PRAC Report: Assessment of Student Learning
IUPUI School of Science
2013-2014 Report

Overview: The School of Science at IUPUI provides outstanding science education for all IUPUI students, education in depth for students in our School, and engages in fundamental and applied research in the physical, biological, mathematical, and psychological sciences to increase knowledge and advance the development of the life sciences at IUPUI and in the State of Indiana. Within the seven academic departments (Biology, Chemistry & Chemical Biology, Computer & Information Science, Earth Sciences, Mathematical Sciences, Physics, and Psychology) and the Forensic and Investigative Sciences Program, there are over 160 full-time faculty members. The School is the academic home of ~2,000 undergraduate majors and ~450 graduate students.

Part I: Student Learning Outcomes for Each Academic Program

The School of Science has been utilizing Student Learning Outcomes developed during the 2010-2011 academic year. A comprehensive list of SLOs for both undergraduate and graduate education and degree programs can be found in the IUPUI Bulletin, 2012-2014 (or by clicking the links below).

Undergraduate SLOs (B.A. and B.S.)	**Graduate SLOs (M.S. and Ph.D.)**
• Biology	• Biology
• Chemistry	• Chemistry
• Computer and Information Science	• Clinical Psychology
• Environmental Science	• Computer and Information Science
• Forensic and Investigative Sciences	• Geology
• Geology	• Industrial Organizational Psychology
• Interdisciplinary Studies	• Mathematics
• Mathematics	• Physics
• Physics	• Psychobiology of Addictions
• Psychology	

How is the School of Science assessing Student Learning Outcomes and Student Learning?

The main focus of this 2013-2014 School of Science's annual report is on the efforts undertaken in the last year to refine, measure, and improve the attainment of the student learning outcomes for our programs. The following data and information provides evidence that we are assessing our programs, that we are addressing the IUPUI Principles of Undergraduate Learning and Principles of Graduate Learning, that we have deliberate and ongoing processes in place for performing these assessments of student learning, and that we are using the results to guide improvements in our programs.

We will also report on assessment and improvement of processes that support student learning and student retention and success, as well as research on formative and summative assessment of student learning. Several continuing grants from the National Science Foundation (NSF) that focus on undergraduate education or undergraduate student success have allowed us to commit significant resources to expanding best practices related to the academic experience in the School of Science.

Part II: Outline of Recent Assessment Activities and Accomplishments: Continued external funding to support course transformation and STEM curricular development

This year's report will next highlight a number of ongoing and new initiatives in the School of Science that assess student learning outcomes and student success. While this is not a comprehensive list, it details many of our major initiatives in the School of Science. Many of the initiatives mentioned in this report are continued efforts of the programs described in detail in our two previous PRAC reports (2011-2012 and 2012-2013), many of which are related to our ongoing NSF funded **Central Indiana STEM Talent Expansion (CI-STEP) Program at IUPUI** (Jeff Watt et al.). The focus of CI-STEP is to employ and assess the impact of several intervention strategies on student learning and student success, leading to higher numbers of students graduating with STEM degrees. This program takes a coordinated and systemic approach to increasing undergraduate success in STEM at all levels, from pre-college to the important first year experience, to the sophomore year and onto graduation, through leadership and career development. To meet these goals, the School of Science has spent the last 4 years initiating a series of new programs and funded a series of STEP mini-grants to expand, extend, or develop new programs at IUPUI based on successful existing high-impact practices. In addition, several other externally funded student success initiatives allow us to continue to make process in assessing student learning and success, including the NSF funded **Cyber PLTL (cPLTL): Development, Implementation, and Evaluation** (Pratibha Varma-Nelson et al.), and the NSF funded **Advancing Undergraduate Chemical Education Through Contextualized Organic Laboratories** (Martin O'Donnell et al.).

As a result, *we have met or exceeded our target goals for each year of the funding*, including a:

10% increase in the number of new and transfer students admitted to STEM majors,
10% increase in the number of minority students admitted to STEM majors
10% decrease in the DFW rates for MATH, CS, PHYS, TECH and other courses
15 additional students participating in internship and research experiences
50 graduating seniors participating in honors seminars

The current report (2013-2014) will discuss new initiatives as well as provide updates based on evidence to support continuous improvement in instruction, curriculum, assessing student learning outcomes, and increased efforts in student support and Science Career Development Services.

Based on last year's suggestion by the PRAC report review team: "What is contained in this report that other programs might benefit from seeing?" We will focus on their suggestion to highlight results from the PLTL project (and cPLTL) programs in Chemistry, course improvement efforts in biology, chemistry, and mathematics, and SOS Career Development Services updates.

Part III: Evidence of Continuous Assessment related to Student Learning Outcomes: Research on Course and Curriculum Development or Redesign

<u>1. NSF TUES: Cyber PLTL: Development, Implementation, and Evaluation</u>, Pratibha Varma-Nelson (PI), Lin Zhu, J. Randy Newbrough, Tom Janke, Lorie Shuck

Peer-Led Team Learning (PLTL) is a model of teaching where six to eight students work as a team to solve carefully constructed problems under the guidance of a peer leader. The impact of the PLTL workshop on students, leaders, faculty and institutions has been assessed and evaluated in a variety of settings for more than ten years (review and references), with additional funding by the NGLC Wave I and Follow-On Initiatives (EDUCAUSE, Bill and Melinda Gates, and William and Flora Hewlett, foundations). As already reported, PLTL students earned 14% more ABC grades (76%) than their non-PLTL counterparts (62%), with students making positive gains in critical thinking when compared to their non-PLTL counterparts. The DFW rates for fall semesters has been steadily decreasing from above 45% before PLTL was implemented to below 20% in 2010.

The 2011 launch Cyber PLTL (cPLTL) — synchronous, interactive online CHEM C105 workshops — allows for an assessment of the effectiveness of cPLTL to PLTL. Data indicates that achievement levels of students enrolled in cPLTL are commensurate with those enrolled in PLTL. As previously reported, cPLTL students at IUPUI (M = 72.3) significantly outperformed control group students enrolled in PLTL (M = 66.5), and the national average (M = 61.3) on the American Chemical Society (ACS) Exam taken as a final. Assessment data from 2012-2013 indicate high student satisfaction with cPLTL: 83.3% of cPLTL participants and 81.5% of PLTL participants agreed or strongly agreed. Among cPLTL participants 65.7% (M = 3.77 in Likert scale) agreed or strongly agreed that their knowledge and understanding of the material taught in the course was a result of the cPLTL workshops, while 83.2% of PLTL students (M = 4.19) agreed or strongly agreed with the same statement. The other statistically significant item asked if students enjoyed their participation in cPLTL/PLTL workshops. In this case 63.9% of the cPLTL participants (M=3.72) and 76.3% of the PLTL (M= 4.00) agreed or strongly agreed.

A new assessment of PLTL and cPLTL was recently published in the *Journal of Research in Science Teaching*: 51: 714–740 (2014). The study, Replicating Peer-Led Team Learning in Cyberspace (P. Varma Nelson et al.,) revealed distinct similarities and differences between PLTL and cPLTL sections. Students in the traditional PLTL (n=220) condition were more satisfied with their workshop and earned statistically significantly higher course grades, yet earned comparable standardized final exam scores (cPLTL 62.2%; PLTL 63.8%). Qualitative assessment revealed that comparable deep student learning occurs in both settings, although student behavior is different in the cPLTL setting in that students make increased use of online resources and there is a higher proportion of discussion. Interestingly, there is a statistically <u>lower probability</u> of earning ABC versus DFW grades for underrepresented minority or low-income students in cPLTL sections. Further analysis is needed to better understand issues associated with the digital divide, attendance, and active engagement differences for these two groups. The key differences in student interactions, experiences, and pedagogical practices will continue to be reported annually.

Table 4: Final Course Grades

	cPLTL		PLTL	
Mean Course Grades	**n**	**Mean (SD) Grade**	**n**	**Mean (SD) Grade**
(Fall 2010-Spring 2013)	175	2.26 (1.16)	220	2.43 (1.15)
Final Course Grades	n	% Earned ABC	n	% Earned ABC
(Fall 2010-Spring 2013)	137	69.2%	n	78.3%
	n	**% Earned DFW**	**n**	**% Earned DFW**
(Fall 2010-Spring 2013)	61	30.8%	50	21.7%*

*p≤.05; Note: Total sample size for mean course grades did not include students who withdrew

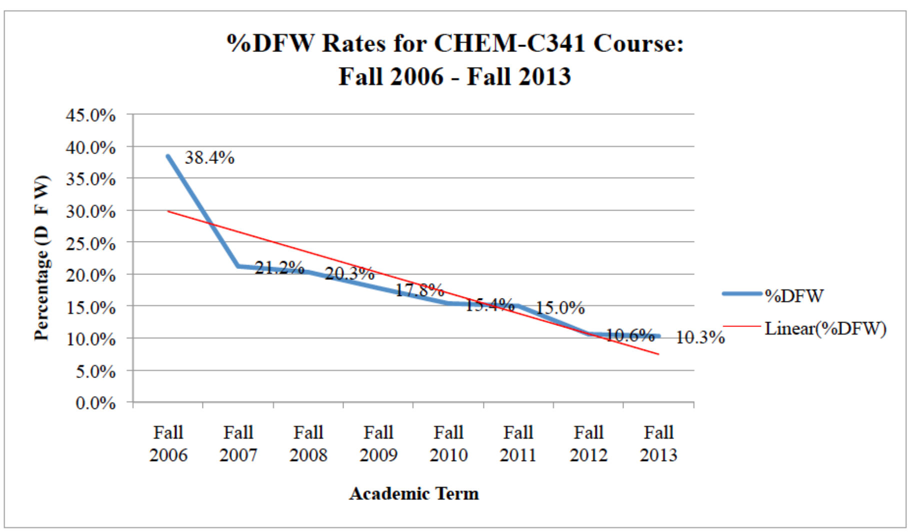
2. Chemistry C341: First Semester Organic Chemistry continues PLTL Workshop Series

Organic Chemistry is a challenging course that bring together many of the student learning outcomes for Chemistry as well as a Major Emphasis on PUL 2: Critical Thinking. To facilitate students' collaborative development of Organic Chemistry problem-solving skills, as measured by performance on an ACS Organic Chemistry Exam and survey data, a modified Peer-Led Team Learning (PLTL) workshop series was instituted as a component of the first semester Organic Chemistry course, funded by the NSF-STEP grant. The peer leaders elicit the participation of all group members, challenge students to expand their conceptual understanding through Socratic dialogue, share insights from being reflective on their problem-solving processes, and encourage students to explain their new understanding of concepts to one another in their small group during these 75-minutes workshops.

Objectives:

1. Decrease the DFW rate for C341
2. Increase performance on the national ACS Organic Chemistry final exam
3. Increase problem solving and critical thinking in the course

Results and Major findings of 2013-2014 include: To assess the curricular value of this modification, common semester exams and a standardized final exam (again developed by the ACS) were implemented. Student engagement was assessed continuously through weekly discussion leader reflections, while student perceptions were assessed through end-of-semester surveys. Each peer-led problem-solving workshop has been organized as a 75-minute (2010-2013) or 110-minute (2014) additional meeting within the 3-credit first semester organic chemistry course. Workshop sections consist of approximately 30 students organized into small groups that are facilitated by two (2010-11) or three (2011-14) undergraduate peer leaders. The two lecture sections and multiple Workshops are harmonized by means of a common syllabus, weekly collaborative selection of problems, and a weekly peer leader training meeting.



- Implementation of the Workshop Series with two discussion leaders per section had an immediate positive effect on the DFW rate, which dropped from a five-semester range of 23-30% to 15-16% over the past two semesters (2013).
- Furthermore, there was a stepwise improvement in the performance of the students on the standardized ACS exam after the implementation of the workshop series with two discussion leaders per section. Student achievement on the ACS organic chemistry exam is statistically significantly higher since implementation of the PLTL workshop series.

Other significant findings include: (1) the DFW rates have decreased about 10% after workshops were implemented, (2) 6 to 10% increase in positive student perception of problem-solving ability, (3) 25% of the peer mentors expressed an interest in teaching after this experience, and (4) study findings to date suggest that faculty have been successful in using the PLTL approach to lower the failure rates. Reduction of DFW rates for the course and training of discussion leaders to decrease the number of students in each workshop are positive interventions for increasing the success and number of STEM graduates.

3. Biology: Use of Mastering Biology software to assess Student Learning

The Department of Biology has long realized the benefit of undergraduate peer mentoring on success of students in Gateway Courses (typically large enrollment introductory courses for majors or non-majors). Gateway courses often have unacceptably low student success rates (A, B, and C grades), indicating that students are not attaining the learning goals and outcomes of the course.

We have continued our peer mentoring and active learning efforts in Biology K101 and have focused this year on the use of **Pearson's Mastering Biology software**, an on-line homework, quizzing, and active learning site for students that comes included with the purchase of their textbook.

As mentioned in our two previous PRAC reports, a number of Gateway and other large enrolling courses have been using active learning and classroom technology such as Just in Time Teaching (JiTT), clickers and other classroom technologies, and electronic homework to assess student understanding and learning in real time or in a greatly reduced time frame that permits rapid formative feedback. These systems include **Mastering Biology, Mastering Chemistry,** and **smartPhysics** - integrated systems in which the textbook, homework problems, testing, classroom response and assessment metrics are all linked through a single course site for students and faculty. By setting up continuous feedback loops between the instructor and the students, inside and outside of class, students are better prepared and instructors can access powerful data to understand their students' strengths and weaknesses.

With these systems, assessment occurs at every phase of learning, including:

- Embedded questions within each Warm Up / PreLecture assignment
- Interactive clicker questions for use during lecture
- Quizzes that follow each Lecture
- Student homework that includes concept-driven feedback
- High level exam questions that connect formative and summative assessments
- Easily displayed data to demonstrate assessment outcomes.
- **New for Fall 2013**: Adaptive Feedback, proprietary software personalized for each student and continuously adaptive. Students are individually given up to 3 additional assignments after completing an assignment with a score that indicates further practice is needed.

While our results are still being analyzed (next page), it is clear from looking at average scores for each SLOs that there are areas that can be targeted for further attention and improvement, including Quantitative Skills, Demonstrating knowledge of how biological molecules such as DNA, RNA, proteins, lipids, and carbohydrates contribute to the structure and function of prokaryotic and eukaryotic cells, and Appling basic principles of chemistry, math, and other disciplines to the functioning of living systems. In addition, we are planning to undertake a more comprehensive study to analyze and integrate all Biology and Chemistry data related to SLOs using Mastering software in the year ahead.

Assessment Outcomes using Pearson's Mastering Biology: Analysis of Global SLOs as well and SLOs related to Biology and Chemistry in Fall 2013 Biology K101 and K102 (n=420)

LEARNING OUTCOMES	# OF ITEMS	% COMPLETE	% AVERAGE SCORE
Global: Demonstrate an understanding of the impact of science on society.	3	52.2	94.1
Global: Demonstrate an understanding of the principles of scientific inquiry.	2	44.5	81.8
Global: Demonstrate the ability to make connections between concepts across biology.	8	32.0	87.7
Global: Demonstrate the ability to think critically and employ critical thinking skills.	9	56.5	83.0
Global: Demonstrate the quantitative skills needed to succeed in Introductory Biology.	6	61.3	79.0
Global: Read and interpret graphs and data.	3	60.5	83.1

LEARNING OUTCOMES	# OF ITEMS	% COMPLETE	% AVERAGE SCORE
Use examples to demonstrate how carbon's atomic structure results in a wide range of molecular structures.	1	93.6	87.4
Use examples to demonstrate the processes of diffusion, osmosis, and facilitated diffusion.	1	13.6	83.2
Use examples to illustrate each theme of this book.	1	95.2	82.2
Use examples to illustrate how the structure of an element's atoms determines its properties.	4	65.9	93.5
Use examples to show how genetic inheritance patterns can be affected by complete dominance, incomplete dominance, codominance, multiple alleles, pleiotropy, epistasis, and polygenic inheritance.	3	55.2	84.9

LEARNING OUTCOMES	# OF ITEMS	% COMPLETE	% AVERAGE SCORE
Identify four properties of water that are important for life and describe how they result from hydrogen bonding.	1	29.8	97.0
Identify key derived characters of land plants.	1	77.6	86.8
Identify major phylogenetic groups of prokaryotes.	2	78.3	94.9
Identify sources of genetic diversity in prokaryotes.	2	39.3	84.8
Identify the key chemical groups that affect the function of biological molecules.	3	68.6	86.1
Identify the parts of the endomembrane system and describe their roles in the cell.	3	91.7	89.4
Identify the steps of oxidative phosphorylation and account for the total ATP produced per glucose molecule during cellular respiration.	1	91.4	85.0
Identify the ways in which sexual life cycles generate genetic variation that contributes to evolution.	1	83.8	92.8

LEARNING OUTCOMES	# OF ITEMS	% COMPLETE	% AVERAGE SCORE
Apply basic principles of chemistry, math, and other disciplines to the functioning of living systems.	1	92.1	77.8
Compare and contrast (1) prokaryotic and eukaryotic cells and (2) animal and plant cells.	2	91.8	84.3
Compare and contrast the structures of DNA and RNA and their component nucleotides.	5	61.8	82.6
Define "noncoding RNAs" and explain how they participate in regulating gene expression.	3	79.6	84.1
Demonstrate knowledge of how biological molecules such as DNA, RNA, proteins, lipids, and carbohydrates contribute to the structure and function of prokaryotic and eukaryotic cells.	4	91.4	70.4
Describe characteristics and reproductive processes of seedless vascular plants.	1	78.1	83.3
Describe characteristics of chromalveolates and how they might have originated.	1	78.6	90.6
Describe evidence that helped us understand the process of gene expression, and describe the process.	1	81.0	88.2
Describe how cells respond to signaling, including fine-tuning of the response.	2	82.7	85.9
Describe how regulation of enzyme activity helps control metabolism.	3	64.6	81.5
Describe structural and functional adaptations of prokaryotes.	1	78.6	95.2

4. Biology: Use of course-based undergraduate research experiences (CUREs) to enhance Student Learning in Honors Biology and Cell Biology K324

In response to national calls for transformation in STEM education to increase student engagement and persistence among undergraduate STEM majors at IUPUI, authentic research was introduced in the introductory biology honors class and cell biology laboratory K325 class to replace traditional biology laboratories with multi-year, interdisciplinary Course-based Undergraduate Research Experiences (CUREs) with humanitarian challenges and to establish fundamental, interdisciplinary "research habits of mind" to develop STEM undergraduate scholars who engage in science as effective researchers and discerning citizens.

In Fall 2013, Honors labs were redesigned to allow students to develop original research projects investigating prenatal alcohol, nicotine and caffeine exposure effects on development of zebrafish embryos was introduced into the Introductory Biology K102 course, facilitated be Dr. Grady Chism, Dr. Martin Vaughan, Dr. Swapnalee Sarmah, and Dr. Jim Marrs. The course was also linked to a new interdisciplinary Themed Learning Community titled "From Molecules to Medicines" that involved students in a interdisciplinary CURE experience developed through NSF funded Advancing Undergraduate Chemical Education Through Contextualized Organic Laboratories (Martin O'Donnell et al.) that integrates drug discovery aspects to a global health concern.

In documenting the developmental effects on zebrafish embryos, and designing new protocols to address student research questions, students gained experience with authentic research methods, laboratory techniques, microscopy, image analyses, statistical analyses, scientific writing and presentation skills. To continue an inquiry-based lab on global health issues and to keep IUPUI biology curricula current with the rapid rise of bioinformatics, Cell Biology Laboratory K325 was also redesigned in spring, 2014. Students were allowed to work on their own investigatory projects and analyze zebrafish microarray data to find genes affected after ethanol exposure, and ended the semester.

Assessment of the Biology CUREs (Preliminary data; full study will be submitted for publication in August 2014) Students completed a survey designed along the lines of national models to assess:
1. Identity and Self-efficacy: Does this project increase positive attitudes and confidence among students in relation to STEM courses and STEM research?
2. Scientific Expertise: Do students gain the knowledge, skills and abilities needed to succeed in K325 and other STEM courses?
3. Persistence framework: Do students in CUREs and TLCs show increased engagement, retention, persistence, and academic success?

Laboratory Assessment Questionnaire Responses

Statement	Average Rating
Confidence with bioinformatics Skills (before the class)	
I am aware of and comfortable using the tools on Ensemble and NCBI websites.	2.71
I know how to retrieve DNA/protein sequences from online genomic database.	3.14
I am aware of the bioinformatics field and know how bioinformatics stores, retrieves, and analyzes huge biological datasets.	2.90
I am aware of web-based bioinformatics tools and how these tools are used in biomedical research.	2.86
I feel comfortable performing web-based research projects.	3.76
I am aware of ClustalW2, multiple sequence alignment computer program	1.67
I know how to use DNA/protein sequence data to analyze evolutionary relationships among a group of organisms.	2.85
I understand protein structures and comfortable using 3-D protein visualization software.	2.86
I understand protein translation and can translate DNA sequence into protein sequence.	3.71
I am aware of biostatistics and understand probability values and statistical test outcomes.	3.10

1 = disagree completely, 2 = disagree somewhat, 3 = neither disagree nor agree, 4 = agree somewhat, 5 = agree completely

5. Biology: Embedding Clickers in an Undergraduate Introductory Anatomy Course

Teaching a clinically-integrated introductory undergraduate human anatomy course presents a unique set of challenges, including gathering continuous formative assessment with large class sizes comprised of various majors and backgrounds, providing formative feedback back to students while teaching higher levels of understanding, and integrating appropriate clinical correlations into formal teaching sessions. To address these challenges, Mike Yard and colleagues in Anatomy N261 investigated the use of clickers (audience response systems) in a large undergraduate anatomy course (n = 117). Students voluntarily answered clinically-oriented questions during each lecture with their clickers, with answers automatically collated for immediate display. The feedback provided immediate opportunities to realign follow-up discussions of relevant concepts in lecture. In a study submitted for publication (in review), results show that the use of clickers was well-received by students, and their performance on clicker exercises were highly correlated with overall course grade ($r = .880$, $p < 0.01$). Students felt motivated to participate, engaged with the novelty of clinical cases, and encouraged to apply factual information in order to reason through clinical problems. Clickers also provide a means of identifying struggling students prior to examinations. While many students felt that the advantages of using clicker technology to integrate clinical anatomy into the course far outweighed the disadvantages, there were some that expressed concerns about the technology due to time pressures to answer the questions without opportunity for active discussion. Additional studies are planned for this year to examine the effect of allowing students to take their quizzes together in teams during the anatomy course.

6. Assessing Progress in Lowering Math DFW Rates:

The DFW Rates in the MATH Dept. have decreased significantly over the past 10 years. The table on the following page shows rates in multi-section courses, and the bottom row shows the department rate for all courses (multi- and single-section).

Assessment and implications for practice: Activities that have a positive impact on lowering DFW Rates:

- Re-evaluating and changing cut-scores on the Math Placement test in Fall 2009, which sent an increased number of students to IVYTech to take pre-algebra;
- Implementing post-requisite checking in Fall 2012, where one week before classes start we remove students who did not have the correct pre-requisite in the past two years;
- Conducting professional development on best practices for increasing student learning, for math faculty each semester (the fall meeting is required for all our adjunct faculty);
- Increased space and new academic programming/training in the MAC, under the leadership of a new MAC director;
- Implementing various best practices in STEM education (articulation with IVYTech, use of recitations, post-req checks, etc.), funded by an NSF Grant, CI-STEP;
- Increased emphasis by advisors, for freshman to take math courses immediately (while high school pre-requisite is still fresh), and not wait until junior/senior status to take introductory math courses; and
- Second courses in sequences tend to have higher DFW rates in fall, because these courses are off sequence in the fall semester and tend to have weaker students who are off-track or repeating course (i.e., 13100, 16600, and 22200).

Comparison of DFW Rates by Course
Over Past Fall Semesters

Conclusion: The DFW rate for the department has steadily decreased over the past 7 years, from 41.0% in F07 to 25.4% in F13. However, some courses have erratic rates from year to year, attributed to individual instructors rotating thru courses. Changes in cut scores for intro math courses in F09 had positive effect, but sent a large number of students to IVYTech for math. Implementing Post-Requisite checking in F12 had positive effect in MATH 150s.

- Courses highlighted in green the F13 rate is lower F07 + F08 average.
- Courses highlighted in yellow the F13 rate has not changed over the years.
- Courses highlighted in red the DFW rate is increasing or not stable.

Course	F07 Rate	F08 Rate		F10 Rate		F12 Rate	F13 Rate	Comments
MATH 001	32.6%	39.4%		24.2%		23.0%	26.3%	Changed placement test's cut score, F09
MATH 110	41.0%	41.5%		29.7%		24.7%	21.2%	Changed placement test's cut score, F09
MATH 111	51.6%	46.0%		38.0%		35.9%	24.3%	Changed placement test's cut score, F09
MATH 130	13.7%	21.3%		16.7%		25.8%	13.5%	Varies based on instructos assigned
MATH 131	NA	0.0%		5.3%		12.5%	4.0%	Varies based on instructor assigned
MATH 132	13.3%	5.3%		20.0%		38.5%	17.9%	Varies based on instructors assigned
MATH 136	12.1%	11.8%		5.4%		9.7%	6.1%	
MATH 153	59.8%	60.2%		55.8%		35.6%	32.7%	Post-req check, F12
MATH 154	43.5%	50.3%		42.5%		37.5%	32.4%	Post-req check, F12
MATH 159	53.7%	51.9%		45.0%		31.9%	23.8%	Post-req check, F12
MATH 165	35.8%	30.6%		34.9%		27.9%	32.3%	
MATH 166	41.3%	40.8%		47.2%		44.9%	34.7%	
MATH 171	NA	39.4%		40.4%		27.4%	28.1%	
MATH 221	28.0%	39.1%		36.9%		23.3%	22.9%	
MATH 222	40.0%	43.8%		42.7%		32.0%	43.6%	Varies based on instructors assigned
MATH 231	30.3%	21.4%		16.6%		21.3%	21.1%	
MATH 232	NA	33.3%		33.3%		19.0%	18.2%	
MATH 261	33.3%	42.3%		29.8%		30.8%	17.2%	
MATH 266	29.9%	11.3%		25.3%		17.8%	30.1%	Varies based on instructors assigned
STAT 113	25.3%	30.1%		26.2%		25.3%	20.1%	
STAT 301	23.6%	20.0%		22.3%		21.8%	23.5%	
STAT 350	16.9%	52.5%		18.4%		20.7%	14.3%	
M118	37.4%	37.9%		33.1%		34.9%	29.1%	
M119	43.9%	30.9%		32.8%		25.2%	23.9%	
Entire Dept (STAT only)	41.0% (19.9%)	40.6% (33.2%)		35.1% (19.8%)		27.5% (21.2%)	25.4% (18.3%)	

7. The Effects of Implementing Recitation Activities on Success Rates in a College Calculus Course

This study (Jeffrey X. Watt, Andrew D. Gavrin, Kathleen A. Marrs and colleagues, in press, *Journal of Scholarship of Teaching & Learning*, October 2014) investigated the effects of using different types of recitation sessions with a large-enrollment section of a college calculus course on student achievement, success rates, and first-year retention. The study involved 1,956 calculus students who, over a six-year period (three two-year phases), enrolled into either a small section of calculus or a large lecture section. The small sections of the calculus course had enrollments below 50 students per section (average was 46) with a traditional style of classroom presentation and discussion format. The large lecture section of the course had enrollments averaging 92 students per section, with additional recitation sections of 25 students per recitation.

Breakdown of Students by Phase and Section Size

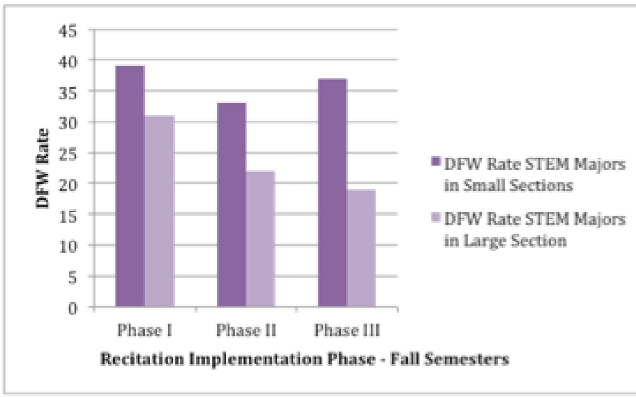
Phase	Small Section Control	Large Section Treatment
I	450	130
II	463	213
III	490	210

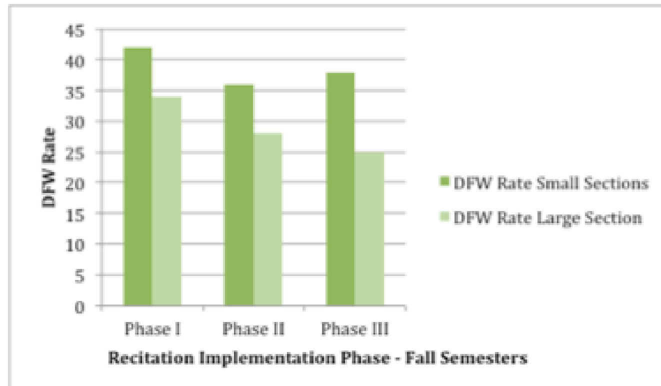
The recitation format evolved over time, but can be divided into three distinct phases lasting two years each. During Phase I (2007 and 2008), the students in the large lecture section (like all students in the course) had optional mentoring sessions at the Math Assistance Center conducted by undergraduate students (peer mentors). During Phase II (2009 and 2010), the students had required mentoring sessions (recitations) conducted by graduate students. A quiz was administered during recitation, and the score became part of the course grade. During Phase III (2011 and 2012), newly created recitation activities focused on developing mathematical concepts via an integrated Verbal, Geometric, Numeric and Algebraic understandings approach (VGNA Concept activities). These VGNA Concept activities were collected, graded, and became part of the course grade. The three types of recitation sessions studied were: (1) optional mentoring sessions at the Math Assistance Center conducted by undergraduate students (peer mentors), (2) required mentoring sessions conducted by graduate students, and (3) required VGNA (Verbal, Graphical or Geometric, Numeric, and Algebraic) Concept activities, which were also coupled with mentoring sessions conducted by graduate students. The success of the students in the large enrollment section of the course, which included one of the three different types of recitation sessions, was compared to the success of students in the small enrollment sections of the course (enrollments less than 50 students). The results of this study demonstrate methods of raising student success rates in large enrollment (lecture-format) courses.

Three measures were used to assess student success in the calculus course: the department final examination scores, the DFW rate, and the one-year retention rate after taking the calculus course. The DFW rate for the course, or a section of the course, is determined by dividing the number of students receiving a course grade of D, F, or W (withdrew from the course) by the number of students enrolled in the course at census. A freshman-level or general education course with a DFW rate above 30% is considered an at-risk course by University College (the freshman advising unit) for students at IUPUI. The majority of freshman-level mathematics courses (13 out of 22 in 2010) were considered at risk for freshman at IUPUI.

The departmental final examination is written each year by the coordinator of the course (who did not teach the course during the period of this study). The exam is a paper-and-pencil open-response instrument, with the same number of items testing the same learning objectives each year. The instructors of the course do not see the final examination until the day of the exam. Students from all sections of the course take the departmental final examination at the same time and place during final exam week. The exams are then commonly graded (each instructor of the course grades one page of the exam, for all students in the course).

During the fall semesters, the results on the departmental final examination, the DFW rates, and the one-year retention rates of STEM majors (left panel) and all math students (right panel) were examined by the type of recitation session used.





The success of the students in the large enrollment section of the course, which included one of the three different types of recitation sessions, was compared to the success of students in the small enrollment sections of the course. The effects of using each type of recitation session on raising departmental final examination scores, lowering DFW rates, and raising one-year retention rates were examined.

This study found that the most significant increases in student learning outcomes and one-year retention rates clearly occurred in the third type of recitation, in which students were taken out of their passive learning environments and integrated into environments of active learning (e.g. group work and collaborative learning) where, through the use of the VGNA Concept activities, knowledge construction occurred. In addition, this study has demonstrated that, even in large-enrollment sections of calculus, the implementation of highly structured recitation activities that focus on placing the student in an active role of developing their conceptual understandings of mathematics via verbal, geometric, numeric and algebraic representations can increase the student success rate in calculus and increase the first-year retention rate for STEM students.

8. Psychology Introductory Sequence Course Redesign:

The Psychology curriculum prior to 2012 had several strengths. It featured the four categories of courses (introductory, methodology, content, and integrative) recommended by the APA in its Handbook for Enhancing Undergraduate Education in Psychology. Students were provided with a strong introductory and methodological foundation, and also required two specialization courses that enable students to focus their degree in a particular area of psychological specialization. It provides majors with a wide variety of choices in the way they complete their core and specialization classes, including choices from both the social and biological aspects of psychology. However, several concerns about the old curriculum as a consequence of the wide variety of choices available to fulfill the psychology core requirements prompted a reassessment of the psychology curriculum.

In 2011, the Psychology Undergraduate Curriculum Task Force proposed a revised curriculum with five major changes, but no change in number of credit hours required: (1) Replacement of the two-course introductory sequence (B104 Introduction to Psychology as a Social Science and B105 Introduction to Psychology as a Social Science) with a single introductory course (B110 Introduction to Psychology as a Social Science); (2) replacement of B103 Orientation to a Major in Psychology with B303 Career Planning in Psychology, and students would take a Freshman Experience course (with psychology instructors) as a General Education requirement; (3) addition of B203 Ethics and Diversity in Psychology as a required course; (4) decreasing the number of required core courses from six to four, with the requirement that a course be taken within each of four content domains (Learning/Cognition; Sociocultural; Biological Bases; and Developmental); and (5) removing the B.A. and B.S. designations from the capstone courses, allowing students to take the capstone course that best suited their future career plans. The faculty approved all proposed changes and the new requirements are shown in Table 5.

The new curriculum addresses discrepancies the old curriculum had in reaching the learning goals put forth in the APA Guidelines for the Undergraduate Psychology Major. Students now take a single introductory course that provides a broad foundational understanding of psychology and emphasizes critical thinking with a scientific approach to psychology. Prior to taking psychology core and elective courses, students will take a course in ethics and diversity to provide a lens through which they can examine and understand psychology content and research. The methods sequence (B305 Statistics and B311 Research Methods in Psychology) remains the same to provide a strong methodological foundation. All students will take B310 Life Span Development, B320 Behavioral Neuroscience, B340 Cognition, and B370 Social Psychology to provide a strong foundation in the four major content domains of psychology. Students will complete their major requirements with four psychology content courses and a capstone course to reach the 40 credit hours in psychology required for the undergraduate degree (Table 5).

Criteria and methods for assessing the success of the new curriculum will be a priority for the department's Undergraduate Committee in the FY13 and FY 14 academic years. Criteria for assessment will include, but not be limited to how well the new curriculum satisfies PULs and SLOs, as well 50 as feedback from exiting seniors. The criteria will address both student learning and student satisfaction with the new curriculum.

Table 5. Psychology Curriculum

Curriculum Element	*Old Curriculum*	*New Curriculum*
First-Year Experience	• B103 Orientation to a Major in Psychology	• SCI-I120 Windows on Science
Introductory Sequence	• B104 Introduction to Psychology as a Social Science • B105 Introduction to Psychology as a Biological Science	• B110 Introduction to Psychology • B203 Ethics and Diversity in Psychology • B303 Career Planning in Psychology
Research Methods Sequence	• B305 Statistics • B311 Introductory Laboratory in Psychology	• B305 Statistics • B311 Research Methods in Psychology
Psychology Core or Foundation Courses	Choose six of the following core courses: • B307 Test and Measures • B310 Life Span Development • B320 Behavioral Neuroscience • B334 Perception • B340 Cognition • B344 Learning • B356 Motivation • B358 Introduction to I/O Psychology • B370 Social Psychology • B380 Abnormal Psychology • B398 Brain Mechanisms of Behavior • B424 Theories of Personality	Take the following foundation courses: • B310 Life Span Development • B320 Behavioral Neuroscience • B340 Cognition • B370 Social Psychology
Psychology Specialization or Content Courses	Two upper-level (300 or above) psychology specialization or elective courses	Four 300-level psychology content courses, including B201 (See Appendix UG-2 for list of all undergraduate psychology courses)
Capstone	Choose one of the following: • B425 Capstone Laboratory in Personality • B431 Capstone Laboratory in Cognition • B433 Capstone Laboratory in Applied Psychology • B461 Capstone Laboratory in	Choose one of the following: • B433 Capstone Laboratory in Psychology • B454 Capstone Seminar in Psychology • B462 Capstone Practicum in I/O Psychology • B482 Capstone Practicum in

Part IV: Summative Assessment of Student Learning and PULs

1. PUL Data: Principles Of Undergraduate Learning Faculty members teaching a variety of undergraduate courses assessed the performance of their students on the Principles of Undergraduate Learning (PULs) identified as receiving a Major and a Moderate emphasis in their courses, from 100-level to 400-level senior / capstone courses. These data were pooled together with data from each semester back to Spring 2010. Appendix A contains the complete set of data.

Faculty Ratings of School of Science Student Performance on PULs with Major Emphasis (300 Level)

PUL – Major Emphasis	Mean [2]	Not Effective	Somewhat Effective	Effective	Very Effective	Total
1A. Written, Oral, & Visual Communication Skills	96 3.47	4 4.2	5 5.2	29 30.2	58 60.4	96 100.0
1B. Quantitative Skills	368 3.16	41 11.1	45 12.2	96 26.1	186 50.5	368 100.0
2. Critical Thinking	1,344 3.06	145 10.8	243 18.1	341 25.4	615 45.8	1,344 100.0
3. Integration and Application of Knowledge	1,128 2.88	189 16.8	195 17.3	307 27.2	437 38.7	1,128 100.0
4. Intellectual Depth, Breadth, and Adaptiveness	839 2.87	126 15.0	174 20.7	223 26.6	316 37.7	839 100.0
Total [1]	3,775 2.98	505 13.4	662 17.5	996 26.4	1,612 42.7	3,775 100.0

[1] Combined number of student ratings in all 300-level courses sampled in Spring 2010, Fall 2010, Spring 2011, Fall 2011, Spring 2012, Fall 2012, Spring 2013, Fall 2013 and Spring 2014. A student may be evaluated more than once if he or she is taking more than one 300 level course.

[2] Scale: 1 = "Not Effective", 2 = "Somewhat Effective", 3 = "Effective", 4 = "Very Effective"

Faculty Ratings of School of Science Student Performance on PULs with Major Emphasis (400 Level)

PUL – Major Emphasis	Mean [2]	Not Effective	Somewhat Effective	Effective	Very Effective	Total
1A. Written, Oral, & Visual Communication Skills	20 3.45	1 5.0	2 10.0	4 20.0	13 65.0	20 100.0
1B. Quantitative Skills	42 2.48	5 11.9	14 33.3	21 50.0	2 4.8	42 100.0
2. Critical Thinking	474 2.91	48 10.1	84 17.7	207 43.7	135 28.5	474 100.0
3. Integration and Application of Knowledge	269 3.55	10 3.7	15 5.6	62 23.0	182 67.7	269 100.0
4. Intellectual Depth, Breadth, and Adaptiveness	154 2.77	19 12.3	34 22.1	64 41.6	37 24.0	154 100.0
6. Values and Ethics	5 3.80	0 0.0	0 0.0	1 20.0	4 80.0	5 100.0
Total [1]	964 3.06	83 8.6	149 15.5	359 37.2	373 38.7	964 100.0

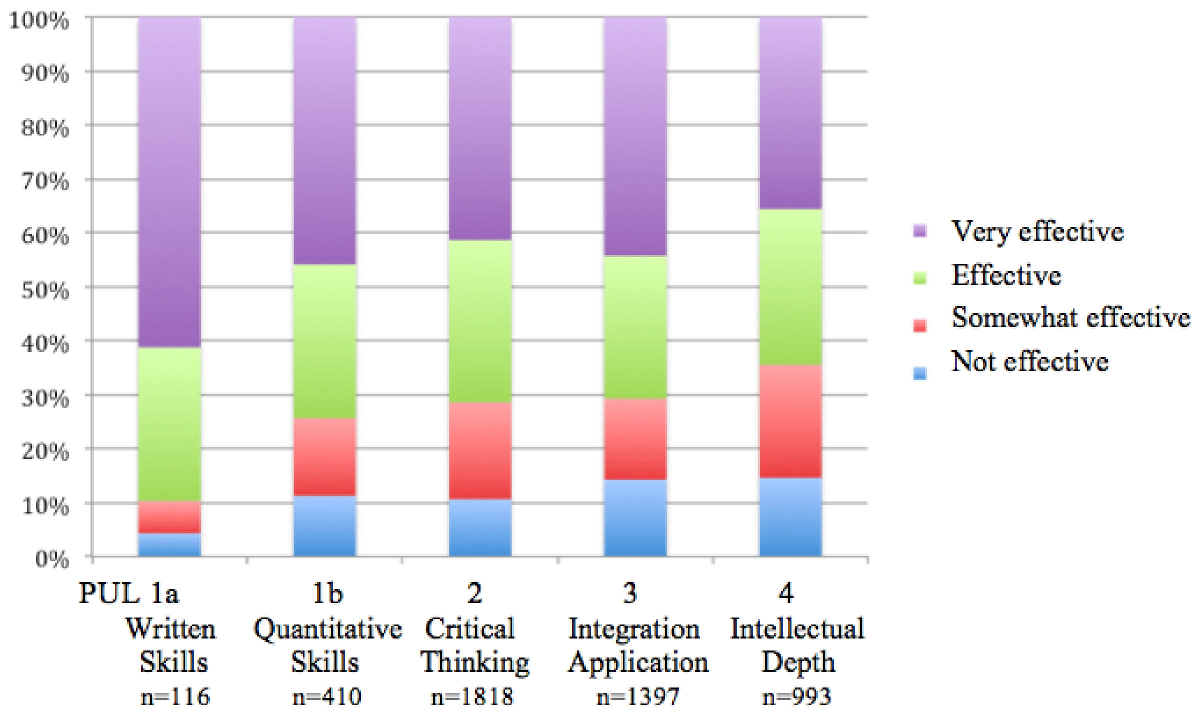
[1] Combined number of student ratings in all 400-level courses sampled in Spring 2010, Fall 2010, Spring 2011, Fall 2011, Spring 2012, Fall 2012, Spring 2013, Fall 2013 and Spring 2014. A student may be evaluated more than once if he or she is taking more than one 400 level course.

[2] Scale: 1 = "Not Effective", 2 = "Somewhat Effective", 3 = "Effective", 4 = "Very Effective"

To compare how faculty rated science majors on each of the PULs for which a major emphasis was specified, results from all 300 and 400 level spring course PUL assessments from the past 4 years (2010-2013; data above and attached in Appendix A from Steve Graunke / IMIR) were combined in the next graph, with each rating category (not effective, somewhat effective, effective, very effective) expressed as a percentage of the total ratings for that PUL.

This analysis reveals that science faculty teaching 300 and 400 level courses (populated mainly with science majors) feel that students as a whole have developed strong writing skills (PUL 1a), with almost 90% stated as effective or very effective, and assessed ~70% of students as being effective or very effective in quantitative skills (PUL1b), critical thinking (PUL 2), integration and application of knowledge (PUL 3) and intellectual breadth, depth and adaptiveness (PUL 4). These results suggest that our faculty members are generally confident with our majors' performance on these measures.

Major Emphasis PULs at the 300 and 400 level



B. Student Ratings: A second report asked students to rate their effectiveness on each of the PULs. Here we compare the results of IUPUI Science students with IUPUI students as a whole:

IUPUI Undergraduate Student Self Ratings of Effectiveness on the Principles of Undergraduate Learning Scales

School	N	Written, Oral & Visual Skills	Quantitative Skills	Information Resources and Technology Skills	Critical Thinking	Integration and Application of Knowledge	Intellectual Depth, Breadth and Adaptiveness	Understanding Society and Culture	Values and Ethics
IUPUI	483	3.43	3.01	3.36	3.33	3.27	3.29	3.37	3.41
School of Science	53	3.52	3.07	3.41	3.40	3.40*	3.39	3.45	3.46

In general, these data indicate that Science undergraduate students are confident in their attainment of the campus PULs, and that they are consistent with other students' self-reported scores. It will be necessary to compare these self-reported data with more objective data to draw further conclusions.

Part V: Evidence of assessment and changes made towards continuous improvement in student success initiatives and and student support services

A. Continuation and Expansion of Summer residential STEM Bridge program designed for students who will be residents on campus. There were several positives to the residential STEM bridge program. Students living in the same buildings had an opportunity to get to know one another before the semester began and there was more interaction as the semester continued. The number of students participating in the STEM, Science and Psychology Bridge programs continues to increase each year. Recent data indicates that STEM and other bridge participants have higher GPAs compared to non-participants; students participating in Summer Residential STEM Bridge have lower DFW rates compared to non-participants; and minority students (especially African Americans) participating in Summer STEM Bridge obtained higher GPAs, lower DFW rates and higher Fall-to-Fall retention rates compared to non-participating AA students. Based on an end of the semester assessment for Science Bridge participants, students are meeting the stated IUPUI Bridge Learning Outcomes:

- Develop a perspective on higher education
- Develop a community of learners
- Develop communication skills
- Develop critical thinking skills
- Develop study skills
- Develop college adjustment skills
- Understand the demands and expectations of college
- Understand information technology
- Understand and use university resources;

B. Continuation of the Physics Learning Space (PhyLS) In order to reduce the DFW rates in Physics, PhyLS has adopted the "assistance center" model that has proven successful in Math, Chemistry and Biology. Since its opening, the PhyLS or "Phyllis" as it is known, has proven to be a popular destination for many students. Students are able to interact with mentors and faculty in small groups or one-on-one, focus on the areas that cause them the most trouble, receive individual support, guided access to computer simulations, video analysis software, and other online tools that support learning in physics.

During its first three semesters of operation, visits to the PhyLS typically number 800- 1000/semester, with the mean stay being over one hour. Initial assessment showed that students' are highly positive about almost all aspects of PhyLS, based on a Likert scale survey was conducted in May 2013 by a campus evaluator.

In response to this, the Department of Physics has expanded the hours (the PhyLS is now open 42 hours/week), and has made an attempt to increase physical space by adding an "overflow whiteboard" to the corridor outside (unfortunately, no larger rooms are available) and by adding a second mentor during peak hours. Students, faculty and tutors have all had positive reactions to the PhyLS. Typical student comments focused on the "peer" aspect, fining that the help they get from other students is often more accessible than that from faculty.

C. School of Science PREPs (Pre-Professional and Career Preparation for Science Students): The Science Career Development Services moved to the new University Tower space (HO 200) in July 2013, launching their name as "PREPs" Pre-Professional & Career Preparation for Science Students" (SciencePREPs.iupui.edu), which has positioned the center as a key resource for Science students. One of the initial goals of the new Director was to increase the awareness of the center, its location, and services provided. The center was promoted through various programs and methods. Although only two employees initially staffed the center, outreach to hundreds of undergraduate and pre-professional students, has been successful. Strategic and intentional efforts were undertaken to acquaint faculty with PREPs staff and services, incuding:

Advising (1:1 sessions including appointments and drop-ins)

- October 2010 to June 2011 = 113 total contacts
- July 2011 to June 2012 = 271 total contacts
- July 2012 to June 2013 = 483 total contacts
- July 2013 to June 2014 = 646 total contacts

Educational Programs (includes class presentations and standalone career workshops)

- August 2010 to June 2011 = approximately 250
- July 2011 to June 2012 = 492 students
- July 2012 to June 2013 = 984 students
- July 2013 to June 2014 = 1298 students

This October, the second PREPs Life Health Sciences Career Fair will be held Tuesday, October 14, 2014. The Life Health Sciences Career Fair is designed to connect talented students face-to-face with employers in science related fields who are offering internships, full- and part-time positions, research experiences, and job-shadowing contacts. The inagural event in Spring 2014 drew over 60 employers and over 250 IUPUI students.

Part VI: Graduate Program Assessment

1. Program Overview: Graduate programs at the Ph.D. and M.S. level are advanced fields of study that provide new knowledge in areas unique to the specialization of particular faculty members within research disciplines. At the graduate level overall, however, there are generally similar educational outcomes that are usually independent of the specific field of scientific study. IUPUI has a series of Principles of Graduate Learning (PGLs) that form a conceptual framework that describes expectations of all graduate/professional students at IUPUI. Virtually all graduate students in almost all disciplines are assessed on:

(a) Ability to undertake appropriate research, scholarly or creative endeavors, and contribute to their discipline;
(b) Demonstrating mastery of the knowledge and skills in an advanced area expected for the degree and for professionalism and success in the field
(c) Thinking critically, applying good judgment in professional and personal situations
(d) Behaving in an ethical way both professionally and personally"
(e) Ability to teach, often at the undergraduate level; and
(f) Communicating effectively to others in the field and to the general public
(g) Success in finding employment in a field related to their graduate work.

Together, these PGLs are expectations that identify knowledge, skills, and abilities graduates will have demonstrated upon completing their specific degrees.

Based on the results of the Department of Biology's Program Review, the department has recently implemented a new program in Summer 2014 to help graduate students meet the Principles of Graduate Learning, called **Research in Progress**:

Research in Progress is a weekly meeting for graduate students and postdoctoral fellows to present their research. Attendance for these meetings is required for graduate students. In addition to providing experience with research presentations, these meetings can also be used for graduate Biology 696 seminar requirements for PhD students on topic unrelated to their thesis work. A new Journal Club was also formed to host weekly meetings for graduate students and postdoctoral fellows to present journal club papers on recent research papers. Research in Progress students will be assessed as to their attainment of the Principles of Graduate Learning.

2. Program Outcomes: In general, graduate programs in the School of Science assess M.S. and Ph.D. students through comprehensive written and/or oral examinations by a committee related to their field of study, and regular committee meetings to discuss research progress and mastery of skills and knowledge. Graduate students often teach in the department, and they are assessed on their ability to teach by the campus Student Satisfaction of Teaching survey that all faculty receive. Depending on the department, the Teaching Assistants may receive peer evaluation, if teaching. Their record of presentations at meetings, invited talks, publication and submission for grants or fellowships is also a means of assessment, and contributions to the scholarly literature both during and several years immediately after graduation similarly have are used as a form of program assessment.

Evaluation of these undertakings by committees of graduate faculty remains the ultimate assessment standard of student success at the graduate level. These metrics are generally found to be an academically acceptable method of capturing most of the information necessary for graduate student assessment. In terms of final numbers, over 200 students earned the M.S or Ph.D. in the School of Science in 2013-2014.

Part VI: Assessment Plans for 2014-2015

Assessment Committee Plans For 2014-2015: The creation of cohorts and tracking their performance through the pipeline to graduation has proved to be a challenge, but with the progress the School has made as a result of the STEP grant, we have been better able to track cohorts and chart their progress towards graduation, as well as gather data necessary to determine whether our students are not only meeting the standards set by the PULs but also developing the skills needed for graduate or professional school or a career after college . Currently, are collecting the following data on each cohort for both first-time freshman and transfer students (by gender, race, FT/PT, etc.):

1) Average GPA each year for cohort
2) Track those who attended a STEM or other Science Bridge, First year Experience or Themed Learning Community, and assess the impact of student persistence and retention
3) Track number who changed major, but dropped STEM major each year
4) Track students in each cohort involved with each student resource center (BRC, CRC, MAC, PhyLS), and compare their DFW and retention rates as well as graduation rates to others in cohort
5) Track number who use Career Development Services
6) Track the number of students who complete 2 or more RISE experiences

We will also continue to assess the effects of course development and course transformation efforts in the School of Science such as Chemistry PLTL workshops, Math, Biology, and Physics Recitations, CUREs in Biology and Chemistry, and other curricular innovations.