

## STUDENTS GET A PERSONALIZED LEARNING EXPERIENCE WHEN USING A SCIOER RESOURCE

In the fall semester of 2022, the SCIOER resource for object-oriented programming was used instead of an assigned textbook for the Introduction to Object-Oriented Programming course at the University of Guelph. Students in the computer programming class (n=255) had access to the self-contained interactive open educational resource (SCIOER) for the duration of the fall semester 2022. A total of 113 students participated in two surveys, one at the beginning of term and one at the end. Of the 113 students, 38 students completed both surveys. The research team also conducted six focus group sessions with a total of 17 students.

Of the students who participated in this study, 68.5% were in semester 3 of their program (second year of university), 87.4% had previous coding experience from high school, college, or from a past or current job, and 81.5% were taking computer science or software engineering as their major. 40.3% identified as equity seeking individuals.

### SCIOER INSTALLATION AND USAGE

Most participants were able to install the resource successfully (95.2%) by the end of the term. More than half of student participants (55.2%) reported using the SCIOER resource semi-regularly (1-2 times per week) or regularly (3 times per week) and another 20.7% used it 5 or more times a

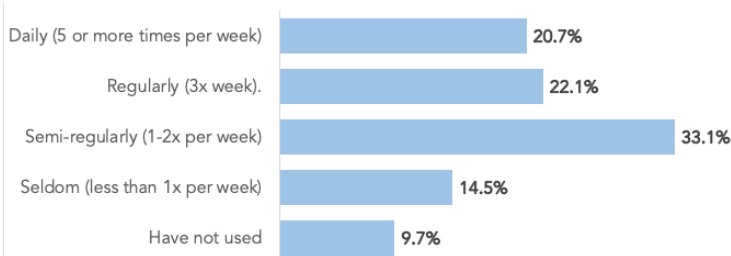


Figure 1: Use Frequency of Sci-oeer by Students.

week. Just under one quarter of participants indicated they seldom used the resource or did not use it at all. Insights provided by students during the focus group sessions and in the survey's open text box questions suggest that minimal

usage of the SCIOER resource by students resulted from challenges with installation, difficulty navigating the software, and preference for using other educational internet resource, such as YouTube and Google to find answers to their questions. However, focus group sessions supported students in learning about the multiple learning tools contained in the resource, some of which participants had not previously tried using for one reason or another.

Use of the resource remained the same throughout the course for approximately 38% of student participants. For the other 62% of students, use varied during the term, with some using it more at the beginning, some using it more by the end, and some indicating their use varied throughout the course.

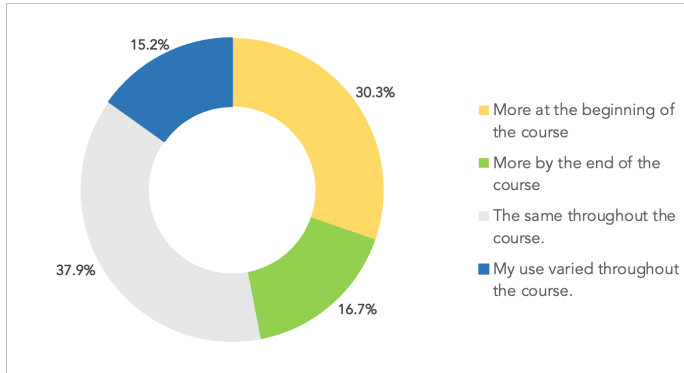


Figure 2: Change in Use During Semester

Reasons provided by students whose use varied were:

- More use of the resource when completing assignments
- More use of the resource at the beginning of the course to learn concepts
- More use of the resource when doing exam review
- Used it to find specific information that wasn't easy to find on the internet

## THE RESOURCE AS A LEARNING TOOL

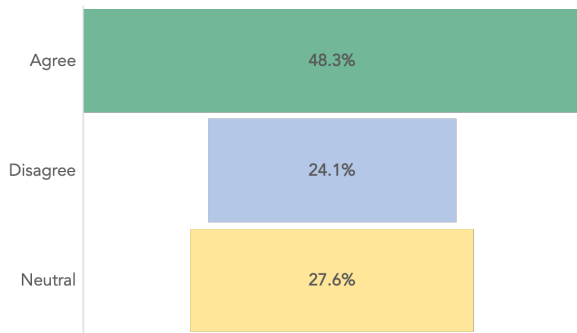


Figure 3: Preference for SCIOER resource compared to Commercial Textbook

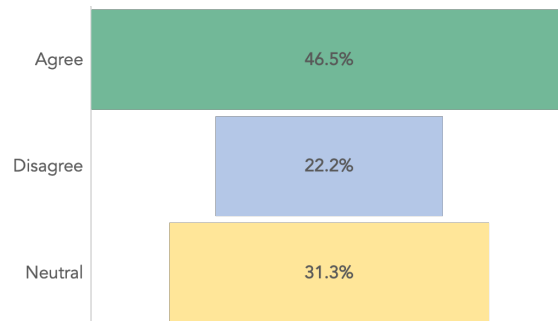
Students were asked to compare the SCIOER resource to a commercial textbook and **a majority of students preferred the SCIOER resource!** Nearly half of the students (48%) indicated they agreed, that the SCIOER resource was better than a commercial textbook. Over one quarter of students (28%) selected neutral, indicating they felt the resource was neither better nor worse than a commercial textbook, and the final 24% selected disagree.

Students shared which elements of the resource they liked the most, including:

- It is a cost-free learning tool
- It is organized and easy to navigate
- Helpful that it does not have to connect with the internet
- All learning materials for the course are contained in one place

- Ability to go through the material at their own pace and create notes inside the resource allowed for a personalized learning experience
- The multiple elements that were integrated into the resource, including Jupyter labs, Java documents, Wiki pages explaining concepts for self-directed learning and as a reference tool, the weekly schedule, the integration the resource had with Git, Gradle, and Java
- Being able to create and run code in the shell and test it

**Student learning was supported by use of the SCIOER Resource.** Nearly half of the students (47%) indicated they agreed, that the SCIOER resource supported their learning. Almost one third (31%) selected neutral, and the final 22% selected they disagreed, the resource did not support their learning in the computer programming course.



**Figure 4: Students Shared Whether the SCIOER resource Supported Their Learning**

During the focus group discussions students commented on the

**personalized learning experience** they were able to gain from using the SCIOER resource. Some students felt the resource was best served as a complementary resource to support their learning, alongside instructor-led workshops/lectures. One student shared, *"[I use the resource as] more of a reference because I [can] go to it if I need clarification or to make sure I know specific things, [and] I'll just search them up"*. Others preferred to read the content, sharing, *"I just go to the wiki. I like to read and skim through information. It's faster for me and I gain information that way better."*

## THE RESOURCE COMPONENTS

A SCIOER resource can contain five different kinds of content:

- A wiki
- Prerecorded video lectures
- Practice problems and solutions
- Interactive tutorials
- Official documentation for a programming language if the resource is a programming course.

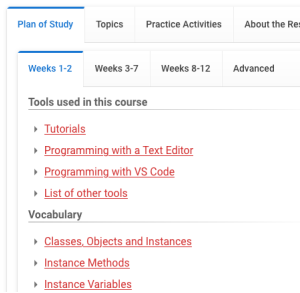
The multiple components within the resource, whether that be wiki pages with written content and diagrams, video lectures, practice problems, or interactive tutorials, supported a personalized learning experience for users.

**Commented [JNI]:** Should there be a section somewhere in the document that outlines the different components in the sci-oer - table above?

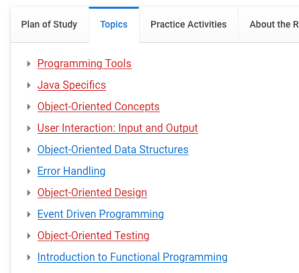
It would have been nice to ask about which parts students used the most/least and how the different components were helpful/not helpful for their learning. We got a bit from the interviews, but would love to put some stats with it. Something to think about for the future.

## Wiki

The wiki is the central organizing mechanism for the course that provides links to the other resource types as appropriate. The wiki contains content that would traditionally be placed in a textbook. In this offering the wiki provided both a topic-based navigation and a week-by-week navigation for students to use. Anecdotally it seemed that more novice students preferred the week-by-week navigation and more advanced students preferred the topic-based navigation.



week by week navigation



list of topics navigation

## Tutorials

The interactive tutorials (using [JupyterLab](#) as the software) provide learners with step-by-step practice using a specific coding technique. At each step the student can run the solution within the tutorial web page and see immediate output. When asked which they preferred, some students said the tutorials were their preferred learning tool because, *"the Jupyter labs [allowed me to] go along and see what this little block of code does, what the next block of code does. It help[ed] me learn."* This sentiment was shared by students in the survey as well.

## Pre Recorded Video Lectures

Video lectures are hosted within the SCIOER resource which provides a separate web address to view the entire set of lectures. The wiki also provide links to specific lectures on the content pages. Every prerecorded lecture has an accompanying transcript as well as a separate audio track so that learners can customize how they consume the lecture material. Lecture content video files can also be hosted on an external web server and served through a reverse proxy in the image instead to reduce the image size at the cost of requiring internet access and a separate video hosting server.

The lecture component of the SCIOER resource used for the Fall 2022 offering was, unfortunately, incomplete. Students reported being frustrated because the lecture content was missing, but placeholder links had been placed in the wiki. The mechanism for viewing the lectures is extremely simple and did not allow students to rewind. While students were able to open the video file in their own video player, many did not realize that was possible.

Commented [JN2]: Can you help with this part?

Students did report some use of the video lectures as well as the transcripts and audio files. A computer-generated voice narrated the lectures and students reported that they found the computer voices to be unengaging.

### Practice Problems

The practice problems are provided as self-study problems in the wiki. The answers to simple recall practice problems are provided as drop-down text directly in the wiki. The solutions to practice programming problems are provided on the mounted volume in the container. Practice problems were less popular than the interactive tutorials, with many students indicating they did not use the practice exercises because of either being confused by them or not finding them challenging enough.

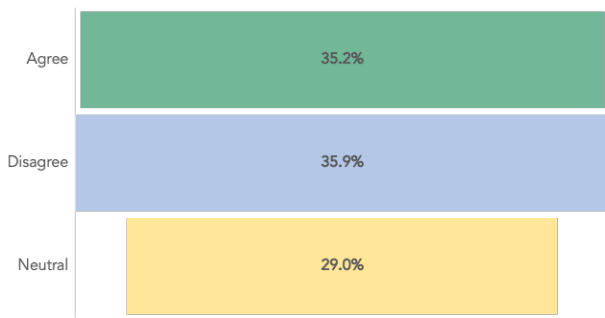
## THE RESOURCE AS A CODING ENVIRONMENT

Students appreciated being able to code in the SCIOER resource shell using Gradle build and Java. The coding environment allowed them to check for errors and develop skills that support having a good foundation of proper coding techniques. This is reflected by the sentiment shared by this student, *"I learned quite a bit about how to use Git via the command line [and] the Java compiler gives you a lot of helpful error messages...like a lot of times I'll fix the errors without needing the textbook because the Java compiler tells you this line of this error. It takes a while to figure it out sometimes, but [it] was pretty helpful. The check style helps you maintain good programming practices as well."*

Students also shared their appreciation for being able to code in the same environment their instructor and teaching assistants were grading in, *"I like being able to use the same running environment that the TAs would use when marking my work as I didn't have to be afraid that my programs works on my machine, but not theirs."*

One student commented on their appreciation for being able to use the SCIOER resource as a coding sandbox that allowed them to practice their code *"without worrying about damaging [their] computer."* During focus group sessions, many students shared similar sentiments and said they were using the SCIOER resource to run their code, rather than running their code on their host machine.

## USER EXPERIENCE



Feedback from students about the user experience was generally positive. The SCIOER resource supported student learning because of its diverse and interactive elements, and it was accessible offline, meaning students did not have to be connected to the university server or any other network when doing their coursework.

Figure 5: Students Indicated If They Felt Installation Was Easy

The installation of the resource was found to be challenging. Based on the survey results, 35% of students

said installation was easy and they were happy with the process, simply replying, "easy to install."

However, for almost 36% of student participants, installation was more difficult. Student comments generally fit into two themes: unfamiliar with running command lines on their computer to complete a task, or not understanding the installation instructions. Regardless of the issue, students who had a hard time with the installation process expressed feelings of frustration and annoyance, and shared thoughts about their level of coding experience as a contributing factor to their installation distresses. In some cases, they shared that they didn't bother to use the resource as a result. One student suggested providing a video to aid in the process, "I think it would be better if there were a video explaining how to install the docker for each operating system" while another student said they would have liked to know, "the purpose and usage" explained in more detail.

Navigation of the resource was easy for some, but not for others. 37% of respondents found the SCIOER resource easy to navigate and easy to use as a search tool when looking for specific topics.

Students who found the resource easy to navigate shared their appreciation for the week-by-week breakdown of content and the search bar to quickly access the necessary item they were looking for information on.

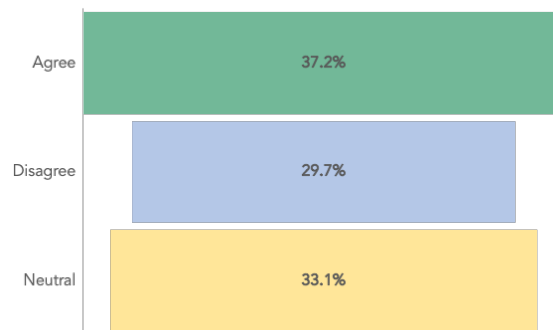


Figure 6: Students Indicated If They Found the SCIOER resource Easy to Navigate

Students who did not find the resource as easy to navigate commented on the organization of content and the hyperlinks from one page to another, to another overwhelming for them, sometimes making information seem *"hidden or buried within hyperlinks."*

## **OVERALL, A POSITIVE EXPERIENCE WITH THE RESOURCE**

Overall, students using the SCIOER resource enjoyed the opportunity to use an interactive learning tool that provided all the software required for the course and was accessible with or without internet connection. Student feedback provides evidence of the success of the SCIOER resource and its practicality as a learning tool. Students shared a lot of positives about their experience using the sci-oer. They liked...

*"the ability to access all the information about the course, at any time, without internet access - it's better organized than a giant textbook and easier to search through"*

*"the numerous resources to learn content in different ways, and the ability to have interactive learning environments that kept me engaged in learning OOP (as opposed to a passive textbook)."*

*"the fact that the learning experience is one that I can personalize. I can choose my own pace, how I divide my units and can practice at my own pace."*

*"[that] information on the wiki is short and concise, yet informative [and] that you don't have to install any additional resources; everything you need is in the shell."*

*"10 out of 10. I love it because it's free, it's available offline and I personally like digital because I'm able to use control F or in this case a search bar. [When] I'm looking for one specific thing, I don't like having to flip through, and read everything."*

## **FEEDBACK FOR IMPROVEMENT**

There were some areas students consistently recommended improvement.

- Video lectures - change the style from a robotic voice to one that is done by a person so listening to the content is more engaging. Some students reporting not being able to go back and forward in the video, so they would have to rewatch the entire thing if they missed a part and tried to go back.
- Having the resource take up less storage space on the computer
- Having knowledge of all the different parts of the resource, when to use them, and having incentive to go through important elements at relevant times during the term (integration with course layout)

- Improving the practice problems and interactive tutorials. Students expressed a desire for solutions to the tutorials to pinpoint where mistakes are.
- Improved organization and layout of information in such a way that students can easily recall where specific topics, diagrams, etc. are located within the resource.

