We are working to introduce the ideas of eResearch to a multi-disciplinary research domain: those researchers examining Free/Libre and Open Source Software (FLOSS) and its development (Howison, Wiggins, & Crowston, 2008). The first phase of this work focused on building a repository for data on FLOSS teams, FLOSSmole (Howison, Conklin, & Crowston, 2006), and collaborating with other nascent data repositories in the field. Recently we have begun a second phase, which is to introduce another established principle of eResearch, that of broader collaboration through shared workflows accessing these data repositories. To provide an example of the potential value of this principle, we are replicating seminal FLOSS papers using eResearch approaches. This paper describes research outcomes and lessons learned from translating published literature into eResearch workflows.

The replication involves the reconstruction of workflow, data, and analyses of several published papers in the field of empirical FLOSS software engineering research. The effort has three purposes: to provide examples of workflows and workflow elements for FLOSS research, to determine how replicable current research is, and to provide a platform for extending the original research by publishing the workflows with parameterized values wherever possible. The last goal allows others to more fully explore the analyses, including running the workflows on data collected since the original publications.

Wherever possible we are working to reproduce the analyses in collaboration with the authors. This means ensuring that the data repository contains the needed data, and offering to host original data if not. It also means ensuring that the workflows capture all the stages of the original research. This step turns out to be key to the replication of research analysis because, as we discovered in the early stages of this effort, the details provided in the methods sections of most published literature are insufficient for operationalization in an eResearch workflow using Taverna Workbench.

This paper reports in detail the challenges we have encountered replicating the analysis of English & Schweik (English & Schweik, 2007). We emphasize that our goal is to make this valuable work more widely available rather than simply to critique its execution, and that similar difficulties have been found in other papers. English & Schweik (2007) classify OSS projects based on metrics for success versus abandonment and stage of project growth. The basic steps to reproducing the research begin with replication of the data selection and the reported analysis. An abstract analysis workflow and subsequent functional workflow was developed in Taverna. The data sources were then integrated with the analysis via Taverna's MySQL components. After debugging and verification of the workflow's performance with a subset of data, the final analysis was run with a full replicated data sample and compared to the original published research.

For the replication of the success-abandonment classification analysis, we were able to use the same FLOSSmole data repository, but found it challenging to determine the

correct parameters for raw data selection from the article text. Fortunately, the workflow implementation allowed us to remain flexible in our data selection. Second, we sought to reproduce the classification table in the published article in the format of a truth table, which would allow us to meet the criteria for completeness and exhaustiveness in classification, but discovered that the classification as published was not complete, as some of the negative cases were not included in the published table. This is not to say that the authors did not consider these cases, but perhaps they did not arise in the original data sample and so were not explicitly discussed. For the most part, we were able to fill in the appropriate classifications for negative cases based on inheritance from other criteria for each class, but found that success and abandonment criteria conflicted ambiguously in one of these negative cases.

This experience directly demonstrates the value of using eResearch approaches, as building a scientific workflow for classification forces the researcher to consider all possible combinations of criteria, and generates a more robust and replicable analysis than can be expressed in an article in the literature. In our workflow implementation, all of the classification criteria have been parameterized and we are able to adjust both classification rules and thresholds for more flexible and robust analysis.

A significant portion of the FLOSS research community works primarily with secondary data that is increasingly available through federated repositories, so for our research replication efforts, we can leverage the same data resources. However, as our experience shows, the article publication format does not necessarily provide sufficient detail to accurately replicate the analysis in a modular workflow based solely on the standard descriptions of an article's methods section. This finding furthers our position that the FLOSS research community stands to benefit significantly by adopting eResearch practices, particularly for sharing of data and analysis workflows. The FLOSS research community can only be strengthened by embracing same ethic of openness that is characteristic of the FLOSS projects that we study.

References

English, R., & Schweik, C. M. (2007). Identifying Success and Tragedy of FLOSS Commons: A Preliminary Classification of Sourceforge. net Projects. *Emerging Trends in FLOSS Research and Development, 2007. FLOSS'07. First International Workshop on*, 11-11.

Howison, J., Conklin, M., & Crowston, K. (2006). FLOSSmole: A Collaborative Repository for FLOSS Research Data and Analyses. *International Journal of Information Technology and Web Engineering, 1*(3), 17-26.

Howison, J., Wiggins, A., & Crowston, K. (2008). *eResearch workflows for studying free and open source software development.* Paper presented at the Fourth International Conference on Open Source Software (IFIP 2.13), Milan, Italy.