Faculty Course Modification Incentive Grant – Maine Learning Assistant Program

2016-2017 Academic Year Program Report

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Executive Summary

The Faculty Course Modification Incentive Grant – Maine Learning Assistant (FIG-MLA) Program is an innovative, growing, and successful program that improves undergraduates' STEM course experiences and outcomes while providing a rewarding professional development opportunity for exemplary STEM majors and STEM faculty. Through the program, STEM faculty receive assistance in planning and implementing course modifications that incorporate research-based techniques for STEM instruction, including those that promote active learning and peer learning. Maine Learning Assistants are hired to assist with the faculty course modifications and receive professional development through a seminar course. RiSE Center graduate students and staff assist STEM faculty in gathering and analyzing data to support course improvements. These supports and the professional community fostered by the RiSE Center have profound, positive impacts on the STEM course experience offered to University of Maine undergraduates.

Enrollment in multiple FIG-MLA courses is a factor in stronger institutional retention for first year students, with 79% of FIG-MLA students retained compared to 69% of Non-FIG-MLA students within highly impacted majors. In addition, FIG-MLA courses and course sections have significantly lower course fail rates (also known as DFW rates) than Non-FIG-MLA courses and sections within a comparable pool of STEM courses. In other words, students in FIG-MLA courses experience higher rates of course success than students in comparable courses that are not involved in the FIG-MLA program. Course success is a strong predictor of institutional retention.

Institutionalized funding for this program is crucial to its stability and success. Since 2012, the program has grown each year in the number of FIG-MLA courses and sections offered, the number of MLAs hired to support courses, and the number of instructors involved – with the exception of 2015-16 academic year, when program funding was uncertain.

Across two recent academic years (2014-15 and 2015-16), 77% of incoming STEM majors took at least one FIG-MLA course. All parties to the FIG-MLA program including students, faculty, and Maine Learning Assistants, self-report important academic and professional benefits as a result of the program.

FIG-MLA Program Overview

The Maine Center for Research in STEM Education (RiSE Center) offers opportunities for science, technology, engineering, and mathematics (STEM) instructors at the University of Maine to apply for course modification incentive grants through the Faculty Course Modification Incentive Grant – Maine Learning Assistant (FIG-MLA) Program. As of 2016-17, 38 instructors with 40 courses in 14 departments have received awards.

The goals of the FIG-MLA program are to:

- improve the quality of undergraduate STEM education,
- promote research-based teaching,
- prepare talented STEM majors for careers in teaching, and
- encourage institutional change in the way STEM courses are taught.

To participate in the FIG-MLA program, STEM instructors submit grant proposals requesting support in order to modify their courses/course sections to include more evidence-based and student-centered teaching strategies. Examples of evidence-based strategies include use of clicker questions, collaborative group work, and facilitated peer discussions. Proposals include the use of undergraduate Maine Learning Assistants (MLAs) in the classrooms to help instructors implement course modifications. To date, 236 undergraduate students have been hired to fill MLA positions. MLAs serve as peer instructors, facilitating group work and assisting faculty as they transform their courses to incorporate more interactive-engagement and student-centered instruction. MLAs learn to use innovative, research-based instructional strategies, develop relevant pedagogical skills, deepen their content understanding, and have the opportunity to explore their interest in STEM teaching, while participating in a vibrant community of peers and faculty.

University of Maine's FIG-MLA program began in 2012 under a significant grant awarded to the RiSE Center through the National Science Foundation's Math and Science Partnership (MSP) program. Key aspects of the FIG-MLA program were originally adapted from a highly successful Learning Assistant program developed at the University of Colorado Boulder and now used at over 200 institutions worldwide. Funding from the NSF MSP grant came to a close in 2015-16 and future funding for the FIG-MLA program was uncertain. At that time the University of Maine, recognizing the importance of the program in supporting exemplary STEM education on campus, committed to providing ongoing funding to the FIG-MLA program. The program is currently funded by the University of Maine.

Significant Growth in the FIG-MLA Program Over Time

The FIG-MLA program has grown from 5 faculty modifying 5 courses across 4 STEM departments in 2012-13, to 23 faculty modifying 40 courses across 14 STEM departments in 2017-18. In parallel, the number of students impacted per year grew from 1,200 in 2012-13, to over 4,200 in 2016-17. Detailed graphs of program growth are shown below.

Figure 1. Growth in Number of FIG-MLA Courses Offered

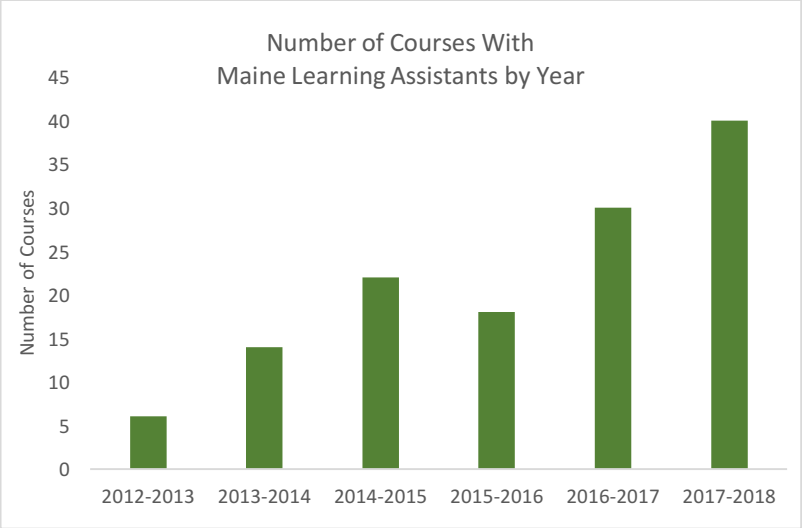


Figure 1 shows the number of courses being offered as a part of the FIG-MLA program. In these courses faculty have proposed course modifications and MLAs are hired to work as peer instructors. In 2012, five courses were a part of the program and today there are 40 courses offered that include improved evidence-based teaching strategies and MLAs as an additional and important learning resource to students.

Figure 2. Students Enrolled in FIG-MLA Courses

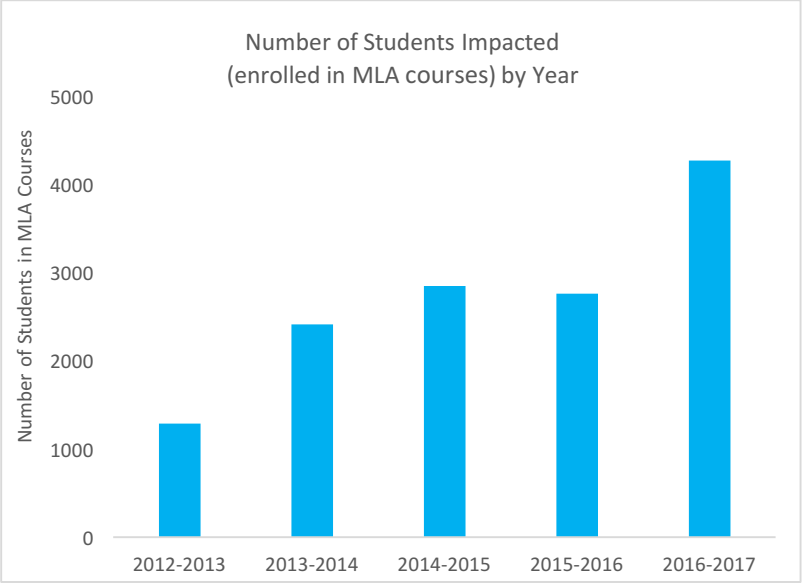


Figure 2 shows that the number of students enrolled in courses with faculty who have been awarded course modification grants and who use the help of Maine Learning Assistants, has grown from 1,200 in the 2012-2013 academic year to 4,200 in the 2016-2017 academic year.

Figure 3a (next page) shows that the number of departments on campus involved in the FIG-MLA program has grown from just four in 2012 to 14 today, and now are found across three colleges (**figure 3b**) at the University of Maine: the colleges of Natural Sciences, Forestry, and Agriculture; Liberal Arts and Sciences; and Engineering.

Figure 3a. Departments participating in the FIG-MLA program

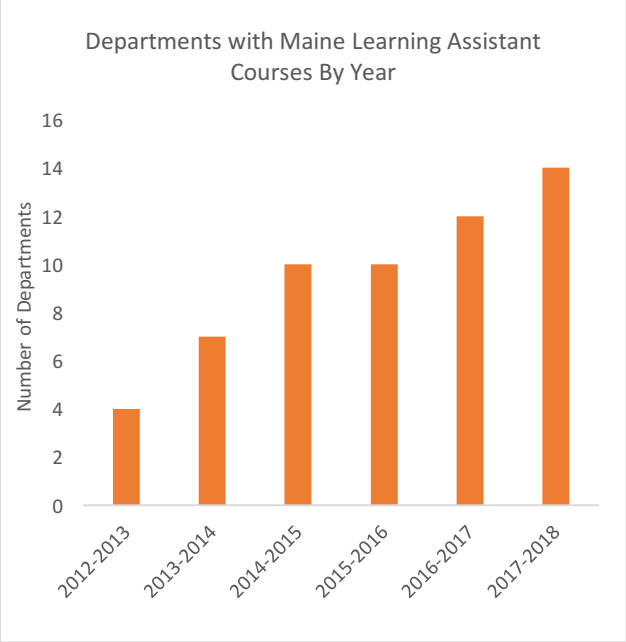
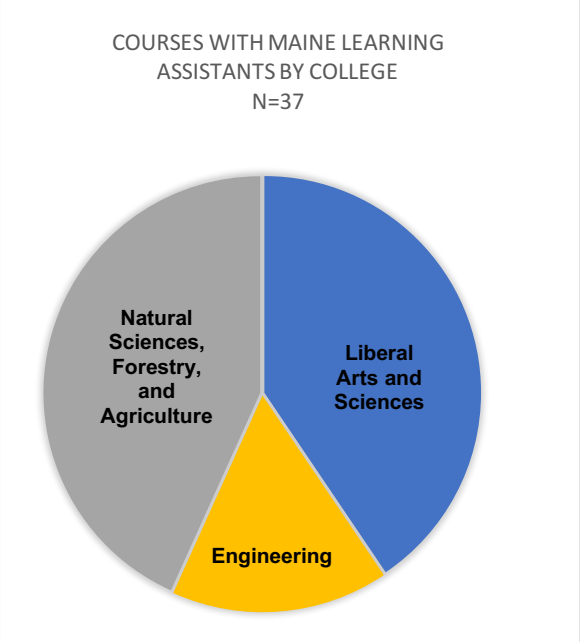


Figure 3b. Courses with Maine Learning Assistants by College, N=37



The courses and departments added to the FIG-MLA program each year are listed below in **Table 1**.

Table 1. Departments and Courses Added to FIG-MLA Program by Year

2012-2013	School of Biology & Ecology Physics & Astronomy School of Marine Sciences Earth Sciences	BIO 100, BIO 350, ERS 201, PHY 121/122, SMS 300
2013-2014	Chemistry Electrical & Computer Engineering Mathematics & Statistics	CHY 121/122, ECE 342, MAT 122, MAT 126, PHY 441, SMS 422
2014-2015	Chemical & Biological Engineering Computer Sciences Molecular & Cellular Biology	BMB 155, CHE 386, COS 250, MAT 126*
2015-2016	No new departments added	BIO 465, BIO 480, CHE 350, MAT 103, PHY 121/122*
2016-2017	Food Science Ecology & Environmental Science	AST 109, BIO 100*, BIO 307, CHY 121/122*, CHY 251, CHY 472, EES 100, ERS 151, FSN 330, MAT 122*, PHY 121/122*, SMS 201
2017-2018	Civil & Environmental Engineering Mechanical Engineering	BIO 200, BMB 322, CIE 331, ERS 102, MAT 116, MAT 122*, MAT 127, MET 320

*some courses are repeated above either because a different instructor was awarded a FIG-MLA grant for a course already involved or the same instructor was awarded an additional FIG-MLA grant

Figure 4. Growth in Faculty Involvement in the FIG-MLA Program

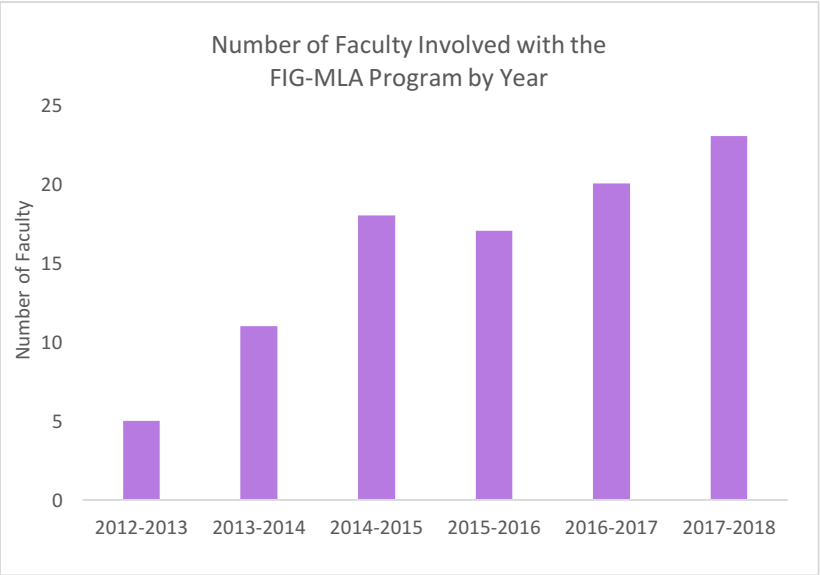


Figure 4 shows that the number of faculty involved with the FIG-MLA program has grown over the years from 2012-present. With only five faculty involved the first year in 2012, we will have 23 faculty actively involved for the 2017-2018 academic year.

Figure 5. Growth in Maine Learning Assistant Positions

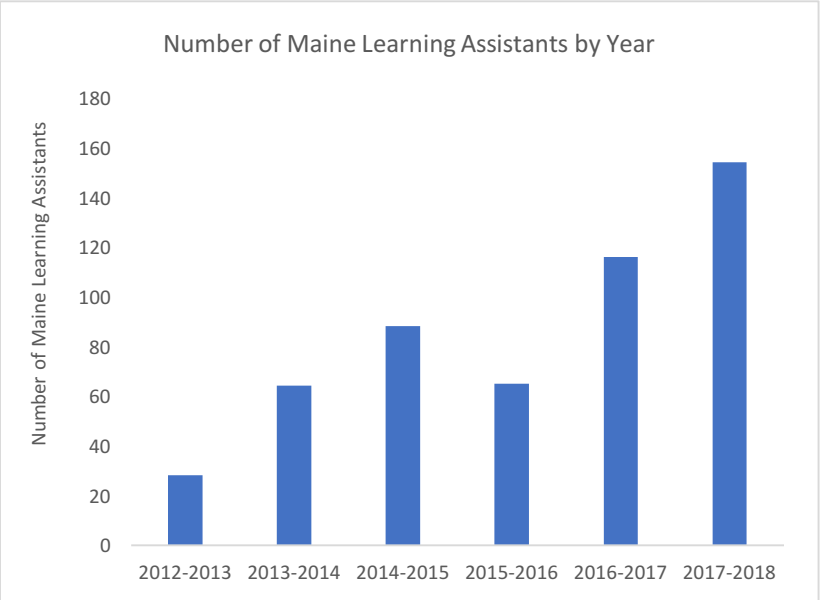
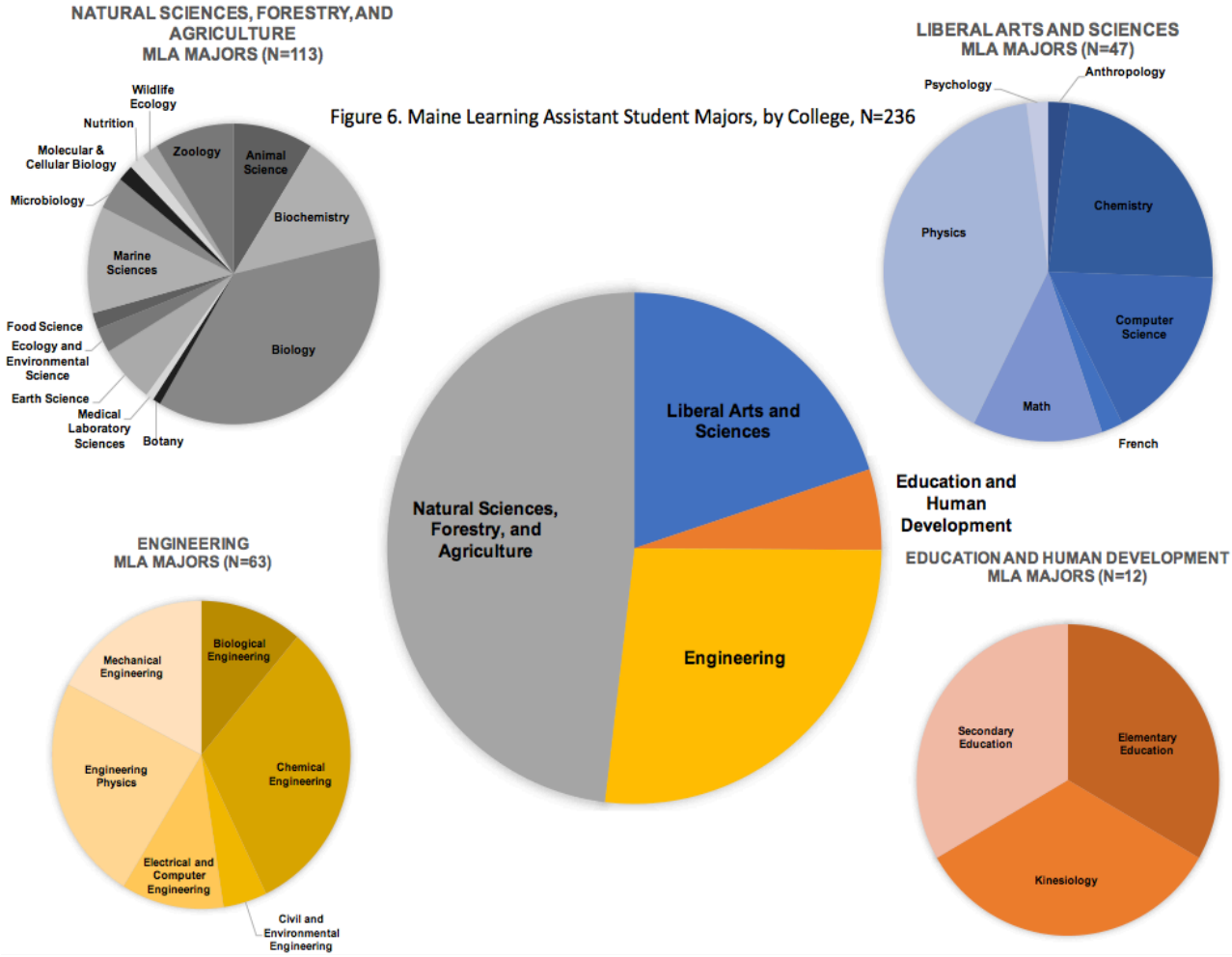


Figure 5 shows that the number of MLA positions has grown from 28 offered during the first academic year of the program (Fall 2012 and Spring 2013) to 154 positions being offered during the 2017-2018 academic year. In the five years that the program has been running (including students who have been MLAs up through Spring 2017), 236 undergraduates have had the opportunity to serve as Maine Learning Assistants.

Figure 6 (next page) shows the diverse STEM disciplines from which undergraduate Maine Learning Assistants have been drawn, by college and major.

Figure 6. MLA STEM Disciplines, by College and Major



Student Outcomes: Improved Retention and DFW Rates

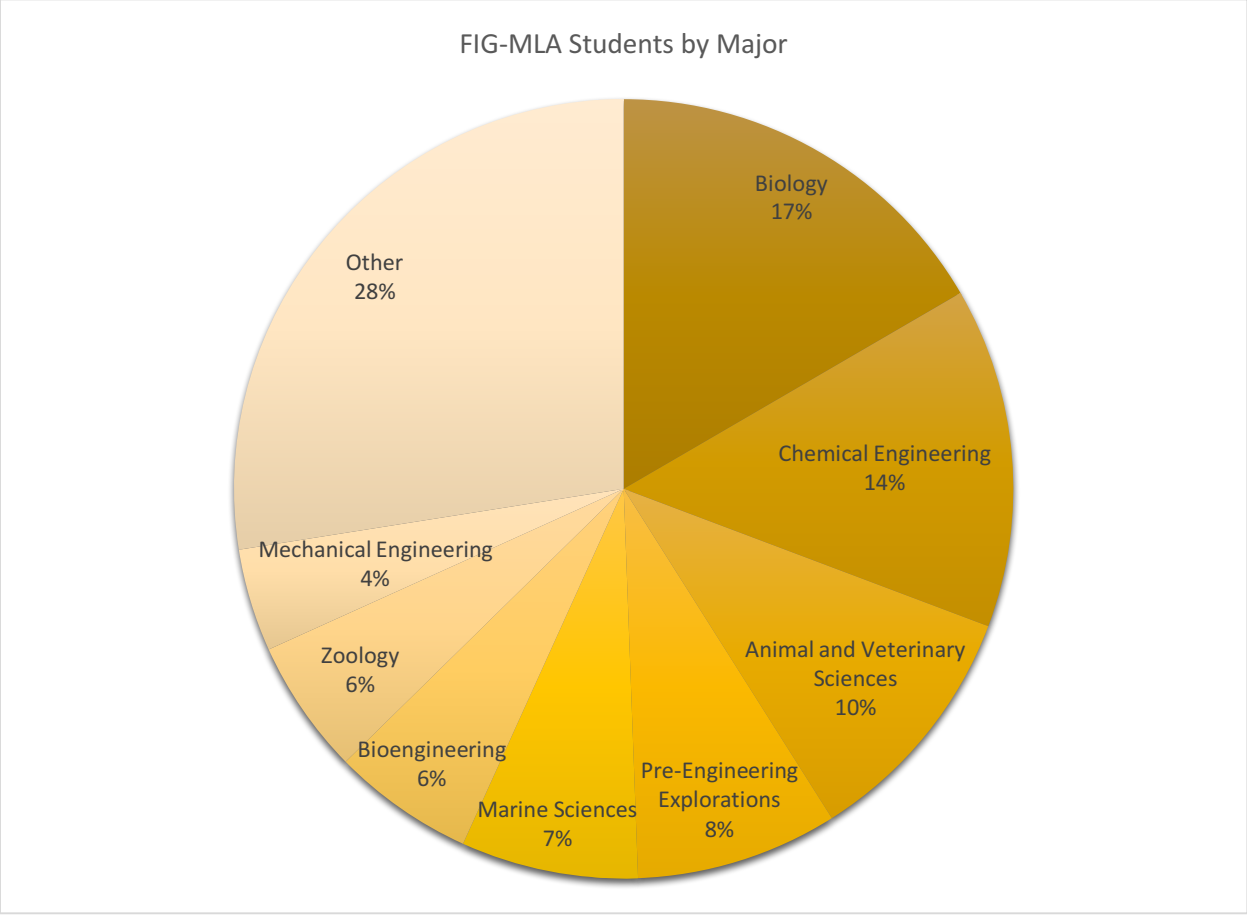
Retention Analysis

Institutional data from 2014-15 and 2015-16 were analyzed for this report. Data were obtained from the University of Maine Offices of Institutional Research and Student Records. Analysis of institutional retention focused on two cohorts (2014 and 2015) of incoming First Year Full Time (FYFT) students. Students from these cohorts who returned to the University of Maine for the fall semester of their second year were considered "retained" for the purposes of this analysis. Students taking two or more FIG-MLA modified courses during their first year of enrollment were considered to be FIG-MLA students for retention purposes. Initial analysis of data from the full cohorts indicated a statistically significant effect of FIG-MLA enrollment on institutional retention. Deeper analysis suggested that the effect of the FIG-MLA program would be more clear if outcomes for FIG-MLA and Non-FIG-MLA students within specific majors could be

compared. This turned out to be possible because in some large introductory STEM courses, such as MAT 126 and CHY 121, some sections of the course are in the FIG-MLA program because the instructor has submitted a proposal for course modification and has been accepted to the program. Other sections are not in the FIG-MLA program. It is therefore the case that students taking these courses as a required part of their major are equally likely to enroll in a FIG-MLA section, or in a Non-FIG-MLA section. This provides a unique opportunity to compare outcomes for students who are comparable in terms of Year 1 GPA, incoming SAT, and course profile – but whose course experience differs as a result of being in modified or non-modified sections of courses.

Over the two cohort years (2014 and 2015), students in 40 majors took two of more FIG-MLA courses during their first year. **Figure 7** shows a chart of 8 majors with the largest number of FIG-MLA students, with enrollment in the other 32 majors indicated by an "Other" category.

Figure 7. First Year Full Time FIG-MLA Students by Major (N=680 FIG-MLA Students)



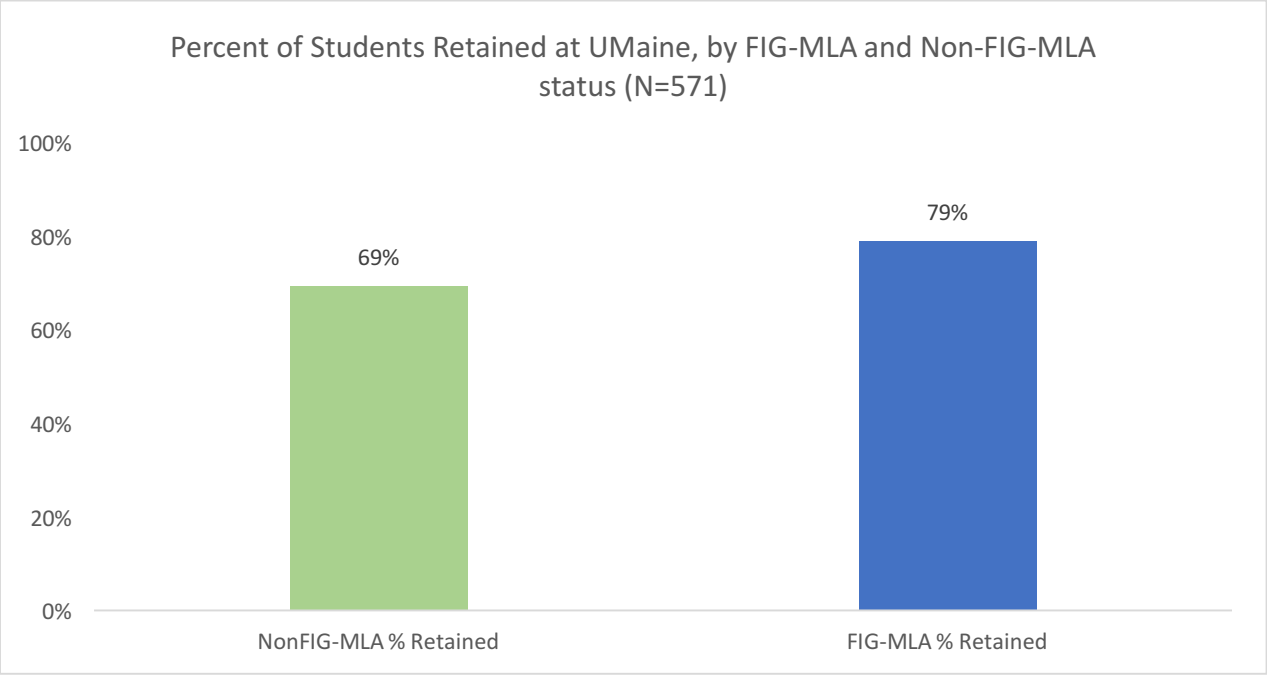
Overall, 680 of University of Maine's 4,033 incoming freshmen took two or more FIG courses – representing nearly 17% of the incoming class and 50% of all incoming STEM majors. Of these 680 students, 386 or 57% were concentrated in 5 STEM majors. These majors, from highest to lowest number of FIG students, were Biology (113 FIG-MLA students), Chemical Engineering (96

FIG-MLA students), Animal and Veterinary Sciences (70 FIG-MLA students), Pre-Engineering Explorations (57 FIG-MLA students), and Marine Science (50 FIG-MLA students). Taken in combination, four of these majors (Biology, Animal and Veterinary Sciences, Pre-Engineering Explorations, and Marine Science) had both FIG-MLA and Non-FIG-MLA students, with 51% FIG-MLA and 49% Non-FIG-MLA, and therefore provided an opportunity for balanced analysis of retention outcomes. In Chemical Engineering, 91% of students were FIG-MLA students, and this major was therefore excluded from the analysis.

The two groups of students (FIG-MLA and Non-FIG-MLA) in the four selected majors were statistically the same in terms of combined incoming SAT score (Math+Reading+Writing) and first year GPA (a strong predictor of retention). The FIG-MLA students were slightly more likely to be female (60%) than the Non-FIG-MLA students (52%) in these majors. Within these majors, with Year 1 GPA controlled for, gender is not a significant factor in retention.

Analysis of retention outcomes for FIG-MLA vs. Non-FIG-MLA students showed that 79% of the FIG-MLA students were retained, compared to 69% of the Non-FIG-MLA students. This statistically significant difference was not explained by any other factors or combinations of factors that were available to include in the statistical models. **Figure 8** shows the difference in institutional retention.

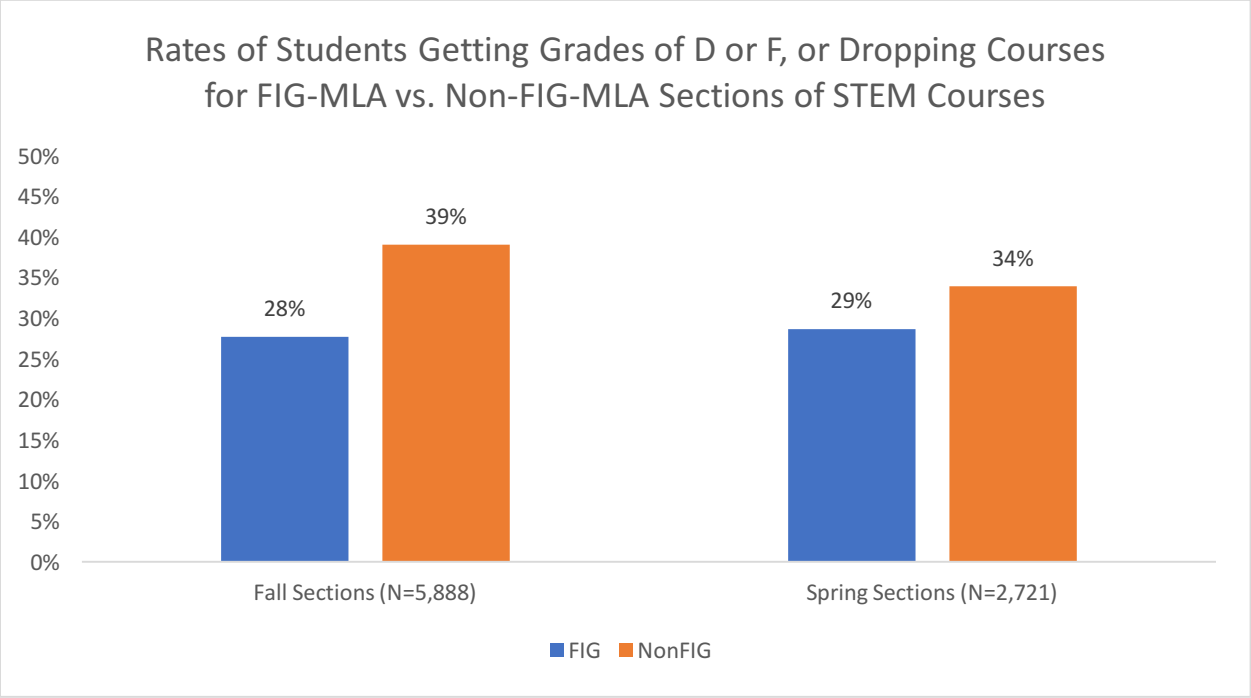
Figure 8. Percent of Biology, Animal and Vet Sciences, Pre-Engineering Explorations, and Marine Sciences students retained at the University of Maine after their first year of instruction, by FIG-MLA and Non-FIG-MLA status



DFW (Grade of D, Grade of F, or Drop/Withdraw) Analysis

Analysis was conducted to determine rates of students receiving grades of D or F, or withdrawing (DFW rates) from FIG-MLA courses/sections, compared to these rates for Non-FIG-MLA courses/sections. DFW rates are significant for many reasons including: (1) these outcomes indicate course failure, meaning that a student who is required to take the course for their major will have to re-take the course and (2) grades of D and F impact GPA, and GPA is a strong predictor of institutional retention. Our analysis focused on DFW outcomes over a period of two academic years, 2014-15 and 2015-16. The comparison made was between DFW outcomes across all FIG-MLA STEM course sections, and DFW outcomes across all comparable Non-FIG-MLA STEM course sections offered during the same time period. In aggregate, the FIG-MLA course sections had a significantly lower DFW rate than the Non-FIG-MLA course sections. **Figure 9** shows the difference in DFW rate across two Fall and two Spring semesters. In each individual semester, the FIG-MLA DFW rate was lower than the Non-FIG-MLA DFW rate by a statistically significant margin.

Figure 9. DFW rate for FIG-MLA vs. Non-FIG-MLA sections of STEM courses in 2014-15 and 2015-16



Feedback from Impacted Students, Maine Learning Assistants, and Course Instructors

The RiSE Center administers surveys each semester to gather data and feedback from those involved in the FIG-MLA program, including students enrolled in MLA courses, the MLAs themselves, and the instructors of the MLA courses. Surveys are emailed to students and MLAs at the beginning of the semester, mid-point through the semester, and at the end of the

semester. Pre- and post-surveys may include attitude and perception surveys (from nationally validated surveys published by experts in the field), content assessments or concept inventories (also nationally validated), and our own feedback questions for program evaluation. Instructors of the courses are emailed a feedback survey about the course, the MLAs, and the learning outcomes in their FIG-MLA course at the end of each semester.

Feedback from Students Enrolled in FIG-MLA Courses

Below are the **student responses** to various questions at the end of the Fall 2016 and the Spring 2017 semesters.

Figure 10 shows student responses to two questions in which students were asked to describe their overall experience in the course and the overall impact of MLAs in the course as either positive, neutral, or negative. Of respondents, 60% and 56% (in Fall 2016 and Spring 2017, respectively) described their overall course experience positive, while 71% and 77% described the impact MLAs had as positive.

Figure 10. Percent of Students Reporting Positive STEM Course Experience and Positive Experiences with MLAs

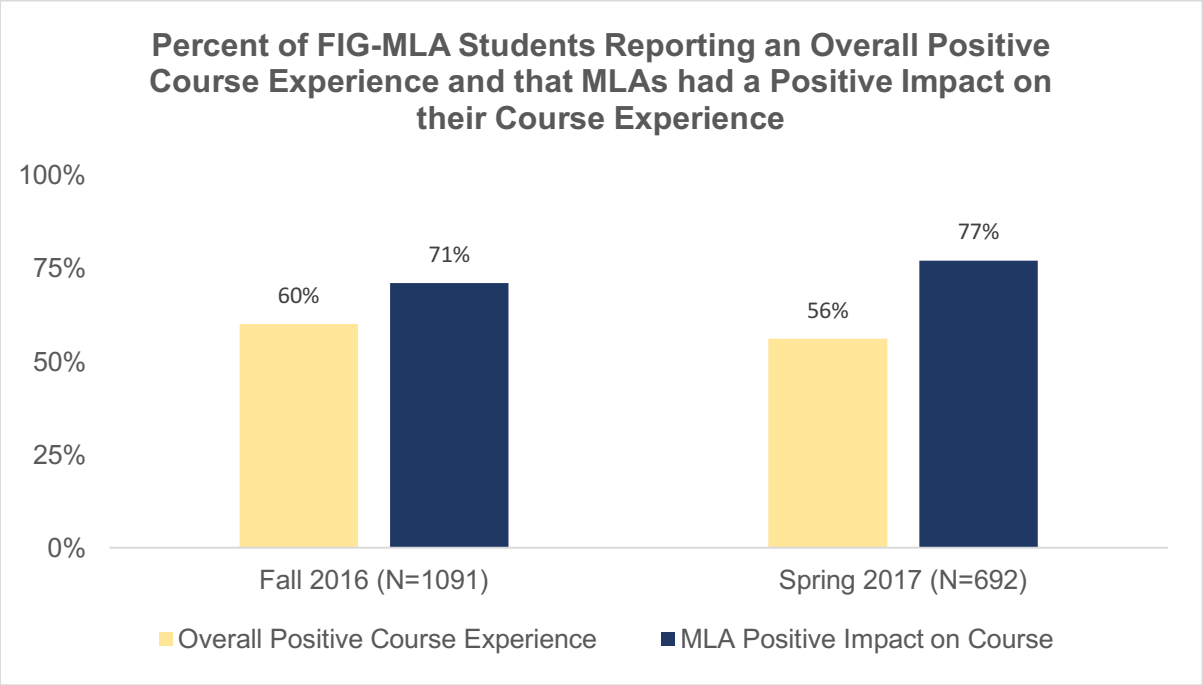
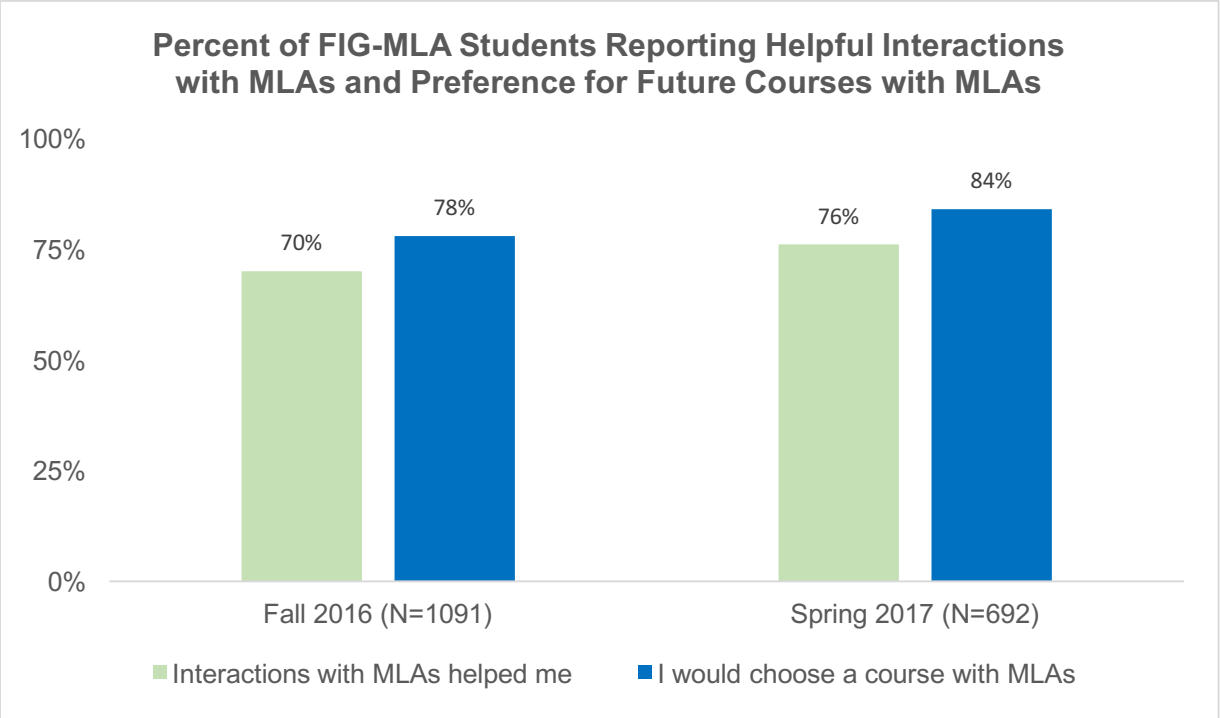


Figure 11 (next page) shows that 70% and 76% (Fall 2016 and Spring 2017, respectively) either strongly agreed or agreed with the statement, "My interactions with the Maine Learning Assistants in this course were useful for my learning." When asked in Spring 2017, how often students were interacting with MLAs in a typical week, we found that 88% of students interact with MLAs at least once per week and 61% interact with MLAs two or more times per week. Students stated a strong preference for courses with MLAs over courses without. In the post-

survey, students are asked at the end of the semester whether they agreed or disagreed with the statement, “If I had to choose between two of the same courses and one used MLAs and one did not use MLAs, I would choose the one that used MLAs.” Approximately 78% and 84% (Fall 2016 and Spring 2017) strongly agreed or agreed with this statement.

Figure 11. Percent of FIG-MLA Students Reporting Helpful Interactions with MLAs and Preference for Courses with MLAs



Student Comments on Maine Learning Assistant Support

“Having the MLAs in class to help with working problems in class was very useful. They help build confidence in the classroom where there is a lot of potential risk for lowering self-confidence. My MLA was outstanding. She connected with us, she had wonderful control of the group, facilitating work and conversation. She was very kind and knowledgeable and we always felt like she cared that we did well.”

“My MLA was very knowledgeable and able to answer the majority of our questions in class. Often it was helpful to ask him to explain a problem because he explained it slightly differently than [the professor] and sometimes you just need that different perspective in order to understand a concept. He was more accessible than [the professor] so we got our questions answered more quickly and didn't have to wait for her to come to us. I felt that it made the class go more smoothly, especially considering the large classroom size. He also didn't get frustrated with us or offended when we were frustrated.”

"Especially in such a very large class it was helpful to have several MLAs assisting the professor with helping us with in class examples. Sometimes it can be mortifying to ask questions in class, again especially when there is such a large enrollment. However, the way that each MLA was assigned to a couple of rows of the classroom made it less intimidating to ask for help from them rather than in front of the whole class. In a math class especially where much of the material builds on itself, it's important that we feel comfortable getting the help we need so our issues don't snowball as the class progresses."

"My MLAs were always available when I needed help with a problem and provided me with multiple opportunities to ask questions throughout the duration of a week."

"Many times during class when we were doing an activity or working on a clicker question, I found myself confused or having trouble working out a problem and a learning assistant would always come over and help me work through the problem myself. They didn't just give me the answer but they would help me to understand the reasoning behind the answer."

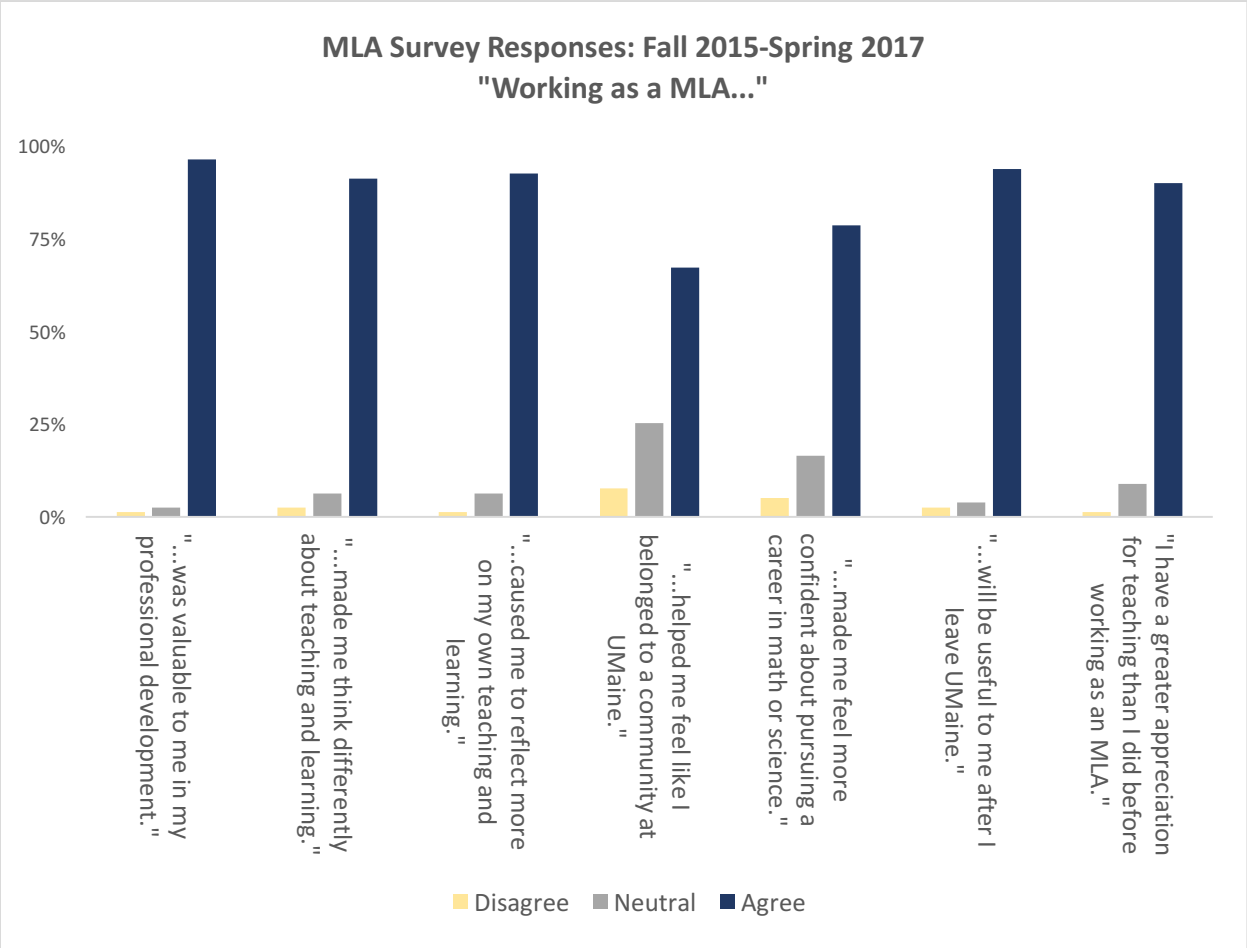
"They [MLAs] will go above and beyond to help you."

Feedback from Maine Learning Assistants

Below are the **MLA responses** to various questions at the end of the semester surveys including the Fall 2015 through Spring 2017 semester data.

Figure 12 (next page) shows that the vast majority of MLAs, 97% report having an overall positive experience as an MLA. A large percentage of MLAs also report specific benefits that come with working as a MLA (seen in the bar graph below), with 90% or more who agreed or strongly agreed with the value of professional development and skill building, as well as a greater appreciation of teaching and learning as a whole.

Figure 12. Maine Learning Assistant Feedback



Maine Learning Assistant Comments on Impacts of the MLA Experience

"When a student's face lights up because they finally get it is the most rewarding feeling ever. When I know that I have helped them become a better student and more enlightened really makes a big difference for me. Especially when I can find a really simple way to explain a complicated concept. Because it can be difficult but I get the feeling that anything can be made simple and understood if you say it the right way and ask the right questions. Giving students a better understanding is definitely the best thing about being an MLA."

"Being an MLA has instilled in me a more thoughtful approach to both teaching others and my own personal learning process."

"The most valuable thing was learning more effective approaches to helping students learn and progress through their own strengths."

"I have really enjoyed forming relationships with the students I have helped throughout the semester and with my fellow MLA's. I feel proud and accomplished that I was able to be a positive influence in somebody's academic life and to even help them love biology as much as I do."

"Being an MLA has solidified my decision to become an educator. I love the profession and I look forward to becoming an influence to future generations."

"I know for a fact now that I do really enjoy teaching, and though I may not pursue a career directly as a teacher, I will be taking as many opportunities as I can from now on to make teaching at least a small part of job."

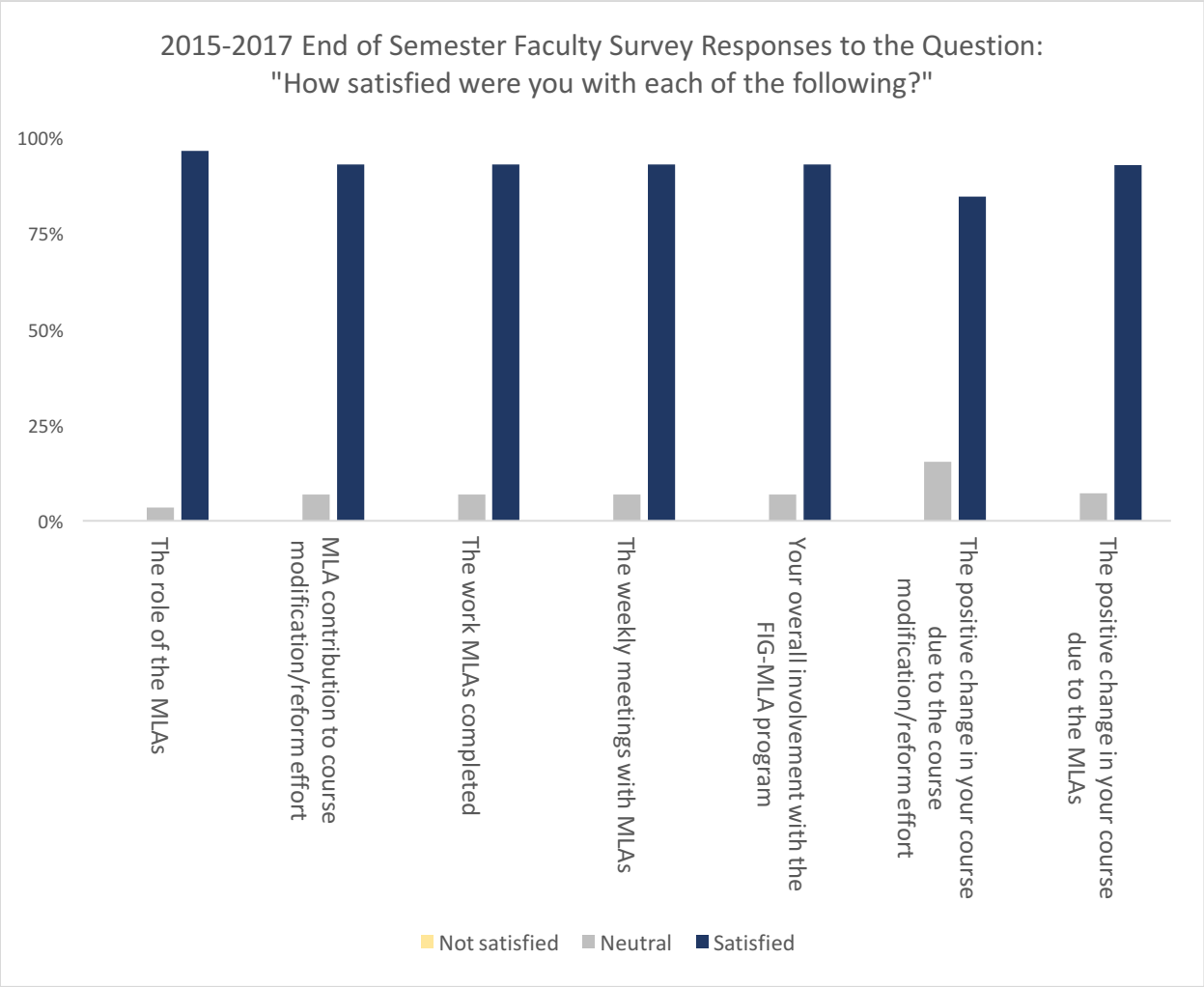
"I have gained confidence in teaching and interacting with people, both of which are very valuable to me. The seminar gave me insights into teaching techniques and made me think a bit more about myself as a student as well."

"I think it has helped me feel confident going in to grad school and to become a TA and know that I am prepared to have that responsibility. I look forward to being able to teach students."

Feedback from FIG-MLA Instructors

Surveys are emailed to FIG instructors at the end of the semester for feedback about their experiences with the program. Below are the **instructor responses** to various questions at the end of the Fall 2016 and the Spring 2017 semesters. **Figure 13** (next page) shows that instructors involved with the FIG-MLA program are overwhelmingly satisfied with various aspects of the program and the outcomes in their classes.

Figure 13. FIG-MLA Faculty Feedback



Comments from FIG-MLA Program Instructors on Benefits of the FIG-MLA Program

"They [MLAs] aided in discussions and were available to students that did not want to come to me for help. I think many students feel more comfortable asking a peer for help, rather than an instructor."

"The recitation MLAs are always useful to me in helping me understand the way I ask questions on homework assignments. They help struggling students by encouraging them to use their own resources, empowering them."

"The students benefited by having a closer-to-peer person to engage with."

"The MLAs qualitatively changed the mood of the 2 lecture sections they took part in. Students in these 2 sections seemed more engaged and focused [than the section without MLAs]. These MLAs also helped us understand confusion in the class because students were more ready to voice this to them than to the instructors."

"MLAs are invaluable because they extend my reach to all the students in a class or recitation. Without MLAs, students with questions would be far less productive; wait times to get questions answered would be impossibly long. Students would ask fewer questions, preferring as they often do to ask an MLA peer rather than the instructor."

FIG-MLA Program Products

Publications

An active-learning lesson that targets student understanding of population growth in ecology. *E. Trenckmann, M.K. Smith, K.N. Pelletreau, M.M. Summers. CourseSource. (Accepted 2017)*

A clicker-based case study that untangles student thinking about the processes in the central dogma. K.N. *Pelletreau, T. Andrews, N. Armstrong, M.A. Bedell, F. Dastoor, N. Dean, S. Erster, C. Fata-Hartley, M. Guild, H. Greig, D. Hall, J.K. Knight, D. Koslowsky, P.P. Lemons, J. Martin, J. McCourt, J. Merrill, R. Moscarella, R. Nehm, R. Northington, B. Olsen, L. Prevost, J. Stoltzfus, M. Urban-Lurain, M.K. Smith. CourseSource. (2016).*

Helping Struggling Students in Introductory Biology: A Peer-Tutoring Approach That Improves Performance, Perception, and Retention. *Zachary Batz, Brian J. Olsen, Jonathan Dumont, Farahad Dastoor, and Michelle Smith. CBE-Life Sciences Education Volume 14 (2015): ar16*.

Investigating Physics and Engineering Students' Understanding of AC Biasing Networks. *K. L. Van De Bogart and M. R. Stetzer. Proceedings of the 2016 Annual Conference & Exposition of the American Society for Engineering Education (New Orleans, LA, June 26-29, 2016), American Society for Engineering Education (2016).*

Investigating Student Understanding of Operational-Amplifier Circuits. *C.P. Papanikolaou, G.S. Tombras, K.L. Van De Bogart, and M.R. Stetzer. American Journal of Physics Volume 83 (2015).*

Teaching Genetics: Past, Present, and Future. *M. K. Smith, W.B. Wood. Genetics. Volume 204 (2016): 5-10.*

Press

Emily Illingworth: Fearless Fortitude (Spring 2017 MLA) UMaine News – April 12, 2017
RiSE Center Announces FIG-MLA Program Awardees UMaine News - April 4, 2017
Math Lecturers Receive RiSE Grants in UMaine News – November 11, 2016
First-Year Students Get Hands-on Experience UMaine News – January 29, 2016

Presentations

Lindsay, Sara. 2017. Active Learning Strategies in large-enrollment classes in Biology and Marine Sciences. Webinar presented by T. Jack and S. Lindsay for the PULSE New England and Mid-Atlantic networks.

Stetzer, MacKenzie R. 2017. Investigating student learning in upper-division laboratory courses on analog electronics.

Smith, Michelle K. 2016. Using Evidence to Transform Undergraduate Teaching.

Smith, Michelle K. 2016. Transforming the Classroom and Helping Others to Adopt Teaching Innovations.

Smith, Michelle K. 2016. Using Classroom Data to Navigate from Vision to Change.

Smith, Michelle K. 2016. Supporting Faculty in Making Changes: Opportunities to Promote Instructional Transformations in STEM Education.

Vinson E., Bruce M., Millay, L., McKay, S., Smith, M., Speer, N., Stetzer, M. 2016. Promoting Change and Evidence-Based STEM Instructional Strategies with the University of Maine's Faculty Course Modification Incentive Grant and Maine Learning Assistant Program. International Learning Assistant Conference, Boulder CO.

Bruce, Mitchell R. 2015. Innovative Instruction: Strategies and Evidence Panel. Maine PSP Summit, Northport ME.

Smith, Michelle K. 2015. Strategies that Promote Institutional Transformation in STEM Education. National Science Foundation, Arlington VA.

Smith, Michelle K. 2015. Using Student Learning and Observation Data to Guide Changes in STEM Classrooms. Dartmouth College, Hanover NH.

Smith, Michelle K. 2015. The End of Lecture: The Future of Evidence-Based Teaching, co-presented with Dr. Mary Pat Wenderoth.

Smith, Michelle K. 2015. Documenting STEM Education Practices at a University-wide Level and Using Data to Guide Institutional Change.

Stetzer, MacKenzie R. 2015. Investigating student learning in upper-division laboratory courses on analog electronics. Department of Physics Colloquium, University of Washington, Seattle WA.

Stetzer, MacKenzie R. 2015. Investigating student learning in upper-division laboratory courses on analog electronics: Building a solid foundation for the advanced lab. American Physical Society, San Antonio TX.

Smith, Michelle K. 2014. York University, Toronto, Canada, March 2014, “Using Assessment and Observation to Improve Student Learning” and “Peer Discussion and Clickers: Using Student Answers to Impact Instruction”

Stezer, MacKenzie R. 2014. The role of research in improving instruction: New insights from introductory physics and upper-division analog electronics. Physics Department Colloquium, University of New Brunswick, Fredericton, NB, Canada.

Stetzer, MacKenzie R. 2014. Conducting research in upper-division laboratory courses. American Association of Physics Teachers Summer Meeting, Minneapolis, MN.

Stetzer, MacKenzie R. 2014. Investigating student understanding of op-amp and multiple-battery circuits in upper-division analog electronics courses. Seminar, Technischen Universität Hamburg–Harburg, Hamburg, Germany.

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