A Longitudinal Assessment of Bioinformatics Training for Librarians

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Contents

Abstract

Introduction

The Bioinformatics and Biology Essentials for Librarians (BBEL) was developed to introduce key biology and bioinformatics topics and NLM resources to librarians. There were two goals: 1) To determine how and to what extent students were using the skills and knowledge learned in the class, 2) To determine what enablers and barriers were impacting students' abilities to act on the skills they had learned during the class.

Methods

After completing the BBEL class, students were asked to participate in a phone interview and complete an online survey. Students were asked to reflect on the action plan they wrote upon completion of the class and which of the activities on their plan they were able to complete. The survey was implemented in Qualtrics and sent to students via personal links.

Results

Students most frequently identified *course materials and tools* and *opportunity to use* as enablers. Students most frequently identified *no opportunity to use* and *lack of manager/supervisor support* as barriers. Students completed a variety of items on their action plans, but some indicated that bioinformatics services were not a priority for their institution or that they had not had patron requests for bioinformatics services or training.

Discussion

Planning promotional activities may take time many librarians do not have. It may be difficult to convince their institutions of the value of adding bioinformatics services and training. Some students had difficulty reviewing class materials or finding additional training in bioinformatics resources or specific topics of interest.

Recommendations

Promotional materials could help students promote their new skills to their institution and patrons. Having a standard format that the students write action plans in can simplify later data analysis. Future cohorts of the BBEL class will be larger and it may be necessary to reduce or eliminate the phone interview component of the assessment.

Introduction

The Bioinformatics and Biology Essentials for Librarians (BBEL) class is an asynchronous online class developed by NLM to introduce key biology and bioinformatics topics and NLM resources to librarians. The class is co-developed and co-taught by National Center for Biotechnology Information, Library Operations, and National Network of Libraries of Medicine staff and it covers topics from basic genetics, searching various NCBI databases, bioinformatics and

librarianship, and the future of genomic research. The first cohort completed the class in the spring of 2018 with 15 students.

There were two main goals of the assessment: 1) To determine how and to what extent students were using the skills and knowledge learned in the class, 2) To determine what enablers and barriers were impacting students' abilities to act on the skills they had learned during the class. Students took part in a structured phone interview and were then emailed a personal link to complete a Qualtrics survey.

In addition to determining how graduates are applying the knowledge and skills learned in the class, the process of administering the assessment can provide insight into improving the efficiency and efficacy of future assessments. As future cohorts grow in number, assessments may need to adopt less time-consuming methods of data collection to remain scalable.

Methods

Approximately 6 months after completing the BBEL class, students were asked to participate in a phone interview and complete an online survey. Students were individually emailed a request to sign up for a 15-minute phone call interview via link to a Doodle poll or by contacting the interviewer to arrange a time. Interview times were confirmed with students via email. After completion of the phone interview, students were sent a personal link to the online survey. A follow-up email requesting participation in a phone interview was sent to remaining students approximately one week after the initial email. A final follow-up email requesting participation in a phone interview was sent three weeks after the initial email to remaining students. These students were asked if they would be able to complete the online survey but not the phone interview. Students requesting to complete only the online survey were emailed a personal link to access the survey. Email templates used can be found in Appendix A.

The phone interview was conducted as a structured interview with 7 questions focusing on the actions that students have taken since completing the class. During the structured interview students were asked to reflect on the action plan they wrote upon completion of the class and which of the activities on their plan they were able to complete (student action plans can be found in Appendix B).

The survey was designed using the evaluation of the PubMed for Trainers course as a reference and considering the Kirkpatrick Model for evaluating training. The Kirkpatrick Model involves 4 different levels of measurement: reaction, learning, behavior, and results. The reaction level measures students' affective response to the training. Learning measures how effectively students retained the information in the training. Behavior measures how students' behaviors have changed because of the training. Results seeks to measure the impact the training has had at an institutional level. The survey was implemented in Qualtrics and sent to students via personal links. The phone interview script and Qualtrics survey questions can be found in Appendix C.

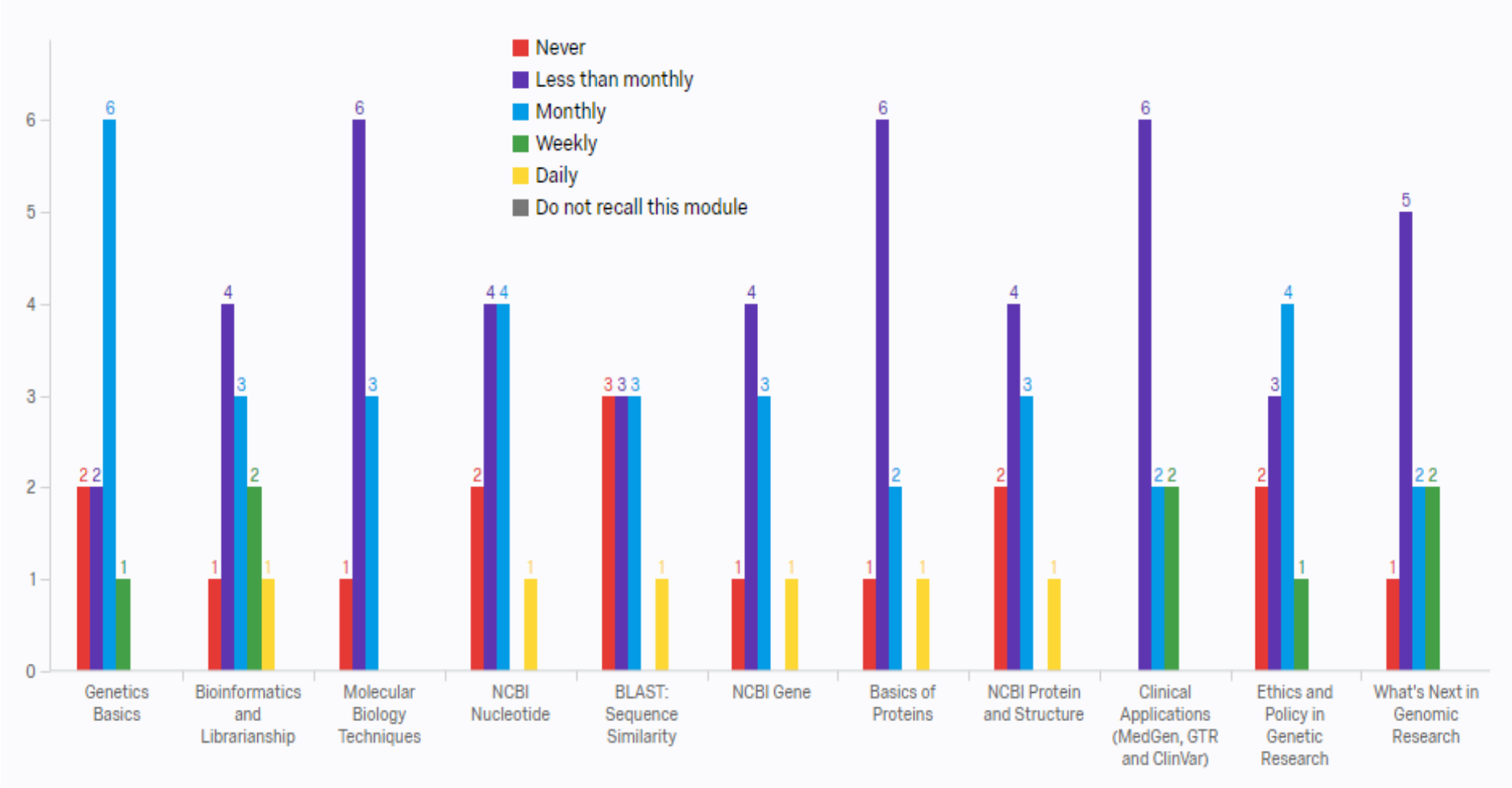
Results

Fifteen students were contacted via email. Eight students completed both the phone interview and online survey. Two students completed only the online survey. One student requested the online survey link but did not complete the survey. The remaining 4 students did not respond to the emailed requests to follow up.

Online Survey

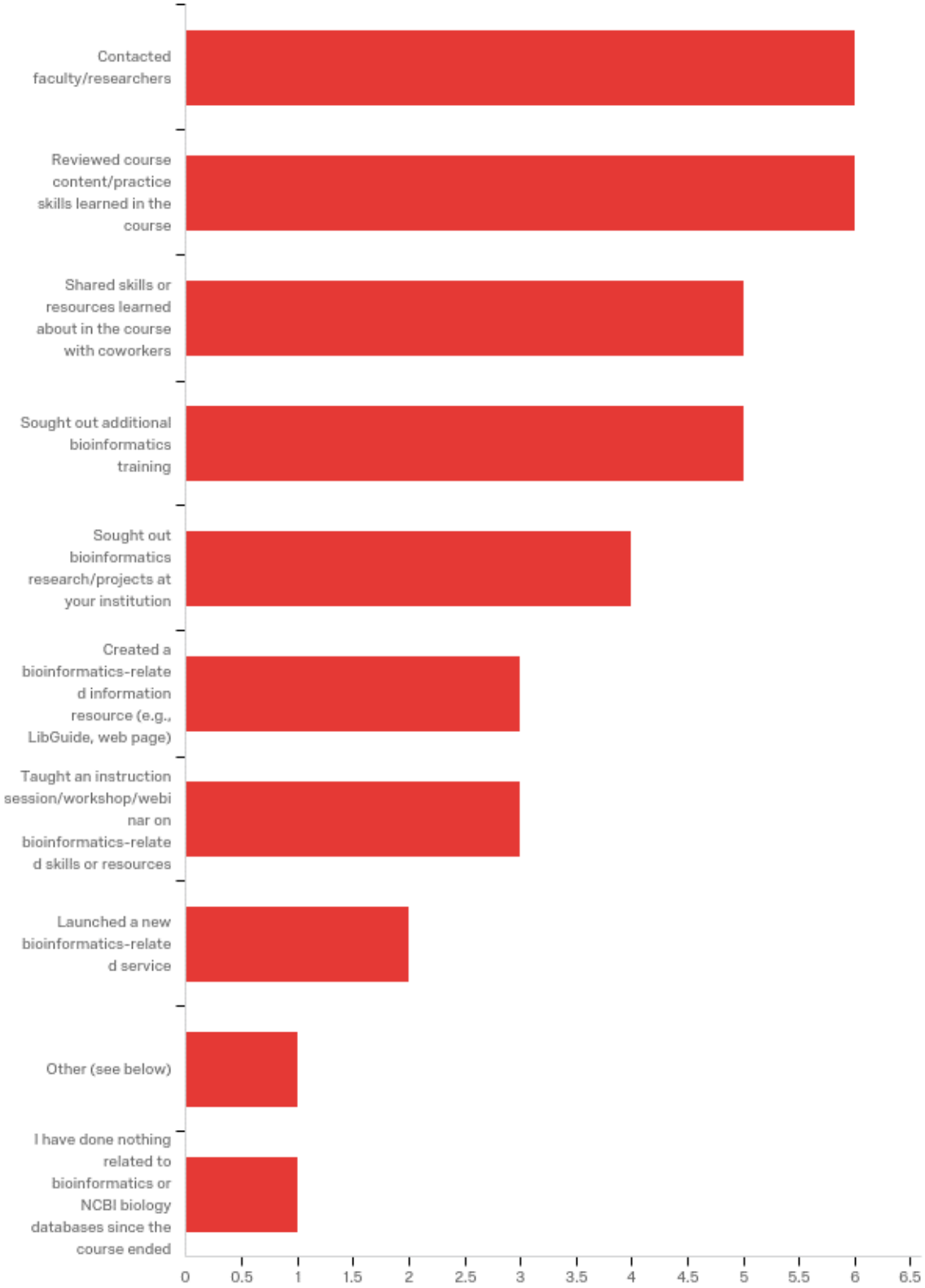
The course was divided into 11 different modules. Students were asked to indicate how often they used what they learned from each module as *never*, *less than monthly*, *monthly*, *weekly*, or *daily*. Students were also able to indicate if they did not remember the module. Six modules were ranked as being used daily (Bioinformatics and Librarianship, NCBI Nucleotide, BLAST: Sequence Similarity, NCBI Gene, Basics of Proteins, and NCBI Protein and Structure). However, this level of usage was only indicated by one student. Two students indicated using what they learned from the Bioinformatics and Librarianship, Clinical Applications, and What's Next in Genomic Research modules weekly. The Genetics Basics and the Ethics and Policy in Genetic Research modules each were indicated to be used weekly by one student. Most students indicated using the modules monthly or less than monthly. Genetics Basics was the module which was most often indicated to be used monthly with 6 students indicating this amount of usage. No students indicated that they did not remember a module. The BLAST: Sequence Similarity module had the least indicated frequency of use with 3 students indicating they never used what they learned from this module.

Figure 1. Q3 - How often do you use what you learned in the following modules of the class?



A list of 8 common actions was determined by looking at students' action plans. Students were asked to indicate which of these actions they have taken since completing the course and could also indicate if they had taken no action or other actions not listed. Students could then write in other actions they have taken. *Contacted faculty/researchers* and *reviewed course content/practiced skills learned in the course* were the most frequent with 6 students indicating they had taken these actions. *Shared skills or resources learned about in the course with coworkers* and *sought out additional bioinformatics training* were the next most frequent with 5 students indicating they had taken these actions. Four students indicated they had *sought out bioinformatics research/projects at their institutions*. *Creating a bioinformatics-related information resource* and *teaching an instruction session/workshop/webinar on bioinformatics related skills or resources* were indicated by 3 students. Two students *launched a new bioinformatics-related service*. One student indicated they had taken other actions. One student indicated that they had taken no actions since completing the course. There were 4 write in responses for other actions taken which included providing reference support, speaking with patrons about bioinformatics software, collaborating with a researcher on a grant, and publishing an article in the Journal of the Medical Library Association.

Figure 2. Q1 - Please indicate which, if any, of the following actions have you taken since completing the course:



Students were asked to identify enablers and barriers that affected their application of the knowledge and skills from the course. *Course materials and tools* was the most selected enabler with 8 students. *Opportunity to use* was the next most selected with 6, followed by *organizational support* and *manager/supervisor support* with 3, and *time* with 2. *Other courses*, *peer support*, and *other enablers* were the least selected enablers with only one student selecting each. There was one write-in enabler: "Hiring new people…ability to converse with experts (PhDs, Department Chair of Bioinformatics Program) in bioinformatics knowledgeably to try to create collaborations." The most selected barrier was *no opportunity to use* with 5 students selecting this option. *Lack of manager/supervisor support* was selected by 3 students. *Lack of organizational support*, *no time or insufficient time to apply*, and *other barriers* were selected by 2 students. *Lack of peer support* was selected only once. Four students wrote in other barriers: 1) "Few patron questions related to bioinformatics" 2) "Delays in the research projects at my institution" 3) "No demand" 4) "Not enough money to update hardware & assign more hours to Independent Contractors/Grad Students/Paid or Unpaid Consultants to speed development, and for taking more courses…"

Figure 3. Q5 - What factors enabled you to apply the knowledge and skills learned in the Bioinformatics and Biology Basics for Librarians course? (Select all that apply)

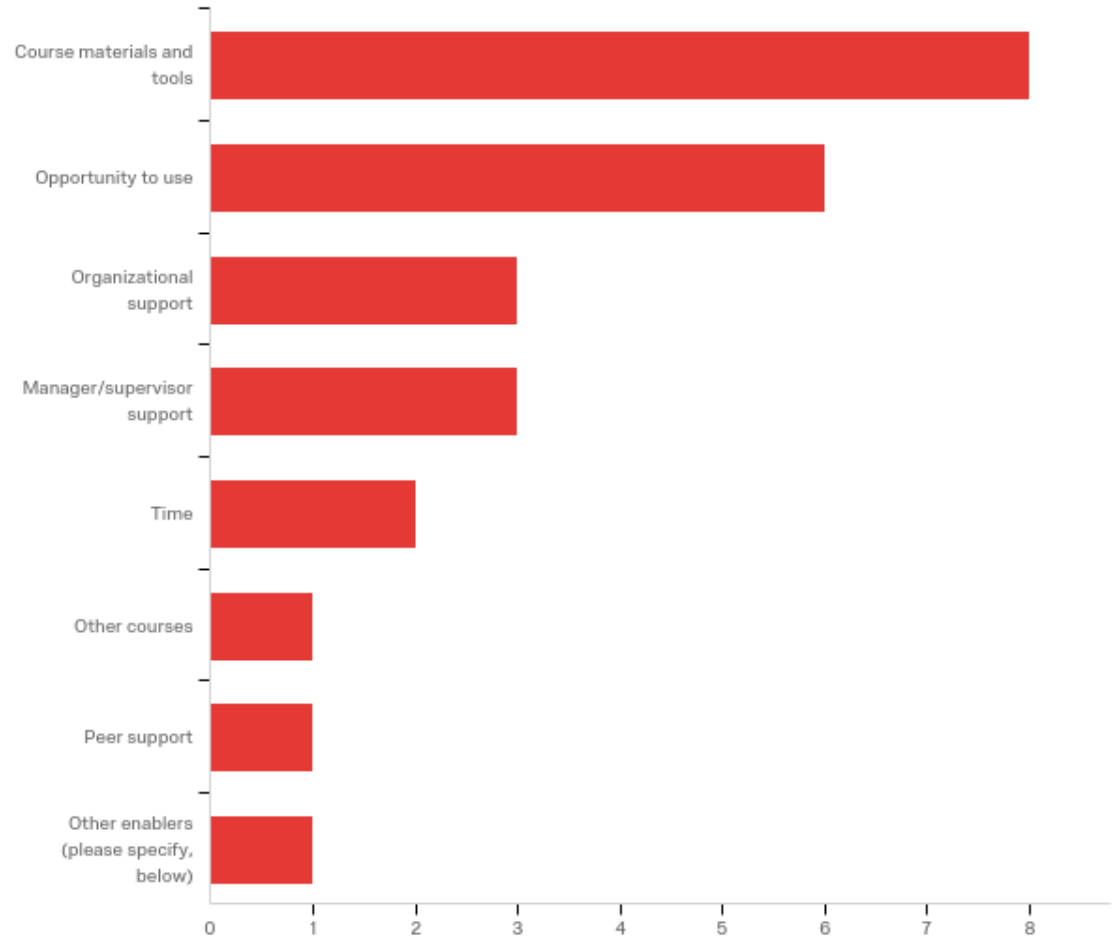
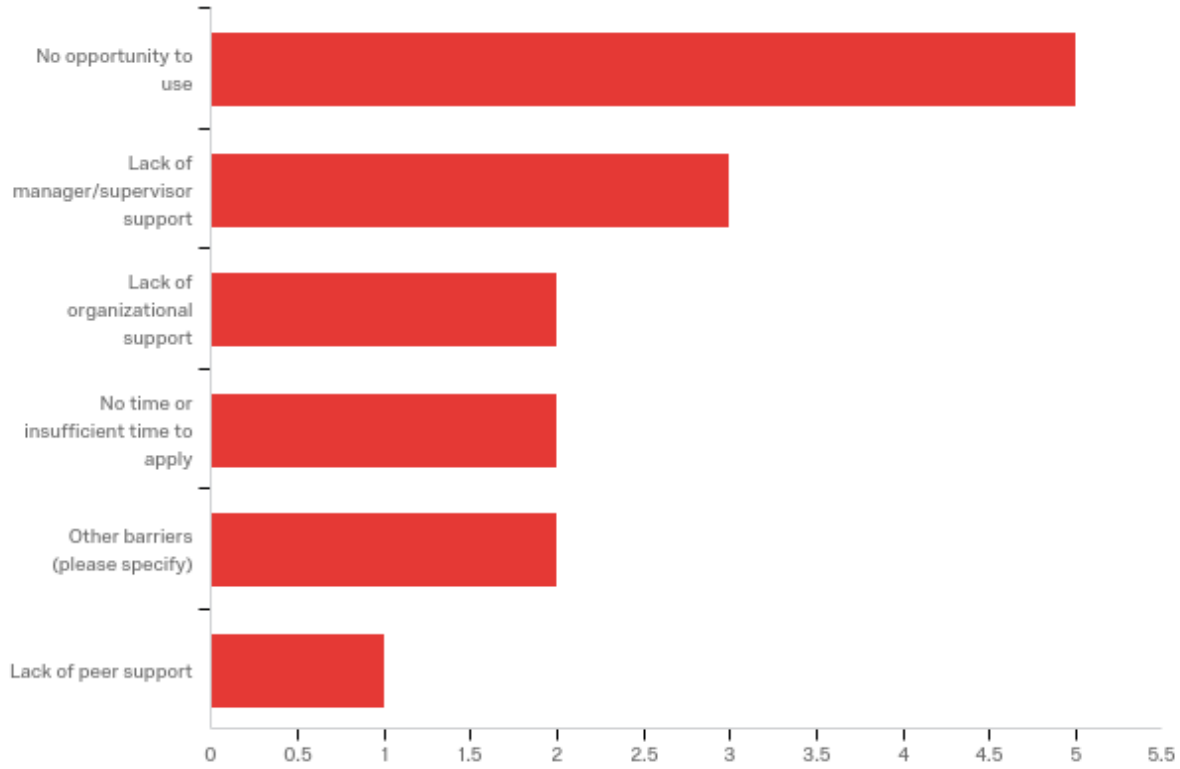
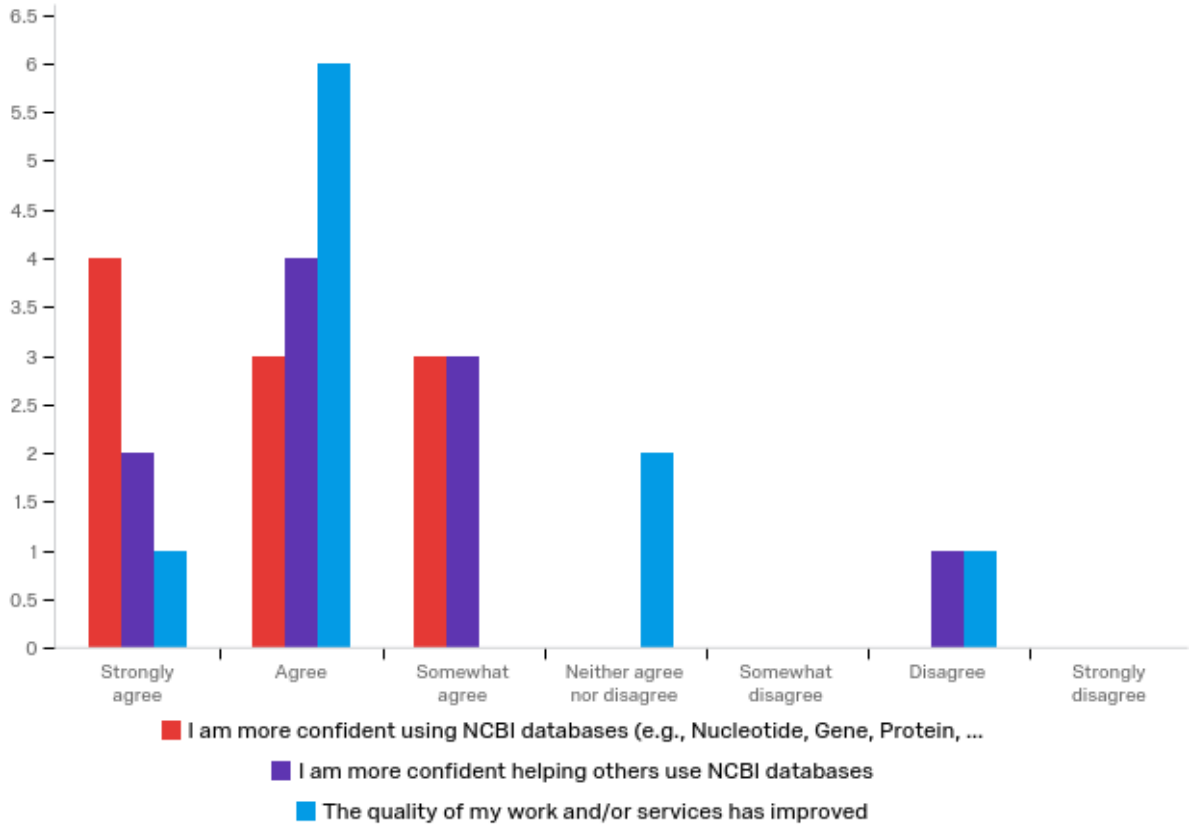


Figure 4. Q6 - What barriers prevented you from fully applying the knowledge and skills learned in the Bioinformatics and Biology Basics for Librarians course? (Select all that apply)



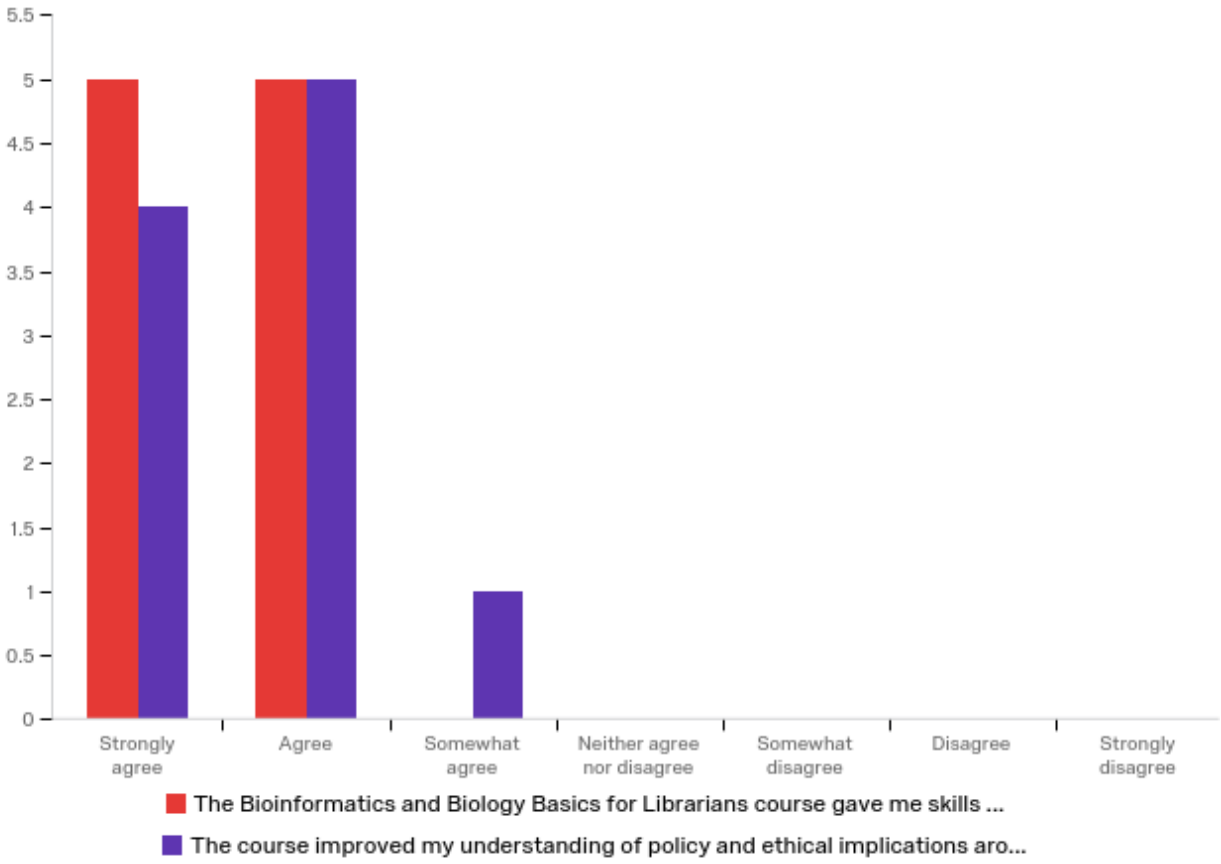
Students were asked to rank the following statements on a 7-point Likert scale: 1) I am more confident using NCBI databases, 2) I am more confident helping others use NCBI databases, 3) The quality of my work and/or services has improved. Four students strongly agreed with the first statement, 3 agreed, and 3 somewhat agreed. Responding to their confidence when helping others use NCBI databases, 2 strongly agreed with the second statement, 4 agreed, 3 somewhat agreed, and 1 disagreed. One student strongly agreed that the quality of their work/services has improved, 6 agreed, 2 neither agreed nor disagreed, and 1 disagreed. Overall, most students showed some level of agreement with all three of the statements.

Figure 5. Q2 - Since taking Bioinformatics and Biology Essentials for Librarians:



Students were also asked to rank the following statements on a 7-point Likert scale: 1) The Bioinformatics and Biology Basics for Librarians course gave me skills which I can build upon, 2) The course improved my understanding of policy and ethical implications around bioinformatics data storage, access, and use. Five students strongly agreed with the first statement and 5 agreed. Four students strongly agreed with the second statement, 5 agreed, and 1 somewhat agreed.

Figure 6. Q4 - Rate your level of agreement with the following statements:



Students were asked what percentage of the knowledge and skills acquired in the course have they applied on the job and what percentage is necessary for their job. The percentage of knowledge and skills applied ranged from 1% to 80% with a mean of 36.20 and a standard deviation of 29.74. The percentage of the student's job requiring knowledge and skills from the course ranged from 5% to 80% with a mean of 33.89 and a standard deviation of 25.25.

Phone Interviews

The 8 students who participated in the phone interview are working in various library contexts and 2 students are not currently working in libraries. For the students not working in libraries most of the interview questions did not apply. Interview notes can be found in Appendix D.

Students completed a variety of activities from their action plans. One student collaborated with the Cancer Genomics and Precision Medicine department at her institute on a project. Another student collaborated with a faculty member on a successful grant proposal. Other students have reviewed skills and resources learned in class, created informational resources like handouts and LibGuides focused on bioinformatics resources, and created new trainings or incorporated bioinformatics resources into their existing trainings. The two students not currently working in libraries have also been working on their action plans. One student is creating a website to help make bioinformatics resources accessible in multiple languages. The

other student is engaged in a variety of projects involving bioinformatics and has completed an ICD-10 code dictionary—a project which lead to a publication in the Journal of the Medical Library Association. Only one student did not complete any items on their action plan.

While one student was able to complete all the items on his action plan, the other students identified activities which they were not able to complete. Many students noted that some items on their action plans are still in progress or have been delayed. One student said that her project with the Cancer Genomics/Precision Medicine department was delayed due to building construction and physical relocation of the department. Another student said that her plans to select bioinformatics software are on hold as her library is currently more focused on strategic planning. Some students said that they had not had time to review things learned in the course or to pursue further bioinformatics training. One student created a new action plan to work on while delaying his first action plan due to needing a collaborator.

Students identified a variety of ways in which they had promoted their new skills since completing the class. One student has forwarded emails with information about the class to colleagues and offered ClinVar and MedGen trainings to researchers. Another student has created a handout on bioinformatics resources and created a training for NCBI resources. The student who wrote a grant with a faculty member said that this successful collaboration will be a way of making his bioinformatics skills and knowledge visible at his institution. A few students said that they had not promoted their new skills since completing the class. One student said that she "does not have the confidence" to promote her new skills and feels she "needs more training and more time to digest and use the info." Another student said that while she had not promoted her new skills she was planning to list completing the class on her annual review as a professional activity.

Most students said that they had not had an increase in the number of patrons they were serving. One student said she did not know if there had been an increase in patrons as she did not have access to statistics as a part-time worker. One student noted a small increase and described talking to researchers after meetings and asking them questions after presentations to find out what resources they were using in their research. One student said that while she hasn't noticed an increase in the number of patrons, the course helped her better understand the research done by genomic medicine faculty. After the course she felt confident enough to reach out to these faculty members and talk to them about the systematic review service the library provides and how it could benefit their research.

Most students said that they had not had an increase in requests for bioinformatics services or training. One student said his library had a small increase in requests. Another student said that while she has not seen an increase in requests for services or training, she has received more requests for bioinformatics-related articles. Similarly, another student said that she has not seen an increase, but patrons in interviews have asked about getting bioinformatics software for the library. Another student said that she doesn't seen any real institutional demand for

bioinformatics services or trainings, she and her colleagues generally are not trained to deliver these services, and patrons may not think to come to the library for these services.

Most students said that they can now respond to patrons' requests for bioinformatics information or resources more quickly and efficiently. One student said she had not had any requests for bioinformatics information or resources. Another student said that while she had not had specific bioinformatics requests that she had incorporated what she had learned into the monthly training sessions she does, e.g. incorporating the NCBI taxonomy resource into her training about animal searching. One student said that while she feels she could handle some requests better and point patrons to the information they need, she would want to look back at course materials answer more complex questions that required searching NCBI databases.

Most students said that the quality of their work and/or services had improved since taking the class. Several students said that taking the class made them more aware of what bioinformatics resources were available. One student said that he has been looking at more bioinformatics publications and has been "more proactive about recommending resources." Two students commented that they have not had a chance to practice their new skills yet at work. Two students said there was no change in the quality of their services.

After answering these interview questions, students were given the opportunity to make any other comments they would like about the class. Students comments were generally positive. One student commented that a class focusing on ClinVar and MedGen would be useful to her. One student commented on the difficulty of keeping learning resources up-to-date as websites change and then screenshots must be updated. Another student commented that finding information about genetics and bioinformatics was somewhat daunting to her before taking the class, but she now finds this information to be more accessible. One student felt that the class was done at a very high level for her and that she felt she needed more background in biology. She also stated that limited time and the online structure of the course made it harder for her to follow. Another student commented that he would have liked more 'practical homework' and more video content would have helped him to learn searching the different databases. One student commented that she had recommended the class on her Facebook page and had suggested it to librarians who are seeking to obtain or renew their AHIP membership.

Discussion

Eight students were able to participate in phone interviews and 10 completed the online survey. Phone interviews were conducted from December 17th to January 4th, during a busy time of the academic year and with many people celebrating holidays. This could potentially have resulted in a lower response rate. Overall, the students in this first cohort had many positive things to say about the class. Most students identified course materials and tools as enabling them to apply the skills and knowledge from the class. However, students identified opportunity to use (or no opportunity to use) as both an enabler and barrier. The students are working in a variety of institutions with different goals and priorities, and bioinformatics may be

a priority at some of these institutions but not others. In fact, some students indicated that bioinformatics was not currently a priority for their institutions. This is also reflected by the students who mentioned lack of manager/supervisor support as a barrier.

Many students agreed that they felt more confident using NCBI databases and helping others use these databases. Most students also felt that the quality of their work or services had improved since taking the course. In the interviews, many students expressed that they now felt they had more resources at their disposal to help patrons find bioinformatics information. One student stated that taking the class had made bioinformatics information "more accessible for myself and my patrons" directly connecting the impact of the class on the services she was now able to provide to patrons.

Most students are using what they learned from the different class modules on a monthly or less than monthly basis. Only one student indicated using any of the modules daily and only a few students indicated using modules weekly. Which modules students find most useful is likely to be influenced by the type of institution they are working with. A student who works closely with clinical researchers mentioned ClinVar and MedGen being the resources she found most useful. Another student who does not work in a health sciences library but provides biology research support for undergraduates found the Genetics Basics module very helpful. As cohorts grow, future assessments may be able to determine if certain modules deserve to be broken off into stand alone courses or if a more advanced or in-depth offering of a module or series of modules should be offered. With this initial small cohort, it is difficult to make those recommendations.

When asked what percentage of knowledge and skills from the class they are applying and what percentage of the knowledge and skills are necessary for their job, on average students indicated that they were applying slightly more than they indicated was necessary at their job (average of 36.20 vs average of 33.89). This can be seen in the interview where a student said that she incorporated what she had learned in the class into her monthly trainings even though she was not receiving more bioinformatics requests from patrons. Also, many students take training because of a love of learning not necessarily a direct need to increase skills or knowledge for their job.

Students described a range of different behaviors as promoting their new skills. Some students mentioned emailing colleagues, speaking to researchers, creating handouts and other resources, and creating trainings. Other students mentioned more passive forms of promotion such as increased visibility after cowriting a grant or listing the class on an annual review. Librarians often build strong relationships with the faculty and researchers which can help when promoting new skills. One student mentioned that after taking the class she felt she gained background knowledge and confidence which helped her approach faculty members to promote the library's existing systematic review service. However, students may think of promoting new skills to their institution differently than promoting new skills to patrons. A

manager or supervisor may need to be convinced of the value new bioinformatics services will add to the library which may already be operating with time, staff, and budget constraints.

Students did identify some challenges or areas where the class could be improved. Some students wanted to access resources and materials after the class closed to review or use as a reference when answering patron questions. Students do have access to class materials for 6 months after the class ends, but students may be unaware of this or wish for a longer access time. It is typical for online classes to close and students to no longer have access to materials. Some students may have assumed this would be the case for the BBEL class. One student wanted more video content to learn about database searching and more 'practical homework.' A similar concern that a few students brought up was that they have limited chances to apply their new skills from the class at their job. Another student felt that the class level was too high and that the online structure and lack of time impeded her learning the material thoroughly. Some students indicated wanting to pursue more bioinformatics training, but they were prohibited by cost or not being able to find applicable training.

Originally a completion percentage was supposed to be calculated for each student's action plan. This proved to be difficult as not all students created numbered action plans and some action plans were broken down into multi-step projects rather than discrete items. Also, many students indicated that items on their action plans were not fully complete but were rather 'in progress' or items that they still intended to complete later. Future assessments may need a better way of calculating a meaningful completion percentage or maybe do away with this measure. There are many reasons why an item on an action plan may not have been completed by a student. Classifying these reasons for noncompletion into barrier categories may be more meaningful than calculating an overall percentage completion for each action plan.

Recommendations

Future Classes

Some students identified that bioinformatics was not a priority for their institution or that their patrons did not yet know that bioinformatics help was available. Having promotional material could help students promote their new skills to their institution and patrons. Students have already taken the time to complete the course, and BBEL is a time intensive course. They may not have time to promote their new skills. Having readymade promotional materials that students could use or adapt would make it easier for them to promote their new skills without having to put in additional time or effort. In creating these promotional materials it may make sense to have different types of promotional materials for supervisors/managers and patrons.

A potential disadvantage of an online class is that content and resources from the class become unavailable to the students after the class closes. Although the BBEL class continued to offer access to class materials for 6 months after the class ended, some students seemed unaware of this fact. Several students mentioned that they would like to review the materials periodically or have them to reference in the event of a patron question. In the future, instructors might

promote the fact that course materials will continue to be available to students for a period after the class ends. This would benefit both students who want to go back and review and students who feel they need to go through the class at a slower pace. There seemed to be a similar lack of awareness of the graduate forum that students are invited to join after completing the course. At least two students were looking for potential collaborators for their projects and several students mentioned wanting to further their bioinformatics training, both goals which the graduate forum and wiki could have helped facilitate.

Future Assessments

It would simplify data analysis for students to have a standard format for their action plans. Having students format action plans as a numbered list of discrete tasks would allow future interviewers to go item by item on the list to evaluate it for completion. The action plans could also be incorporated into the online survey more easily with this structure. Students could rate each item on their action list as completed, partially completed, or not completed. Then items which were partially completed or not completed could be assessed for barriers and completed items could be assessed for enablers. This will require a more complex online survey but can help pre-sort the data into meaningful categories for analysis. Future cohorts of the BBEL class will be larger and it may be necessary to reduce or eliminate the phone interview component of the assessment.

Acknowledgements

Thanks to Kate Majewski, project sponsor, and the other instructors of the Bioinformatics and Biology Essentials for Librarians class for their support and feedback in designing the survey and interview questions. Thanks also to Siobhan Champ-Blackwell for her help in analyzing the interview data.

Appendix A

Dear _____,

I'm Amelia Llorens, an Associate Fellow at the National Library of Medicine. I am helping to conduct a longitudinal assessment for the Bioinformatics and Biology Essentials for Librarians class which you successfully completed several months ago.

I was wondering if you would have time to participate in a brief phone conversation about your activities since completing the class. The phone call would take approximately 15 minutes and would be followed by a brief online survey.

Please sign up for a time for your phone call by clicking on the link to the Doodle poll below.

[link to Doodle poll]

Please respond to the poll with both your **name** and **preferred phone number**. If you do not see a time which works for you, please email me so we can find an alternate time.

I have attached a copy of the action plan you wrote as part of the class for you to review before our phone conversation.

Thank you for your interest in the Bioinformatics and Biology Essentials for Librarians class. Your feedback helps improve the class to better meet the skill needs and career goals of librarians.

Thank you for your

time! Amelia Llorens

Email subject: Bioinformatics and Biology Essentials for Librarians Follow-Up

I am reaching out again to ask for your feedback on the Bioinformatics and Biology Essentials for Librarians class which you successfully completed several months ago. Would you be willing to participate in a 15-minute phone call about your activities since completing the class?

Please sign up for a time for your phone call by clicking on the link to the Doodle poll below.

[link to Doodle poll]

Please respond to the poll with both your **name** and **preferred phone number**. If you do not see a time which fits in your schedule, please email me. I am happy to find a time which works for you.

I have attached a copy of the action plan you wrote as part of the class for you to review before our phone conversation.

Thank you for taking the time to give feedback during this busy time of year. Your feedback helps improve the class to better meet the skill needs and career goals of librarians.

Email subject: Bioinformatics and Biology Essentials for Librarians Follow Up

Happy New Year____!

I am reaching out one last time to see if you would be able to participate in a 15 minute phone call to give feedback on the Bioinformatics and Biology Essentials for Librarians course you successfully completed a few months ago.

Please sign up for a time for your phone call by clicking on the link to the Doodle poll below.

[link to Doodle poll]

Please respond to the poll with both your **name** and **preferred phone number**. If you do not see a time which fits in your schedule, please email me. I am happy to find a time which works for you.

I have attached a copy of the action plan you wrote as part of the class for you to review before our phone conversation.

If you do not have time for a 15 minute phone call, but would be able to complete a 5 minute online survey, please reply to this email so I can send you a link to the survey.

Thank you for taking the time to give feedback and helping us improve our courses to meet the skill needs and career goals of librarians!

Email subject: Bioinformatics and Biology Essentials for Librarians Follow Up

Dear_____,

Thank you for taking the time to talk to me today about your experiences since completing the Bioinformatics and Biology Essentials for Librarians class!

As a final step, please click the link below to complete a 5-minute online survey.

[link to online survey]

Thank you for your feedback!

Email subject: Bioinformatics and Biology Essentials for Librarians Assessment Final Step

Appendix B

Bioinformatics action plan
by Student #1

A library guide on bioinformatics may be useful not only for students in the associated master's program (http://www.utoledo.edu/med/depts/bioinfo/masters.html), but for all health science students. I would work with my colleagues (liaisons in the areas of medicine and nursing) and any professors they would recommend for topics/resources to include as well as what level of detail would be best.

Also, I would consider auditing one of the basic bioinformatics classes to get a better feel for what is needed.
My position (part time, non-faculty) includes coordinating the library's social media account and monthly "themed" bulletin board.
Blogs and tweets on current bioinformatics applications of interest could be posted. A monthly bulletin board item could include
bioinformatics applications of interest as well as some of the basics.

I would also work with my colleagues on any additional ideas as inviting bioinformatics students/faculty to display at our library their poster session material, summaries of their research, etc.

Hope to become expert user of ClinVar and MedGen
by Student #2

I work at Intermountain Healthcare where there is a Cancer Genomics/ Precision Medicine Department https://intermountainhealthcare.org/services/cancer-care/precision-genomics/

I am currently involved in doing EB literature searches about variants associated with Myeloproliferative Disorders which will be included in a submission to CMS for reimbursement for certain genetic tests the scientists have developed.

April 13, 2018, the FDA issued Use of Public Human Genetic Variant Databases to Support Clinical Validity for Genetic and Genomic-Based In Vitro Diagnostics https://www.fda.gov/downloads/MedicalDevices/DeviceRegulationandGuidance/GuidanceDocuments/UCM509837.pdf Scientists at Intermountain are happy about this ruling because they believe that it will shorten the process for reimbursement from CMS.

So, I need to upgrade my skills using ClinVar and MedGen in particular. I will search out any training materials on these from NCBI and YouTube.

I would like to thank the developers and organizers of this course because my awareness of resources available from NCBI has increased exponentially. The next steps are to practice and use the resources.

My bioinformatics action plan
by Student #3

After this class, I feel less daunting the special databases from NCBI, such as NCBI Gene. I think I still have a lot to learn in bioinformatics. At the protein level, I feel more comfortable because a lot of the basics have been covered in biochemistry. But I feel less comfortable at the gene and nucleotide level and I had to translate terms in to my native language from time to time to help myself understand better.

1. I know several research guides discussed in this class that I can refer to in the future.

2. I also know how to use YouTube videos from NCBI when I need to refresh my knowledge.

3. One challenge I face is that many NCBI databases are interrelated. But I am not familiar enough with them to use them as a whole. I also noticed that once I finished an NCBI online class, the class materials would not be available to me. If later I would like to use what I have learned in instruction but need to check details, I could not get access any more. Not sure whether accessibility could be an option after class was completed.

My bioinformatics action plan
by Student #4

At my institution, I plan to create the following learning resources for patrons:

I'll create a 2 or 3 page guide (in PDF or LibGuides format) about bioinformatics resources available through the NCBI network. I may also include some of the additional non-NCBI bioinformatics resources I've learned about through this course.
I hope to create a playlist of webinars about bioinformatics resources (especially using the videos at https://www.youtube.com/user/NCBINLM/featured) that can be shared through our intranet or LibGuides.
I plan to look into both free and subscription bioinformatics visualization and data analysis software that may be used to create a "makerspace" station in the library.
I also plan to speak more frequently with patrons during daily interactions to see what types of bioinformatics trainings or learning resources they would be most interested in. On a personal level, I plan to keep an eye out for webinars or interesting articles related to bioinformatics in order to continue learning about this topic.

My next steps after this course in furthering bioinformatics
by Student #5

My next steps after this course in furthering bioinformatics at Morehouse School of Medicine and exploring bioinformatics education for my professional development are:

Review of the contents of this course and NLM resources
Acquire additional reading on bioinformatics
Work with the Annual HELA conference
Conduct an inventory of library bioinformatics resources in print and online

My Bioinformatics Action Plan
by Student #6

Here is my bioinformatics action plan in a list format.

1. To continue to practice what I've learned in this class about searching the NCBI bioinformatics databases.

2. To further my training in genomic medicine and bioinformatics.

3. To add new resources to our library research guide for genomic medicine.

4. To share my knowledge with other librarians both at our institution and beyond.

5. To start thinking about our existing library services and how they can also support bioinformatics.

6. To understand published research related to bioinformatics better and how I can support researchers at our institution.

My bioinformatics action plan
by Student #7

Actually, I am working on a project to represent the actual data within NCBI databases using RDA & MARC format. I want to make an RDA catalog entry for a DNA sequence, with metadata about that sequence. My steps in this project as the next:

1) Understand and analysis the biology record within NCBI databases (PubMed, Gene, Nucleotide, Protein, etc.)
2) Looking in MARC format to finding the equivalent fields and suggest unmatched fields from that are unused.
3) Mapping biology records with new MARC fields Using RDA rules.
4) The project output is a RDA catalog for a DNA and Amino Acids sequence to link between sequences and related researches.

Revised action plan

by Student #7

Actually, I have changed (delay) my action plan which I wrote it as part of the class due to many challenges I faced it. But If you are interested in, I am working now on new project (Website) "**The Scientific Bioinformatics Portal SBP"** which contains the next three comprehensive databases with a definition of each source in 10 languages:

A) Bioinformatics Resource: DB collects the next resource types on the Internet: (1) Databases (2) Web Tools (3) Software. DB look up resources in next Categories : (01) Bibliographic Resources (02) Cellular Regulation (03) Chromosome Aberrations (04) Comparative Genomics (05) Gene Expression (06) Gene Identification and Structure (07) Gene Mutation (08) Gene Sequences (09) Genetic and Physical Maps (10) Genetic Disorders (11) Genomic Variants (12) Genomic Sequences (13) Intermolecular Interactions (14) Metabolic Pathways (15) Protein Motifs (16) Protein Sequences (17) Protein Structure (18) Proteome Resources (19) RNA Sequences (20) Transgenic Organisms.

B) Bioinformatics Institutions: DB observes the next Institution Types: (1) Academic Institution (2) Research Institution (3) Medical Institution (4) Society Institution (5) Commercial Institution.

C) Bioinformatics Experts: DB try collecting experts in next experience fields: (1) Biochemistry and Molecular Medicine (2) Physiology (3) Pathology and Cell Biology (4) Microbiology and Immunology (5) Information Science.

Bioinformatics Action Plan
by Student #8

During this course, I have shown examples of some of the work that I have done with AI. I would like to continue to build on my AI files that enable natural language queries and responses in voice and text to medical information, bioinformatics data, and medical database searching by associating files currently operating on the 3D web to the 2D web and mobile applications.

MY ACTION PLAN

A) Finish the following files I started during this course:

1) ICD-10 code dictionary, associating a non-dotted format ICD-10 code with its description AND ICD-10 code crosswalk tool, enabling search in several NCBI databases by non-dotted format ICD-10 code numbers - COMPLETED (approximately 72,000 items)
2) A general medical, MeSH, and bioinformatics dictionary associating a term with a definition - IN PROGRESS using terms and definitions from MeSH descriptions and selected terms from Merriam-Webster's Medical Dictionary as starting points, with original summarizations or quotations from the "best" online resources
3) A list of FDA approved drugs, associating an active ingredient with a proprietary name - IN PROGRESS (over 36,000 items; duplicate entries need to be removed)
4) Associate FDA drugs with pharmacogenomics information and Genetics Home Reference information - DIFFICULTIES understanding how to do this with GHR.
5) A Sequence Alignment tool that can analyze whole human genome sequences (by chromosome), then identify variants with known pathogenic results, mapping them to a description of the disease, literature, clinical trials, etc. - DIFFICULT!

B) Obtain additional education:

6) Study the existing sequence alignment tools to gain a better understanding about how their sequence alignment process works (including a variety of standard algorithms) so that I can build my own tools to compare new whole genome sequences and SNPs against a reference genome, particularly the human genome. These may include the following, which I have used within existing tools as part of my bioinformatics classes (U Toronto), but have not yet attempted to build into my own tools such as:
* Alignment by Tuples
* Global alignment / Needleman-Wunsch algorithm
* Local alignment / Smith-Waterman algorithm
* BLAST algorithm - Altschul, S. F., Gish, W., Miller, W., Myers, E. W., & Lipman, D. J. (1990). Basic local alignment search tool. Journal of molecular biology, 215(3), 403-410. (Cited by 71,450) - Written in C; BLASTP "utilizes a word size of four" ("computational complexity of BLAST is approximately aW + bN + cN W/20^w, where W is the number of words generated, N is the number of residues in the database and a, b and c are constants.")
* Pairwise alignment
* Bootstrap method

* Gap penalties
* Frameshift identification
* BLOSUM

Objective: Mobile bioinformatics app for **commercial use** for medical professionals (doctors, genetic counselors, researchers, etc.)

7) Possibly take a course in bioinformatics through Johns Hopkins as part of my second master's degree program in Science Writing. However, I did not see any courses that have a lot of practical applications in their online offerings. A good deal of it had a lot of prerequisites, mostly focused on theory and readings, and it is very expensive. A course elsewhere may be more beneficial.

Objectives: I would rather take courses or read books that would help me with #1. The classes found on the site that Dr. Khatapov recommended are also very expensive, but more aligned with my objectives. However, I felt that the free courses I took through the Univ. of Toronto covered much of this.
https://www.coursera.org/api/legacyCertificates.v1/spark/statementOfAccomplishment/971626~178658/pdf
https://www.coursera.org/api/legacyCertificates.v1/spark/statementOfAccomplishment/971625~178658/pdf
These courses from Hopkins look more affordable and related to what I'm interested in: #3-Python for Genomic Data Science (Begins May 2018), #4 Algorithms for DNA Sequencing):
https://www.coursera.org/specializations/genomic-data-science#courses

8) Learn how to apply/create machine learning predictive algorithms using:
* Matrices - I have only a minimal understanding based on Andrew Ng's Stanford course on Machine Learning that I audited; complex mathematics proves to be a challenge
* TensorFlow - Class: Udemy - Complete Guide to TensorFlow for Deep Learning with Python - Paid. Finish course after this one is done.
* R - Basic review and practice problems using Youtube videos - COMPLETED
* Touch-based training method (Supervised Reinforcement Learning for AI) -PARTIALLY COMPLETED

Objectives: Learn generalizable ML techniques, and then learn how they can specifically be applied to bioinformatics

9) Research activities, projects, and publications at NLM-Lister Hill - COMPLETED

Objectives: Understand current research in the field in terms of AI/ML applications to bioinformatics

10) Complete additional MLA/NLM continuing education courses

C) Begin the following new actions:

11) Apply to bioinformatics jobs

12) Create and direct a Subscription-based Digital Medical Library similar to the Netflix business model as a legitimate and legal alternative to SCI-HUB
* MLA AHIP credential - Renewal completed, valid until 2022
* Board member solicitation - UNDERWAY
* DOCLINE ILL program through NLM - QUERIES ANSWERED
* Journal article vendor offerings - COMPLETED - complied list of journals offered by each major vendor
* Open Access article resources - PARTIALLY COMPLETED
* AI Voice-enabled Reference Service - IN DEVELOPMENT - presently in a 3D virtual world; transfer to 2D/mobile is needed
* Embodied AI empathy development (gestures/facial expressions) triggered by natural language - IN DEVELOPMENT - presently applied to a 3D virtual world; transfer to 2D/mobile (if needed)
* Integration of bioinformatics and pharmacogenomics information / databases - in development (see files 1-5 above).

13) Publish articles

14) Find and apply for funding for which I may be eligible

15) Participate in BioASQ - http://participants-area.bioasq.org/general_information

My plan
by Student #9

I forgot to add this before the class closed, but my plan includes:

More practices with these tools! There is so much they can do I feel like I need more practice with them.

Discuss with faculty and researchers at WVU how they use these tools and how the library can help them use them more efficiently.

Develop a bioinformatics libguide to highlight these resources.

Bioinformatics plan by
Student #10

This course has inspired me to

1. Reach out to researchers on my campus and find out their need for bioinformatics assistance

2. Volunteer in the labs and actually do, or at least watch some procedures. I would like to observe actual lab techniques.

3. Design and publish a LibGuide on the library's website with links to NCBI and other informatics sites

4. Design and some infographics to aid bioinformatics researchers

5. Take additional courses from NCBI

6. Offer a "lunch & learn" session for medical and health faculty over the summer

Appendix C

Hi,_____. Thank you for taking the time to talk to me today about your experience in the Bioinformatics and Biology Essentials for Librarians class. I'm going to briefly review the action plan you wrote and then ask you some questions about what actions you have taken since completing the class. These questions will take about 10-15 minutes to answer but feel free to provide as much detail as you want. I will be taking notes on your responses, but this call will not be recorded or transcribed. Do you have any questions before we begin?

[Review of Action Plan]

1. Thinking back to your action plan, which of the planned activities were you able to complete?
2. Were there any activities from you action plan which you started but were unable to complete or continue?

   [calculate completion percentage for action plan]
3. Have you taken any actions to promote your new skills and knowledge to your patrons or your institution?
4. Since completing the course, have you experienced an increase in the number of patrons you are serving?
5. Have you experienced an increase in requests for services or training related to bioinformatics?
6. Since completing the course, are you able to respond to patron requests for bioinformatics information or resources more quickly and efficiently?
7. Since completing the course, has the quality of your work and/or services improved? If so, please describe how the quality has improved.

Other comments:

Thank you for talking with me today. I will be emailing you a link to complete a brief online survey. The survey should take about 5 minutes to complete. Thank you again for helping with this assessment.

Training - Longitudinal Evaluation

Start of Block: Default Question Block

Q1 Please indicate which, if any, of the following actions have you taken since completing the course:

- ☐ Launched a new bioinformatics-related service (1)
- ☐ Created a bioinformatics-related information resource (e.g., LibGuide, web page) (2)
- ☐ Shared skills or resources learned about in the course with coworkers (3)
- ☐ Contacted faculty/researchers (4)
- ☐ Taught an instruction session/workshop/webinar on bioinformatics-related skills or resources(5)
- ☐ Sought out bioinformatics research/projects at your institution (6)
- ☐ Sought out additional bioinformatics training (7)
- ☐ Reviewed course content/practice skills learned in the course (8)
- ☐ Other (see below) (9)

- ☐ I have done nothing related to bioinformatics or NCBI biology databases since the course ended (10)

Q7 Please describe other actions you have taken as a result of the Bioinformatics and Biology Essentials for Librarians course:

_____

Q3 How often do you use what you learned in the following modules of the class?

	Never (1)	Less than monthly (2)	Monthly (3)	Weekly (4)	Daily (5)	Do not recall this module (6)
Genetics Basics (1)	○	○	○	○	○	○
Bioinformatics and Librarianship (2)	○	○	○	○	○	○
Molecular Biology Techniques (3)	○	○	○	○	○	○
NCBI Nucleotide (4)	○	○	○	○	○	○
BLAST: Sequence Similarity (5)	○	○	○	○	○	○
NCBI Gene (6)	○	○	○	○	○	○
Basics of Proteins (7)	○	○	○	○	○	○
NCBI Protein and Structure (8)	○	○	○	○	○	○
Clinical Applications (MedGen, GTR and ClinVar) (9)	○	○	○	○	○	○
Ethics and Policy in Genetic Research (10)	○	○	○	○	○	○
What's Next in Genomic Research (11)	○	○	○	○	○	○

Q10 What percentage of the knowledge and skills acquired in the Bioinformatics and Biology Basics for Librarians course have you applied on the job?

0 10 20 30 40 50 60 70 80 90 100

Percent of course applied ()	

Q11 What percentage of your job requires knowledge and skills gained in the course?

0 10 20 30 40 50 60 70 80 90 100

Percent of job requiring course content ()	

Q5 What factors enabled you to apply the knowledge and skills learned in the Bioinformatics and Biology Basics for Librarians course? (Select all that apply)

- ☐ Course materials and tools (1)
- ☐ Opportunity to use (2)
- ☐ Other courses (3)
- ☐ Organizational support (4)
- ☐ Manager/supervisor support (5)
- ☐ Peer support (6)
- ☐ Time (7)
- ☐ Other enablers (please specify, below) (8)

Q8 Please specify other factors that enabled you to apply what you learned:

_____

Q6 What barriers prevented you from fully applying the knowledge and skills learned in the Bioinformatics and Biology Basics for Librarians course? (Select all that apply)

- ☐ No opportunity to use (1)
- ☐ Lack of organizational support (2)
- ☐ Lack of manager/supervisor support (3)
- ☐ Lack of peer support (4)
- ☐ No time or insufficient time to apply (5)
- ☐ Other barriers (please specify) (6)

Q9 Please specify other barriers that prevented you from applying what you learned:

_____

Q2 Since taking Bioinformatics and Biology Essentials for Librarians:

	Strongly agree (1)	Agree (2)	Somewhat agree (3)	Neither agree nor disagree (4)	Somewhat disagree (5)	Disagree (6)	Strongly disagree (7)
I am more confident using NCBI databases (e.g., Nucleotide, Gene, Protein, Structure) (1)	○	○	○	○	○	○	○
I am more confident helping others use NCBI databases (2)	○	○	○	○	○	○	○
The quality of my work and/or services has improved (3)	○	○	○	○	○	○	○

Q4 Rate your level of agreement with the following statements:

	Strongly agree (1)	Agree (2)	Somewhat agree (3)	Neither agree nor disagree (4)	Somewhat disagree (5)	Disagree (6)	Strongly disagree (7)
The Bioinformatics and Biology Basics for Librarians course gave me skills which I can build upon. (1)	○	○	○	○	○	○	○
The course improved my understanding of policy and ethical implications around bioinformatics data storage, access, and use. (2)	○	○	○	○	○	○	○

End of Block: Default Question Block

Appendix D

Hi, **Student #1**. Thank you for taking the time to talk to me today about your experience in the Bioinformatics and Biology Essentials for Librarians class. I'm going to briefly review the action plan you wrote and then ask you some questions about what actions you have taken since completing the class. These questions will take about 10-15 minutes to answer but feel free to provide as much detail as you want. I will be taking notes on your responses, but this call will not be recorded or transcribed. Do you have any questions before we begin?

[Review of Action Plan]

1. Thinking back to your action plan, which of the planned activities were you able to complete?

She did not complete any of the activities from her action plan.

2. Were there any activities from you action plan which you started but were unable to complete or continue?

She did not get a chance to begin any of the activities on her action plan.

[calculate completion percentage for action plan= 0%]

3. Have you taken any actions to promote your new skills and knowledge to your patrons or your institution?

"Not related to the bioinformatics class"

4. Since completing the course, have you experienced an increase in the number of patrons you are serving?

She is "only part-time" and has "no access to statistics or numbers of patrons"

5. Have you experienced an increase in requests for services or training related to bioinformatics?

No access to statistics on this

6. Since completing the course, are you able to respond to patron requests for bioinformatics information or resources more quickly and efficiently?

No requests from patrons for bioinformatics information or resources

7. Since completing the course, has the quality of your work and/or services improved? If so, please describe how the quality has improved.

No change

Other comments:

"Wonderful class" She has been unable to apply what she learned in the class. She states that some of the reasons she has been unable to implement things she learned in the class/complete activities on her action plan: 1. She is on a part-time contract, 2. Her library was "emphasizing other things and it didn't fit the need at the time"

Thank you for talking with me today. I will be emailing you a link to complete a brief online survey. The survey should take about 5 minutes to complete. Thank you again for helping with this assessment.

Hi, **Student #2**. Thank you for taking the time to talk to me today about your experience in the Bioinformatics and Biology Essentials for Librarians class. I'm going to briefly review the action plan you wrote and then ask you some questions about what actions you have taken since completing the class. These questions will take about 10-15 minutes to answer but feel free to provide as much detail as you want. I will be taking notes on your responses, but this call will not be recorded or transcribed. Do you have any questions before we begin?

[Review of Action Plan]

1. Thinking back to your action plan, which of the planned activities were you able to complete?

She has been continuing her project with the Cancer Genomics/Precision Medicine Department doing EB literature searches about variants associated with Myeloproliferative Disorders. The project is delayed at the moment as the Cancer Genomics department had to move buildings and this has 'set them back months.' She states that the Cancer Genomics/Precision Medicine department is the only department which would require the kinds of searches she learned in the class.

She says that she learns most effectively when there is an actual problem or query she is working on.

2. Were there any activities from you action plan which you started but were unable to complete or continue?

Many of her planned activities are still in progress due to the delay caused by the Cancer Genomics/ Precision Medicine department moving buildings. However, she anticipates continuing the project to completion.

[calculate completion percentage for action plan- 50%, although the items on her action plan are not complete they are all related to her project doing literature searches and collaborating with the Cancer Genomics/Precision Medicine Department which continues albeit at a reduced pace]

3. Have you taken any actions to promote your new skills and knowledge to your patrons or your institution?

Yes, she has forwarded info about the course in emails. She has also offered trainings to researchers to give an overview of ClinVar or MedGen. So far, no takers, but she likes doing this so will keep this up. She gave a seminar on research data management.

4. Since completing the course, have you experienced an increase in the number of patrons you are serving?

No

5. Have you experienced an increase in requests for services or training related to bioinformatics?

She has received more requests for articles, but not specifically services or training. However, incidentally, the research department now wants more in the way of journal access, but obviously she is still budget limited.

6. Since completing the course, are you able to respond to patron requests for bioinformatics information or resources more quickly and efficiently?

"Yes, definitely."

7. Since completing the course, has the quality of your work and/or services improved? If so, please describe how the quality has improved.

Yes. More aware of the resources that are available. More skills to be able to utilize those resources. "I feel quite good about that." "Wish I was using them more at the moment, but that will come…always initial lack of awareness." "Once clinicians realize I can do these things much faster than they can, I will get more requests."

Other comments:

"Really enjoyed the class. Very challenging." "Enjoyed feeling that I was getting current again." She particularly found ClinVar and MedGen very useful. She would really like a class focusing on just these two resources.

After completing the class, she took the Research Data Management class and sees both classes as teaching skills which will be valuable in her work with the Cancer Genomics/Precision Medicine Department.

Thank you for talking with me today. I will be emailing you a link to complete a brief online survey. The survey should take about 5 minutes to complete. Thank you again for helping with this assessment.

Hi, **Student #3**. Thank you for taking the time to talk to me today about your experience in the Bioinformatics and Biology Essentials for Librarians class. I'm going to briefly review the action plan you wrote and then ask you some questions about what actions you have taken since completing the class. These questions will take about 10-15 minutes to answer but feel free to provide as much detail as you want. I will be taking notes on your responses, but this call will not be recorded or transcribed. Do you have any questions before we begin?

[Review of Action Plan]

1. Thinking back to your action plan, which of the planned activities were you able to complete?

Most of Yuening's action plan activities were related to reviewing skills she had learned in the course or getting a better understanding of the resources. She notes that she received an email reference request from an undergraduate student and remembered there was a good resource that she learned in the class that she wanted to refer them to. However, since she no longer had access to the course content she had to Google what she remembered (that the researcher was based in the University of Colorado) but she was able to find the information to refer the student to. She does not work in the health sciences library, so she often refers patrons with more complex biology and bioinformatics questions there.

2. Were there any activities from you action plan which you started but were unable to complete or continue?

She has reviewed some of the NCBI videos on YouTube.

[calculate completion percentage for action plan- 33%, most of Yuening's action plan involved reviewing skills and resources learned in the class—but this became difficult when she lost access to the class content once the class was over]

3. Have you taken any actions to promote your new skills and knowledge to your patrons or your institution?

She has not had a chance to promote her new skills and knowledge but says that she "will list it in my annual review as a professional activity."

4. Since completing the course, have you experienced an increase in the number of patrons you are serving?

No increase in the number of patrons.

5. Have you experienced an increase in requests for services or training related to bioinformatics?
   No.

6. Since completing the course, are you able to respond to patron requests for bioinformatics information or resources more quickly and efficiently?

Yes.

7. Since completing the course, has the quality of your work and/or services improved? If so, please describe how the quality has improved.

Yes, she feels that the quality of her services has improved but notes that she "doesn't have many opportunities" to use the skills learned in the class. "Before the class, I only knew PubMed and not very well." She felt more comfortable using Web of Science. She states that she "learned a lot of new tools" in the class.

Other comments:

She brings up how hard it is to keep learning resources up-to-date, every time a website changes the screenshots in a guide will change. She is currently reading Chemical Information for Chemists, a book published in 2014 and the last chapter is about BLAST and she already knows it will not have a completely accurate description of the features as things have changed.

Thank you for talking with me today. I will be emailing you a link to complete a brief online survey. The survey should take about 5 minutes to complete. Thank you again for helping with this assessment.

Hi, **Student #4**. Thank you for taking the time to talk to me today about your experience in the Bioinformatics and Biology Essentials for Librarians class. I'm going to briefly review the action plan you wrote and then ask you some questions about what actions you have taken since completing the class. These questions will take about 10-15 minutes to answer but feel free to provide as much detail as you want. I will be taking notes on your responses, but this call will not be recorded or transcribed. Do you have any questions before we begin?

[Review of Action Plan]

1. Thinking back to your action plan, which of the planned activities were you able to complete?

She has created a 2-3 page handout of bioinformatics resources it "doesn't go to deeply into each specific tools." It is a print handout and downloadable online, she may still turn this into a LibGuide.

Links to NCBI webinars are available on website, didn't make a playlist—had tried that format previously and patrons did not like it.

She hasn't gotten to the point of finding software. Plans for a makerspace are not in the works right now. There is a focus on strategic planning goals.

She recently did a training focusing on the NCBI resources and demoing the databases that got "relatively popular—8 attendees, good feedback from patrons."

She says she has been keeping up to date by reading the Technical Bulletin.

Her library has been doing some interviews with patrons about their information needs and bioinformatics software has been requested by at least one patron.

2. Were there any activities from you action plan which you started but were unable to complete or continue?

The webinar playlist and the software selection were not completed. With the software 'there are a lot of obstacles to implementing.' Her library is currently more focused on strategic planning.

[calculate completion percentage for action plan- 70%, 3.5/5 activities completed. I gave partial completion for the playlist because while she did not create a playlist she showcased the webinars in a different format]

3. Have you taken any actions to promote your new skills and knowledge to your patrons or your institution?

Yes. About a month after she created the handout, and 2-3 months after she created the training on NCBI resources. Slides from this training are available so people can download, as patrons were asking for a copy of the slides after the training.

4. Since completing the course, have you experienced an increase in the number of patrons you are serving?

"Not particularly." She did note that the bioinformatics training she taught was popular with 7-8 attendees while normally training sessions will have 3-4 people/

5. Have you experienced an increase in requests for services or training related to bioinformatics?

"Not particularly." People have mentioned in interviews that they would like to see more bioinformatics software available at the library.

6. Since completing the course, are you able to respond to patron requests for bioinformatics information or resources more quickly and efficiently?

She has had "no specific requests" but she has been able to incorporate what she learned into her monthly trainings. A specific example she gives is that she teaches a training on animal searching and has now incorporated the NCBI taxonomy resource into the training.

7. Since completing the course, has the quality of your work and/or services improved? If so, please describe how the quality has improved.

"It allows me to offer a broader range of resources, especially with regards to genetics. I can give people a sampling of the tools available. Show people how the sites are linked together." She says she has been incorporating resources into the monthly trainings she does to make people aware of them.

Other comments:

"I was very happy to take the course. I found it very useful." She says that before the course she found browsing and finding genetics and bioinformatics information somewhat daunting. Taking the course has "made this information more accessible to myself and my patrons."

Thank you for talking with me today. I will be emailing you a link to complete a brief online survey. The survey should take about 5 minutes to complete. Thank you again for helping with this assessment.

Hi, **Student #5**. Thank you for taking the time to talk to me today about your experience in the Bioinformatics and Biology Essentials for Librarians class. I'm going to briefly review the action plan you wrote and then ask you some questions about what actions you have taken since completing the class. These questions will take about 10-15 minutes to answer but feel free to provide as much detail as you want. I will be taking notes on your responses, but this call will not be recorded or transcribed. Do you have any questions before we begin?

[Review of Action Plan]

1. Thinking back to your action plan, which of the planned activities were you able to complete?

"Basically, all of them. One faculty member submitted a grant (about $200,000) and I have worked with other researchers to make sure we are keeping up in that area."

2. Were there any activities from you action plan which you started but were unable to complete or continue?

No, all activities were completed. Joe noted collaborating with the faculty member who submitted the grant. Also, they are monitoring researcher's outputs and looking at what resources they are using to do their research.

[calculate completion percentage for action plan= 100%]

3. Have you taken any actions to promote your new skills and knowledge to your patrons or your institution?

He noted the collaboration on the grant as a way that his new skills and knowledge are being promoted or made visible at his institution.

4. Since completing the course, have you experienced an increase in the number of patrons you are serving?

He states there has been "a small increase." He says he will catch people outside of their labs or in meeting and in the process of catching up on what is new find out about their research. At presentations and poster sessions they are asking researchers questions about what sources they are using. Many researchers are conducting PubMed searches and after finding this out Joe will recommend other NLM resources they might find helpful.

5. Have you experienced an increase in requests for services or training related to bioinformatics?

"A small increase."

6. Since completing the course, are you able to respond to patron requests for bioinformatics information or resources more quickly and efficiently?

"Yes, since the course I am more aware of what [resources] are available from NLM/NIH."

7. Since completing the course, has the quality of your work and/or services improved? If so, please describe how the quality has improved.

"Yes, I have been really looking at what resources researchers and clinicians can use since taking the course and looking at other [bioinformatics] publications to enrich my experience." He also notes that he has been "more proactive about recommending resources."

Other comments:

Thank you for talking with me today. I will be emailing you a link to complete a brief online survey. The survey should take about 5 minutes to complete. Thank you again for helping with this assessment.

Hi, **Student #6**. Thank you for taking the time to talk to me today about your experience in the Bioinformatics and Biology Essentials for Librarians class. I'm going to briefly review the action plan you wrote and then ask you some questions about what actions you have taken since completing the class. These questions will take about 10-15 minutes to answer but feel free to provide as much detail as you want. I will be taking notes on your responses, but this call will not be recorded or transcribed. Do you have any questions before we begin?

[Review of Action Plan]

1. Thinking back to your action plan, which of the planned activities were you able to complete?

She was able to complete or start several items on her action plan. Many of the items she thinks of in terms of long-term goals that she is working on rather than in terms of completion. She has been able to share her knowledge with other librarians, add new resources to her library's research guide for genomic medicine, and has started thinking about how existing library services can also be used to support bioinformatics.

She notes that she became interested in bioinformatics after a patron question and fortunate timing with the start of the class. She says bioinformatics is more of a personal interest and not something she was already involved with at her institution.

2. Were there any activities from you action plan which you started but were unable to complete or continue?

She has been unable to find time to practice searching the NCBI databases, but would like to block off time to do this in the future. She hasn't been able to do any of this type of searching as part of her day-to-day work.

She has not completed her goal to better understand published research related to bioinformatics better. She has not been able to find a lot of training to help with this. What she would particularly like to learn about is the different study designs used in bioinformatics research.

[calculate completion percentage for action plan >50%, many items she considers long-term or in-progress]

3. Have you taken any actions to promote your new skills and knowledge to your patrons or your institution?

She says at this point she 'doesn't have enough confidence' to promote new skills and knowledge from the class. She feels she still needs 'more training' and 'more time to digest and use info' especially as she has not really been able to use it during her day-to-day work.

4. Since completing the course, have you experienced an increase in the number of patrons you are serving?

'Not really an increase.' She has been reaching out to genomic medicine faculty to educate them about the library's systematic review service and how it might be useful to their research. She says the class gave her 'confidence and a better understanding of their research' so she was able to reach out to them about this service.

5. Have you experienced an increase in requests for services or training related to bioinformatics?

As of now she doesn't see any real institutional demand for these services or trainings. She states in talking with her colleagues who are science librarians that they have not really experienced any requests for bioinformatics-related services or trainings either. She thinks that most people don't think to come to the library for bioinformatics services and that staff aren't really trained to deliver these services.

6. Since completing the course, are you able to respond to patron requests for bioinformatics information or resources more quickly and efficiently?

She feels she "could handle [these requests] better" and could point a patron to the information more easily. However, she would want to look back at course materials for more complex requests and how to search the NCBI databases.

7. Since completing the course, has the quality of your work and/or services improved? If so, please describe how the quality has improved.

No impact on quality. She says she personally strives for high quality in all the services she provides. So doesn't see what she has learned in the class as impacting that.

Other comments:

She says, "the course was done at a very high level" and "the online structure and limited time" made it difficult for her to follow. She felt like she needed more background before getting into searching as she doesn't really have a background in biology.

Thank you for talking with me today. I will be emailing you a link to complete a brief online survey. The survey should take about 5 minutes to complete. Thank you again for helping with this assessment.

Hi, **Student #7**. Thank you for taking the time to talk to me today about your experience in the Bioinformatics and Biology Essentials for Librarians class. I'm going to briefly review the action plan you wrote and then ask you some questions about what actions you have taken since completing the class. These questions will take about 10-15 minutes to answer but feel free to provide as much detail as you want. I will be taking notes on your responses, but this call will not be recorded or transcribed. Do you have any questions before we begin?

[Review of Action Plan]

1. Thinking back to your action plan, which of the planned activities were you able to complete?

He had originally planned do a project representing data within NCBI databases using RDA and MARC format and making an RDA catalog entry for a DNA sequence with metadata about the sequence. However, he realized that this was a project would require a team effort so he is working on a different project until he forms a team to complete the original project. The new project involves created a website—The Scientific Bioinformatics Portal SBP—which would add the capability to search for resources in 10 languages other than just English. The website would allow searchers to filter by resource type and would include descriptions for the resource types in the 10 languages.

2. Were there any activities from you action plan which you started but were unable to complete or continue?

Delayed original action plan activities and is currently working on new action plan project.

[calculate completion percentage for action plan ? in progress]

3. Have you taken any actions to promote your new skills and knowledge to your patrons or your institution?

He is not currently working in a library as he completes his PhD. He states that he came to the US to learn about providing bioinformatics services because there are currently no libraries in Egypt providing these services. He wants to eventually use his knowledge to bring bioinformatics services to the Central Library of Cairo University.

4. Since completing the course, have you experienced an increase in the number of patrons you are serving?

N/A

5. Have you experienced an increase in requests for services or training related to bioinformatics?

N/A

6. Since completing the course, are you able to respond to patron requests for bioinformatics information or resources more quickly and efficiently?

N/A

7. Since completing the course, has the quality of your work and/or services improved? If so, please describe how the quality has improved.

N/A

Other comments:

Student #7 had two comments about course content. He would have liked 'more practical homework.' He also said that more video content would have helped especially with learning how to search the databases.

Thank you for talking with me today. I will be emailing you a link to complete a brief online survey. The survey should take about 5 minutes to complete. Thank you again for helping with this assessment.

Hi, **Student #8**. Thank you for taking the time to talk to me today about your experience in the Bioinformatics and Biology Essentials for Librarians class. I'm going to briefly review the action plan you wrote and then ask you some questions about what actions you have taken since completing the class. These questions will take about 10-15 minutes to answer but feel free to provide as much detail as you want. I will be taking notes on your responses, but this call will not be recorded or transcribed. Do you have any questions before we begin?

[Review of Action Plan]

1. Thinking back to your action plan, which of the planned activities were you able to complete?

She had a very detailed action plan and was able to complete or at least start many activities. Actions she completed include: completing an ICD-10 code dictionary which lead to a publication in the Journal of the Medical Library Association, creating a list of FDA approved drugs associating an active ingredient with a proprietary name, researching activities/projects/publications at Lister Hill, publishing an article (as a result of completing the ICD-10 code dictionary).

Actions which she has started and are in progress are: creating a general medical, MeSH, and bioinformatics dictionary associating a term with a definitions*; creating a sequence alignment tool that can analyze whole genome sequences by chromosome, identify pathogenic variants, map them to a description of the disease, literature, and clinical trials*, and learning how to apply/create machine learning predictive algorithms**.

*She is looking to hire or otherwise obtain partnerships to work on these projects as they are both quite large undertakings.

**She participated in a competition using TensorFlow to look at images of cancer cells. The competition was a way to motivate herself to begin looking at machine learning algorithms. She found a partner to help her set up her laptop for the machine learning algorithms but found that hardware limitations kept her from completing this project.

One of her main objectives is the creation of a mobile app for medical professionals which could use NLP to do voice searching and utilizes machine learning. She is in the process of trying to develop touch-based training as a means of implementing supervised learning in the app.

Mobile bioinformatics app doi:dx/doi.org/10.5195/jmla.2018.500

2. Were there any activities from you action plan which you started but were unable to complete or continue?

She has not completed the following activities: study existing sequence alignment tools, take a bioinformatics course through John Hopkins (too expensive), complete additional MLA/NLM CE courses, apply to bioinformatics jobs, create a subscription-based Digital Medical Library as legal alternative to SCI-HUB, find and apply for funding, participate in BioASQ.

[calculate completion percentage for action plan]

3. Have you taken any actions to promote your new skills and knowledge to your patrons or your institution?

N/A, She is currently working on her second master's degree and running her own company. She says she may be looking for employment in a medical library after finishing her master's.

4. Since completing the course, have you experienced an increase in the number of patrons you are serving?

N/A

5. Have you experienced an increase in requests for services or training related to bioinformatics?

N/A

6. Since completing the course, are you able to respond to patron requests for bioinformatics information or resources more quickly and efficiently?

N/A

7. Since completing the course, has the quality of your work and/or services improved? If so, please describe how the quality has improved.

N/A

Other comments:

She states it was a "wonderful class" and a "great experience." She has recommended the class to librarians seeking to get or renew their AHIP. She has also recommended the class on Facebook.

Thank you for talking with me today. I will be emailing you a link to complete a brief online survey. The survey should take about 5 minutes to complete. Thank you again for helping with this assessment.