DELTA 2016 CPCR Assessment Summary

CSC 216: Programming Concepts - Java

Description of Project	Dr. Sarah Heckman received a DELTA course redesign grant to use toward redesigning *Programming Concepts - Java* (CSC 216). This project focused on moving the course to a lab-based class to increase active learning. It incorporated new course resources, updated automated grading technologies, and additional support through the implementation of interventions targeting main challenges noted in the traditional course.
Assessment Timeframe	From Fall 2015 through Fall 2016 DELTA staff and Dr. Heckman analyzed, designed, planned, and developed the new course redesign. Implementation and data collection started Fall 2017 and continued into Spring 2017. Project and data analysis started shortly after and continued until Spring 2019.
Desired Outcome/Goal	Project objectives included: ● *Improving student learning outcomes* in lab exercises (use of software engineering best practices), programming projects, and exams. ● *Increasing student engagement* with lab materials and activities as well as with the computer science community. ● *Increasing student self-efficacy* about CSC216 topics, skills, tools, and general programming and testing.
Related DELTA Goal	As an organization, DELTA has a dual focus on (1) Distance Education (DE) enrollment growth and (2) providing “enterprise-level infrastructure and faculty support for the incorporation of learning technologies and pedagogically-sound principles into instruction.” DELTA’s 2017-2020 Strategic Plan states that “while online and distance education instruction continues to be an emphasis for NC State, future enrollment strategy manages growth in the context of limited resources.” To this end, DELTA’s Goal One involves leveraging learning technologies to improve student success and establishes DELTA awards to fund course redesign initiatives throughout the university. This course redesign project explicitly furthers DELTA Goal One.
Project Background	CSC216 is a three-credit second semester programming course required for Computer Science majors and minors, serving approximately 100-200 students every semester. CSC216 starts the student’s transformation from a coder into a software engineer. The course covers advanced object-oriented programming (composition, inheritance, polymorphism, interfaces, and abstract classes), software engineering (requirements, design, and test), linear data structures (array-based lists, linked lists, iterators, stacks, and queues), finite state machines and the state pattern, recursion, GUIs, sorting, and searching. The course redesign transformed CSC216 by creating a new TA-lead laboratory portion of the course that relates to recently covered lecture topics where student can collaboratively explore materials and software engineering best practices in small sections with lightweight teams, similar to the model used in SCALE-UP. To support the move to a lab-based class, course resources and automated grading technologies were also

	updated. In particular, the redesign effort incorporated additional support for the students in CSC216 through the implementation of interventions targeting main challenges noted in the traditional course. The redesign was administered in two phases. In the first semester, a partial form of the redesign course was administered. This excluded the use of the Eclipse and Training tutorials, and included the use of guided project one (GP1) and guided project two (GP2). In the semester following, additional components of guided project three (GP3) was added to form the full/complete version of the redesigned course.
Assessment Tools	The impact of the redesign on student learning outcomes were assessed in the following ways: **(A) Student Success** 1. *Student performance* – Descriptive and inferential statistical methods were used to compare the grade distribution (ABCDFW) in CSC216 before and after course redesign. 2. *Retention and successful completion* – Descriptive and inferential statistical methods were used to compare DFW rates. *3. Student Participation* - Descriptive and inferential statistical methods were used in order to see student engagement and participation in tutorials and guided projects over the course of the redesign project *4. Prediction of course outcomes* - Inferential statistical methods were used to predict various course grade outcomes given other course components. ***(B) Student Experience*** 1. *Views of course* – Descriptive statistics were used to outline students' general perceptions of the redesigned course and its impact on their learning. 2. *Engagement* – Descriptive statistics were used to outline students' level of engagement in aspects of the redesigned course. 3. *Efficacy* - Descriptive statistics were used to outline students' confidence in their ability to complete course related tasks.
Population	The population of interest for this LCR assessment is all full-time, on-campus undergraduate students at NC State who took CSC216 for a grade between fall 2016 and spring 2017.
Sample (If Applicable)	We had access to performance and retention data for the entire population of interest from Fall 2015 to Spring 2017 (N = 455). A smaller sample of students (N = 291) were eligible to participate in surveys administered in Fall 2016 and Spring 2017.
Response Rate	115 students (28.7% of the class, or 39.5% of the survey population) responded to at least one item on the student survey completed during redesign semesters. Response rate differed slightly for sections of the survey:

	• 67 students (23.0%) responded to items relating to their general views of the course and engagement in the course/lab, and efficacy towards completing course related tasks. • 57 students (19.6%) responded to items relating to their transition to the course.
Brief Summary of Results	**(A) Student Success** *Student Performance* Chi-square tests revealed significant differences between semesters over the course of the course redesign project CSC216 (χ^2 (15) = 32.779, p = .005). When comparing prior semesters with semester 1 of the redesign (Fall 16), chi-square tests revealed significant differences in grade distributions between pre-, partial-, and post-LCR semesters (χ^2 (10) = 20.56, p = .024). Post-hoc analysis revealed students in the post-LCR course to have a significantly higher rate of A grades compared to the partially redesigned course, as well as significantly lower rate of F grades compared to pre-LCR course ($p < .05$). However, when comparing prior semesters with semester 2 of the redesign (Spring 17), no significant differences between pre-, partial-, and post-LCR semesters were found (χ^2 (10) = 8.694, p = .561). *Student Participation* Statistical measures were used to obtain completion rate of individual tutorials and guided projects. Students partial- and post-LCR have a higher average completion rate on assignments compared to those in the pre-LCR. On average, across all the projects in a semester student assignment completion rates were 91.3%, 98.8%, and 96.1% for pre-, partial-, and post- LCR, respectively. *Student Retention and Completion* In both analyses comparing semester 1 (Fall 16) and semester 2 (Spring 17) of the redesign to pre- and partial semesters, no significant differences in DFW rates were found ($\chi^2(2)$ = .54, p = .76 semester 1; $\chi^2(2)$ = 1.58, p = .45 semester 2). *Prediction of Course Outcomes* Statistical models were created in order to understand the influence of specific courses components (guided projects, project average, and exam averages) on course success/outcomes. Using regression analyses, two models were tested, 1) the impact of guided project grade/success on course project grade (controlling for semester and exam score), and 2) the impact of guided project grade/success on course exam grade (controlling for semester and project grade). (Note: exam grade was measured using a students average score on exam one and exam two. The final, commonly exam three, was not considered as it is cumulative and taken at the conclusion of the course). Assumptions are met - please see full paper for more.

The first model, predicting project average given guided projects, semester, and exams, was significant (F = 152.960, p < .001). Controlling for semester and exam average, for every increase in guided project average students are expected to have an increase in their project average. 63.9% of the variation in project average can be explained by the model (R = .802).

The second model, predicting student performance on exam average given the guided projects, semester, and average project score, was also significant (F = 126.407, p < .000). Controlling for semester and project average, for every point increase in guided project average the students' average exam score is expected to increase. Model two adjusted r-squared suggests that 59.4% of the variation in student performance on exam average explained by project average given the semester and guided project average (R= .774).

(B) Student Experience

Engagement

Overall, a majority of students agreed that they found both the course structure (lecture and lab) to be more engaging than a traditional lecture only course format (53.7%), as well as that the labs kept them engaged in the course (58.2%).

With specific aspects of the course, students varied in their use of lab resources (see *Figure* 3 below). Students noted that they engaged with class readings the least, with 52.9% using them rarely or never. In comparison, lecture notes and example code appeared to be used more often by students, with 44.2% (lecture notes) and 47.1% (example code) of individuals reporting using these resources very often or always.

Views of Course

Students views of the course itself were largely positive, with 60.6% of students agreeing that they learned course material better in the redesign course than they did in more traditional lecture only courses. Further, they also viewed the lab in a positive light, with a large majority of students agreeing that 1) the labs provided a foundation for completing the course projects that came later in the course (63.3%), 2) the activities during the labs have clear connections to real-world applications (79.4%), and 3) that they will be able to use the skills they learned in the labs in future CSC courses (86.8%).

Efficacy

When asked about their ability to complete course related tasks/their competency in course related objectives, students reported a high level of agreement.

- 88% of students who responded agree/strongly agree that they are able to use software engineering best practices (e.g., test-driven

	development, code coverage, static analysis, version control, continuous integration) and documentation with supporting tooling to implement and test object-oriented systems. • 88.1% of students who responded agree/strongly agree that they are able to navigate and extract information from the Java API, and employ the Javadoc tool to construct internal documentation of source code. • 89.5% of students who responded agree/strongly agree that they are able to design and implement a finite state machine. • 61.2% of students who responded agree/strongly agree that they are able to identify when recursion is useful, and design and implement recursive algorithms and simple recursive data structures. • 86.5% of students who responded agree/strongly agree that they are able to construct and use a stack, queue, array-based list, and linked list. *Transition from CSC116 to CSC216* • 44% of students who responded stated that they found their transition from CSC116 to CSC216 difficult/very difficult.
Contact Information for Further Details	To request a copy of the full report for CSC 216, please email Chris Willis. *For information regarding the course redesign of CSC216:* Dr. Sarah Heckman Director of Undergraduate Programs Teaching Associate Professor Department of Computer Science Engineering Building II (EB2) 2297 Campus Box 8206 Raleigh, NC 27695 sarah_heckman@ncsu.edu 919-515-2042 *For information regarding the instructional design of CSC 216:* Yan Shen, PhD Instructional Designer Distance Education and Learning Technology Applications (DELTA) North Carolina State University 1010 Main Campus Dr. Suite 220 Campus Box 7113 Raleigh, NC 27695 yshen8@ncsu.edu 919-513-7096 *For information regarding the assessment of the CSC216 course redesign:* Chris Willis Assistant Director, DELTA Planning & Assessment Distance Education and Learning Technology Applications (DELTA)

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Interpretation of Results	***(A) Student Performance in CSC216*** Quantitative analysis of final grade data demonstrated there is a difference between the Pre-, Partial-, and Post- (Fall 16) LCR. Results suggest students in the post- (Fall 16) LCR of CSC216 have a significantly higher rate of A grades compared to the partial-LCR semester. Similarly, students post- (Fall 16) LCR are less likely to receive an F than those in the partial-LCR. However, testing and analysis suggests there is no difference between pre-, partial-, and post- (Spring 17) LCR. Since there was no difference no further investigation and analysis was done. ***(B) Attrition and Course Completion*** As mentioned above, analysis testing shows there is a significant difference between the spring and fall semesters of the post -LCR and not of the Pre-LCR. Analysis of the proportions of students with D, F, and W final grades do not show a significant difference between pre-, partial-, and post- (Fall 16) LCR or pre-, partial-, post (Spring 17) LCR. Though there was no significant difference, percentages suggest there is a slight downward, but varying, trend on student receiving a DFW in CSC216. ***(C) Positive response from students*** The positive responses from students when comparing the redesign course to the traditional course, in relation to their future career, and efficacy in completing course related tasks provides strong support for the benefit of the redesign on course perceptions. The majority of students viewed the lab not only as being beneficial for successful course completion, but also more engaging than traditional lecture format. Furthermore, students showed a high level of confidence in their ability to complete course related activities following completion of the course itself.
Limitations	Because there are many factors that can contribute to or hinder students' success in a given course, causation is difficult to establish. Given this and the potential for intra-class relationships between the grades in individual course sections, the independent observations assumption made by the Pearson Chi-square test is called into question. Caution is therefore warranted when referencing these results. Hierarchical linear modeling (HLM) (see Raudenbush & Bryk, 2002) techniques should be utilized in future reports with larger samples. Moreover, the small sample size for survey data and lack of comparison data between pre- and post-LCR in regard to students efficacy and value of the course to their future career limits the ability of the current report to understand whether the redesign led to changes in students' perceptions of their own ability to complete course related tasks and/or perception that the course is valuable for their future.

	Finally, caution is warranted when referencing the regression models in student prediction of course outcomes section. The histogram of the distribution of grades in CSC216 does not appear to be normal. Additionally, scatter plots show slight unequal bandwidth on the extremes of the graph suggesting deviance from assumptions of equal variance and independence. Although not ideal in the context of the current analyses, this finding is not uncommon in education (i.e., that grade data distributions are found to verge from normality).
Impact	The efforts of Dr. Heckman, DELTA, and the assessment outcomes reported here are intended to provide meaningful information and data for instructors at NC State and other universities who wish to embark on course redesign with the goal to improve teaching methods, and with the intended outcome being to improve student achievement in undergraduate level courses. Overall, this study adds to the evidence that the positive results in the improvement of students' grades and completion rates in CSC216 are associated with the course redesign project.