

HFOSS Education

Gregory W. Hislop and Heidi J. C. Ellis

Introduction

Open source software has become part of the mainstream of software development with the adoption of open source by a large majority of all business and governmental organizations. Results of recent surveys [1] indicate that 95% of responding organizations use open source in mission critical software applications and plan to increase spending on open source activities in the coming years.

One reason for the broad adoption of open source is that it delivers significant innovation for businesses. Many emerging technologies and approaches including cloud computing, containerization, and serverless computing originated with open source. Other areas such as AI and FinTech have significant products that are open source. Processes such as continuous integration and DevOps are heavily based on open source concepts. Open source application software also provides a basis for collaboration across companies, even within the same industry.

The widespread use and development of open source creates a clear need for more software professionals who have open source software experience. This provides a strong motivation for students to learn about open source tools and practices as a part of their undergraduate degree programs.

Humanitarian Free and Open Source Software (HFOSS) is software that provides some social benefit and provides an opportunity for students to learn all the general principles and practices of open source and engage in computing for social good at the same time.

Benefits of HFOSS Education

The idea of involving students in on-going software projects with a community of developers and clients is intuitively appealing to many faculty and students. Experience with HFOSS education [2] has shown a variety of benefits that can be organized into the following general areas:

Attracting and retaining students

There are many aspects of the use of HFOSS that have the potential to attract new students to computing as well as to enhance the interest of existing students. There is also evidence that HFOSS is particularly helpful for attracting students in underrepresented groups [3]. This appeal seems to be due to:

Relevance – Conveying the relevance and practical application of computing seems to be important to attracting a broader range of students to the computing disciplines. Female students in particular appear to desire to understand the applicability of software to practical needs.

Social Impact - The nature of HFOSS, which focuses on helping people, can engage students who respond to the incentive of helping others in a visible and concrete manner.

Community - The HFOSS community is diverse, composed of people from various countries, backgrounds and professions. HFOSS has a potential user base that spans the globe. Student participation in this community provides opportunities to expose students to developers and also humanitarian professionals and users from a variety of walks of life.

Enhancing student learning

Student work on open source projects provides learning opportunities in key technical areas including dealing with large code bases, testing techniques, software development tools such as version control systems, and experience with software processes including Git-based development processes. Learning in these areas can be approached without open source projects, but the open access to all project artifacts as well as the ability to interact with the open source community provides students with exposure to a professional project that is difficult to achieve with closed-source projects. This gives open source projects a real advantage in preparing students for professional versions of these skills. Key aspects of this experience that relate to software development include:

Software process – Students participating in an HFOSS project must conform to the development process used by a particular FOSS project. Students gain an understanding of the steps necessary to plan and carry out a software project in a real-world environment for a significant project.

Distributed development –The global reach of the HFOSS community provides a unique opportunity for students to develop software in collaboration with professionals in a variety of locations and from a variety of cultures. This experience prepares students for increasingly distributed professional environments.

Project scale and complexity – HFOSS provides students with a project of significant size and corresponding complexity, allowing students to see first-hand how these factors create the requirement for software engineering tools and processes.

Projects with long product life – In order to better understand the development lifecycle, students need to be exposed to a project that is ongoing and has a longer lifespan than a single-semester project. HFOSS projects can help students gain an understanding of software maintenance and evolution and to understand the impact of decisions made by developers earlier in the product's history.

Open Source – Beyond humanitarian FOSS, open source software has become a significant part of the entire software industry. Students need to understand the role of open source and its impact on business.

Creating social benefit

A core result of successful HFOSS education is to make real contributions to the HFOSS products. This result fits academic environments in several ways:

Student societal awareness – A critical aspect of a student's education is gaining an understanding of social responsibility. Educational institutions have long worked to help students prepare for lives as good citizens and useful members of the community and the world at large. In a manner similar to pro bono work in law, HFOSS allows computing

students to employ their computing skills to help others and to develop an awareness of the potential of computing for social good.

Institutional outreach and social service – Most academic institutions include contributions to the community as part of their mission. The participation in and support of an HFOSS project allows the institution to fulfill this mission in an unusual manner.

Leveraging academic resources – The involvement of multiple institutions collaborating on HFOSS projects could bring substantial resources to bear on social needs. In this manner, the academic community at large can have a positive impact at a global level.

In summary then, these three themes provide a broad perspective on what constitutes success for HFOSS educational projects. At the core, the goal is to use HFOSS to enable student learning. More generally, HFOSS may help attract students to the discipline. Finally, HFOSS provides a potentially interesting contribution to the social mission of academic institutions.

Challenges and Opportunities for Instructors

HFOSS education appeals to many instructors as an excellent way to motivate learning about software engineering, to expose students to software practice, and to introduce students to computing for social good. Basic approaches to HFOSS education have a low barrier to entry.

A first level of engagement might be to use HFOSS projects in class examples or as case studies. Open source projects typically provide access to a full range of software artifacts starting with source code, but also including issue trackers, product documentation, planning documents, etc. This provides a rich base of source materials for study.

A second level of engagement could be to fork the project (creating a copy of the full source code) and work with the code, e.g. doing analysis or adding features, but not engaging with the project development community.

A third level of engagement would be to have students participate in the HFOSS project community. This approach is significantly more difficult but also has larger potential rewards for the students. The hurdles of HFOSS community engagement include:

First, many instructors are not familiar with open source culture or tools and face steep learning curves for these topics, as well as for project domain knowledge. Instructors face an additional learning curve related to supporting student participation in the HFOSS project. Assignment creation, assessment, and development of rubrics can all be challenging.

Second, Instructors need to help students adjust to a less-structured learning environment and one that has significant size and complexity. Instructors also need to help students learn about open source culture and technologies. Student expectations about the role of the faculty member as a “guide by the side” rather than the “sage on the stage” must be set early and frequently reinforced. Instructors may also need to serve as a liaison between their students and the open source community, which may take additional time.

Third, instructors need to select an appropriate HFOSS project for use in a course. Ideal projects are open to student contributions, welcoming, and have clear communication channels, all while also fulfilling course learning objectives.

Finally, academic and HFOSS project planning may not match. An HFOSS project schedule and the instructor's academic calendar may not align well. An HFOSS project may make major, unplanned changes in direction. In addition, instructors must plan for contributions over the limited time of a term, once or twice a year.

Instructors who have engaged extensively with HFOSS projects [4] also report wanting more time to prepare course materials and having difficulty finding enough course time to cover HFOSS education.

Faculty interested in HFOSS education have been working for some years to help with the challenges listed above [5]. Progress has included:

- Development of a community of HFOSS educators who share challenges and results.
- Creation and sharing of instructional materials that are available to any interested instructor under a Creative Commons license.
- Development and application of a basic rubric to help instructors evaluate whether an HFOSS project is suitable for use in courses.
- Delivery of faculty workshops and other meetings to help faculty learn about open source and HFOSS education. These events are often held in conjunction with SIGCSE conferences and also include a workshop series called POSSE (Professors' Open Source Software Experience).



Outcomes

A series of evaluations of HFOSS education indicate that a variety of positive benefits are realized via this approach. These include:

Software engineering learning - Based both on student's self-assessment and review of student reflective writing, HFOSS engagement deepens student understanding of software engineering including software processes, team interactions, and SE tool use.

Appeal to underrepresented groups - Based on a series of studies, all student groups tend to prefer educational use of humanitarian over non-humanitarian software applications. In addition, women students and some underrepresented ethnic groups seem to have a significantly stronger preference for humanitarian software applications than students who are white men.



Getting Involved

Instructors interested in exploring HFOSS education can begin by visiting the TOS site at <https://TeachingOpenSource.org>. On that site, select “Our Community” and then “Join Us” to join the TOS email list. This is a very low volume list where events related to HFOSS education are announced. The site also contains a collection of Creative Commons licensed learning materials available for classroom use.

References

- [1] Chandrasekaran, Arun, and Mark Driver. A CTO’s Guide to Open Source Software. Gartner Group. 2022.
- [2] Heidi J. C. Ellis, Gregory W. Hislop, Stoney Jackson, and Lori Postner. 2015. Team Project Experiences in Humanitarian Free and Open Source Software (HFOSS). ACM Trans. Comput. Educ. 15, 4, Article 18 (dec 2015), 23 pages.
- [3] Lori Postner, Gregory W Hislop, and Heidi J.C. Ellis. 2023. Humanitarian Applications Increase Interest and Motivation of Women in Computing. In Proceedings of the 54th ACM Technical Symposium on Computer Science Education V. 1 (SIGCSE 2023). Association for Computing Machinery, New York, NY, USA, 416–422.
<https://doi.org/10.1145/3545945.3569832>
- [4] Lori Postner, Heidi J.C. Ellis, and Gregory W. Hislop. 2018. A Survey of Instructors' Experiences Supporting Student Learning using HFOSS Projects. In Proceedings of the 49th ACM Technical Symposium on Computer Science Education (SIGCSE '18). Association for Computing Machinery, New York, NY, USA, 203–208.
<https://doi.org/10.1145/3159450.3159524>
- [5] https://teachingopensource.org/Main_Page