

ARTICLE

Secondary Students' Perceptions of Open Science Textbooks

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In an attempt to align instructional resources with new state standards and to increase teacher awareness of these standards, one large suburban public school district piloted the development and adoption of open secondary science textbooks. Open textbooks created by teachers in grades six through nine replaced conventional science textbooks provided by mainstream publishing companies. Therefore, grade nine students were not included in this study. At the end of the first quarter, middle school students (grades six through eight) who used the open textbooks were surveyed. Survey responses required respondents to consider their learning before and during the use of the open textbook. The survey included quality and presentation of content questions, as well as an opportunity for students to explain their responses. There were qualitative and quantitative indications that students' perceptions of an open textbook in place of a standard textbook are improving students' attitudes and behaviors toward learning.

Keywords: secondary; open textbooks; perceptions; OER; student; science

Introduction

From the launch of the World Wide Web to the everyday use of smartphones, technology has become an integral component of the lives of our nation's citizens. In fact, 38% of children under the age of two have used a mobile device (Common Sense Media Study, 2013). Therefore, it is only practical that technology continues to become a fundamental part of public education. The internet has increased our ability to acquire knowledge on a larger scale, expanding perspectives, resources, and our capability to share with one another for a minimal to nonexistent cost.

Open Education Resources (OER) refers to a variety of resources, distributed for free under an open license that grants comprehensive consent for full reuse rights to the public that include copying, printing, and modifying. In 2013, the William and Flora Hewlett Foundation defined OER as "teaching, learning, and research resources that reside in the public domain or have been released under an intellectual property license that permits their free use and re-purposing by others" (Hewlett, 2013). Wiley (2014) describes how users may interact with an OER through the 5 R's. Users are able to retain, reuse, revise, remix and redistribute the content in an OER. By adding the 5th R, retain, in his 2014 blog post, Wiley attempts to clarify confusion concerning ownership, thus reinforcing the importance of openly licensing content.

The open license for an OER can be created through a Creative Commons license.

Creative Commons provides an easy avenue for creators to decide on the type of license they want to use and, then, create it. Decisions a creator must make include whether they want to allow their content to be used for commercial purposes and whether they want other users to be able to license other works created with the original content under a different license type. Once an open license has been established for content, users are able to interact with the content as described in the 5 R framework (Wiley) without the restrictions of copyright laws.

The use of one type of OER, an open textbook, as a replacement for the conventional textbook is in its beginning stages in public K-12 education in the USA. An open textbook is a curation of information similar to a traditional textbook. However, an open textbook is openly licensed making it freely available to teachers and students to use. The adoption cycle for each content area in Oklahoma State is traditionally six years, but because of budget shortfalls at the state level, the adoption of new science textbook was delayed an additional four years.

Washington Public Schools decided to support a pilot initiative to use open textbooks in place of textbooks for middle school grades (grades 6–8) in their Freshman Academy. Each grade level/content area scheduled three days for a six-teacher team to meet and create a district open textbook. Each team came together with an instructional sequence of standards.

After an introduction to the Creative Commons, the 5 Rs, and open textbooks teachers divided the sequence into three sections and worked in pairs assembling open

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content they felt would best support students' progressing towards the performance expectations. Each open textbook was created in a district Google drive.

The district provided teachers with a template which guided them in writing styles, font size, margins, and spacing. The teachers made a note of each academic standard, identified skills and depth of knowledge included in each assessment, and were encouraged to provide interactive and grade-level appropriate text. All reading text was remixed using content from the CK-12 website which includes only resources under the Creative Commons License (<https://www.ck12.org>). However, the teachers were also given significant discretionary space to select and arrange the sequence of topics, supporting material, and assessment items.

Pilot year funds were \$2100 per book for substitute coverage during OER development days. There were 5 books produced for a total of US\$ 10,500 in substitute expenses. Printing of grades 6–8 texts was approximately US\$25,000 with costs ranging from US\$6–12 per book. Grade 9 open textbooks were digital because each student was provided a device, so there was no printing cost.

Review of Literature

The history of OER began in 1994 when Wayne Hodgins introduced the concept of the “learning object.” The resulting initiative emphasized the popularity of digital materials designed for exchange and reuse by educators. By 1998, Wiley, who is considered to be one of the founding fathers of the OER movement, transferred the term “learning object” into “open content” and created the first related licensure – the Open Publication License. Although this license accelerated the creation of OER, it was considered confusing and subject to legal issues (Wiley, n.d.). In 2001, the Open Publication License developed into the Creative Commons License. This license improved the legal viability of public access to instructional resources. This same year the Massachusetts Institute of Technology (MIT) released their OpenCourseWare, which involved publishing almost all their university courses and making them available to the public for non-commercial use. Finally, in 2002, the United Nations Educational, Scientific, and Cultural Organization (UNESCO) sponsored a meeting for those leading a movement towards developing universal education resources which lead to the development of referencing these learning devices as OER. Despite almost two decades of development and the increasing use of OER projects at hundreds of universities in dozens of countries, there is limited research available regarding higher education students' perceptions and no research on K-12 students' perceptions of using an open textbook.

Perceptions of Open Textbooks

Hilton (2016) conducted a review of the research surrounding both efficacy and perceptions in higher education. Based on his findings, there have been nine peer-reviewed empirical studies on the teacher and student perception of using open textbooks. To meet the criteria Hilton set for inclusion in the review, an OER had to be the primary learning resources, there had to be over 50

participants, and the research had to have been published before October 2015.

Of the nine studies, five studies focused on student perception of an OER as compared to traditional resources (Bliss, Hilton, Wiley, & Thanos, 2013a; Bliss, Robinson, Hilton, & Wiley, 2013b; Gil, Candelas, Jara, Garcia, & Torres, 2013; Hilton, Gaudet, Clark, Robinson, & Wiley, 2013; Pitt, Ebrahimi, McAndrew, & Coughlan, T. 2013). A study conducted by Petrides, Jimes, Middleton-Detzner, Walling, and Weiss (2011) focused on preference in which they found that two-thirds of students preferred using an open textbook over a traditional textbook. They noted that cost was a significant factor for this preference. Since the current study focuses on K-12 students who do not pay for their textbooks, the cost is not a factor addressed. However, the cost has been identified as an important factor in another perception study in higher education (Lindshield & Adhikari, 2013) because “students consistently reported that they faced financial difficulties and that OER provided a financial benefit to them” (Hilton, 2016, p. 588).

The results of two other studies (De los Arcos, Farrow, Pitt, Weller, & McAndrew 2016; Kimmons, 2015) indicate teachers have a positive perception of the quality of open textbooks as compared to traditional textbooks. These two studies included over three hundred participants in three different countries. The context of all perceptions studies that focus on OER has been in higher education. However, with the increased adoption, creation, and use of open textbooks due to the United States Department of Education's #GoOpen initiative, more research in K-12 contexts needs to be conducted.

The #GoOpen campaign supports and encourages districts as they begin the process of going open. As of the writing of the current study, there have been 91 school districts in 27 different states who have committed to transitioning to OER (United States Department of Education, n.d.). The students in this study attend one of the #GoOpen schools.

All studies on open textbook perception include teacher or higher education students as participants. Students in K-12 schools have yet to be studied, which has led to the current study and research question: what are middle school students' perceptions of using an open science textbook?

A 2006 study on textbook use noted that textbook publishers and authors appear to have limited regard for how students learn (Carpenter, Bullock, & Potter). If OER is a product constructed by educators who *do* appreciate how students learn and, in turn, their involvement in that process results in improving their practice, then it does seem practical to examine students' perception of OER.

Theoretical Framework

When deciding to adopt an innovation, institutions usually progress through a complex process. Users of the innovation go through this decision-making process when considering whether or not to implement the new idea or concept. This is true of school districts who adopt open textbooks and users include not only the administrators

or teachers, but also the students. This study examines student use as they are part of the social system. Rogers (2003) defines social system as “a set of interrelated units engaged in joint problem-solving to accomplish a common goal” (p. 23). The individual units work together to identify and solve problems to help with implementation. In the case of this study, the students were able to identify and describe difficulties they faced when using the open textbooks. Once these challenges were brought to the attention of the teachers and administrators they were able to make adjustments and modifications to allow for greater ease of use, which should lead to a quicker rate of adoption according to Rogers.

Methodology

The purpose of this research was to examine the perceptions of middle school students who use open textbooks in place of traditional textbooks. Middle school (grades six-eight) students had their own print copy of the open textbook and anonymously answered questions on a paper survey administered by their teacher to monitor students' perception of the open textbook and their learning.

Significance of Study

Using OER in place of traditional textbooks can save school districts money. The OER online texts are free to access, and printed copies cost around \$5 apiece which is significantly cheaper than secondary textbooks that cost around \$100 each (Kamenetz, 2013). This reduction in costs could assist public K-12 school districts with providing resources despite the lack, or complete absence, of available funds.

Participants

The participants in the study are students in grades sixth through eighth from five different middle school sites. **Table 1** shows 2015–16 student enrolment and the number of students who scored proficient or above on the latest standardized science assessment for each site, based on the district's School Net student management system. Teachers used the open science textbooks to teach the student learning outcomes measured in the standardized state science test.

In the spring of 2014, the state where the study took place adopted new educational standards for science. They were signed into rule the following summer (State Department of Education, 2014). The late adoption of the standards allowed textbook vendors limited time to establish standard-aligned resources. This delayed

Table 1: Number of Students Enrolled & Standardized State Science Proficiency.

School Site	Sixth Grade	Seventh Grade	Eighth Grade	Percent Proficient
Site 1	343	366	351	55
Site 2	269	246	258	67
Site 3	280	276	264	63
Site 4	284	274	257	64
Site 5	195	202	172	42

adoption, in combination with the ever-present shortfall of educational funding, has led to some public K-12 school districts in the state to consider open textbooks to replace out-of-date science textbooks.

The open textbook provided to students included a perfect-bound, black and white hard copy text. The students and teachers also had access to a color version online. In addition to color, using the online version of the open textbook allows students to view supporting videos, participate in virtual laboratory exercises, and employ the use of the Google Read and Write application when they log into the district account from any electronic device.

Instrument

Survey questions were selected from surveys created by the OER Research Hub (OERRH, 2014; Farrow, Perryman, de los Arcos, Weller, & Pitt, 2014). Students using an open textbook were provided a paper survey administered by their science teacher. Questions provided a choice (i.e. yes/no, more/less) with an opportunity to explain their choice. These questions encouraged comparisons with learning before and while using an open textbook.

Results

The frequency for each question on the survey was tabulated for each question. The results from the open-ended portion of the questions were coded and analyzed based on each question. An immersion approach to coding was used. The coding emphasized researcher “insight, intuition, and creativity” (Bloomberg & Volpe, 2008). For example, for question one, a student response that included positive terms, or their comparable, such as “easier,” “like,” or “good” were coded as a “positive” response to question one. The results of this analysis of the survey questions are shown in the graphs below. Further discussion on these results follows. The term “OER” is referencing the open science textbook.

The first survey question (**Figure 1**) is designed to discover students' specific experiences with the open textbook and asks ‘What has been your experience using OER in class and for learning?’ Hundreds of students appeared to answer as if they read this question as “How has your experience been...”. The majority ($n = 212$) of these respondents were positive providing responses such as “My experience is good so far,” “they are easy to use,” and “they have helped me learn a lot.” Another set of positive responses ($n = 107$) were based on personal ownership of the text. The ability to have access to the text at their discretion at all times was also stated. Dozens of like responses were also neutral ($n = 50$) or negative ($n = 22$) such as “It's been pretty much the same as a textbook,” or “I hate it because I hate reading.”

Sixty-four percent of the 176 students who did provide specific experiences referenced writing or highlighting within the open textbook, while only about 10% noted using the internet supported resources such as videos, demonstrations, or online practice quizzes. There were also a few dozen students ($n = 36$) who cited a specific reference to science content or tools such as the Periodic Table, atoms, molecules, or scientific processes. A group

of students who made a statement about their limited exposure was also represented in the survey results. An interesting note is all these students were from the same middle school site and in the same grade which may indicate one or more teachers are not using the open textbooks.

The second question (**Figure 2**) asked students to reflect and consider whether the OER was changing the way they are learning. Over one-fourth of respondents (26%) stated there was no change and the “open textbook is just like my other textbooks.” However, there were students who stated there was a positive change to their learning because presented concepts were “easier” to understand ($n = 221$), or they were more engaged because concepts were more challenging or because they could write in the text ($n = 157$). There were a small number of students who cited a specific experience that seemed to make learning different to them including the use of

“video links,” discussion, reading support, or finding the presentation more enjoyable (“I find it cool that we can go through our textbooks while the teacher has it on the SMART board”). There were a few dozen students who sensed a difference in their learning but could not articulate what it was. For example, one student stated, “Yes, it’s something. I don’t know.” Only six students stated a negative difference in learning, but all of these responses were specific to the black and white hard copy text – not the online open textbook.

The third survey item (**Figure 3**) asked students to note whether the open textbook made any difference to their motivation to study. Almost 70% ($n = 501$) of students indicated they were more motivated to study. Only 47 of these respondents provided no explanation, the remaining 454 indicated the increased motivation resulted from less intimidating presentation or the textbook was more interesting, engaging (i.e. videos, online interactive features,

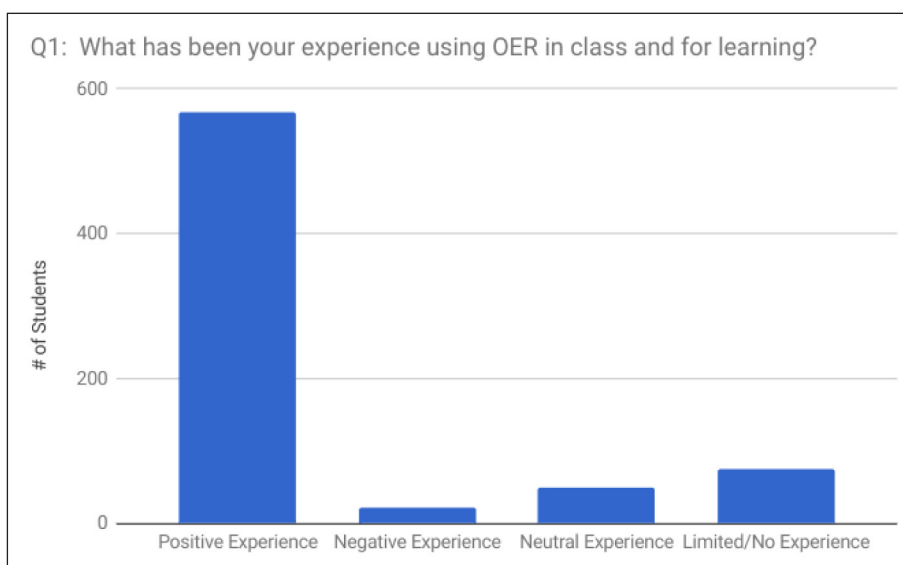


Figure 1: Student Perception of OER Learning Experience.

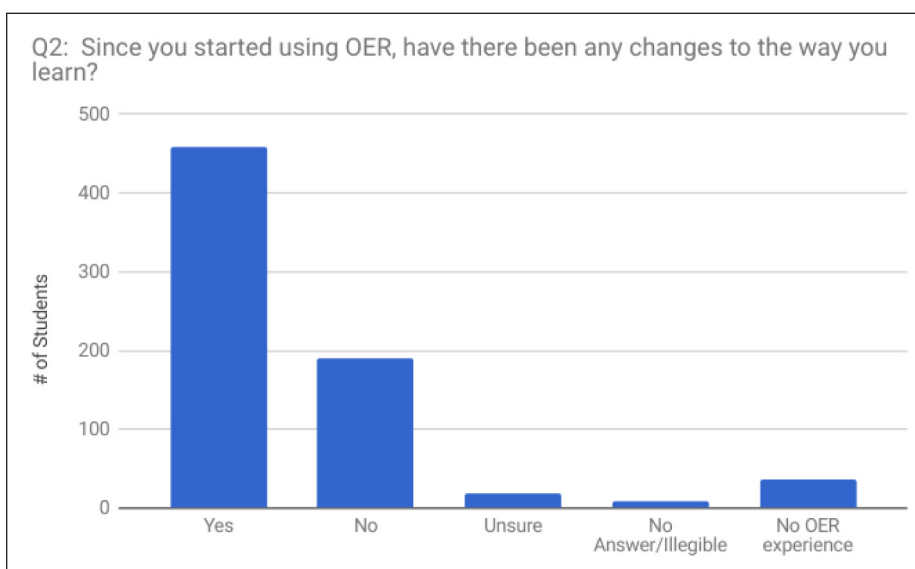


Figure 2: Student Perception of OER and Learning Differences.

being able to write in the hard copy open textbook), and relevant. A smaller portion ($n = 96$) stated they were less motivated to study. Although almost a third of these students provided no explanation ($n = 32$), the others stated a lack of motivation for a variety of reasons including the lack of color in the black and white printed version of the open textbook, and the textbook not having a glossary or index. A handful of students ($n = 5$) implied that owning the text resulted in a mismanagement of time. ("Less [motivated] because you can take it home. When I take things home, I don't do them.") An interesting note was some of these students ($n = 19$) explained they were less motivated to study because what they were required to learn came more easily, "Less because I'm learning faster, so I don't need to study."

After asking students whether the open textbook has made a difference in how students *feel* about studying, the following question asked whether the open textbook has made a difference to *how* students study – if and when they do study. The results of question four (**Figure 4**) showed that slightly less than half of the students ($n = 322$) said there was no difference in the way they

were studying. Although well over half of these respondents ($n = 195$) refrained from providing any supporting explanation, another fourth of them ($n = 79$) indicated no difference since the open textbook is "really the same as a normal book" or a smaller number ($n = 48$) stated no change because they had not had enough exposure to the resource.

Students who stated that the open textbook had made a difference in their studying were far more likely to explain how and why ($n = 375$); and there were a variety of examples noted. Several listed using the internet resources, highlighting the text as they read, making notes in the margin, or finding that they are using their class time differently (i.e. less note-taking, more discussion). There were a few students who indicated they were "getting better grades" so they felt there was a difference to their studies, but they could not explain why ($n = 25$). Only seven students indicated the open textbook had a negative effect on their studies and specifically referenced the black and white hardcopy.

The fifth question (**Figure 5**) asked students if they were satisfied with the quality of the open textbook as a

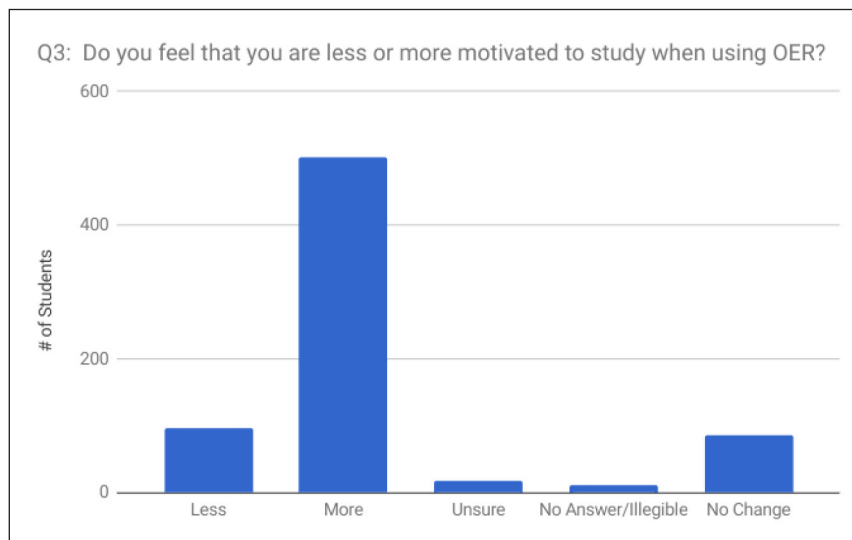


Figure 3: Student Perception on OER and Learning Motivation.

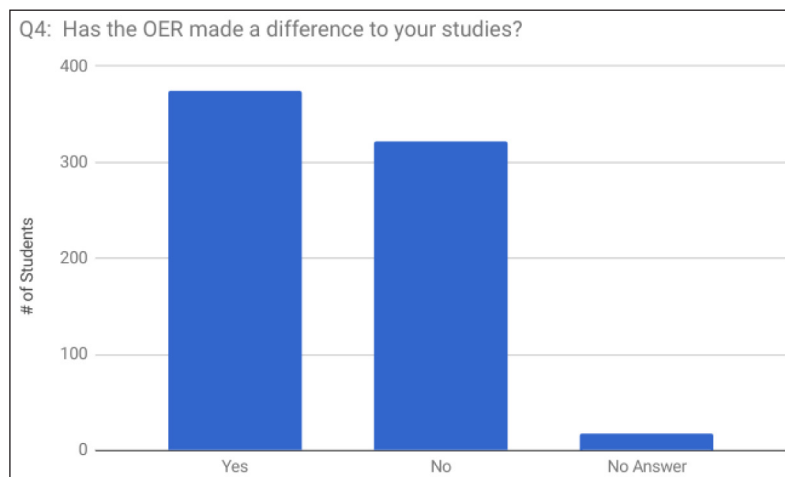


Figure 4: Student Perception on OER and Independent Study.

hardcopy text and/or with what is accessed online. The majority of students ($n = 572$) affirmed their satisfaction with the materials. Almost 20% of these respondents refrained from providing an explanation ($n = 112$). Another 20% ($n = 97$) explained in terms of the hard copy's structure and composition (i.e. "light and easy to carry," "doesn't break easy"), while the majority of these respondents ($n = 313$) referenced in terms of the content (i.e. "understandable," "gives us videos and pictures," "very good explanations"). There were 50 students who stated they were satisfied because they were able to write in them. A smaller number of students ($n = 77$) stated they were not satisfied in the same contexts. Some did not like the lack of color in the hardcopy or felt it was "flimsy" ($n = 38$), while others felt the content was "hard to read" or they felt obligated to use some of the embedded online features ($n = 15$). The remaining students who stated dissatisfaction with the quality of the open textbook ($n = 24$)

either provided no explanation or stated that they had not used the open textbook enough as their reason.

According to the responses to question 6 (Figure 6), over half of responding students ($n = 424$) stated there were benefits to using the open textbook. The benefits students listed included being able to write and highlight in the hardcopy text, more "understandable" explanations, and more accessibility due to having their own hard copy and an online version available. A few students stated that being able to write in them made them more organized. Most students who did not feel there were benefits did not provide an explanation ($n = 144$), and twelve of these stated they just had not used the resource enough.

A challenging aspect of this question is that it appears there was a notable portion of students who may not have understood the meaning of "benefits" or could not provide a specific example. These students ($n = 104$) submitted responses such as, "Well, it's helped me with my

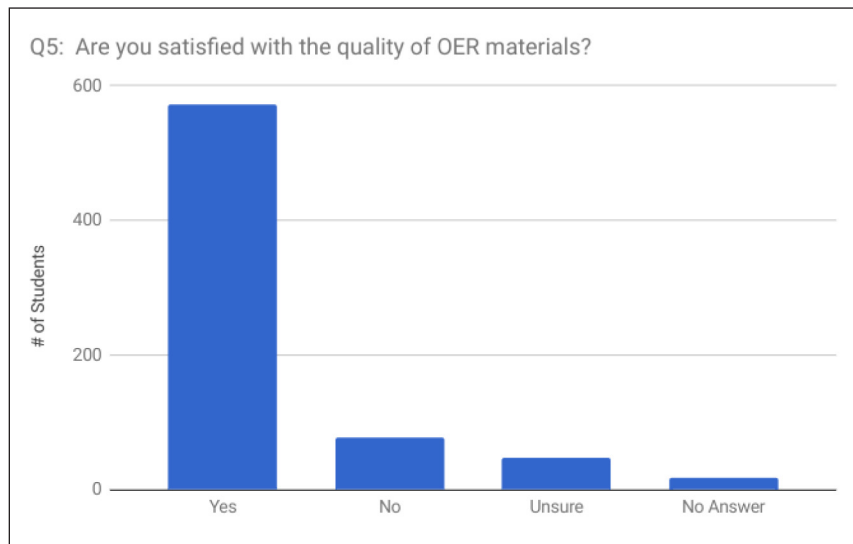


Figure 5: Student Perception of OER Quality.

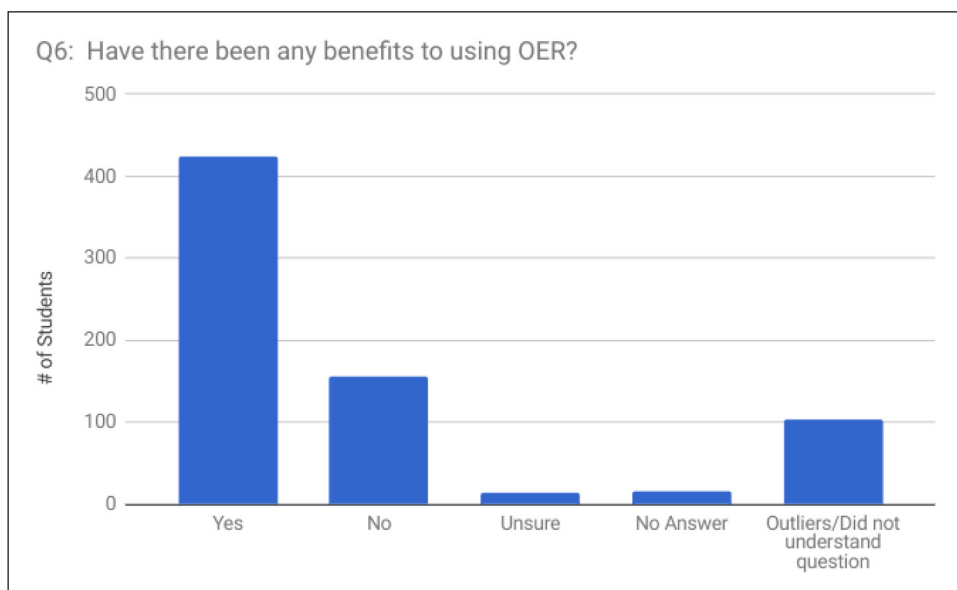


Figure 6: Student Perceptions on OER Benefits.

science class,” or “Yes, they need more color, though.” One student appeared to have looked up the meaning of the word benefits, but was not able to understand stating, “To have advantages – more specific.” Only 30 of the respondents answered that they were either unsure or did not respond.

For the seventh survey question (Figure 7) almost 70% of students ($n = 494$) stated there were no challenges to using the OER, and a large number of these did not provide an explanation for their response. The remaining thirteen of these respondents stated there were no challenges because they had too limited exposure to them to form an opinion. There were 197 students who identified challenges that were either related to the hard copy or the level of content. Students' explanations specific to the hard copy challenges were in regards to no color, lack of an index or glossary, difficulty seeing some of the pictures or limited writing space. Students who referenced the level of content as a challenge cited “hard questions”

or seemed to think the question asked them to identify specific science content they considered difficult by providing responses such as, “learning how the Periodic Table works” or “Yes, measuring stuff.” There were also a few in this response portion who stated the availability and accessibility created by the open textbook resulted in more accountability, which was perceived as a challenge. Examples include: “I have to keep track of a book now,” or “There’s no way to get out of reading it because it’s always there.”

The objective of the final survey item (Figure 8) was to solicit students' opinions regarding the future use of open textbooks. Almost 81% of students ($n = 577$) indicated “we should have more OER” because it positively affected their learning. Students stated they could “learn with no troubles” and wanted to see similar open textbooks in other content areas. A smaller number of respondents wanted to see “less OER” ($n = 73$) and referred to the absence of color, index, or glossary in the hard copy as

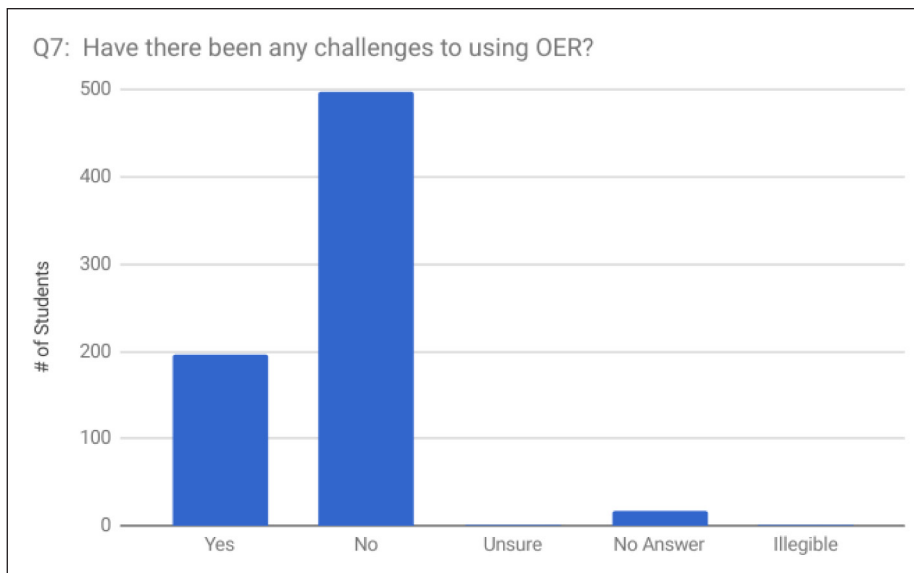


Figure 7: Student Perceptions on OER Challenges.

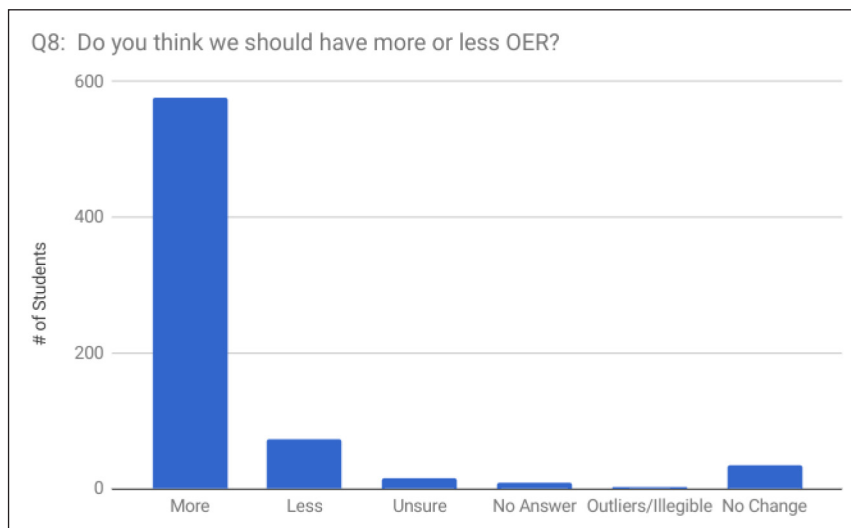


Figure 8: Student Perception on Frequency of OER Use.

learning barriers. There was also a small number of these students who thought there should be less use of open textbooks because they did not feel they were challenged, "Less because less work." Another set of students ($n = 39$) stated the current rate of open textbook use was satisfactory while another sixteen were unsure. There were nine students who did not answer and another three submitted an illegible response.

Discussion

Students' responses to this survey are indicative that the flexibility of open textbooks is more appealing than the more rigid, copyright-restricted textbooks typically used in the classroom. When considering the history of textbook use, one could say that the earliest handwritten versions were technically open, but their limited production resulted in limited availability. The invention of the printing press increased the availability of text, but even then, the content was often not relevant or current for students (Goslin, n.d.). The majority of students' responses supported the argument that the open textbook addresses both of these challenges by being readily available *and* modifiable to respond to the learners' needs and maintain relevance.

Although students have provided feedback that has been considered during the revisions of future editions, teachers have not formally incorporated open pedagogy assignments into their instruction. However, this could be something that results from continued open textbook use.

There are many elements that contribute to student learning, but it would seem natural to educators that curriculum materials play a role. "Theory and practice both suggest that well-designed science textbooks can enhance student understanding" (Chambliss & Calfee, 1989, p. 307). It is the definition of "well-designed" that is the point of contention among interested parties and may be clarified by the needs identified by students in this survey and further forthcoming OER research.

Limitations

At the time of data collection, students had only had limited exposure to the open textbook use, since it took place during the first quarter of the academic year. The novelty of the open textbook means students could have been excessively enamored with the notion of writing and highlighting in their text and increased use of technology. However, the initial reports by students are encouraging.

Implications

For students, the use of open textbooks instead of copyright-restricted texts appears to result in more positive student perceptions towards reading and learning. Students indicated the ability to write in the hard-copy text, or to access online videos that support the reading, makes the learning process more comfortable and the concepts more approachable. The personal ownership of the product also indicates an increase in the students' accountability of their learning. Furthermore, students are aware that teachers

are editing the open textbook every year and are encouraged to provide feedback on the product. This practice has resulted in students recommending resources that will better support concepts. It is possible that when students are given a voice in the refinement of open textbooks, it provides an opportunity for them to reflect on their learning.

For teachers, the development of the open textbook requires focused discussions on the student performance expectations that include deciding which are good indicators of mastery and which materials best support students' progress towards mastery. Also, because it is possible to revise and improve the open textbook every year, it is plausible the frequency of formatively assessing students' understanding is greater in classrooms utilizing the open textbooks. The OER curation and revision process has provided an opportunity for the curriculum to be considered more frequently and has allowed collaborative reflection on instructional methods.

The perceptions of open textbooks of the students in this study were, for the most part, positive. However, some negative aspects of using the open textbooks did emerge through coding the data from the open-ended questions on the survey. The school district in this study can take these perceptions of use into consideration and modify the open textbook to address the issues brought to light through this study. Also, other school districts planning on creating their own open textbook can consider these concerns in the early stages of development.

While this study indicates that secondary students seem to have a positive perception of using an open textbook, it does not address the implications using this resource may have on learning outcomes or potential cost savings for the district. Further research, beyond the limited body of literature of the two studies conducted on student learning outcomes in secondary science (Robinson, Fischer, Wiley, & Hilton, 2014; Wiley, Hilton III, Ellington, & Hall, 2012), is recommended.

Competing Interests

RM works for the school, which was the setting for this study. All other authors have no competing interests.

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