Adopted Technologies – Smart Sparrow (2)

Answer the following question:

Based on the function defined here:

```
int z(int k, int n)
{
    if (n == k)
        return k;
    else
    {
        if (n > k)
            return z(k, n-k);
        else
            return z(k-n, n);
    }
}
```

What is the value of $z(6,8)$?


- 1
- 2
- 3
- 4
- 8

Please provide an answer.

Next

Adopted Technologies – Smart Sparrow (3)

- + Branch Page (Left) and Content Page with Embedded Video (Right) of Redesigned Adaptive Lesson

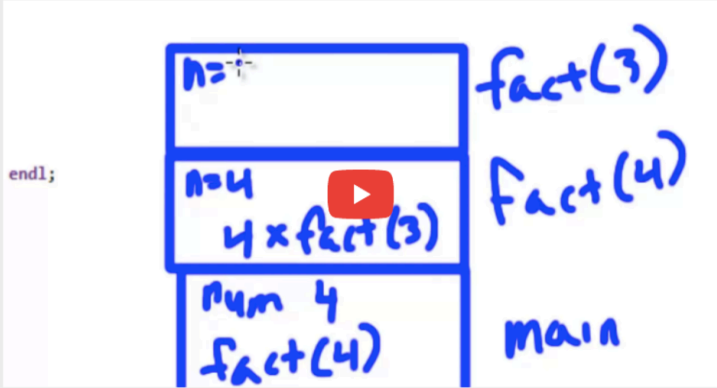


Congratulations! You got all of the quiz questions correct. Would you still like to review the lesson content on recursion?

Yes
 No

Next

What is Recursion?



```
endl;
```

Next

Flipped Classroom, Project-based learning, and Pair-Programming

- + 1st half of class: *mini-lectures*
 - + On certain topics based on the results of pre-lecture quiz
- + 2nd half of class: *practice*
 - + Group-based projects, Pair-programming

Monitor classroom performance

Grades

Track student performance including time spent, number of attempts and what pathways are being utilized

Target students who need support

Follow up

Target students who may need additional support and follow up directly with them

Analyze your assessments

Are you actually measuring what you think you are?

Analyze areas that multiple students are skipping or missing to help improve assessment techniques

SI: Supplemental Instruction

- + SI sessions after each class
 - + Monday & Wednesday 1–2 pm @ MI 3079
- + SI leader is hired
 - + manage all SI sessions and discussions
- + Students attended SI sessions



Affordability – OER Textbooks

- + Free Open DSA: “CS3 Data Structures and Algorithms”
- + <https://opensda.cs.vt.edu/ODSA/Books/CS3/html/index.html>

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Make a recursive call on left child.

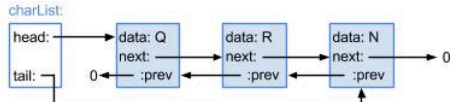
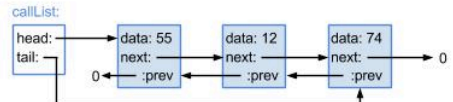

```
static void inorder(BinNode rt) {  
    if (rt == null) return;  
    inorder(rt.left());  
    visit(rt);  
    inorder(rt.right());  
}
```

B D A G E C

Affordability – zyBooks

- + Online textbook with programming lab
- + Plenty of interactive activities and animations

P Participation Activity 1.5.3: Doubly-linked list data structure.

#	Question	Your answer
1	ListAppend(charList, node F) inserts node F _____. 	after node Q before node N after node N
2	ListAppend(callList, node 5) executes which statement? 	list->head = newNode list->tail->next = newNode newNode->next = list->tail
3	Appending node K to rentalList executes which of the following statements? 	list->head = newNode list->tail->next = newNode newNode->prev = list->tail

Feedback?

P Participation Activity 6.3.4: Insert with linear probing.

1 2 3 4 5 ◀ 2x speed

```

HashInsert(hashTable, item) {
  // Hash function determines initial bucket
  bucket = Hash(item.key) % 10 = 9
  bucketsProbed = 0

  while (bucketsProbed < N) {
    // Insert item in next empty bucket
    if (hashTable[bucket] is Empty) {
      hashTable[bucket] = item
      return true
    }

    // Increment bucket index
    bucket = (bucket + 1) % N

    // Increment number of buckets probed
    ++bucketsProbed
  }

  return false
}
    
```

hashTable:

0	10	Occupied
1	19	Empty Occupied
2	202	Occupied
3	42	Occupied
4		
5	85	Occupied
6		
7		
8		
9	89	Occupied

bucketsProbed: 2

```

HashInsert(hashTable, item 42) // Returns true
HashInsert(hashTable, item 19) // Returns true
    
```

Insert linearly probes each bucket until an empty bucket is found.

Feedback?

Results – Assessment Findings

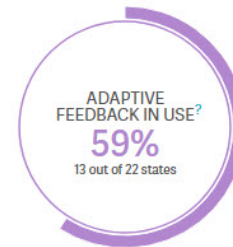
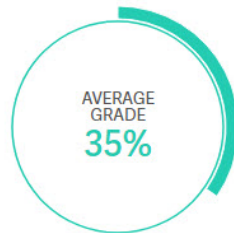
+ Ch5 Post-lecture Smart Sparrow Results



CS 3240 | Chapter 5 | Post

Overview | 20172_CS3240 (Apr 2017)

Lesson Summary



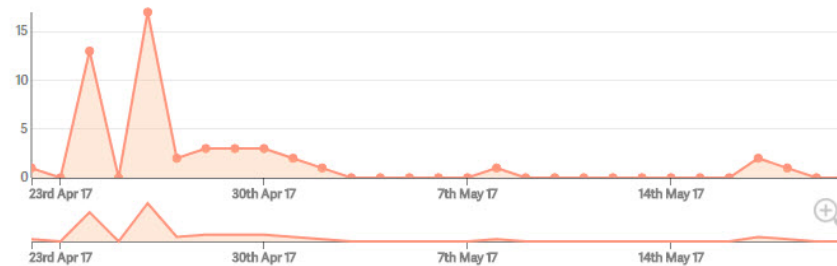
Online in the Last Hour

0

Median Time Spent

0.3_{HR} 3_M

Student Traffic (Unique)



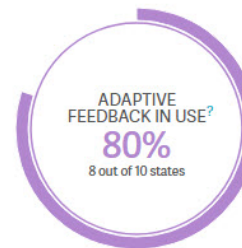
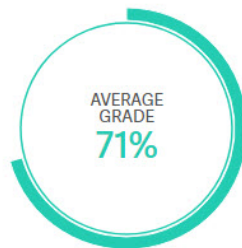
Results – Assessment Findings (2)

+ Ch7 Post-lecture Smart Sparrow Results

 CS 3240 | Chapter 7 | Post

Overview ▾ | 20172_CS3240 (May 2017) ▾

Lesson Summary



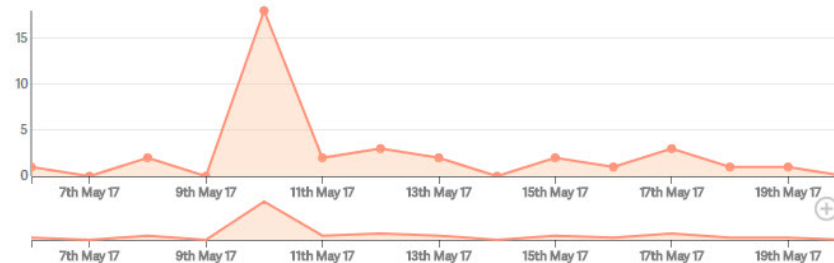
Online in the Last Hour

0

Median Time Spent

0.6
HR M

Student Traffic (Unique)



Results – Pre-lecture Quiz

CS 3240I Chapter 10 | Pre

Overview | 20172_CS3240 (May 2017) ▾

Lesson Summary



Online in the Last Hour

0

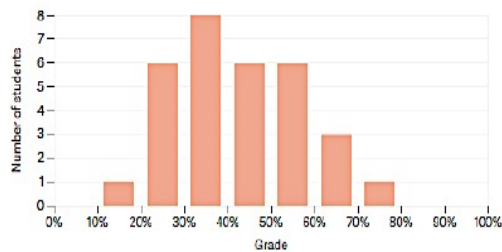
Median Time Spent

0 HR 8 M

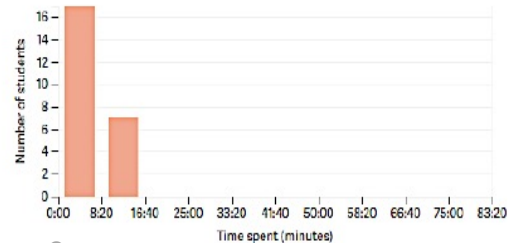
Student Traffic (Unique)



Grade on Lesson



Time Spent on Lesson

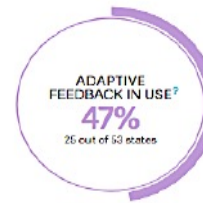


Results – Post-lecture Quiz

CS 3240I Chapter 10 | Post

Overview - 20172_CS3240 (May 2017) -

Lesson Summary



Online in the Last Hour

0

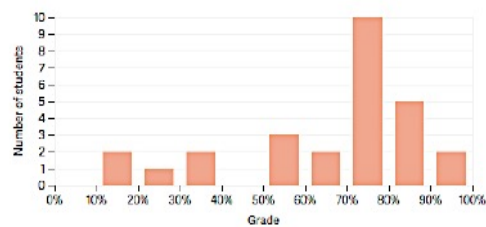
Median Time Spent

0.7 HR M

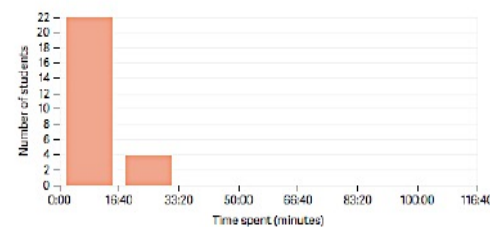
Student Traffic (Unique)



Grade on Lesson



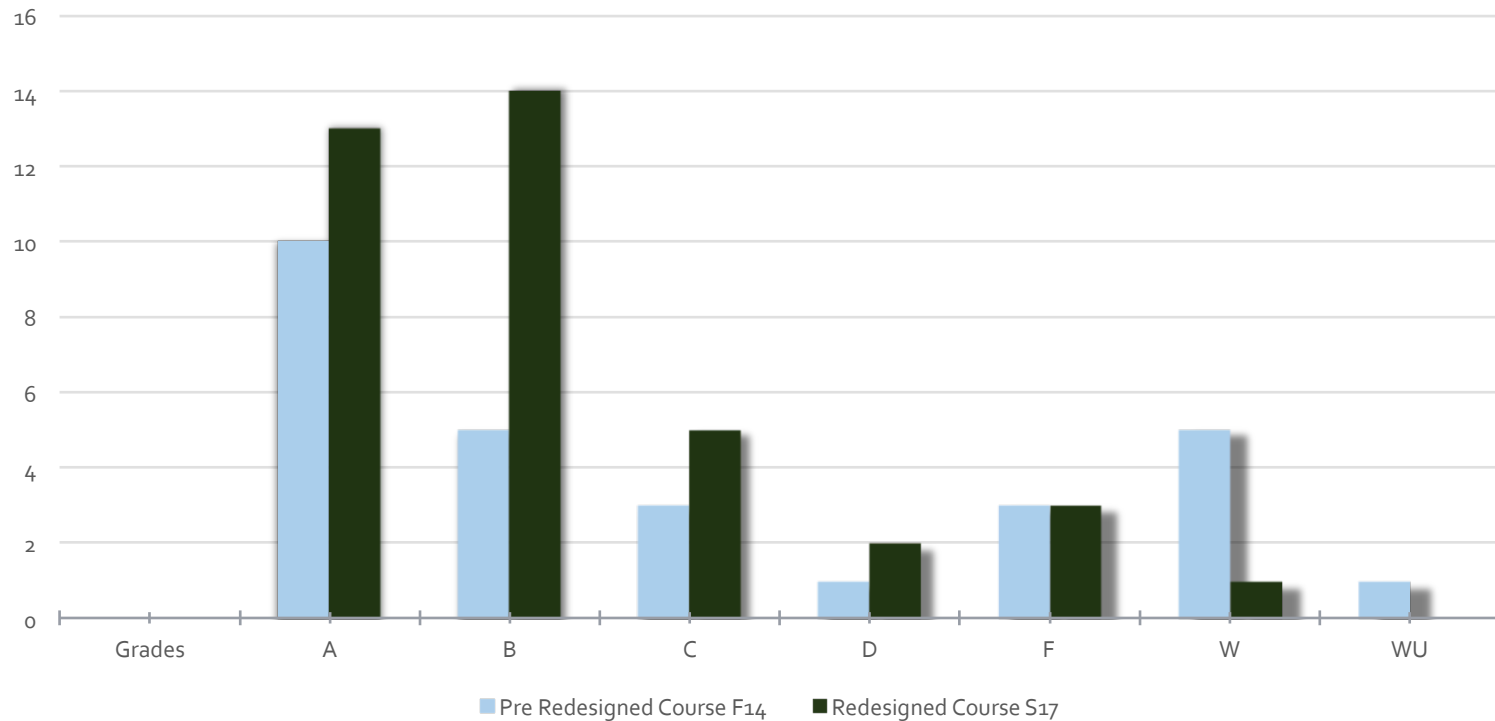
Time Spent on Lesson



Results – Midterm Exam

- + Pre-redesigned course in Fall 2014
- + Redesigned course in Spring 2017

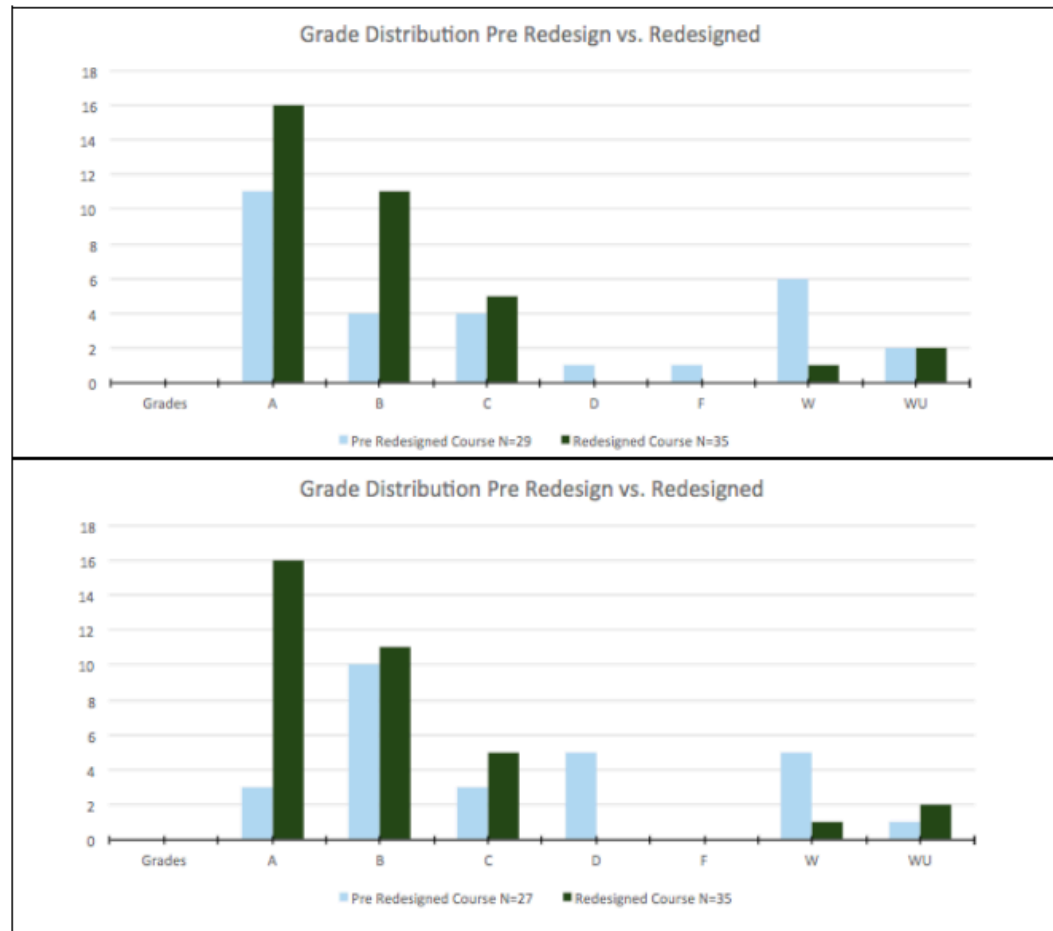
Grade Distribution Pre Redesign vs. Redesigned



Results – Final Grade

+ Comparison Results:

- + Pre-redesign in Fall 2014 vs. Post-Redesign in Spring 2017 (top);
- + Pre-redesign in Spring 2016 vs. Post-redesign in Spring 2017 (bottom).



Student Feedback

- + “Very **helpful.**”
- + “it was really **easy** to go to the chapter I wanted to read.”
- + “The awesome part about the online textbook is that it's **interactive.**”
- + “Instead of simply looking at the pictures within the text, I was able to interact with them, and **practice** the concepts that I was learning.”
- + “It made reading the textbook **fun!**”

Acknowledgements and Publications

- + Special Thanks to San Jose State University and CSU Chancellors' Office. This material is partially based upon work supported by the NSF Grant No. DUE-1626612.
- + **Publications:**
 - + Jiaofei Zhong (2018). Paper: Actively Engage Students with Diverse Background Using a More Personalized Approach. IEEE Frontiers in Education. San Jose, CA, USA.
 - + Jiaofei Zhong (2018). Poster: Designing Personalized Learning Objects for Enhanced Student Engagement. ACM SIGCSE 2018, CS For All. Baltimore, Maryland, USA.
 - + Jiaofei Zhong (2017). Presentation: Course Redesign with Technology Data Structures and Algorithms. CSUEB Celebration of Teaching, and CSU Course Redesign with Technology Summer Institute 2017. Hayward, CA and Sacramento, CA. Fay Zhong, Monica Munoz, Cheryl Saelee.
 - + Jiaofei Zhong, Monica Munoz, and Cheryl Saelee (2017). Presentation: Designing Personalized Learning Objects for Enhanced Student Engagement: Two campus case studies. CSUEB Back to the Bay. Hayward, CA.
- + **Course materials developed:**
 - + https://drive.google.com/drive/folders/100Bbf7ejYoFmld_L3HDX8lXh_5KvdP?usp=sharing

References

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- + [2] E. Lavieri, "A Study of Adaptive Learning for Educational Game Design." ProQuest UMI, 2014.
- + [3] J. L. Bishop, J. Lowell, and M. A. Verleger, "The flipped classroom: A survey of the research." *ASEE National Conference Proceedings, Atlanta, GA*. Vol. 30, No. 9, 2013.
- + [4] D. Arendale, "History of supplemental instruction (SI): Mainstreaming of developmental education." *Histories of developmental education*, pp. 15-28, 2002.
- + [5] P. Blumenfeld, E. Soloway, R. Marx, J. Krajcik, M. Guzdial, and A. Palincsar, "Motivating project-based learning: Sustaining the doing, supporting the learning." *Educational Psychologist*, vol. 26 (3/4), pp. 369-398, 1991.
- + [6] A. Cockburn, and L. Williams, "The costs and benefits of pair programming in extreme programming examined." Boston, MA: Addison Wesley, 2001.
- + [7] Smart Sparrow, <http://aelp.smartsparrow.com/>
- + [8] A. Marcus-Quinn, and Y. Diggins. "Open educational resources." *Procedia-Social and Behavioral Sciences* 93, pp. 243-246, 2013.
- + [9] OpenDSA Project, <http://iiscs.wssu.edu/drupal/OpenDSA>
- + [10] OpenDSA CS3 Book, <https://opensda.cs.vt.edu/ODSA/Books/CS3/html/>
- + [11] ZyBook, <http://www.zybooks.com/>