Analysis of Usage Statistics of MATLAB Marina - A Virtual Learning Environment

Thomas Murphy, Priya T. Goeser, and Christopher Williams
Associate Professor, Georgia Southern University/Professor, Georgia Southern University/Lecturer, Georgia Southern University

Abstract

MATLAB Marina is a Virtual Learning Environment (VLE) developed by faculty at Armstrong State University. The VLE is dedicated to the improvement of student learning of programming concepts using MATLAB. The VLE consists of learning modules containing primers that review algorithmic concepts, terms, MATLAB syntax and examples; multimedia tutorials that reinforce the algorithmic concepts using MATLAB; and practice exercises. The VLE is used as the primary resource for an introductory programming course. This paper presents a study of the usage of the MATLAB Marina VLE: the VLE website, the individual modules, the static documents (primers and exercises) for each module, and the multimedia tutorials that are housed on YouTube. The usage data was analyzed to determine: how much is MATLAB Marina used by Armstrong students; which resources get the most usage; and what are the peak days and times of usage of MATLAB Marina.

Keywords

Virtual leaning environment, open educational resource, online textbook, usage of online educational resources

Introduction

MATLAB Marina[1] is a virtual learning environment (VLE) developed by faculty at Armstrong State University (As of January 2018, Armstrong State University was consolidated with Georgia Southern University. All data was collected prior to January 2018, hence all references are to Armstrong students). VLEs are often used as supplements for courses and VLEs for teaching programming show positive results: reinforcement of class lecture concepts, exposure to practical applications, and serving diverse learning styles[2-7]. Precursor components of MATLAB Marina were originally developed as supplements for several Armstrong engineering courses. The components were enhanced and combined into MATLAB Marina in spring and summer 2013 with the goal of replacing an introductory programming textbook with the MATLAB Marina VLE. The VLE has been the primary resource (in lieu of a textbook) for the course Computing for Engineers (ENGR 1371) since fall 2013.

MATLAB Marina consists of a main website, hosting 29 modules primarily focused on introductory and advanced programming topics but also including applications, and a YouTube channel[8], hosting multimedia tutorials. Each learning module consist of primers (pdf documents) that review programming concepts, terms, and MATLAB syntax; multimedia tutorials (hosted at the YouTube channel) that reinforce the algorithmic concepts using MATLAB; and practice exercises (pdf documents).

Previous work[9-12] has examined MATLAB Marina's development, impact on student performance and learning, as well as effective ways to use VLEs. This paper presents a study of the usage of the MATLAB Marina VLE. The usage data is analyzed to answer the following questions:

- How much is MATLAB Marina used by Armstrong students?
- Which MATLAB Marina resources get the most usage?
- What are the peak days and times of usage of MATLAB Marina?

Student surveys from previous work[11] found that students used the website portion (primers, exercises, and code samples) of MATLAB Marina similar to the way they would use a print textbook. Students overwhelmingly indicated they found the MATLAB Marina resource useful and did not feel they needed a standard print textbook in addition to MATLAB Marina.

In a future study, this usage data analysis along with student performance data will be used in an attempt to improve the overall effectiveness of MATLAB Marina as well as explore possible additions and/or modifications that may need to be made.

MATLAB Marina Usage, August 2013 - Present

MATLAB Marina was active in summer 2013 but was predominantly being used for testing by the developers. For analysis purposes, the first day of the fall 2013 semester, August 12, 2013, is used as the initial date for MATLAB Marina and November 10, 2017 is the end date. Usage was determined using Google analytics[13] and YouTube analytics[14]. To separate Armstrong students from the rest of web users, data was filtered by city. Armstrong students include all users in a city within a 50-mile radius of Savannah, GA excluding Statesboro, GA. This includes users in bordering South Carolina counties. Tables 1–3 provide an overview of the usage of the MATLAB Marina website and tables 4-6 provide an overview of MATLAB Marina YouTube multimedia views. YouTube analytics are not as detailed, so usage numbers are filtered only to the state of Georgia to represent Armstrong students.

Tracking for multimedia usage is done automatically through YouTube's services. For web visits, Google Analytics is used. This service requires JavaScript code that has to be included on each page that needs to be tracked. This was accomplished through a pseudo-templating system with small modifications to track PDF and MATLAB sample code file views.

	Users	**Sessions**	**Avg. Session Duration (min:sec)**	**Page Views**
All	17632	35572	6:07	168764
Armstrong	6512	20751	8:37	125683

Table 1, MATLAB Marina Website Usage August 2013 to Present

The estimates for percentage users by age and gender are Google analytic estimates using 22% of the total sessions for all users and 3% of the total sessions for Armstrong users (10% of the total Armstrong user sessions). The Google analytics documentation does not make it entirely clear how these estimates are determined from the sessions.

	Device Category	Users	Sessions	Avg. Session Duration (min:sec)	Page Views
All	Desktop	17008	33971	6:12	161999
	Mobile	471	1165	3:49	4416
	Tablet	160	436	5:43	2349
Armstrong	Desktop	6221	19919	8:45	121496
	Mobile	204	525	4:51	2389
	Tablet	90	307	6:20	1798

Table 2, MATLAB Marina Website Usage by Device

	Gender		Age			
	Male	**Female**	**18-24**	**25-34**	**35-44**	**45+**
All	81.9%	18.1%	67.3%	21.8%	5.7%	5.3%
Armstrong	79.2%	20.8%	69.0%	19.2%	6.1%	5.8%

Table 3, MATLAB Marina Website Usage by Age and Gender

Overall, 17632 users, 60% from the United States, have used MATLAB Marina with 6221 of the users estimated to be Armstrong students. The number of sessions and number of page views per user; and average session duration is much higher for Armstrong students than other users. Access, by device type, of MATLAB Marina is predominantly from desktops (notebooks are included with the desktop category), 96% of users, sessions, and page views for both the overall group and Armstrong users. Average session duration is also highest from desktops although average session duration from tablets is close to that of desktops.

	Views	Watch Time (min)	Avg. View Duration (min:sec)
All	717879	874590	1:13
Georgia	24711	36312	1:28

Table 4, MATLAB Marina Multimedia Usage August 2013 to Present

	Device Category	Views	Watch Time (min)	Avg. View Duration (min:sec)
All	Desktop	675651	817385	1:12
	Mobile	30384	39367	1:18
	Tablet	10458	15860	1:30
Georgia	Desktop	23491	34187	1:30
	Mobile	708	1318	1:54
	Tablet	489	779	1:36

Table 5, MATLAB Marina Multimedia Usage by Device

	Gender		Age			
	Male	**Female**	**18-24**	**25-34**	**35-44**	**45+**
All	81.0%	19.0%	49.0%	39.0%	7.0%	4.3%
Georgia	79.2%	20.8%	52.0%	36.0%	5.7%	6.2%

Table 6, MATLAB Marina Multimedia Usage by Age and Gender

Overall, MATLAB Marina multimedia have had 717873 views, 31% from the United States, with 24711 of the users estimated to be from Georgia. The number of views and watch times per user; and average view duration is higher for Georgia users than other users. Access, by device type, of MATLAB Marina multimedia is predominantly from desktops, with 95% overall and for Georgia users. For all users, average view duration is highest from tablets while Georgia users have a higher average duration on mobile phones. For both groups, the desktop represents the lowest average view duration.

MATLAB Marina Usage by Armstrong Students, Spring 2017

Armstrong engineering students use MATLAB Marina as the main resource for ENGR 1371 and students also refer back to it for programming help in subsequent classes. Armstrong usually offers two sections of ENGR 1371 with enrollment typically around 20 – 25 students per section. In spring 2017, two sections, one Monday-Wednesday (MW) and one Tuesday-Thursday (TR), were offered with 13 and 16 students enrolled in the respective sections. Two and three students withdrew from the respective sections by midterm. Lab days were Tuesday and Wednesday and students were not necessarily in same class and lab section. Exam days were Monday for the MW section and Tuesday for the TR section.

A typical week during the spring 2017 semester was: projects and prelab assignments posted on Thursday, class meetings either MW or TR, lab work either Tuesday or Wednesday, and projects due on Thursday. For usage during the semester, a week was classified as Friday to Thursday, and for exam preparation usage, the preparation times were assumed to be the three days before the exams (Friday to Tuesday).

Table 7 shows average weekly usage, Table 8 shows usage during class and lab periods versus all day, and Table 9 shows average exam preparation usage for the four regular semester exams. Times of day with most use of MATLAB Marina is 11:00 AM to 2:00 PM hours with the next most used times are 9:00 and 10:00 AM hours and 3:00 PM hours. There was very little use between 12:00 AM and 7:00 AM hours and fairly even moderate use for the rest of the day hours.

	Friday	**Saturday**	**Sunday**	**Monday**	**Tuesday**	**Wednesday**	**Thursday**
Users	2.9	1.6	3.3	10.1	25.3	16.5	11.4
Sessions	3.7	2.5	4.9	14.5	35.9	24.6	14.1
Average Session Duration (sec)	244.3	645.6	259.1	328.3	563.7	292.4	577.0
Pages per Session	2.4	3.6	3.8	4.4	6.2	4.3	5.0

Table 7, Average Weekly Website Usage Spring 2017 (excluding spring break and finals)

	Sunday	**Monday**	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday**
User Hours All hours of day	75	204	498	329	191	58	41
User Hours class/lab periods	NA	42	352	217	80	NA	NA

Table 8, Website Usage during Class and Lab Periods Spring 2017

	Friday	Saturday	Sunday	Monday	Tuesday
Users	4.0	2.0	6.75	12.75	26.25
Sessions	5.25	4.0	11.75	21.0	44.0
Average Session Duration (sec)	465.0	1314.1	337.5	432.4	510.3
Pages per Session	3.3	6.7	5.0	5.2	6.1

Table 9, Average Exam Preparation Website Usage Spring 2017

The use of MATLAB Marina correlates with when students have class/lab work to complete. Class/lab time involves mostly problem solving/programming work with less than half the class meeting time and very little lab meeting time being spent in lecture type activities. On class/lab days the number of users during class and lab periods is consistent with the number of students in class/lab performing work. Tuesday and Wednesday have the highest use as there was both a class and lab those days with projects due on Thursday. There was minimal use from Friday to Sunday. On days leading up to exams, there was a slight increase in the MATLAB Marina website use with the largest increase seen on Sunday.

Tables 10 and 11 show multimedia usage during the semester broken down by day. YouTube analytics do not allow an examination by hour. All values are an average across the time periods as specified.

	Friday	Saturday	Sunday	Monday	Tuesday	Wednesday	Thursday
Views	5.9	6.3	20.8	27.9	34.1	18.3	12.5
Watch Time (minutes)	9.9	10.2	31.9	47.2	48.2	25.7	13.7
Average View Duration (min:sec)	1:18	1:36	1:30	1:48	1:30	1:30	1:06

Table 10, Average Weekly Multimedia Usage Spring 2017 (excluding spring break and finals)

	Friday	Saturday	Sunday	Monday	Tuesday
Views	6.8	5.3	26.5	41.4	28.4
Watch Time (minutes)	9.6	6.2	54.0	72.2	46.4
Average View Duration (min:sec)	1:2	1:1	1:7	1:8	1:3

Table 11, Average Exam Preparation Multimedia Usage Spring 2017

During a normal week, usage followed a common pattern. Friday and Saturdays showed the lowest utilization with approximately 6 views. Sunday through Monday had the largest use with 20.8-34.1 views during those days. Wednesdays and Thursday usage slowly declined with 18.3 and 12.5 views respectively. Exam week usage showed that most students began studying on Sundays with watch times increasing from 6.2 to 54 minutes, peaking on Mondays with 72.2 minutes and falling back to 46.4 minutes on Tuesdays. This corresponds to exam days being on Mondays and Tuesdays. There was higher usage on exam weeks compared to a “normal” week during the semester.

The data in Tables 7 – 11 most likely slightly over counts Armstrong ENGR 1371 student usage of MATLAB Marina. A small proportion of the Armstrong student usage is likely for other engineering courses that have a programming component or assignment requiring MATLAB programming.

Tables 12 – 14 show Armstrong student usage of the MATLAB Marina website and corresponding YouTube videos for spring 2017. Tables 12 and 13 show the top five MATLAB Marina URL visits and YouTube Video views. There are 104 videos that had YouTube views and 249 MATLAB Marina URLs that had visits by Armstrong students in spring 2017.

Page (URL)	Visits
/index.html	1028
/thermodynamics.html	345
/1darrays.html	275
/introductionmatlab.html	194
/2darrays.html	188

Table 12, MATLAB Marina URL Visits by Armstrong Students (Top 5) Spring 2017

Video Title	Views
Using recursion to create the fibonacci sequence in MATLAB	66
Creating vectors in MATLAB	53
Writing data to an Excel file using the xlswrite command in MATLAB	49
Reading from an Excel file using xlsread in MATLAB.	46
Useful commands with vectors	41
Using recursion to create the fibonacci sequence in MATLAB	66

Table 13, YouTube Video Views by Armstrong Students (Top 5) Spring 2017

Table 14 shows MATLAB Marina URL visits and YouTube Video views by topic along with the number of class periods devoted to the listed course topics.

Fundamental Topics	Page (URL) Visits	Video Views	Class Periods
MATLAB IDE, Variables	427	126	1
Arrays	463	534	4
Conditional	337	114	1.5
Iteration	285	181	4.5
Functions	188	68	3
Advanced Topics and Applications			
Plotting	156	132	0
Data Structures	363	249	2
File Input/Output	92	131	0
Numerical Methods	442	212	4
Images and Sound	144	19	2
Searching/Sorting	72	NA	2

Table 14, MATLAB Marina Usage (by Topic) by Armstrong Students Spring 2017

Google analytics uses embedded JavaScript in the webpages to track user data. URL hits are accurately tracked, but there is a possibility that pdf and m code documents are undercounted. For example, the first non-html document URL, /pdf/matlab marina 1d arrays and vectors primer.pdf, in Table 12 would be number 14 by number of visits if the table was extended. Thus to track MATLAB Marina website usage, the URLs of the pages linking to the documents is being used.

Of the fundamental topics, arrays had the most usage and functions the least. Of the advanced topics and applications, numerical methods had the most usage. Plotting and file input/output are not formally covered during class periods but are used extensively in lab and project work. Students generally do not have problems mastering this material using only MATLAB Marina and additional help during lab periods. The MATLAB IDE and conditional structures have little class time devoted to them compared to other topics as students typically have less problems mastering these. Students are using MATLAB Marina extensively for this material.

Numerical methods and applications such as interpolation, differentiation/integration, and images and sound individually do not get much class time. There was a significant amount of lab and project work based on these topics and again students appear to be using MATLAB Marina for this material.

Summary and Future Work

For the website, Armstrong users account for a very large percentage of sessions and page views compared to the overall number of users. Number of sessions, session duration, and number of page views per user; and average session duration are all higher for Armstrong students than other users. The average session duration is 6 minutes and 12 seconds for all users and 8 minutes 45 seconds for Armstrong users. The average number of page views is 3.8 for non-Armstrong users and 19.5 for Armstrong users. Users other than Armstrong users may be one time (or few times) users looking for help on something specific whereas Armstrong users should be using MATLAB Marina on a regular basis for class preparation and class/lab work.

Armstrong student use of MATLAB Marina corresponds to when students have class/lab work and is slightly higher during the days before exams. Usage is minimal during days prior to class/lab work and over the weekend, even leading up to an exam. Students do not appear to be spending much time on class/lab preparation and are mostly accessing materials when work needs to performed. Student usage does increase during exam weeks, but not substantially more than a normal week. Students appear to be using MATLAB Marina to get more exposure to material for lab and project work and to learn material that is not formally covered in class periods.

In fall 2015 a separate mobile site was considered and developed for MATLAB Marina. After looking at some preliminary usage then, it was determined not to be needed. The current MATLAB Marina usage confirms the lack of need for a mobile version of the VLE, the vast majority at this time access the VLE with a desktop or notebook computer. Hence, it still looks as if it is not needed as almost all use is from desktops.

The authors plan to perform similar weekly usage analysis on additional semesters as was done for spring 2017 to verify that patterns from spring 2017 hold in general. It is also planned to delve more deeply into exactly how the VLE is used: are the primers used more often than tutorials, is one used more for class/lab help versus exam preparation. These will be difficult, though, due to how the website/multimedia tracking is performed. Additional work will be concentrated on attempting to measure the affect the VLE has on learning outcomes within the course.

References

1 MATLAB Marina, http://matlabmarina.com, Priya Goeser, Engineering Studies, Armstrong State University, 2011 – 2017.

2 Campbell, C., "On-Line Video-Based Training for MATLAB, MATHCAD and MAPLE", *American Society for Engineering Education Annual Conference*, Austin, TX, June 2009.

3 Kaw, A., Besterfield, G. and Eison, J., "Assessment of a Web-Enhanced Course in Numerical Methods", *International Journal of Engineering Education*, Vol. 21, No. 4, pp. 712-722, 2005.

4 Wickert, J. and Beuth, J., "Web-Based Computer-Aided Engineering Tutorials across the Mechanical Engineering Curriculum", *American Society for Engineering Education Annual Conference*, Salt Lake City, UT, June 2004.

5 Hsi, S. and Agogino, A.M., "The Impact and Instructional Benefit of Using Multimedia Case Studies to Teach Engineering Design", *Journal of Educational Multimedia and Hypermedia*, 1994, 3(3/4): p. 351-376.

6 Regan, M. and Sheppard, S.D., "Interactive Multimedia Courseware and Hands-on Learning Experience: An Assessment Study", *Journal of Engineering Education*, 1996, 85(2): p. 123-130.

7 Chen, X., Kehinde, L.O., Zhang, Y., Darayan, S., Olowokere, D.O. and Osakue, D., "Using Virtual and Remote Laboratory to Enhance Engineering Technology Education", *American Society for Engineering Education Annual Conference*, Vancouver, B.C. Canada, June 2011.

8 MATLAB Marina YouTube channel, https://www.youtube.com/user/matlabmarina, YouTube, 2017.

9 Goeser, P.T., Flett, A., Kriske, J. and Panter, C. "MATLAB Marina: Web-Based Tutorials for Teaching Programming Concepts using MATLAB", *American Society for Engineering Education Southeastern Section Annual Conference*, Starkville, MS, April 2012.

10 Goeser, P.T., Johnson, W.M., Bernadin, S.L. and Gajdosik-Nivens, D. A. "Work-in-Progress: The Impact of MATLAB Marina …A Virtual Learning Environment on Student Learning in a Computing for Engineers Course", *American Society for Engineering Education Annual Conference*, Atlanta, GA, June 2013.

11 Goeser, P., Murphy, T., Williams, C.,, and Johnson, W., "The Effective Use of Virtual Learning Environments like MATLAB Marina as the Primary Resource for an Introductory Programming Course", 2014 ASEE Southeast Section Annual Conference, Macon, GA, March 30 – April 1, 2014. (Refereed conference proceedings, regional).

12 Goeser, P.T., Murphy, T., and Williams, C., "A Virtual Learning Environment as an Open Educational Resource for an Engineering Programming Course", University System of Georgia Teaching and Learning Conference, Athens, GA, April 5 – 7, 2017.

13 Google Analytics, https://www.google.com/analytics/, Google, Inc. 2017.

14 YouTube analytics, https://www.youtube.com/ (need a channel to access analytics)

Thomas Murphy

Thomas Murphy is an Associate Professor of Electrical Engineering at Georgia Southern University-Armstrong Campus. He received his PhD and M.E. in Electrical and Computer Engineering from the University of Florida and his B.S. in Electrical Engineering from the University of Notre Dame. His research interests are primarily in the areas of digital systems, control systems, signal processing, engineering education, and computer applications in these areas. Dr. Murphy is a member of several professional societies including The American Society for Engineering Education (ASEE) and The Institute of Electrical and Electronics Engineers (IEEE).

Priya T. Goeser

Priya T. Goeser is a Professor of Mechanical Engineering at Georgia Southern University-Armstrong Campus, Savannah GA. She received her Ph.D. in Mechanical Engineering from the

University of Delaware and her B. Tech in Mechanical Engineering from the Indian Institute of Technology, Chennai, India. Her current research interests are structural health monitoring, functionally graded materials and innovative teaching methods in engineering education. She is the coordinator of the Computing for Engineers course at Armstrong and is the project director of MATLAB Marina.

Christopher Williams

Christopher Williams is a Lecturer at Georgia Southern University-Armstrong Campus in Savannah, GA. He received his B.S. and M.S. in Computer Science from Armstrong Atlantic State University. His research interests are primarily in the areas of mobile computing, usability, and education. Mr. Williams is a member of the Association for Computing Machinery (ACM).