

# Digital Lab Marking System

Heriot-Watt University

Final Year Dissertation

Masters of Software Engineering

Lewis McNeill  
supervised by Peter J King

November 22, 2016

# Declaration

I, Lewis Francis McNeill, confirm that this work submitted for assessment is my own and is expressed in my own words. Any references, made within it, of the works of other authors in any way (e.g., ideas, equations, figures, text, tables, programs) are properly acknowledged at any point of their use. A list of the references employed is included.

Signed: Lewis McNeill

Date: November 22, 2016

## **Abstract**

The aim of this dissertation project is to replace the current system for the marking of computer labs with a new digital system. This will enable lecturers to create a marking scheme online. Lab helpers will select the student they are marking and the marking scheme will then be loaded, marks will be entered and then made immediately available to both student and lecturers to view. It will also provide useful statistics for both student and lecturers.

# Contents

<b>1</b>	<b>Aims, Objectives and Project Description</b>	<b>1</b>
1.1	Project Description . . . . .	1
1.2	Aim . . . . .	1
1.3	Objectives . . . . .	1
<b>2</b>	<b>Literature Review</b>	<b>2</b>
2.1	Marking Systems . . . . .	2
2.1.1	Lecturer Based . . . . .	2
2.1.2	Peer Based . . . . .	2
2.2	Digital Marking Systems . . . . .	3
2.2.1	Reasons for Digital Marking . . . . .	3
2.2.2	TurnItIn . . . . .	3
2.3	User Access Views . . . . .	4
2.4	Custom Input Forms . . . . .	4
2.4.1	SurveyMonkey . . . . .	4
2.4.2	Customizing Forms In Electronic Mail Systems . . . . .	5
2.5	D3: Data Visualisation . . . . .	5
<b>3</b>	<b>Requirements</b>	<b>6</b>
3.1	Functional . . . . .	6
3.1.1	User Requirements . . . . .	6
3.1.2	System Requirements . . . . .	8
3.2	Non-Functional Requirements . . . . .	9
<b>4</b>	<b>Strategy for testing and evaluation</b>	<b>10</b>
4.1	Testing . . . . .	10
4.2	Evaluating . . . . .	10

<b>5</b>	<b>Project Plan and Risk Analysis</b>	<b>11</b>
5.1	Project Plan . . . . .	11
5.2	Risk Analysis . . . . .	12
<b>6</b>	<b>P.L.E.S Issues</b>	<b>14</b>
6.1	Professional Issues . . . . .	14
6.2	Legal Issues . . . . .	14
6.3	Ethical Issues . . . . .	14
6.4	Social Issues . . . . .	15
	<b>References</b>	<b>16</b>

# **1 Aims, Objectives and Project Description**

## **1.1 Project Description**

## **1.2 Aim**

The aim of this dissertation is to design and implement a system for the digital marking and analysis of computer labs and to help improve the speed at which they are marked. The system will also provide useful statistics for both lecturers and students.

## **1.3 Objectives**

- Simplify the way that labs marks are currently processed.
- Allow lecturers to create marking schemes online that lab helpers can access
- Lab helpers can mark students in labs using marking schemes.
- Develop a system that allows lab helpers to mark labs using an online application.
- Allow students to see the mark they achieved from the lab instantly.
- Provide useful statistics and graphs for lecturers.

## **2 Literature Review**

This section contains the summaries of literature relating to the topic of developing a digital marking system. Covering what marking systems are currently being used, what current digital marking systems exist and why they are an improvement. Along with this it will also cover how to control what users are allowed to see, aswell as explaing systems for creation of custom website forms, and finally it will cover the graphical displaying of statistics.

### **2.1 Marking Systems**

#### **2.1.1 Lecturer Based**

The way lecturer based marking works is that students complete their assignment, the lecturer or tutor marks it and provides result in a timely manner to help the student improve. The advantage of this style of marking is that it provides useful feedback for individual students. A downside to this style of marking is that as the number of students increases on courses the amount of time required to mark assignments consequently takes longer and in some cases can actually cause marking to be scrapped completely [3].

#### **2.1.2 Peer Based**

To cope with increasing class sizes some courses are beginning to move towards peer marking. Peer marking system works by having students assess each other and in some cases the student produced their own marking criteria [11]. This style allows students to gain experience in evaluating other people's work, which some graduates feel is a necessary skill to possess. [10]. Peer marking also deals with increasing amounts of students very well, this is because as the number students increase the number of markers also increases!

Peer marking however has its own set of problems - for example, "Students may have a less well developed sense of the criteria compared to the lecturer which could lead to a lack of reliability of student marking." [11].

## **2.2 Digital Marking Systems**

### **2.2.1 Reasons for Digital Marking**

Digital marking systems are designed to mirror the current paper based marking systems but with the advantage of the electronic environment [7]. These systems help to reduce the increasing workload caused by more and more students taking courses. Along with this it also allows administrative tasks associated with coursework to be automated enabling more time for other tasks.[9]

### **2.2.2 TurnItIn**

There currently exists an online electronic plagiarism system called TurnItIn, [12] currently being used by many universities around the world. It allows students to upload their essay assignments online. It then checks for plagiarism in the document by searching the internet and using a large database of documents. After it processes the document it assigns a plagiarism percentage and highlights any areas that were plagiarised. Lecturers can then login and view all the submitted documents and mark them online.

Current research highlighted [4] conducted a questionnaire and found that students felt that the system was easy to use and more convenient than having to had to provide paper copies. It also found that 50% agreed and 33.3% of students preferred to have their grade shown online rather than have a cover sheet.



## 2.3 User Access Views

Controlling the view that users have, based on their access level, is common practice. Social media websites for instance allow users to limit what others can see. This means that if another user is a friend then they are allowed to see their whole feed, while other users may only see their profile picture.

The patent titled “System and method for restricting user access rights on the internet based on rating information stored in a relational database” [1], describes a system of limiting user web page access through the use of relation databases. The system would work by using two databases; one would hold a list of all the url’s and associated access level, while the second database would hold all the user id’s along with their assigned access level. When a user requests a webpage, the access level for that webpage and the user are looked up. If the users do not have the appropriate access they are denied permission to load the page and depending on implementation may be redirected to another webpage.

## 2.4 Custom Input Forms

### 2.4.1 SurveyMonkey

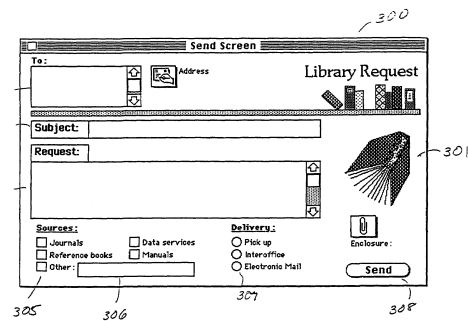
Survey Monkey [6] is an example of custom web forms being created by users. Founded by Ryan Finley in 1999 Survey Monkey enables users to create their own surveys and easily distribute them. It builds the surveys by letting the user select the contents of the question and what the response type will be: The user can also decide if the responses are completely anonymous by default and the participants ip address is stored when they complete the survey. The users can continue to add as many questions as they would like, even after the survey is initially created. After designing the survey the user chooses how they would like to have their survey distributed. The available options that can be selected are a web link, social media, email or embeddable on a website [13] .

When participants complete the survey their results are immediately stored and the results of the survey are visible to the user by login into their account on surveymonkey. They can choose to look at the responses individually or look at metrics about how participants responded.

### 2.4.2 Customizing Forms In Electronic Mail Systems

The patent “Customizing forms in an electronic mail system utilizing custom field behaviors and user defined operations” [8] describes a process for user-customisable forms in an e-mail system where the administrator selects custom field types and behaviours. For example current e-mail forms have a field for address, subject and one for the the actual message to be sent. While an example of what the patent is suggesting can be seen in figure 1, it shows the adding of additional fields allowing for wide variety of form to be created and not limit the users to use the few forms that are precreated.

Figure 1: Example Form (Patent [8])



The figure shows a 'Send Screen' window with a title bar. Inside, there are several fields and sections. At the top right, it says 'Library Request' next to a small bar chart icon. Below this is a 'To:' field with a dropdown arrow and a small icon. To the right of the 'To:' field is a small bar chart icon. Below the 'To:' field is a 'Subject:' field. Below the 'Subject:' field is a 'Request:' field. To the right of the 'Request:' field is a small bar chart icon. Below the 'Request:' field is a 'Sources:' section with checkboxes for 'Journals', 'Reference books', 'Data services', 'Manuals', and 'Other:'. Below the 'Sources:' section is a 'Delivery:' section with radio buttons for 'Pick up', 'Interoffice', and 'Electronic Mail'. To the right of the 'Delivery:' section is an 'Enclosure:' section with a small icon and a 'Send' button. The entire form is enclosed in a box with a title bar. There are reference numerals 300, 301, 305, 306, 307, and 308 pointing to various parts of the form.

This increased flexibility in email forms would allow for easier interpretation of messages, making responding or providing information via email a lot simpler and quicker.

## 2.5 D3: Data Visualisation

D3 [2] is a javascript library, which was designed for the creation of interactive visualisations of data and was first developed in 2011. D3 uses precreated Javascript functions to create scalable vector graphics (SVG's) which are embedded into the html of websites.”SVG is a language for describing two-dimensional graphics in XML” [5] and can have displays changed using Cascading Style Sheet (CSS).

Datasets can also be bound to an SVG allowing for a visual way to interpret the dataset, and as the dataset changes the SVG will be changed allowing for a dynamic display.

## 3 Requirements

### 3.1 Functional

Requirements for the system are each given an idea depending on the type of requirement: FR for functional requirements, NFR for non-functional requirement and SR for system requirements.

Along with this, each requirement has a description stating what the requirement is and a priority. The priority value can be low, medium or high, which shows which requirements will be implemented first into the system.

#### 3.1.1 User Requirements

Functional requirements also include an access column which defines what users should be able to use. Some items are restricted to lecturers as some requirements should only be be usable by lecturers and lab-helpers and not by students.

The access levels are: 1-Admin, 2-Lecturers, 3-Lab Helpers and 4-Students

Table 1: Functional User Requirements

ID	Requirement	Access	Priority
UR-01	Should have to login to view system	1,2,3,4	High
UR-02	Should have accounts created for them	1,2,3,4	High
UR-03	Should be able to change password	1,2,3,4	High
UR-04	Should be able to login using university ID	1,2,3,4	Low
UR-05	Should be able to logout	1,2,3,4	High
UR-06	Should be able to remove students from courses	1, 2	High
UR-07	Should be able to update student accounts	1,3	Low
UR-08	Should be able to look up students in lab	2,3	High
UR-09	Should be able to select students from lab list	2,3	High
UR-10	Should be able to leave comments about students	2,3	High

UR-11	Should be able to search for student by name	2,3	Medium
UR-12	Should be able to mark student even if they are not in the system	2,3	Medium
UR-13	Should be able to assign students to courses	1	Medium
UR-14	Should be able to assign lectures to courses	1	Medium
UR-15	Should be able to create marking schemes	2	High
UR-16	Should display generated stats	2	High
UR-17	Should be able to see submitted marks	2	High
UR-18	Should be able to generate end of year spread sheets	2	Medium
UR-19	Should allow editing of students in class	2	Medium
UR-20	Should be able to create peer marking scheme	2	Medium
UR-21	Should be able to look at students stats	2	Medium
UR-22	Should be able to set what parts of the marking scheme students can see	2	Medium
UR-23	Should be able to update marking scheme	2	Medium
UR-24	Should be able to able to assign students to set labs	2	Low
UR-25	Should be able to set penalties for late marking	2	Low
UR-26	Should be able to access Marking Scheme	3	High
UR-27	Should be able to enter selected students mark	3	High
UR-28	Should be able to submit student mark	3	High
UR-29	Should be able to select the lab they are helping in	3	High
UR-30	Should be able to see current mark	4	High

### 3.1.2 System Requirements

All the functional system requirements for the digital marking system are listed in the Table 2. The system requirements are non-user dependant functions which the system should be able to do.

Table 2: Functional System Requirements

ID	Requirement	Priority
SR-01	Should show different displays depending on access level	High
SR-02	Should load students current lab mark scheme	High
SR-03	Should allow marks to updated	High
SR-04	Should apply penalty for late lab completion	High
SR-05	Should create a set of useful stats based on lab	High
SR-06	Should store what class student belong too	High
SR-07	Should have a list of all students in class	High
SR-08	Should list all students that did not attend the lab	Medium
SR-09	Should track how long it takes to mark a student	Medium
SR-10	Should enable results to be importable to vision	Low
SR-11	Should retrieve student Image from university system	Low
SR-12	Should display what students have been marked	Low
SR-13	Should backup database regularly	Low
SR-14		

## 3.2 Non-Functional Requirements

Table 3 lists all the non-functional requirements for the development of the system. They are ranked in order of priority.

Table 3: Non-Function Requirements

ID	Requirement	Priority
NFR-01	Should have all person data encrypted	High
NFR-02	Should update stats as marks are entered	High
NFR-03	Should take less than 2 seconds to generate stats	High
NFR-04	PHP Should use prepared statements	High
NFR-05	Should be dynamically designed	High
NFR-06	HTML, CSS and Javascript should be validated	High
NFR-07	Should make sure inputs are valid	High
NFR-08	Should prevent SQL Injection	High
NFR-09	Should function on a wide variety of smartphones and tablets	Medium
NFR-10	Should be able to handle a large number of users without any faults	Medium
NFR-11	Should make sure passwords contain alphanumerics and have a minimum and maximum length	Medium
NFR-12	Should autosave marks as they are entered	Medium
NFR-13	Should record what lab help marked what student	Medium
NFR-14	Should have disability options (Increase text size, colour layout)	Low
NFR-15	Should be readable by screen readers	Low
NFR-16	Should take less than 2 second to load student marking scheme	Low
NFR-17	Test@Test	

## 4 Strategy for testing and evaluation

### 4.1 Testing

During each sprint unit tests will be created and run on modules of code to make sure that they function correctly and to check that the system is ready for the next module to be developed.

Each sprint will have set requirements that are to be developed by the end of the sprint. These requirement will each have a test case that will be run at the end of the sprint to make sure that it is successfully implemented.

### 4.2 Evaluating

To evaluate properly how successful I have been at creating a new Lab Marking System I will conduct a usability case study. Lecturers, lab helpers and students will be asked to use the systems and provide feedback, to help evaluate the system and discover what improvements can be made.

To evaluate how effective the code is I will create test cases. These will test how efficient the code is at running functions and help find areas for future improvement in the system.

## 5 Project Plan and Risk Analysis

### 5.1 Project Plan

The Gantt chart for this dissertation can be seen in figure(2). It is broken down into 5 stages: Design, Development, Evaluation, Dissertation and Poster. Each of these stages has multiple tasks that are expected to be completed during the course of the stage. A summary of each stage and their key tasks are stated below.

**Design Stage** Starts at the end of semester 1 to allow myself time to complete other course work. In this stage I will create mock-ups for the user interface, a database schema and define what will be occurring in each of my sprints in the next stage.

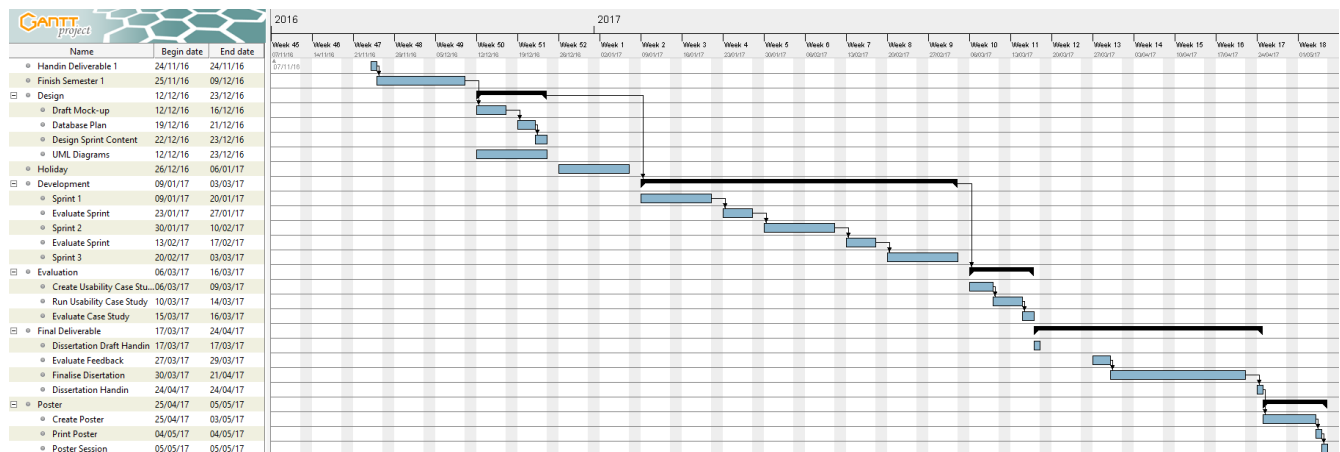
**Development Stage:** Starts once the holidays are over. It consists of three two week sprints with a week's break in between to allow for evaluation, write ups and other coursework. When the third sprint finishes I will go straight into the evaluation stage.

**Evaluation Stage:** During the final two weeks before the draft handin, I will conduct a usability case study and write up the remainder of my dissertation for the draft handin.

**Final Deliverable Stage:** This stage for me is the time to focus on feedback from the draft hand-in and make sure my Dissertation is of a high enough standard.

**Poster Stage:** This stage will be entirely dedicated to the design and creation of my dissertation poster.

Figure 2: Project Gantt Chart





## 5.2 Risk Analysis

The risks relating to this dissertation are shown in table(4), each risk has an associated Likelihood, Impact and a Mitigation Strategy. Likelihood and Impact values can be low, medium or high. The table is sorted by likelihood and then by the impact.

Table 4: Risk Analysis

ID	Risk	Likelihood	Impact	Mitigation Strategy
R-01	Browsers compatibility	High	High	Constantly test browser compatibility after each sprint
R-02	Other university coursework deadlines	High	Medium	Make sure to allocate adequate amount of time to other courses.
R-03	Lecturers cant create custom marking schemes	Medium	High	Create selectable forms that lecturers can edit.
R-04	Requirements changed	Medium	Medium	Evaluate requirements before starting development phase and evaluate requirements regularly during project to notice any required changes before it causes a major issue
R-05	System speed is slow	Medium	Medium	Make sure system is well factored and follow coding standards
R-06	Users cannot understand the system	Medium	Medium	Usability Study is being run at the end of the project to evaluation future improvements
R-07	Used library get updated and causes error	Medium	Medium	Read update information before upgrading to understand where errors might occur
R-08	Admins cant assign courses	Medium	Medium	Assign courses as part of test data and make note as a future improvement to the system

R-09	Supervisor unable to make meeting	Medium	Low	Contact supervisor and arrange another meeting time
R-10	Cannot get D3 to work	Medium	Low	Just display stats as plain text
R-11	Personal Injury	Low	High	Development would have to be delayed and discussions made with supervisor about how to continue
R-12	Loss of data	Low	High	Back-ups will be stored throughout the project
R-13	Family Issue	Low	High	Inform MACS and discuss what options are available depending on the situation
R-14	Users can't login	Low	High	Major testing will be done of the login functionality including multiple unit tests
R-15	Users can't log out	Low	Medium	Login will be using sessions which will timeout after a set time so if the user cannot log out then the system do it for them
R-16	Server hosting the project crashes	Low	Medium	Contact the host and enquire about what has happened
R-17	Supervisor Leaves	Low	Medium	Inform alisdair and request a new supervisor
R-18	Software Licences Expire	Low	Low	Check licences for all software i will be using during the project to make sure they are valid for length of project
R-19	Issues with transport to university	Low	Low	Use SSH to access any required information at the university

## **6 P.L.E.S Issues**

### **6.1 Professional Issues**

The professional part of this project will be done by following coding standards for the languages that I decide to use.

As this project will be a web application I will ensure that both the html and css are validated.

The system will be made open source to allow other people to look at and improve the system once I have completed it.

The project will be provided with a user and developer documentation allow for easy development and implementation of the system.

### **6.2 Legal Issues**

There are multiple legal issues relating to this project. The most important one is the Data Protection Act. Since the systems will be designed to store data about students I will have to make sure that all data is encrypted and securely stored.

I will make sure that I follow the terms and services for any software or libraries I used as part of the project, to ensure I am not breaking any laws.

### **6.3 Ethical Issues**

A major ethical requirement of this project is to do with the storage of students personal information on a digital system; to deal with this issue I should consult the data protection act.

Another issue that is raised by this project is making sure that students are not deceived and that the marks they see are actually the ones they have received.

The last ethical issue relating to this project is privacy. I have to ensure that students, when they are online, are able to see only their own mark and cannot see another student's mark. It should also be made such that final grades are only visible to the lecture and student keeping it confidential from lab helpers.

## 6.4 Social Issues

A few social issues are raised by this project. Such as if students can see the mark they have received straight away, will lab helpers feel pressurised into giving higher grades.

Will this system result in a reduction of lab helpers being required to mark labs? If the system speeds up the time to mark students work, less lab helpers may be required to run labs, resulting in people looking for work.

## References

- [1] B. S. Baker and E. Grosse. “System and method for restricting user access rights on the internet based on rating information stored in a relational database”. Pat. US5678041 A. U.S. Classification 1/1, 726/5, 709/229, 707/999.009, 707/999.001, 707/999.01; International Classification G06F1/00, G06F21/00, H04L29/06; Cooperative Classification G06F21/6218, Y10S707/99939, Y10S707/99931, H04L63/102, G06F2221/2141, H04L29/06, G06F21/604; European Classification G06F21/60B, H04L63/10B, H04L29/06. Oct. 1997. URL: <http://www.google.com/patents/US5678041> (visited on 11/22/2016).
- [2] M. Bostock. *D3.js - Data-Driven Documents*. URL: <https://d3js.org/> (visited on 11/20/2016).
- [3] S. A. Brown and A. Glasner, eds. *Assessment matters in higher education: choosing and using diverse approaches*. Chapter 4. Buckingham [England] ; Philadelphia, PA: Society for Research into Higher Education & Open University Press, 1999. ISBN: 978-0-335-20243-0 978-0-335-20242-3. URL: [https://books.google.co.uk/books?id=KVblAAAAQBAJ&pg=PA1&lr=&source=gbp\\_toc\\_r&cad=4#v=onepage&q&f=false](https://books.google.co.uk/books?id=KVblAAAAQBAJ&pg=PA1&lr=&source=gbp_toc_r&cad=4#v=onepage&q&f=false).
- [4] S. Dahl. “Turnitin The student perspective on using plagiarism detection software”. en. In: *Active Learning in Higher Education* 8.2 (July 2007), pp. 173–191. ISSN: 1469-7874, 1741-2625. DOI: 10.1177/1469787407074110. URL: <http://alh.sagepub.com/content/8/2/173> (visited on 11/21/2016).
- [5] J. Ferraiolo, F. Jun, and D. Jackson. *Scalable vector graphics (SVG) 1.0 specification*. iuniverse, 2000. URL: <https://www.w3.org/TR/2001/REC-SVG-20010904/REC-SVG-20010904.pdf> (visited on 11/21/2016).
- [6] R. Finley. *SurveyMonkey*. 1999. URL: <https://www.surveymonkey.com/home/> (visited on 11/04/2016).
- [7] E. Heinrich and Y. Wang. “Online marking of essay-type assignments”. In: *In*. 2003, p. 768772. URL: <http://www-ist.massey.ac.nz/MarkTool/Publications/EdMedia2003Onscreen.pdf>.

- [8] N. Holt and S. Thomas. “Customizing forms in an electronic mail system utilizing custom field behaviors and user defined operations”. Pat. US7051273 B1. U.S. Classification 715/226; International Classification G06F17/00, G06F15/00; Cooperative Classification G06Q10/107; European Classification G06Q10/107. May 2006. URL: <http://www.google.com/patents/US7051273> (visited on 11/19/2016).
- [9] M. Joy and M. Luck. “Effective electronic marking for on-line assessment”. en. In: *ACM SIGCSE Bulletin* 30.3 (Sept. 1998), pp. 134–138. ISSN: 00978418. DOI: 10.1145/290320.283096. URL: <http://portal.acm.org/citation.cfm?doid=290320.283096> (visited on 11/15/2016).
- [10] A Langan and C Wheeler. *Some Insights into Peer Assessment* \textbackslashtextbar LTiA Issue 4 \textbackslashtextbar CeLT \textbackslashtextbar MMU. URL: <http://www.celt.mmu.ac.uk/ltia/issue4/langanwheater.shtml> (visited on 11/21/2016).
- [11] P. Orsmond, S. Merry, and K. Reiling. “The Use of Student Derived Marking Criteria in Peer and Self-assessment”. In: *Assessment & Evaluation in Higher Education* 25.1 (Mar. 2000), pp. 23–38. ISSN: 0260-2938. DOI: 10.1080/02602930050025006. URL: <http://dx.doi.org/10.1080/02602930050025006> (visited on 11/16/2016).
- [12] *Turnitin - Home*. URL: [http://turnitin.com/en\\_us/home](http://turnitin.com/en_us/home) (visited on 11/21/2016).
- [13] E. Waclawski. “How I Use It: Survey Monkey”. en. In: *Occupational Medicine* 62.6 (Sept. 2012), pp. 477–477. ISSN: 0962-7480, 1471-8405. DOI: 10.1093/occmed/kqs075. URL: <http://occmed.oxfordjournals.org/content/62/6/477> (visited on 11/22/2016).