"I Don't Gamble To Make My Livelihood": Understanding the Incentives For, Needs Of, and Motivations Surrounding Open Educational Resources in Computing

Max Fowler*
mfowler5@illinois.edu
University of Illinois
Urbana, IL, USA

David H. Smith IV*
dhsmith2@illinois.edu
University of Illinois
Urbana, IL, USA

Binglin Chen
chen386@illinois.edu
University of Illinois
Urbana, IL, USA

Craig Zilles
zilles@illinois.edu
University of Illinois
Urbana, IL, USA

ABSTRACT

Background: Prior work has primarily been concerned with identifying: (1) how Open Education Resources (OERs) can be used to increase the availability of educational materials, (2) what motivations are behind their adoption and usage in classrooms, and (3) what barriers impede said adoption. However, there is relatively little work investigating the motives and barriers to contribution in OER.

Objectives: Our goal is to understand what motivates and dissuades instructors to contribute to and adopt OERs. Additionally, we wish to know what would increase the likelihood of instructors contributing their work to OER repositories.

Method: We conduct a 10 question survey with computing instructors on OER, with a heavy emphasis on what would lead to OER contributions. Using thematic analysis, we mine the broad themes from our respondents and group them into broader topical areas.

Findings: Novel contributions include discussions of what faculty are not willing to share as readily — in particular, exam questions are of concern due to possible student cheating — as well as discussions of different views on monetary and non-monetary (e.g., promotion and tenure value) incentives for contributing to OER efforts. With respect to the kinds of OER faculty want to use, findings line up with prior literature.

Implications: As course materials become more sophisticated and the range of topics taught in computing continue to grow, the communal effort required to maintain a broad collection of high quality OERs also grows. Understanding what factors influence instructors to contribute to this effort and how we can facilitate the contribution, discovery, and use of OERs is fundamental to both

how OER repositories should be organized, as well as how funding initiatives to support them should be structured.

CCS CONCEPTS

• **Social and professional topics** → Funding; **Computer science education**.

1 INTRODUCTION

The advent of the internet coupled with the open-source movement initially lead to several universities, starting with Massachusetts Institute of Technology's (MIT) OpenCourseWare, beginning to develop materials that are freely available to students and faculty. These materials, which came to be known as Open Educational Resources (OERs), are now widely available and generally enjoy positive perceptions from faculty and students alike [10, 20]. OERs include a broad range of educational materials, including everything from textbooks and slides to projects and exam questions. Faculty that utilize OERs in their courses report a high level of satisfaction with those materials, generally ranking it equivalent or better than more traditional materials [7, 41]. The existence of these materials in quantities greater than ever before coincides with a growing demand for digital resources [41].

There is a significant body of work that exists on the motivations of and barriers to faculty that adopt OERs. Commonly cited reasons for adoption are reducing costs to the students, increasing access, and improving the quality of materials [9, 51, 59, 61]. Barriers to adoption include difficulty discovering relevant materials created by others, concerns regarding the quality of some materials, lack of time, and general unawareness of OER's existence [9, 41]. However, the majority of prior studies have been done on more general populations of faculty with relatively few surveying faculty specifically in departments of computing and information sciences.

---

*Both authors contributed equally to this research.

The widespread availability of OERs within the CS community in particular may be some reflection of the influence of the virtues that underlie the open-source movement. The Runestone platform provides an authoring suite and platform that allows for the rapid development and deployment of open-source computer science textbooks [14, 28]. PrairieLearn is an extensible, open-source platform for writing questions for computer-based homework and exams [57]. The Special Interest Group on Computer Science Education (SIGCSE) annually hosts a "Nifty Assignments" section where unique assignments are peer reviewed and those that are accepted are presented and then made freely available [34]. More recently, the conference hosted a "Spiffy Questions" panel where a similar process was used to evaluate and release peer instruction questions as OERs [62]. Additionally, the website, peerinstruction4cs.com hosts lectures slides containing peer instruction questions which are published under a creative commons license [24]. As for the integration of resources like these into classrooms, Hanna et al. [18] found that students reported both enjoyment of open, digital resources and that it built their awareness of the open-source software and the open-source movement.

Despite the large body of work that investigates and reports on the affordances, shortcomings, and experiences utilizing OERs there is relatively little work specifically investigating these facets in the context of computing and information sciences. Furthermore, there are even fewer studies investigating what motivates the creation and sharing of OERs. As such, we seek to fill this gap by investigating:

(1) What are the motivations and barriers for computing faculty to adopt OERs?
(2) What types of OERs are computing faculty interested in?
(3) What motivates, or would motivate computing faculty to contribute to OERs?

By investigating these questions, we hope to gain a better understanding of how to design OER repositories and tools that promote the creation of a prolific and high quality collection of educational resources. Such work has been called for by the 40th meeting of UNESCO on Open Educational Resources wherein they state that the exploration of funding opportunities for OERs is needed to ensure such resources remain free to students and for mechanisms that ensure high quality OERs are developed [52].

2 LITERATURE REVIEW

2.1 History and Definition of Open Educational Resources

Sharing of course materials is at least as old as courses having web pages, but MIT popularized the idea when it began uploading large quantities of resources through it's OpenCourseWare project. OpenCourseWare and many other OER efforts found their roots in the Free Software movement which then gave rise to licenses such as GNU Free Document License (FDL) and Creative Common licenses which support this form of free content [61]. The topic of OERs was considered at a forum of the United Nations Educational, Scientific and Cultural Organization (UNESCO). As a result of this meeting a preliminary definition of OER was determined to be:

> The open provision of educational resources enabled by information and **communication technologies**, for consultation, use and **adaptation** by a **community of users** for **non-commercial purposes** [39, 51].

This definition highlights a number of key concepts: (1) the issues of the internet as being the key method of delivery, (2) its ability to be adapted, the importance of communities of users performing this deliver and adaptation, and (3) the lack of a commercial motive. Additionally, the targeted demographic for these resources as being a diverse set of users was stressed throughout the report as well, given the purpose of the report was primarily considering the utility of these resources for usage in developing nations, as they were then referred to. In a set of recommendations put forth by the 40th meeting in 2022, this definition had evolved to:

> Open Educational Resources (OER) are learning, teaching, and research materials in any format and medium that reside in the public domain or are under copyright that have been released under an open license, that permit no-cost access, re-use, re-purpose, adaptation and redistribution by others. [52]

Though quite similar to the original definition, the issues of licensing and cost to the end user are more clearly communicated in this definition. Among their ongoing objectives published alongside this definition, they list: (1) building capacity for the development and use of OERs under their definition, (2) encouraging inclusive and equitable quality OER, and (3) creating sustainable models for OER.

Contributing to this definition further, many studies list the 5R's of OER, introduced by Wiley [58], as a core piece of the definition of and guiding principles for OER [5, 29, 61]:

(1) *Retain:* The right to make, own, and control copies of the content.
(2) *Reuse:* The right to use the content in a wide range of ways (e.g., in a class, in a study group, on a website, in a video).
(3) *Revise:* The right to adapt, adjust, modify, or alter the content itself (e.g., translate the content into another language)
(4) *Remix:* The right to combine the original or revised content with other open content to create something new (e.g., incorporate the content into a mashup)
(5) *Redistribution:* The right to share copies of the original content, your revisions, or your remixes with others (e.g., give a copy of the content to a friend).

Since its inception, MIT's OpenCourseWare project has continued to grow both in the quantity of materials it has available and the degree to which it is used. Several other large repositories of OER have followed in their footsteps, including: Multimedia Education Resource for Learning and Online Teaching (MERLOT) repository [27], LibreTexts [2], OpenStax [3], and engageCSEdu [13]. MERLOT stands as one of the most mature systems, containing both a peer review process for the content it hosts and having amassed a massive quantity of resources. Given the variety of platforms available, this begs the questions: how do faculty discover and utilize OERs and what are the barriers that exist in doing so?

2.2 Motivations for the adoption of OER

Several papers, both commentaries and survey studies with faculty have noted the following motives for the adoption of OER:

- *Cutting Costs:* Documents licensed under Creative Commons are free, which removes the need for institutions or students to pay for expensive materials and subscriptions [9, 59, 61].
- *Access:* Related to cost concerns, prior work has indicated a significant driver for the adoption of OERs is to improve access to materials for students in developing countries and those who simply cannot afford the cost of traditional textbooks and accompanying materials [51].
- *Flexibility and Customizability:* Most licenses allow for the content to be modified to fit the users needs [61].
- *Continuous Improvement:* Collaborative modification of existing materials can lead to those materials being improved and updated over time [61].
- *High Quality Materials:* Though some have noted that OERs are mixed in terms of quality there are gems that meet or exceed the quality of traditional resources [9, 10]

Among these, affordability concerns for students are one of the most often cited reasons for adopting OER textbooks in particular [15]. A study by Feldstein DPS et al. [15] found that prior to the adoption of a free and open textbooks in some of their courses, only 47% of the students bought textbooks for their courses citing cost concerns. Additionally, courses that did adopt open textbooks were found at be correlated with increased grades, a finding that has been replicated in a variety of contexts [21, 35] or at worst has shown no decrease in performance as a result of adopting OERs [6, 11, 19]. This suggests that the argument in favor of the quality of OERs is not merely subjective but can at times have a positive impact on students performance and accessibility of course materials.

Additionally, central to the UNESCO definition of an OER and the 5R framework is the idea that these resources should be modifiable. As Yin and Fan [61] notes, this offers an additional benefit to instructors in that they can pick and choose what OERs they want to use and then modify them to fit their needs. This lowers the burden of adoption as instructors need not adopt an entire resource at once, rather they can slowly adopt parts as they see fit. Additionally, they can then update those parts as needed or replace them ultimately leading to a more modular and therefore flexible approach to building curriculum.

2.3 Barriers to the adoption of OER

Several papers, both commentaries and survey studies with faculty have noted the following obstacles for the adoption of OER:

- *Discoverability:* Many faculty said they had issues finding resources and wanted peer reviewed repositories that were easily searchable [4, 9].
- *Content Coverage:* Some faculty, particularly those teaching specialized subjects, stated that they had difficulty finding OERs that related to their courses or simply did not believe that such resources would exist [9].
- *Lack of Quality:* Some faculty have concerns that OERs may not be of the same quality as traditional, proprietary resources [9].
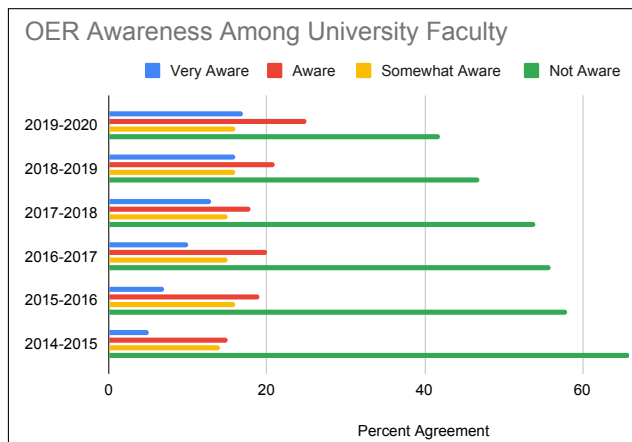

Figure 1: Awareness of OER Resources Among College and University Faculty [7, 8, 40–42]

- *Efficiency and Time Concerns:* Related to discoverability and quality, though there are a wide variety of resources available it takes time to track down and integrate those resources into your course [10].
- *Reputational Risk & Liability:* Some have additionally suggested that those who publish OERs may be concerned that errors in the material may pose a reputational risk or that a modified version of the material could be erroneously associated with them [39, 60].

Though there are concerns that OERs may be of lower quality, their adoption continues to grow, and studies evaluating students and faculty perceptions of OERs used in practice have shown they are well liked [10, 25]. This may suggest that a mix of outreach to help bolster the reputation of OERs and systems that improve the efficiency at which high quality materials can be discovered may further aid in their adoption. In particular, Navarrete and Martínez-Mosquera [31] suggests that more OER platforms such as MERLOT that utilize peer review can be used as ways to ensure the quality of OER.

Awareness of OERs continues to be a persistent issue as well, despite steady improvement over the years. A series of annual surveys by Bay View Analytics on OERs in higher education indicates that, in 2014, 44% of respondents indicated some degree of awareness regarding OERs, and this has only improved to 68% by 2020 when it was last run (Figure 1). This issue of general awareness is reflected in other studies where faculty at a university that had recently launched an OER initiative indicated that only 18% of the faculty were familiar with the term [38]. Additionally, faculty in a survey by Seaman and Seaman [41] indicate the lowest level of awareness for creative commons licenses compared to public domain and copyrighted materials. Though this line may seem somewhat irrelevant for the use of freely available resources, awareness of licensing may impact perceptions of quality and discoverability since licensed materials placed in large repositories such as MERLOT may be of higher quality and more trustworthy. Additionally, the most recent UNESCO explicitly includes open licensing as a part of its definition [52].

2.4 Technology acceptance research and OER

There is rich history of technology acceptance research that tries to explain how users come to accept and use new technology, which could shed light on factors that influence faculty's decisions to adopt or contribute to OER. The Technology Acceptance Model (TAM) [12], originally proposed by Davis around early 1990s to predict user acceptance of computers, is one of the most cited models in the area. A prominent extension of TAM, named the Unified Theory of Acceptance and Use of Technology (UTAUT) [54], was proposed by Venkatesh et al. a few years later. While various extensions of UTAUT have been proposed [55], none of them is remotely as influential as TAM or UTAUT. UTAUT posits that there are four determinants of technology acceptance, the first two of which are the only two determinants in TAM:

- *Performance expectancy (aka perceived usefulness in TAM):* the degree to which an individual believes that using the system will help him or her to attain gains in job performance
- *Effort expectancy (aka perceived ease of use in TAM):* the degree of ease associated with the use of the system
- *Social influence:* the degree to which an individual perceives that important others believe he or she should use the new system
- *Facilitating conditions:* the degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system

TAM and UTAUT have been applied to understand faculty's adoption of OERs. Studies have shown that performance expectancy (perceived better teaching performance from adoption of OERs) and effort expectancy (perceived ease of integrating OERs into own teaching) have positive impact on the adoption of OERs, while social influence and facilitating conditions have little to no impact [30, 33, 36, 43, 45, 48, 49]. It is possible that social influence and facilitating conditions indeed have no impact, but another possible explanation is that these determinants are sufficiently unvaried in reality such that no meaningful signal could ever be obtained (e.g. a pervasive lack of social pressure to adopt OERs or pervasive lack of institutional support to adopt OERs). While adoption of OERs has been studied in the lens of TAM and UTAUT, we are unaware of studies that applied TAM or UTAUT to study instructors' contributions to OERs.

3 METHODS

We produced a survey focused on instructors' use of OER, as well as instructors' attitudes and motivations around contributing to OER. Broadly, the survey focuses on what instructors use and would use, what reservations they may have with using and contributing to OER, and what possible incentives might make them more likely to contribute to OER. Questions 1–4 focus on the OERs themselves and barriers to adoption, as reviewed in Sections 2.2 and 2.3. The majority of the questions focused primarily on the incentives/compensation aspect, as this area has been the least studied. Question 5 overlaps with barriers, particularly in cases where reputation risk is a concern [39, 60], but is open ended enough to allow for further opining on eponymity as compensation. Questions 6–10 are entirely focused on different incentives and compensation mechanisms. The types of compensation, from recognition and statistics

tracking to more monetary compensation, echo existing literature on open source software contributions [32, 37, 46]. Our questions about compensation scale and the fixed vs lottery nature of payment are additionally inspired by research investigating incentives for survey completion and crowd-sourcing tasks both in and outside of computing [17, 22, 26, 50, 53].

The survey consisted primarily of open-ended questions, with one question (question 3) providing both "select all that apply" options and an open-ended "other" option. We anticipated the survey to take roughly 10–15 minutes, and respondents who answered the full survey were awarded a $15 Amazon gift card for their time. The recruitment email and full list of questions is provided in Figure 2.

The survey was disseminated using the Association for Computing Machinery's SIGCSE-members mailing list in January 2023 and left open through March 2023. Per the description on the site, this is an "opt-in mailing list intended for discussion of topics relating to computer science education". Though information on the number of members that have opted into this mailing list is not publicly available, the number of SIGCSE members overall is over 2,700 [1]. A total of 26 instructors responded to the survey and consented to their data being analyzed for research purposes, probably a pretty low response rate. Demographic data was not collected in the survey, although from the domains of the respondents emails, we recognize our respondents include instructors from multiple countries. With that said, we can more generally characterize this group as individuals either involved in or at least interested in computing education and computing education research. The survey responses, therefore, represent the thoughts and opinions of a subset of the broader category of computing faculty that may, in some cases, be more informed on available resources such as OERs. Though this may cause our data to miss some of the barriers that are faced by less informed educators, it does provide us with barriers that are still faced even by informed individuals. Additionally, the SIGCSE community's interests in disseminating information and materials relating to computing education makes it an ideal population to survey for answering our questions relating to motivating factors for the production of OERs.

With IRB approval and informed consent, data was anonymized by a research team member before being provided to the rest of the research team. In analyzing the survey responses we followed the practices for thematic analysis laid out by Jones et al. [23]. This analysis process began with each researcher independently performing inductive coding on each question. Each researcher produced an initial set of codes with respect to each question. Researchers then met, compared code books with respect to each question, and developed a consolidated set of codes. Once the codes were agreed upon and any disagreements were reconciled, the researchers met to group the final set of codes into thematic groups to illustrate broader, cross-question trends.

The research team includes one full professor, one post-doc, and two senior graduate students. All four have experience with working as course staff, with three members having multiple years serving as instructors of record and co-instructors for various computing courses, with over 40 years of combined instructional experience between them. Additionally, all members of the research team have previously contributed to educational resource repositories, with some results being explicitly published as OERs [44].

Recruitment Email:

I am exploring views from our community related to Open Education Resources (OERs). I'm looking for instructors to answer a brief survey about whether they use OERs and their willingness to contribute to them. The survey should take 10-15 minutes and we are offering a $15 Amazon gift card to respondents. The survey can be completed anonymously, but compensation requires providing an email address and fully completing the survey.

Here is the survey link: https://go.illinois.edu/OERSurvey

Question List:

(1) Do you use open educational resources (OERs) in your courses? If so, what?
(2) What, if anything, is preventing you from using OERs more than you currently do?
(3) What kind of resources would you want an OER platform to make available?
(4) Faculty frequently invest their time into the development of lecture slides, in-class activities, assignments, exam questions for use in their personal courses. Would you have concerns with publicly sharing materials that you've developed? If so, what are your concerns?
(5) Would you prefer to contribute materials anonymously or have your name associated with them. Why?
(6) Would you want some kind of recognition or compensation for contributing your materials? If so, what?
(7) How useful would a (private, if you want) web page that provides statistics about your contributions and their usage by others be for use in promotion, etc? Explain.
(8) If you are interested in compensation, should it be designed to compensate you for the effort of uploading your materials or scale based on how popular your materials are? Explain.
(9) What order of magnitude compensation seems reasonable? Describe an artifact that you'd make public and the price that would make it worth it to do so.
(10) For compensation, would you prefer a fixed dollar amount or a chance at a larger amount (e.g., $50 vs. a 1-in-10 chance for $500). Why?

Figure 2: The recruitment email and question list used for the surveys.

This shared experience leaves the research team well positioned to understand and dissect the trends from the survey.

The interpretation of our themes is tightly coupled to the results themselves. Given this, our results are organized such that the survey results for a specific theme are followed directly by the discussion of that theme for improved interpretability.

4 RESULTS AND DISCUSSION

4.1 Usage of OERs

The descriptions of the OERs that respondents indicated they used was varied, but the most commonly mentioned was the use of open textbooks.

> "Open textbooks and other online open resources (guides, manuals, etc)"

> "I use Java, Java, Java by Morelli"

> "yes, The Art of Assembly Language Programming: 8 Bit Edition by Randall Hyde "

> "Yes. I've used a book and set up a class in Runestone Academy, and I'm using an open math book for discrete math"

Many respondents mentioned multiple resources, from widely varying sources, and a respondent mentioned open source tools and source code as being OERs, even when they might not strictly fit under a narrow definition of OER.

> "Yes, VMs, Vulnerability repositories, open source tools, source code"

> "Extensive use of free and open source software as well as materials shared by colleagues and repositories such as foss2serve and nifty assignments."

> "What exactly do you count as an OER? I point students at the Fullstack Open web course to use a reference, but I don't follow it closely. I use w3Schools. I also use *a lot* of freely available software (far more than I can list here)."

Some respondents noted that they often get OER from course web pages instead of OER collections. These responses also highlight users of OERs obtaining permission to use materials.

> "Sort of — I have used slides posted on institutional websites (with permission and citation of course) but not so many 'official' OERs."
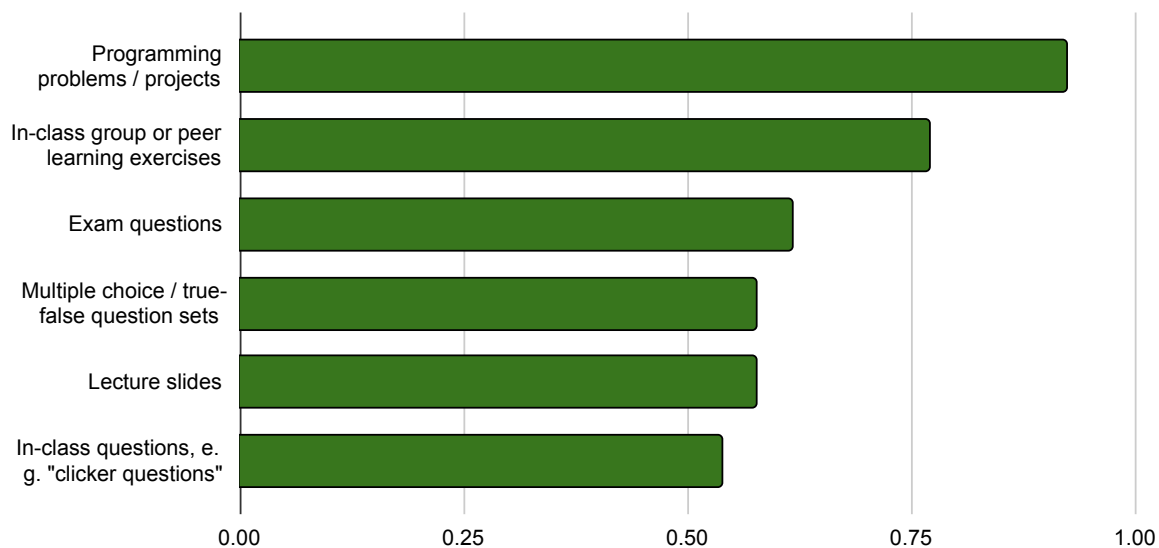
Preferred Resources

Figure 3: Percent of respondents indicating they would utilize the given type of OER

"Yes, I think so. I often use others' materials publicly posted on their web pages, asking permission when not explicitly granted (i.e., by Creative Commons license)."

Additionally, several respondents stated that they utilize resources that they have published as OERs or intend to:

"Yes, my own lecture notes and worksheets that I distributed as OER."

"Yes/no, I use a book I will publish as OER - it's not OER yet."

Though the majority of respondents utilized OERs—or at the very least publicly available resources—in their teaching, there were several who indicated that they did not use OERs. One respondent provided an expanded explanation for why they choose not to use OERs, "Not yet because it's easier to go with a paid text which is usually accompanied by a suite of resources." This response highlights the fact that that many OERs lack the same level of integration that commercial resources have.

The breadth of resources that our respondents use as OERs is likewise reflected in their responses about the kind of material that they would use, shown in Figure 3. There was strong interest in all of the types of resources we suggested. Due to a shortcoming in our survey, "textbook" was not a suggested option, but responses for the question asking faculty what OERs that currently use suggest that textbooks are equally popular.

Two features of Figure 3 are particularly noteworthy. First, the higher demand for programming problems/projects than exam questions foreshadows security concern that respondents express about sharing exam questions. Second, although only one of our

respondents indicated that they are currently using group or peer learning activity OERs, it was the category for which the second most of our respondents were looking. This suggests an unmet demand for this kind of OER.

4.1.1 Discussion: OERs are used and distributed in pieces. Responses indicate that faculty utilized and sought out a wide variety of OERs to utilize in their teaching. Overall, this suggests the population we surveyed has a positive view of OERs and a willingness to adopt or produce them. Notably, these resources were not only from OER platforms but came from an equally wide variety of sources such as slides posted by colleagues, open source software, and other reference sites. Additionally, the large percentage of respondents who expressed interest in programming projects and peer learning activities indicates there may yet be some CS specific OERs that the community would be interested in utilizing.

4.2 Barriers to OER adoption

In response to barriers to adopting OERs, we uncovered five themes: (1) customizability of the content, (2) a lack of features, (3) availability of the material, (4) the discoverability of said material, and (5) the degree to which the material was maintained or is maintainable.

Customizability — Given the eclectic usage of OERs, it may come as little surprise that many of the respondents indicated that the need for customization of OERs was a barrier to adopting them.

"Ease of adoption and customization to the peculiarities of our curriculum."

"I prefer to make my own resources that are tightly coupled"

"The biggest issues for me would be knowledge (I need to know about it before I can use it) and customisability (I need to be able to make the resource fit within my class)"

"A lot of work to adapt new resources to existing courses (often governed by learning objectives in the syllabus of record)"

Lack of Features — Some respondents indicate that OERs didn't have the features they wanted, including integration with their learning management systems (LMS).

"I use some commercial products (such as zybooks) because they provide auto-grading and interactive content; OER is somewhat lacking with respect to these two features (Runestone is getting there though)."

"a quick survey of a networking book revealed a lack of supplemental materials such as exercises, labs, etc., that could be integrated either manually or with an LMS."

"In beginning classes, I want to have a book that will link back to our LMS, so I know the students are interacting with the book."

"Integration with learning management systems and reliability that the resource will be available at all times."

Availability & Discoverability — Many other respondents noted there was a lack of available materials or, as one faculty tersely put it, "*There aren't enough options!*" Though this may seem difficult to believe, given the quantity and breath of material available, this lack of available options may be related to a lack of materials that relate to niche topics that some teach:

"Difficulty finding ones on the topics that I teach."

"Current OERs do not exist for my course."

Another hindrance to the discovery of relevant materials may be the number of resources one must look through before finding relevant resources of a high enough quality that could be deployed in a class. As one respondent puts it:

"It is hard to search out and find a good resource. There is *a lot* of mediocre (or even downright bad) stuff out there, and you can't really tell how good something is just by looking at a brief description. It usually takes a good 5 or 10 minutes to know if a resource is good enough to use. Given that so few resources are good enough to use, it takes a long time to find one if you are searching for it."

The difficulty and time consuming nature of this discovery process was a common theme which was reiterated by many respondents:

"Finding good material is very hard."

"Libraries of resources are kind of overwhelming and don't make it easy to find what might be useful to me."

"Time to get familiar with them. Finding resources that fit my needs."

By improving both the availability and discoverability of OER resources the hope would be that these issues could be mediated.

One faculty made note of the fact their students may require familiarity with industry tools for which they had difficulty finding relevant OERs:

"The industry requires the graduates to be trained on state of the art commercial tools whereas the open source tools/resources may not be the best fit for industry (e.g., financial organizations). Therefore, when dealing with such organizations (during my training) I had to opt for commercial resources."

Though this is unlikely to be applicable within the context of a traditional CS core curriculum, this may be an issue more broadly in computing. Specifically, problems may arise in the ever evolving world of IT and industry-specific tools, such as the finance tools this faculty noted.

Maintenance — A less common, though still noteworthy theme that emerged was concerns that OERs were not kept up to date:

"The content is usually not up to date and lack of maintenance"

"Lack of availability of effective, up-to-date OERs"

"In technology courses, the materials in most OERs are not updated fast enough."

Though perhaps less applicable to core computer science courses (e.g., data structures, discrete math) this may be more of a concern in information and technology courses where changes in software versions may render some materials outdated and misleading. It may also be a concern in computing courses that rely on library and software landscape that is constantly evolving such as data science (e..g, pandas, numpy), machine learning, and embedded systems courses (e.g., Arduino packages, hardware options). This issue bears a strong relationship to discoverability in that it may be difficult to quickly distinguish a resource that is up to date from one that is not.

4.2.1 Discussion: Barriers to be overcome. We can see that some of the issues identified by prior work, such as discoverability and availability of high quality and relevant materials, are also present in the computing community. The importance of keeping up-to-date, however, may be more important in computing than in some less rapidly evolving fields, putting more pressure on development and maintenance of OERs. In addition, computing instructors may have higher expectations for the auto-grading, interactive content because of the content taught, comfort of instructors, and the high enrollment in many of our classes. In addition, this scale may motivate a higher desire for LMS integration.

The desire for auto-grading and other "smart" content brings platform concerns to light. Sophisticated, feature-rich platforms take a significant effort to develop and maintain, requiring a different kind of effort than the development of individual problems and lecture materials. In addition, features such as auto-grading typically involve execution on a server (for security reasons), requiring users to either set up servers locally or some means to financially support a centralized server. Commercial platforms pay for server

costs through their revenue. How OERs can remain free in light of these costs is an interesting open question.

4.3 Material sharing - mostly willing, with caveats on security and ability

The majority of our respondents were willing to share material in some form. For some respondents, material was shareable without limits. One respondent particularly exemplifies this willingness with the following, "I'll surely be willing to share as it benefits the community. For instance, having a large question bank helps us all... Sharing knowledge never limits our ability to lead." Additionally, a number of our respondents already do share their material publicly, with seven providing their specific licensing method or published website. Some respondents specifically point out a desire for reciprocity: "I am generally happy to share materials I create if others are also willing to share."

Among respondents happy to share, there was a particular line they hesitate to cross: exam questions and other high stakes items. Concerns about students' cheating and reduced ease of assignment reuse was a concern for nine respondents. Releasing assignments and questions publicly potentially allows students to find them as well. The following two respondents demonstrate these concerns:

> "I would not be concerned about sharing my slides or most of my in-class activities/assignments. I would be concerned about sharing my 'higher stake' assignments and certainly exam questions if it would lead to an increase in student cheating and my being unable to reuse the questions myself."

> "I would be concerned that the materials would be uploaded to sites like Chegg and coursehero, making exam and other question solutions open to students even more than they are now."

Not all respondents take umbrage with sharing high stakes items. One respondent specifies that they do not publish their lecture notes even though all of their other course materials are already shared, as they "want students to take their own notes, but I could maybe share them where students won't be looking for them."

Some respondents suggested sharing strictly anonymously in order to avoid concerns with revealing OER to their students. In particular, one respondent identified an advantage of not attaching their name to their shared materials: "I would not want to be searchable as it could be linked and searched related to a course."

Two smaller themes emerge from the data on this topic. First, two respondents shared their uncertainty with whether their institution would allow for them to share course content. One in particular said that they would share if not for their institution locking all course content behind a Learning Management System (LMS). Second, multiple respondents express concern about whether their content would be good enough to share or be broadly applicable enough to use. One respondent stated, "I'd worry that my material isn't [of] sufficient quality/polish (or that there may be inaccuracies)". One respondent who is willing to share expressed, "Since I use mainly active/flipped classrooms, I don't create lecture slides, so I may have a concern that others who use my materials would expect lecture slides." In both of these cases, concerns about OER quality and fit present some barriers for our respondents. A third respondent sums

up these concerns as a struggle for many faculty: "Faculty often perceive that they need to 'polish' materials before publishing. I am working with a research team who paid instructors to develop materials and over and over instructors would be reluctant to publish because they didn't think the materials were 'perfect'".

4.3.1 Discussion: supporting all forms of sharing. Concerns about OER quality is an idea that crosses multiple themes. Reputation threat is a potential barrier to OER production and open sharing. Allowing anonymous publishing is one possible way to reduce this risk.

A major concern that respondents had about sharing their material was their students finding it online. Allowing the free sharing of material while keeping it from students seems like a challenging proposition. One could consider restricting access to only instructors, but how to perform the identity validation in a reliable but low cost manner is an open question. If the goal is to merely avoid allowing search engines to link one's identity to their material, anonymous or pseudononymous authorship is one approach, but keeping identity behind a freely available log in, might be enough to prevent search engines from making it straightforward for current students to find the materials.

It remains an open question whether exam questions and other high stakes items are *too* high stakes to share. While students finding answers online is an ever-present threat, there are multiple ways to approach this threat. One way is attempting to prevent students from finding/accessing the material, as noted above. Alternatively, if exams are performed where students can't access the internet (e.g., paper exams or locked-down computers [63]), it is merely sufficient to have much more material available than students can effectively memorize, if they can't predict which subset will be on the exam. Some faculty already use this strategy independent of OERs, by sharing with students a long list of questions from which a subset will be selected for inclusion on the exam. Building large question pools of computerized questions can be facilitated by platforms providing support for sharing within the platform [16, 56].

4.4 What is more enticing: community recognition (and network building) or formal attribution?

We found two slightly different motivations among our respondents for being eponymous (that is, having their name associated with their OER): they wanted their peers to know they authored the OER (what we'll call "recognition") and they wanted their name formally attached to their contributions (which we'll refer to as "attribution").

Many respondents emphasized recognition, with respect to being known as the producer of the OER content, because of a number of benefits. One of these benefits includes boosted reputation from being known as a creator of good OER content. One respondent focuses on the social benefits of recognition, especially in a community as relatively small and tight knit as computing education:

> "CSEd is a small community, and it's nice to be able to talk with people who recognize what you've contributed."

Another respondent expands upon this idea as beneficial both to authors of and users of OER. Recognition helps individuals build a reputation as a maker of good OER and makes them searchable:

> "Have my name associated with them. I assume that I do a good job putting together course materials. Therefore (1) I want to be acknowledged for doing good work. (2) If I know who prepared certain materials, and I know that they have a reputation for doing good work, it makes it easier for me to find new, good resources to use in my class."

Multiple respondents bring up the idea of recognition as a means of networking with their users, so they can provide support and better respond to those users' needs. The following two quotes exemplify this point of view:

> "With Authorship. Allows me to learn the reach, as well as provide support."

> "Name associated — so I could be notified of possible errors or discuss alternatives to my presentation approach or material."

For other respondents, the focus was more on ensuring users of OER know who to attribute those materials to. Within this context, licensing came up frequently among those seeking attribution. Many respondents referred to Creative Commons licensing as good enough attribution for their needs, with the precise level of attribution varying based on content:

> "Name associated as the original creator, but with the appropriate CC license... generally see it as a contribution to the domain."

> "Just the attribution required by the corresponding Creative Commons license. I could see smaller parts (like individual exam questions) being less restrictive that doesn't need to be cited in-line and instead cited at the level of the larger work or course."

4.4.1 Discussion: OERs should support network building and contribute to scholarly reputation. While we expected the reputational benefits of eponymous sharing, we hadn't anticipated the desire to build a community around one's contributions. In hindsight, this isn't surprising, as most creator sites (e.g., YouTube, Patreon) provide support for interacting with one's community, but this support isn't included in many OER repositories. Not every OER contributor, however, wanted the burden of interacting with their community, so perhaps some means of indicating whether they want to be contacted when they provide their information.

As one respondent noted, if you like one of their resources, you are likely to like other resources of theirs. As such, OER repositories should facilitate navigating from one contribution from a creator to their other contributions.

The desire for attribution (beyond recognition) is interesting, because it potentially accomplishes two things. First, it helps one substantiate that the material is being used and how widely. As we'll discuss in the next section, a big incentive to share is to have impact that can be demonstrated to our employers. For many OER materials, we can potentially track views and downloads, but we can't directly measure whether it has been adopted. Attribution potentially lets us do that, if the user of the materials places them

where a search engine can find the attribution. Second, it allows identifying *who* is using the material. This allows creators to potentially initiate contact and identify letter writers as noted in the next section.

4.5 Support for promotion and tenure purposes as an incentive

With respect to the incentives for sharing OERs, a significant contingent of respondents focused on the benefits appropriate recognition or attribution provides for the promotion and tenure process. Frequently, the value of OER as a possible scholarly activity came up among respondents. This was most often for the purposes of including contributions to OERs on promotion and tenure documents, especially for those individuals who are evaluated on their teaching. Some examples from our data include:

> "I just want the 'bean counters' at my university to know that people find my work valuable so I can get 'credit' toward promotion and tenure."

> "Recognition helps with the tenure and promotion portfolio, especially from a teaching college."

One respondent particularly worries about the lack of institutional appreciation of OER activities:

> "There is a lack of institutional recognition of the amount of effort and time that goes into creating resources in a rapidly changing domain (such as computing). Without some explicit recognition it is difficult to justify continually creating new materials to keep pace with the rate of change... especially when commercially-created resources are available."

We asked our survey respondents if having usage statistics for their OER contributions would be useful (question 7 of the survey). Two respondents suggest that a proper citation system is the missing piece that could pave the way for institutional recognition, increasing the value of OER for promotion and tenure:

> "I see this as part of our job and service. Maybe the best recognition I would prefer would be that more learners or instructors use it and we have a formal means to know who is using it. Similar to the academic citation system."

> "At our university, we are required to 'disseminate scholarship'. In most cases, 'dissemination' is expected to come with peer review. Such a site [described in question 7 of the survey] could potentially meet the university's expectation for 'peer review'. Therefore, I could spend more time preparing and polishing resources. (Without a form of peer review, I would have to spend less time on teaching materials and more time writing traditional conference publications.)"

Multiple respondents also comment on how a statistics page would be additionally useful for the promotion and tenure process. In fact, for some respondents, the presence of statistics and usage may lift OERs up to the degree where they can be explicitly included in promotion material. One respondent, in particular, expands on this idea as similar to the materials textbook authors receive and

explains how usage statistics could provide a source of future letter writers for promotion purposes, across two answers:

> "(1) Statistics on usage would be nice to report back to P&T committees, feedback/testimonials would also be good; leads on names of individuals who utilize my resources in order to built [sic] a repository of letter writers for P&T (2) ... When faculty publish a traditional textbook they will get sales/adoption stats from the publisher (questionable or otherwise) which is valuable to a P&T or evaluation committee ..."

Another respondent points out how statistics sharing being private would provide an added benefit, as it would allow individuals to choose whether or not they share their statistics page based on the results:

> "Interesting idea - could be useful for things like tenure and promotion if there was solid evidence of the adaptation of the materials. Could backfire if there wasn't much evidence the materials were being used. But I guess if the website was private, one wouldn't have to include it in the materials given to others."

4.5.1 Discussion: OER platforms should provide support for promotion and tenure packages. Our respondents were clear that being able to document the impact of OER contributions for the purpose of promotion and tenure portfolios is an enticing non-monetary incentive. While it can be difficult to precisely assess usage in some contexts, it is clearly a worthwhile endeavor. In addition, to easily measurable metrics like views, ratings, downloads, and comments, platforms should attempt to collect statistics about actual usage and derivative products. A simple, if unreliable, solution would be to ask OER users to self-report when they access OER resources on a platform.

Because reputational risk could discourage contributions, such metrics should be private to the creator until they want it shared. OER repositories could permit creators to generate links that could be included with their professional review materials that allow reviewers to independently verify the statistics.

4.6 To financially compensate or not to compensate

Most of our respondents appreciate recognition/attribution, but they have markedly different attitudes towards monetary compensation. About half of the respondents hold the view that recognition/attribution is enough and compensation is not necessary: "Compensation not necessary, but having name associated with materials would be enough." Perhaps they view promotion as the more important "compensation," as discussed in Section 4.5.

The rest of respondents are split between two opposing views. One group believes that financial compensation can improve OERs and appropriately reward contributors. One respondent particularly describes how compensation could influence the decision to contribute:

> "If anything, I would want compensation for my time. It takes time to prepare and upload OER materials and even if the compensation is not my primary motive, it would ease the burden a little. (Much like the $15

gift card is not my primary motive for answering this survey, but it certainly makes it easier to justify spending the time on it when I *should* be doing many other more important things instead.)"

The other group outright rejects the idea of compensation. There seem to be two underlying reasons. The first seems to be more based on principal. In one respondent's words: "Compensation and OER are fundamentally at odds." Another respondent opines:

> "Most academic work (e.g., publishing a paper) does not include compensation, so I would view contributing OER materials in the same way."

Other respondents seem more concerned about the sustainability of monetary compensation given that OERs are, by definition, free to use. That is how can we pay creators if we aren't selling their creations.

> "If its OER, it should be free. That's kind of the point."

> "I also know that my target audience doesn't really have a budget to pay for that material. (Hence the reason we are trying to promote 'Open' resources in the first place.)"

> "I think it would be nice to have awards for recognizing the best content or something or maybe a grant based system to motivate authors, but I don't see how compensation can be scaled to anyone who submits an OER."

Perhaps both sides would agree that financial compensation is a motivating factor that can lead to more contributions, but it should not ruin the premise of open, as one respondent summarizes it:

> "I think compensation might defeat the purpose of 'open.' :) But it would certainly make it more attractive to take the time to polish and upload materials."

4.6.1 Discussion: institutional recognition and monetary compensation shall work hand in hand. Overall, our respondents indicate that they are more likely to contribute OERs if they are provided an incentive, whether it is monetary or non-monetary. The primary concern respondents had with monetary incentives is where the money would come from. The obvious answer is grants, either from foundations or the government to create things that are in the public interest. While there may not be direct compensation for publishing papers, we receive indirect compensation in the form of summer salary and research assistantships through grants, and we can't see why the OER enterprise shouldn't be similarly supported. Offering monetary compensation for OER contributions need not jeopardize the openness of the materials.

4.7 Compensation structure: effort vs. usage

Our respondents have a wide variety of interesting ideas on how compensation schemes should work. When asked about whether compensation should be fixed or scale to usage (question 8 of the survey), respondents saw value in both approaches. Some noted that fixed baseline compensation makes sense as it addresses the author's investment: "Compensation is best designed to address the opportunity cost associated with spending the time developing and preparing such materials for others' use..", while others noted

that scaling to usage would encourage higher quality materials: "I prefer scale based on use. I think it incentivizes people to increase quality and focus on materials that are well suited to adoption by others." Therefore, some form of combination might be the best: "Possibly a combination, something small for uploading and bigger for popularity. A well thought-out ratio could provide a nice incentive."

One respondent brings up the idea of compensation for maintenance, which is particularly relevant to the fact that poor maintenance and lack of updates are barriers to OER adoption as discussed earlier in Section 4.2:

> "Recognition or compensation would be helpful. I would prefer both as the amount of time to make or update OER materials is significant."

One form of use-based compensation suggested by a respondent would be voluntary donations from the adopters.

> "If a compensation model is needed, the only one I would consider is a contribution model (i.e., 'if you found this material useful, you can contribute' a la Twitch or other platforms)."

Regarding the amount of compensation (question 9 of the survey), there are two major themes, though our respondents often express low confidence about their responses. One view is that compensation should effectively pay for the creation of the material:

> "Probably based on an equivalent rate for time spent in development rather than the size of the artifact. For example, if developing assessment items and associated rubrics for an examination consumed 30 person-hours, then compensation of an academicians' equivalent hourly rate for 30 hours seems appropriate as a minimum. (All of this assumes that an institution is not compensating the author directly.)"

Two respondents in particular, suggest that compensation could be something comparable to what traditional publishers would offer:

> "I'm not sure. It would be nice if it were somehow competitive with commissions/royalties from more traditional publication and based on use."

> "We typically pay $3000 for materials that support a full 3 credit 'course'."

The other view is that compensation should be nominal, perhaps for the amount of work needed to polish and upload one's existing material: "I guess it would be more of an honorarium rather than direct compensation for the work itself. For individual exam questions, I could see the amount being a token amount like $5 per question."

Because lotteries are frequently used as an incentive in survey research, we asked our participants if they preferred monetary compensation as a fixed amount versus a lottery format with the same expected value (question 10 of the survey). This was the only question in our survey where our respondents were nearly unanimous. Almost all of our respondents choose fixed amount. Disdain for gambling was frequently mentioned: "Fixed dollar amount. Lotteries are for gamblers.", "I don't gamble to make my livelihood." Two respondents suggest that a lottery format could be practically

counterproductive in motivating contributions, even dissuading them out of concern for the offer's legitimacy:

> "I would assume that any place offering a chance at a bigger compensation was a scam."

> "A fixed amount is much better, I believe, even though the reward is lower. This is based on my experience that more faculty, especially at small schools, are motivated to participate if they know for sure if they are getting some compensation."

4.7.1 Discussion: monetary compensation structures. Based on our survey, it seems that there is a lot of value to providing both a base amount for contributing, as well as a scaling amount based on the usage of a resource. The base amount provides a guaranteed return for the investment of time to clean up and upload materials and would likely encourage more contributions. A scaling amount based on usage would encourage development and maintenance of quality materials. This second component, however, relies on being able to (at least somewhat) accurately measure usage. This two-part compensation is not uncommon for top actors and athletes, where contracts include residuals and performance incentives. The exact ratio as how to allocate budget between the two categories for this context, however, remains an open question.

Our respondents were pretty uncertain about how much compensation would be necessary to be an incentive. For existing materials, a small amount of base compensation may be enough to serve as an effective nudge, in the behavioral economics sense of the word [47].

Finally, for computing faculty at least, the compensation scheme should be made clear upfront, and should be deterministic rather than lottery-like, since uncertainty drives faculty away from contributing.

4.8 How should OER be made more discoverable? How is good OER recognizable?

As mentioned in Section 4.2, discoverability of OERs was a major concern for our respondents. In particular, good content, rare content, and content from higher level courses was considered at risk of being lost or unseen, if it exists at all. Popularity is potentially a poor proxy for quality, especially when not many people may use advanced content. Multiple respondents shared their concerns with discoverability and quality tracking:

> "There would be cases were [sic] there is some niche content that may be very difficult to create and time consuming, but might not be 'popular' even if the content is really good."

> "I'm usually disappointed with discoverability on non-commercial platforms since there's not a lot of effort put into the algorithmic side of things."

However, incentives to contribute can muddle the contribution process. If rare material is not appropriately compensated or discoverable, it may not be contributed. One respondent speaks to what different material would be worth to the actual creators of the material:

"I am hesitant to tie compensation to popularity as there are some courses that are infrequently taught and such materials are less available and therefore would be worth more not less to instructors."

Multiple respondents bring up the idea of tracking popularity of resources. In particular, this was attached to compensation, discussed earlier. Some respondents specifically mention that rating systems would be nice to incorporate in order to know what users thought about their content and track this popularity:

"That would be great. I would like to know even the rating users have provided to my questions / slides / tutorial videos / VMs etc."

For other respondents, popularity and ratings are immaterial, with more rigorous review being necessary to truly establish what is and is not high quality OER:

"'Real' contributions require some form of peer-reviewed publication."

"I also think there should be some review process to ensure a high quality of materials being provided."

4.8.1 Discussion: Discoverability and its inexorable link to compensation structure. Discoverability is clearly important to OER adoption, as the time to find and quality check resources is a key barrier to adoption. To this end, OER repositories frequently have support for searching and filtering their contents in various ways. In addition, allowing users to see what resources other users like (by up-voting) or are using can serve as a proxy for quality. Providing support for users to publish curated collections of OERs produced by others could further assist discoverability.

Discoverability interacts with incentives in two interesting ways. First, if we are providing recognition or compensation based on popularity, then it is pretty important that the best resources can be easily found. If popularity is unrelated to quality, then we won't be properly incentivizing the production and sharing of quality resources.

Second, if we provide a base amount of compensation for creators to upload their content, we risk incentivizing the production and sharing of a lot of mediocre content. This will put a lot of pressure on the platform's discoverability system. This, however, is not a novel problem, rather it is part and parcel of all social media platforms, and we have no reason to believe that solutions inspired by those platforms cannot be used in this context.

4.9 OER compensation is not immune from fairness concerns

The subject of fairness came up across multiple respondents' answers to a variety of questions, focused both on fairness in compensation for effort and fairness with respect to discoverability and reputation.

Some respondents were specifically concerned about compensation in situations where the platform hosting OER would somehow make profit that contributors themselves could not access. One respondent voiced this as a request for profit if others were profiting:

"Depends on [my material's] use and collection. If anyone is profiting off of them, then yes.".

Another respondent focused on the idea that since they did not want compensation for their materials, others should also not be be able to profit off of them financially, writing:

"For educational materials, I would not seek compensation - but I would also want to ensure someone else was not making money off of my efforts (i.e., the materials contributed could not be sold by another party)."

Fairness also came up when judging different potential models of compensation (Question 6, 8 – 10). Multiple respondents brought up that fixed rate, per submission compensation would be more fair than popularity systems or lottery systems for compensation. We break down these concerns further below.

A number of respondents had fairness concerns about compensation scaling with usage. One respondent, quoted in Section 4.8, was concerned that popularity, if used to guide compensation amounts, wouldn't be a fair representation of the utility of OER in niche topics. Another respondent was concerned about the impact individuals' existing networks would have on fair compensation.

"I think it should be based on effort of contributing. Basing it on popularity seems like those with a wider following would get more compensation, but those from a smaller institution with really good materials would be left behind."

One respondent had fairness concerns of the lottery compensation, in light of the equal expected value in the question posed.

"I think I would prefer a fixed dollar amount, so that those who contribute a small amount would still receive some compensation, as opposed to those that contribute a lot having a larger chance for all of the compensation."

4.9.1 Discussion: Fixed compensation guarantees a fairer baseline. Regardless of the particular focus our respondents had, there was a clear signal in the data that use-based models and lottery-based models of compensation can be unfair or have the appearance of unfairness. This unfairness can further be exacerbated by existing inequities in our field with respect to which faculty already have strong professional networks and potential discrimination based on institution and identity. How to address this is a complex issue influencing the already open question of how to structure compensation.

5 LIMITATIONS

This work is limited in a few ways. First, our survey response rate is relatively low. While the responses still enable us to mine and speak about themes found in the data, we cannot make broader quantitative claims with respect to the prevalence of certain viewpoints among the whole community of computing educators. In addition to the relatively low response rate, we did not request demographic data from our respondents. This limits the degree to which we can fully understand the population of our respondents. Future work could produce a survey with more reach and explicitly include demographic data collection, perhaps by attaching it to existing OER platforms as a feedback mechanism.

Additionally, there is a likelihood for some bias in our sample. Our survey was explicitly advertised as a survey about OERs and disseminated via a SIGCSE mailing list with engaged computing education researchers and computing instructors. It is likely that our respondent sample was biased towards those with at least some interest in OER while missing more OER cautious and skeptical instructors. Further, our survey offered compensation, which may have biased our sample in favor of those who accept compensation. Future investigations into OER would benefit by expanding their reach to other instructors, particularly those at smaller universities who may not be as plugged into SIGCSE but would benefit from access to OERs.

6 SYNTHESIS AND CONCLUSION

In this work, we report on the themes gleaned from a survey on OERs. In particular, we are able to investigate deeply what motivates and could motivate contributions to OERs, which is currently understudied. Our respondents report a broad range of incentives that would work for them, from knowing that their contributions are being used, to professional recognition, to monetary compensation. We discuss the implications of our findings for the development of future OER repositories and funding structures to support them.

One key area of work is to facilitate recognition of OER contributions in the promotion and tenure process. An important step in this facilitation would be supporting some form of statistics and usage pages for individual OER submissions and contributors' overall content profiles. Generating such pages allow instructors to quickly assess the impact of their contributions, and URL-based sharing enables promotion and tenure committees and letter writers trustworthy access without needing the pages to be made public. Efforts like peer review to make the process more scholarly are important, but it isn't clear how to make them scale. Finally, working to normalize the recognition of OER contributions as scholarly work, perhaps through the annual CRA meeting, will likely be necessary.

One possible way for OER platforms to introduce more peer review to OERs is to (1) periodically review highly popular items and provide reviewed items with some form of quality label and (2) run special issues for OER collection which publish OERs on similar content as a unit. Both of these may be similar to the special issues Engage-CSEdu.org [13] and the latter may be a useful way to attract and incentivize rarer content.

OER platforms should strive to balance the competing desires for supporting discoverability and recognition with the desire for and benefits of anonymity. In an ideal world, OER platforms would support some form of validated login, but the effort of validating users' identities may be untenable. At least, on a contributor level, instructors should get to decide whether or not their contributions are searchable by name or not. This recommendation also expands to other platform features such as content rating and commentary systems.

Another key area of work is to identify funding structures that will facilitate OER-based courses to compete with commercial offerings. Computing is a fast moving discipline with high demands for automated and interactive materials. While individual faculty have developed high quality content and course infrastructures, we need to convince them to put them into the public domain and

facilitate their discovery and curation into complete course ecosystems. It is our belief that given faculty live sufficiently complex and demanding lives, this work will not happen sustainably without compensation. Further, the precise form of monetary compensation is difficult to select: some baseline compensation for the effort of uploading material is the fairest option, but it may incentivize numerous submissions to accrue multiple small rewards. The effort to properly balance the compensation mechanism is non-trivial.

That said, it may not require an enormous amount of funding. It is surprising how much the attendance of a faculty meeting can be increased by offering a free lunch. Many faculty have already developed great resources, we just need to nudge them to clean them up, share them, and maintain them. Finding the right cocktail of praise, recognition, and monetary compensation to accomplish this is exciting open research.

ACKNOWLEDGMENTS

REFERENCES
[1] 2022. ACM SIGCSE. https://sigcse.org/membership
[2] 2023. LibreTexts. https://libretexts.org/
[3] 2023. OpenStax. https://openstax.org/
[4] IS Abeywardena, G Dhanarajan, and Chee Seng Chan. 2012. Searching and locating OER: Barriers to the wider adoption of OER for teaching in Asia. In *Proceedings from the Regional Symposium on Open Educational Resources: An Asian perspective on policy and practices.* 19–21.
[5] Maimoona H Al Abri, Brenda Bannan, and Nada Dabbagh. 2022. The design and development of an open educational resources intervention in a college course that manifests in open educational practices: a design-based research study. *Journal of Computing in Higher Education* (2022), 1–35.
[6] Gregory Allen, Alberto Guzman-Alvarez, Amy Smith, Alan Gamage, Marco Molinaro, and Delmar S Larsen. 2015. Evaluating the effectiveness of the open-access ChemWiki resource as a replacement for traditional general chemistry textbooks. *Chemistry Education Research and Practice* 16, 4 (2015), 939–948.
[7] I Elaine Allen and Jeff Seaman. 2014. Opening the Curriculum: Open Educational Resources in US Higher Education, 2014. *Babson Survey Research Group* (2014).
[8] I Elaine Allen and Jeff Seaman. 2016. *Opening the Textbook: Educational Resources in US Higher Education, 2015-16.* ERIC.
[9] Olga Maria Belikov and Robert Bodily. 2016. Incentives and barriers to OER adoption: A qualitative analysis of faculty perceptions. *Open praxis* 8, 3 (2016), 235–246.
[10] TJ Bliss, John Hilton III, David Wiley, and Kim Thanos. 2013. The cost and quality of open textbooks: Perceptions of community college faculty and students. (2013).
[11] William G Bowen, Matthew M Chingos, Kelly A Lack, and Thomas I Nygren. 2014. Interactive learning online at public universities: Evidence from a six-campus randomized trial. *Journal of Policy analysis and Management* 33, 1 (2014), 94–111.
[12] Fred D Davis. 1989. Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS quarterly* (1989), 319–340.
[13] EngageCSEdu. 2023. Engagement Practices |EngageCSEdu. www.engage-csedu. org/index.php/engagement_practices.
[14] Barbara J Ericson and Bradley N Miller. 2020. Runestone: A platform for free, online, and interactive ebooks. In *Proceedings of the 51st ACM Technical Symposium on Computer Science Education.* 1012–1018.
[15] Andrew P Feldstein DPS, Mirta Martin, Amy Hudson, Kiara Warren, John Hilton III, David Wiley, et al. 2012. Open textbooks and increased student access and outcomes. *European Journal of Open, Distance and E-Learning* (2012).
[16] Dan Garcia, Armando Fox, Solomon Russell, Edwin Ambrosio, Neal Terrell, Mariana Silva, Matthew West, Craig Zilles, and Fuzail Shakir. 2023. A's for All (As Time and Interest Allow). In *Proceedings of the 54th ACM Technical Symposium on Computer Science Education V. 1* (Toronto ON, Canada) *(SIGCSE 2023).* Association for Computing Machinery, New York, NY, USA, 1042–1048. https://doi.org/10.1145/3545945.3569847
[17] Scott D. Halpern, Rachel Kohn, Aaron Dornbrand-Lo, Thomas Metkus, David A. Asch, and Kevin G. Volpp. 2011. Lottery-based versus fixed incentives to increase clinicians' response to surveys: lottery-based versus fixed incentives. *Health*

Services Research 46, 5 (Oct. 2011), 1663–1674. https://doi.org/10.1111/j.1475-6773.2011.01264.x

[18] Dalia Hanna, Abdolreza Abhari, and Alexander Ferworn. 2017. Comparing quantitative and comment-based ratings for recommending open educational resources. In *Proceedings of the 20th Communications & Networking Symposium (CNS '17)*. Society for Computer Simulation International, San Diego, CA, USA, 1–10.

[19] John Hilton. 2016. Open educational resources and college textbook choices: A review of research on efficacy and perceptions. *Educational technology research and development* 64 (2016), 573–590.

[20] John Hilton III, TJ Bliss, T Jared Robinson, and David A Wiley. 2013. An OER COUP: College teacher and student perceptions of open educational resources. (2013).

[21] John Hilton III and Carol Laman. 2012. One college's use of an open psychology textbook. *Open Learning: The Journal of Open, Distance and e-Learning* 27, 3 (2012), 265–272.

[22] Gary Hsieh and Rafał Kocielnik. 2016. You Get Who You Pay for: The Impact of Incentives on Participation Bias. In *Proceedings of the 19th ACM Conference on Computer-Supported Cooperative Work & Social Computing* (San Francisco, California, USA) *(CSCW '16)*. Association for Computing Machinery, New York, NY, USA, 823–835. https://doi.org/10.1145/2818048.2819936

[23] Susan R. Jones, Vasti Torres, and Jan Arminio. 2013. *Negotiating the complexities of qualitative research in higher education: Fundamental elements and issues, second edition.* 1 – 235 pages. https://doi.org/10.4324/9780203123836

[24] Cynthia Bailey Lee and Beth Simon. 2022. Peer Instruction for Computer Science. http://peerinstruction4cs.com. Accessed: 2022-07-28.

[25] Brian L Lindshield and Koushik Adhikari. 2013. Online and campus college students like using an open educational resource instead of a traditional textbook. *Journal of Online Learning and Teaching* 9, 1 (2013), 26–38.

[26] Andrew Mao, Ece Kamar, Yiling Chen, Eric Horvitz, Megan Schwamb, Chris Lintott, and Arfon Smith. 2013. Volunteering versus work for pay: Incentives and tradeoffs in crowdsourcing. In *Proceedings of the AAAI Conference on Human Computation and Crowdsourcing*, Vol. 1. 94–102.

[27] MERLOT. 2023. MERLOT. merlot.org/merlot.

[28] Brad Miller and David Ranum. 2014. Runestone interactive: tools for creating interactive course materials. In *Proceedings of the first ACM conference on Learning@ scale conference.* 213–214.

[29] Sanjaya Mishra. 2017. Open educational resources: Removing barriers from within. *Distance education* 38, 3 (2017), 369–380.

[30] Joel Samson Mtebe and Roope Raisamo. 2014. Challenges and instructors' intention to adopt and use open educational resources in higher education in Tanzania. *International review of research in open and distributed learning* 15, 1 (2014), 249–271.

[31] Rosa Navarrete and Diana Martínez-Mosquera. 2020. Overcoming Barriers for OER Adoption in Higher Education Application to Computer Science Curricula.. In *CSEDU (1).* 559–566.

[32] Shaul Oreg and Oded Nov. 2008. Exploring motivations for contributing to open source initiatives: The roles of contribution context and personal values. *Computers in Human Behavior* 24, 5 (2008), 2055–2073. https://doi.org/10.1016/j.chb.2007.09.007 Including the Special Issue: Internet Empowerment.

[33] Nayantara Padhi. 2018. Acceptance and usability of OER in India: An investigation using UTAUT model. *Open Praxis* 10, 1 (2018), 55–65.

[34] Nick Parlante, John K Estell, David Reed, David Levine, Dan Garcia, and Julie Zelenski. 2002. Nifty assignments. *ACM SIGCSE Bulletin* 34, 1 (2002), 319–320.

[35] Nancy Pawlyshyn, Dr Braddlee, L Casper, and H Miller. 2013. Adopting OER: A case study of crossinstitutional collaboration and innovation. *Educause Review* (2013).

[36] Tanya Percy and Jean-Paul Van Belle. 2012. Exploring the barriers and enablers to the use of open educational resources by university academics in Africa. In *Open Source Systems: Long-Term Sustainability: 8th IFIP WG 2.13 International Conference, OSS 2012, Hammamet, Tunisia, September 10-13, 2012. Proceedings 8.* Springer, 112–128.

[37] Jeffrey A. Roberts, Il-Horn Hann, and Sandra A. Slaughter. 2006. Understanding the motivations, participation, and performance of open source software developers: a longitudinal study of the apache projects. *Management Science* 52, 7 (July 2006), 984–999. https://doi.org/10.1287/mnsc.1060.0554

[38] Vivien Rolfe. 2012. Open educational resources: staff attitudes and awareness. *Research in Learning Technology* 20 (2012).

[39] Niall Sclater. 2011. Open educational resources: Motivations, logistics and sustainability. *Content management for e-learning* (2011), 179–193.

[40] Julia E Seaman and Jeff Seaman. 2017. Opening the Textbook: Educational Resources in US Higher Education, 2017. *Babson Survey Research Group* (2017).

[41] Julia E Seaman and Jeff Seaman. 2020. Inflection Point: Educational Resources in US Higher Education, 2019. *Bay View Analytics* (2020).

[42] Julia E Seaman and Jeff Seaman. 2021. Digital Texts in the Time of COVID: Educational Resources in US Higher Education, 2020. *Bay View Analytics* (2021).

[43] Lassaad Smirani and Jihane Boulahia. 2022. Using the unified theory of acceptance and use of technology to investigate the adoption of open educational resources by faculty members. *International Journal of Information Technology* 14, 6 (2022), 3201–3211.

[44] David H Smith IV, Qiang Hao, Christopher D Hundhausen, Filip Jagodzinski, Josh Myers-Dean, and Kira Jaeger. 2021. Towards modeling student engagement with interactive computing textbooks: An empirical study. In *Proceedings of the 52nd ACM Technical Symposium on Computer Science Education.* 914–920.

[45] Hengtao Tang, Yu-Ju Lin, and Yingxiao Qian. 2020. Understanding K-12 teachers' intention to adopt open educational resources: A mixed methods inquiry. *British Journal of Educational Technology* 51, 6 (2020), 2558–2572.

[46] Joseph Taylor and Ramakrishna Dantu. 2022. For Love or Money? Examining Reasons behind OSS Developers' Contributions. *Information Systems Management* 39, 2 (2022), 122 – 137. https://doi.org/10.1080/10580530.2021.1879323

[47] Richard H Thaler and Cass R Sunstein. 2009. *Nudge: Improving decisions about health, wealth, and happiness.* Penguin.

[48] Beth Tillinghast. 2020. Developing an Open Educational Resource and Exploring OER-Enabled Pedagogy in Higher Education. *IAFOR Journal of Education* 8, 2 (2020), 159–174.

[49] Beth Tillinghast. 2021. Using a technology acceptance model to analyze faculty adoption and application of open educational resources. *The International Journal of Open Educational Resources* 4, 1 (2021).

[50] Oksana Tokarchuk, Roberta Cuel, and Marco Zamarian. 2012. Analyzing Crowd Labor and Designing Incentives for Humans in the Loop. *IEEE Internet Computing* 16, 5 (2012), 45–51. https://doi.org/10.1109/MIC.2012.66

[51] UNESCO. 2002. Forum on the Impact of Open Courseware for Higher Education in Developing Countries. 3 (2002).

[52] UNESCO. 2019. Recommendation on Open Educational Resources. 3 (2019).

[53] Aditya Vashistha, Edward Cutrell, and William Thies. 2015. Increasing the Reach of Snowball Sampling: The Impact of Fixed versus Lottery Incentives. In *Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work & Social Computing* (Vancouver, BC, Canada) *(CSCW '15)*. Association for Computing Machinery, New York, NY, USA, 1359–1363. https://doi.org/10.1145/2675133.2675148

[54] Viswanath Venkatesh, Michael G Morris, Gordon B Davis, and Fred D Davis. 2003. User acceptance of information technology: Toward a unified view. *MIS quarterly* (2003), 425–478.

[55] Viswanath Venkatesh, James YL Thong, and Xin Xu. 2016. Unified theory of acceptance and use of technology: A synthesis and the road ahead. *Journal of the association for Information Systems* 17, 5 (2016), 328–376.

[56] Matthew West, Geoffrey L. Herman, and Craig Zilles. 2015. PrairieLearn: Mastery-based Online Problem Solving with Adaptive Scoring and Recommendations Driven by Machine Learning. In *2015 ASEE Annual Conference & Exposition.* ASEE Conferences, Seattle, Washington.

[57] Matthew West, Nathan Walters, Mariana Silva, Timothy Bretl, and Craig Zilles. 2021. Integrating diverse learning tools using the prairielearn platform. In *Seventh SPLICE Workshop at SIGCSE.*

[58] David Wiley. 2014. The Access Compromise and the 5th R. https://opencontent.org/blog/archives/3221

[59] David Wiley, John Levi Hilton III, Shelley Ellington, and Tiffany Hall. 2012. A preliminary examination of the cost savings and learning impacts of using open textbooks in middle and high school science classes. *International Review of Research in Open and Distributed Learning* 13, 3 (2012), 262–276.

[60] Julie Willems and Carina Bossu. 2012. Equity considerations for open educational resources in the glocalization of education. *Distance Education* 33, 2 (2012), 185–199.

[61] Yueqing Yin and Lei Fan. 2011. Trends of open educational resources in higher education. In *Proceedings of the 4th international conference on Hybrid learning (ICHL'11)*. Springer-Verlag, Berlin, Heidelberg, 146–156.

[62] Craig Zilles, David P Bunde, Jaime Spacco, Cynthia Lee, Leo Porter, and Cynthia Taylor. 2022. Spiffy Peer Instruction Questions. In *Proceedings of the 54th ACM Technical Symposium on Computer Science Education V. 2.* 1226–1227.

[63] Craig Zilles, Matthew West, David Mussulman, and Timothy Bretl. 2018. Making testing less trying: Lessons learned from operating a Computer-Based Testing Facility. In *2018 IEEE Frontiers in Education (FIE) Conference.* San Jose, California.