Understanding K-12 teachers’ intention to adopt open educational resources: A mixed methods inquiry

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Abstract
Teachers in K-12 settings often teach out of textbooks in order to provide differentiated instruction. Open educational resources (OER) might be an effective alternative to traditional textbooks for K-12 teachers because of a free access to a rich collection of open-licensed educational materials. Understanding how to encourage teachers to accept OER is thus critical. However, existing evidence mainly concerns the advantage of OER in cost reduction but overlooks the merit of openness. To fill this gap, this mixed methods inquiry, implementing the technology acceptance model, integrated qualitative and quantitative findings to obtain a comprehensive understanding of teachers’ intentions of adopting OER in K-12 settings. This study found that perceived ease of use and perceived usefulness predicted K-12 teachers’ intention to adopt OER with attitudes toward OER as a mediating variable. Perceived ease of use also determined perceived usefulness. Teachers’ perceptions of OER adoption were also examined for additional insight into the quantitative findings. Practical implications of adopting OER in K-12 curriculum were discussed.

Introduction
It is widely acknowledged that K-12 schools need to become well-versed in providing differentiated instruction beyond a one-size-fits-all model (Patrick & Sturgis, 2015). This trend challenges K-12 educators to teach outside of textbooks, given that textbooks often fail to provide exactly what educators want and students need (Kimmons, 2015, 2016). In general, textbook adoption is overseen by local school districts (eg, France, Portugal, Sweden and the United States) or administrated by regional (eg, China) and national educational authorities (eg, Malta, Mexico and Caribbean) (Adebayo, 2018; Brennetot, 2011). The uniform content in textbooks may not accommodate each student’s unique needs (Carpenter, Bullock & Potter, 2006). In addition, textbook publishers cannot rapidly respond to the latest changes in course standards resulting in a mismatch between contents and standards (Kimmons, 2016). Teachers, as mere content customers, have no control on the textbook adoption but have to resort to online supplemental resources to fill the gap (Blomgren, 2018). However, the high subscription fees and copyright restrictions constrain teachers in customizing many of these resources to meet the students’ needs.
Teachers’ intention to adopt OER

To overcome this challenge, K-12 educators can adopt open educational resources (OER), “teaching, learning and research materials in any medium, digital or otherwise, that reside in the public domain or have been released under an open license that permits no-cost access, use, adaptation and redistribution by others with no or limited restrictions” (UNESCO, n.d., para.1). The adoption of OER has been trending in K-12 settings because teachers can retain, reuse, revise, remix and redistribute free open-licensed resources.

In particular, the United States Department of Education launched the #GoOpen initiative to build a network of school districts to advocate implementing OER in K-12 settings. By the time of this writing, the #GoOpen campaign had involved 119 school districts in 20 states that promised to replace at least one traditional textbook by OER (Office of Educational Technology, n.d.). In addition, Morales and Baker (2018) reported that most of the surveyed middle school students from a #GoOpen school district preferred open textbooks because of a free and flexible access to high-quality content relevant to their needs. Teachers also favored the potential of OER to be implemented in K-12 settings because they could customize open-licensed resources at no cost while simultaneously acting as content creators and curators by remixing and redistributing OER (Kimmons, 2015, 2016).

Despite the seeming popularity of the #GoOpen campaign, it is difficult to ascertain whether OER adoption is pervasive in K-12 settings. de los Arcos et al. (2016) reported that a minority of K-12 teachers had ever heard about OER, while even fewer had been aware of Creative Commons (CC)

Practitioner Notes
What is already known about this topic

• K-12 teachers need to teach out of textbooks to provide differentiated instruction but publishers usually charge teachers high subscription fees without giving them permission to customize the resources.
• Open educational resources (OER) allow teachers to retain, reuse, revise, remix and redistribute free open-licensed resources.
• Teachers’ intention to use technology predicts their actual technology use, but evidence regarding reinforcing teachers’ intention to adopt OER is limited.

What this paper adds

• This paper demonstrates the perceived ease of use of OER is a primary factor in how useful teachers consider them to be, how teachers feel about them in general, and how likely they are to use OER.
• This paper shows perceived usefulness of OER determines teachers’ attitudes toward and intention to use OER.
• This paper shows teachers’ attitudes toward OER mediate the effect of perceived ease of use and perceived usefulness on their intention to adopt OER.

Implications for practice and/or policy

• Simplifying the search process by improving the design of OER repositories to reinforce teachers’ perception that OER are easy to use.
• Establishing quality assurance of OER to strengthen teachers’ perception that OER are useful.
• Advocating open educational practices in K-12 settings to engage students and teachers in the creation and curation of open content.
• Initiating nationwide campaigns (e.g., #GoOpen) to engage school districts and teachers in producing and publishing high-quality OER.
licenses (i.e., the primary legal copyright mechanism under which OER are created and shared). Beyond a lack of apparent awareness, many teachers also perceive barriers to implementing OER in K-12 settings, such as a lack of financial support, community support and professional development opportunities, as well as their own personal insufficient willingness and expertise to create/adapt OER (Kimmons, 2016). Reinforcing teachers’ awareness of OER and their intention to implement OER is needed in K-12 settings.

Understanding factors determining K-12 teachers’ adoption of OER is thus critical. Existing evidence attributes teachers’ adoption of OER mostly to cost considerations, in that OER is seen as a cost-effective alternative to textbooks without harming student learning (Blomgren, 2018). However, such an understanding limits the potential of OER in education since it overlooks the pedagogical merits of openness (Kimmons, 2016). It is noteworthy that low-cost textbooks can have equivalent benefits of cost reduction, but the freedom that OER provide teachers of revising and remixing materials to tailor learning to their students’ specific circumstances is indispensable (Kimmons, 2016). Therefore, a comprehensive understanding of how K-12 teachers adopt OER beyond cost considerations is needed.

This mixed methods research intended to understand K-12 teachers’ perspective regarding which factors influence their intention to adopt OER. Models and theories have been developed to interpret technology acceptance in educational settings, particularly the technology acceptance model (TAM) (Davis, 1989). TAM presents a framework for understanding how to reinforce teachers’ intention of implementing technology in K-12 settings (Granić & Marangunic, 2019). The quantitative phase of this mixed methods study examined how teachers’ perceived ease of use, perceived usefulness, and attitudes toward OER predicted their intention to adopt OER. The qualitative phase supplemented the quantitative findings by exploring teachers’ perceptions of OER adoption.

**Literature review**

**Open educational resources**

OER are openly licensed educational materials that allow users to retain, reuse, revise, remix and redistribute them at no costs (Hilton, 2016; Lin & Tang, 2017). That is, users can download and keep a copy of OER (revise); utilize OER or a portion of OER (reuse); make changes to (“revise”) or merge (“remix”) any existing OER; and share and disseminate OER with limited restrictions (redistribute), complying with the licenses established by CC (Lin & Tang, 2017). For example, the CC-BY license allows users to adapt and share OER for commercial or noncommercial purposes, while the CC-BY-NC only authorizes users to do so for noncommercial purposes (Hilton, 2016).

OER have gained prominence as a way to decrease educational costs and promote educational equity, especially in higher education (Hilton, 2016). Evidence that OER decreased college students’ educational costs without harm to their course performance has been well documented. Clinton (2018) found students using OpenStax textbooks in an introductory Psychology course at an American public university spent significantly less money on course materials while performing slightly better than those using traditional textbooks. Hendricks et al. (2017) reported a significant decrease in textbook expenses in a Canadian college physics course with no drops in students’ final test scores. Ngimwa and Wilson (2012) echoed these findings, stating that OER provided teacher candidates attending the Teacher Education in Sub-Saharan Africa project with high-quality and relevant learning experiences at low costs.

**OER in K-12 education**

Open textbooks published by OpenStax or CK-12 are introduced to K-12 curricula as they provide up-to-date materials and open licenses for teachers to customize them (Kimmons, 2015). As the
#GoOpen initiative swept across America, OER have been increasingly used in different subjects across various grades. Research indicated that, besides saving money, K-12 student performance remained largely the same or even improved after using OER. Hilton et al. (2019) observed no significant difference in mathemathic test scores between elementary students using OER (e.g., EngageNY Math) and those who did not. Robinson et al. (2014) found students using OER in suburban secondary science classes earned higher scores on standardized tests. Kwak (2017) noticed Korean students in a twelfth-grade language arts class claimed substantial benefits of using OER in language learning. Park and Mcleod (2018) found high school students with learning disabilities had significantly higher motivation to learn mathematics when using OER than those who did not. To recap, OER allow K-12 students to maintain an equivalent or even higher level of achievement and motivation at a much lower cost than those use traditional course materials. However, the benefit of OER goes beyond cost reduction and also embraces the merit of openness as expressed in open educational practices (Kimmons, 2016).

Open educational practices
Open educational practices (OEP) describe a series of activities including adapting, remixing, creating and publishing OER for use beyond a teacher’s own class (Cronin, 2017). For example, students remixed OER to create video tutorials, then published them with CC licenses on YouTube or an open repository (Wiley & Hilton, 2018). Research indicated that OEP afforded an authentic environment for learners to undergo the experience of personalizing OER for their purposes, resulting in increased learner motivation and self-efficacy (Cronin, 2017; Wiley, Webb, Weston, & Tonks, 2017). Furthermore, the merit of OEP goes beyond the class given that student-generated OER yield lasting benefits for future students taking the same class, and other learners beyond it (Wiley & Hilton, 2018). Wiley et al. (2017) thus believe that OEP maintain the sustainability of OER in K-12 settings by empowering learners as open content creators and curators.

For teacher preparation and professional development efforts, OEP can also help advocate the benefits of OER to K-12 teachers (Kimmons, 2016). Tondeur et al. (2012) found that empowering teacher educators as role models and enabling authentic experiences with technology helped prepare teachers for technology adoption. Kimmons (2016) implemented OEP to turn teacher educators into role models of adopting OER and create an authentic environment for K-12 teachers to understand, adapt/create and redistribute OER, after which the teachers believed that OER possessed pedagogical, economic and professional potential to be used in K-12 settings. Implementing OEP in teacher education and professional development efforts have helped teachers understand OER and their potential in K-12 settings, but whether the teachers adopt OER on their own after performing OEP through professional development exercises remains unknown (Kimmons, 2016). Without such an understanding, the capacity to strengthen adoption of OER in K-12 setting is limited (Kelly, 2014).

Technology acceptance model
The TAM explains user acceptance of information technology, especially their behavioral intention of technology acceptance (Davis, 1989). Behavioral intention (IN) as a precursor to actual technology usage describes users’ perceptions of the extent to which they would accept or reject technology (Venkatesh, Morris, Davis, & Davis, 2003). Rooted in the theory of reasoned action, TAM has built upon the causal relationship among belief, attitude, intention and behavior (Lala, 2014). TAM recognizes that perceived ease of use (PE) and perceived usefulness (PU) of technology determine whether individuals intend to adopt technology (Davis, 1989; Venkatesh et al., 2003). PE describes individual perceptions of the effort level needed to use technology, while PU explains the extent to which people believe that using technology can enhance their
job performance (Davis, 1989). PE is an antecedent of PU because easily applied technology is perceived as more useful than hard-to-apply technology in work settings (Venkatesh et al., 2003). Another variable mediating the effect of PE and PU on IN is attitude toward technology (AT), referring to people’s affective predisposition to behaviors of using technology (Davis, 1989). Specifically, AT in this study considers teachers’ attitudes toward the behavior of adopting OER rather than the objects of OER.

Since its initial elaboration in the 1980s, TAM has been extended to incorporate additional external variables (Granić & Marangunić, 2019; Lala, 2014), such as TAM 2 (Venkatesh & Davis, 2000) which added social influence (eg, subjective norm) and cognitive instrumental processes (eg, job-fit) as the basis of PU. Later, Venkatesh and Bala (2008) proposed TAM 3 by including self-efficacy as a determinant of PE. Furthermore, Venkatesh et al. (2003) proposed the unified theory of acceptance and use of technology (UTAUT) with a focus on performance and effort expectancy, social influence, and facilitating conditions. Performance expectancy explains the extent to which people expect using technology can boost their job performance while effort expectancy reveals the apparent effort level required to use technology (Jung & Lee, 2020; Nistor, Ferde, Weinberger, Ceobanu, & Heymann, 2014). Similarly, UTAUT has also evolved with Venkatesh, Thong and Xu (2012) developing UTAUT2 with three added variables, including hedonic motivation, price value, and habit. Numerous models have been established to interpret the complexity of technology acceptance, but the inquiries into technology acceptance were limited by their lack of generalizability, especially given context-dependent influences on the findings (Granić & Marangunić, 2019; Scherer, Siddiq, & Tondeur, 2019).

It is thus critical to choose a model that interprets technology acceptance in teacher education and professional development settings. Meta-analytical reviews have confirmed that PE and PU primarily determine teachers’ intention to adopt technology (Granić & Marangunić, 2019; Scherer et al., 2019). Particularly, PU has a stronger effect than PE on teacher’s intention to implement technology (Granić & Marangunić, 2019), with AT as a mediator between IN and PE/PU in this setting (Scherer et al., 2019). Therefore, this study applied the original version of TAM with a focus on its primary variables, PE, PU, AT, and IN.

Framing the study
This study sought to understand teachers’ acceptance of OER after performing OEP, aligned with TAM. Very few studies have investigated OER adoption from this perspective. Kim et al. (2015) found PE predicted Korean adult learners’ intention to use OER, but PU and AT did not. Kelly (2014) conducted a path analysis on educators’ perception of adopting OER, revealing that neither PE nor PU predicted IN but PE determined PU. However, participants in these two studies did not have a thorough understanding of OER or the merits of openness which might constrain teachers’ intention to adopt OER (Kimmons, 2016). To this end, understanding factors influencing teachers’ acceptance of OER after their experience with OEP is necessary for OER adoption in K-12 settings.

Based on the TAM, we made the following hypotheses (see Figure S1):

\( H_0: \) Teachers’ PE of OER positively influences their PU of OER.

\( H_1: \) Teachers’ PE of OER positively influences their AT of OER.

\( H_2: \) Teachers’ PU of OER positively influences their AT of OER.

\( H_3: \) Teachers’ PE of OER positively influences their IN of using OER.

\( H_4: \) Teachers’ PU of OER positively influences their IN of using OER.

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Teachers’ intention to adopt OER

H₅: Teachers’ AT of OER positively influences their IN of using OER.

Furthermore, technology acceptance in K-12 settings is complicated as additional factors also influence teachers’ decisions, such as whether available OER are age-appropriate and subject-appropriate for students and whether OER align with course standards (Blomgren, 2018). A comprehensive understanding, beyond TAM determinants, of K-12 teachers’ perception of adopting OER is thus also needed. Specifically, this research investigated the following questions:

1. What is the relationship between each determinant of K-12 educators’ intention to adopt OER?
2. What are K-12 teachers’ perceptions of OER adoption?

Methods

This research showcased a two-phase explanatory sequential mixed methods design, with quantitative inquiries preceding qualitative ones (Creswell & Clark, 2017). The quantitative phase hoped to determine the relationship among each variable in TAM to predict K-12 teachers’ intentions of OER adoption. Participants in this phase completed an instrument after engaging with OEP themselves. The qualitative inquiries sought to surface relevant patterns in participants’ reflection notes to explain and extend quantitative findings. For a more comprehensive understanding, findings from the two phases were integrated (Creswell & Clark, 2017).

Research context and participants

This research was performed in an online course at a public university in the southeastern United States. This 16-week course was offered to graduate students enrolled in an educational technology program. For this offering, students (N = 78) needed to coach another teacher in their school district to implement OER-based assessments (knowledge tests and/or surveys created or adapted by students) to evaluate learning in technology-enhanced instruction. Aligned with this goal, students needed to engage in a series of OEP including (1) reviewing effective assessment samples; (2) receiving instructions on OER; (3) submitting assessment plans; (4) developing the assessment by creating or adapting an OER; (5) coaching peer teachers to implement the OER-based assessment; (6) submitting an implementation report; (7) completing self-reflections; and (8) publishing the assessment in an OER repository. This ensured students had experience with OEP before the quantitative data collection.

Before recruiting participants, Institutional Review Board (IRB) approval was obtained. Sixty-eight certified teachers attending the course agreed to voluntarily participate in this research, though they had the right to withdraw at any time. Of the 68 participants, 84% (n = 57) were female and 91% (n = 62) had more than 5 years of teaching experience. Each participant was given an alias without any personal identifier.

Instruments

This research adapted the TAM instrument used in Kim et al. (2015) to understand teachers’ adoption of OER (see Table S2). Given the limited sample size, this study focused on questions about PE, PU, attitudes (AT), and intention to adopt OER (IN). The instrument consisted of 12 questions, with each variable being assessed by three questions. Each of these questions used a 5-point Likert scale ranging from “strongly disagree” (1) to “strongly agree” (5). Specifically, PE was assessed with specifications regarding the effort level needed for teachers to find, access, and use OER. PU was evaluated on the extent to which teachers believed their productivity and performance could be improved using OER. AT was rated on whether teachers had positive or
negative feelings about adopting OER. IN was estimated by the degree to which teachers would adopt OER. Cronbach’s $\alpha$ ($\alpha = 0.94$) was calculated to confirm the reliability of the instrument was acceptable in this research (see Table S2).

**Procedures**

**Quantitative phase**

**Data collection.** The instrument was sent via a Qualtrics link in the 15th week of the course when participants submitted their implementation reports. All 68 participants responded, and their responses were recorded.

**Data analysis.** Due to the small sample size ($N = 68$), we applied partial least squares (PLS) which focused on the analysis of variance. PLS is an effective alternative to covariance-based structural equation modeling, particularly with a small sample size (Wong, 2013). We used SmartPLS 2.0 to build the paths of the inner and outer model before analyzing the data. The assessment of the PLS model included target endogenous variable variance ($R^2$), inner model path coefficient, indicator reliability [ie, outer model loading, composite reliability (CR)], and validity [ie, average variance extracted (AVE) and latent variable correlation].

**Qualitative phase**

**Data collection.** To explain and extend the quantitative results, we included the 68 participants’ self-reflection notes as qualitative data. Self-reflection was a key assignment due in the last week of the course. Participants responded to guiding questions to describe their perception of and experience with OER adoption. Each self-reflection note was retained as a separate Microsoft Word document.

**Data analysis.** A deductive coding approach (Fereday & Muir-Cochrane, 2006) was applied to seek codes from each self-reflection note guided by the TAM and quantitative results. First, the researchers individually read each document and took preliminary notes to become familiar with the data. Second, the researchers paired to aggregate relevant codes into themes.

**Validity and reliability.** Two measures reinforced the validity and reliability of the findings. First, constant comparison was used when eliciting themes to ensure findings were grounded in the data itself (Patton, 2002). Second, member check was conducted (Merriam, 1998) by sending a summary of the findings to five participants, all of whom validated the findings.

**Results**

*What is the relationship between each determinant of K-12 educators’ intention to adopt OER?*

Table S3 presents the model index. The explained variances for PU, AT, IN were respectively .470, .660, and .527; in addition, $R^2$ dropped from .660 in AT to .527 in IN. Bagozzi and Yi (1988) suggested the AVE value should be .5 or higher and CR should achieve .7 or above. All of our AVE values fell between .747 and .830, while our CR values ranged between .900 and .936. Fornell and Larcker (1981) indicated the square root of AVE should be higher than the correlation value of latent variables. All values of our AVE square root fell between .782 and .911 with one exception in IN (.782) which was smaller than the correlation of PU and AT (.795). Hulland (1999) suggested that the outer model loadings preferred to be .7 or higher. All of our outer model loadings were in the proper range, falling between .834 and .949. Overall, the entire model was considered an acceptable fit. All the endogenous coefficients were positive, indicating positive relationships among these latent variables, $H_0$, $H_1$, $H_2$, $H_3$, $H_4$, and $H_5$ (see Figure 1).
What are K-12 teachers’ perceptions of OER adoption?
Guided by the literature and quantitative results, a deductive coding process yielded findings on perceived strengths and weaknesses of OER through the lenses of PE and PU and also the relationship among each variable of the TAM.

Perceived ease of using OER

Strengths. Twenty-four of the 68 participants wrote about the ease of using OER in teaching, especially in terms of low cost, open licenses, and accessibility. First, participants mentioned OER were easily accessible without financial concerns, especially for those from school districts with a limited budget. Second, participants noted OER were easy to use because the open licenses allowed them to customize the resources. Third, participants commented that many OER repositories (e.g., OERCommons) were easily accessible as a central hub of a variety of helpful resources from multiple platforms, avoiding switching back and forth between platforms.

When I located the website Share My Lessons, I was amazed at the number of OERs and the quality of work. Teachers pay good money on Teachers Pay Teachers to get a lesson that could easily be found on this site. OERs could be an invaluable resource for teachers if they would give them a chance. (DW)

I do believe there are many pros (that definitely outweigh the cons) with OER usage in the K-12 classroom. One of the major conversations my fourth-grade team and I have is about sharing resources and about the copyright laws with licenses on specific products. (HV)

Student access to the OER commons is something that I feel is important, because it gives them access to a variety of helpful and reliable resources they otherwise would have to find on various digital platforms. (AZ)

Weaknesses. Half of the participants (N = 34) complained that the difficulty of finding appropriate resources was the primary barrier to using OER. Participants attributed this barrier to the duplicated resources, inefficient navigation of OER repositories, non-alignment between OER and course standards, and teachers’ struggles in narrowing the search for OER.
Initially, it took me several days of searching and researching to find OERs that I felt would be useful and useable for my assessment. The OER commons are difficult to navigate and many of them offer the same resources. (AJ)

I had a challenge finding OERs for this assignment that aligned with the grade level and standards my client was looking for. (LH)

Each of these OERs were beneficial to the project however, the overall goal I need to work on is how to find OERs more effectively and efficiently. OERs are supposed to make teaching easier; however, there was too much time spent on finding OERs that it took the easiness of using the OER out of the equation. (AB)

Perceived usefulness of OER

Strengths. Thirty-two participants stated that OER improved their instruction and reduced the workload of course planning in four aspects, including enriching teachers’ perspectives, supporting personalized instruction, saving teachers’ time, and engaging students in authentic learning. First, participants thought that the use of OER enriched their own perspectives when creating course materials. For example, OER provided supplementary resources for teachers when textbooks failed to meet instructional goals. Second, participants agreed that OER offered various formats of open-licensed multimedia products to address various users’ personal needs. Third, participants indicated OER helped save time as they avoided preparing instructions from scratch. Fourth, participants believed OER better engaged their students than textbooks.

OERs provide alternatives for teachers especially when classroom resources are not meeting the needs of all learners and for that reason they are a great resource for educators. (DC)

The good thing about OERs is that they are free to use and can be modified by the teacher to meet the needs of the students they are teaching. (TS)

I do like the fact that there are OERs on just about any topic you can think of that can be used in the classroom. This makes creating lessons somewhat easier. Instead of having to create lessons and units from scratch, an OER can be incorporated and revised to meet your classrooms needs. (AG)

The OER my team used engaged students on a technological level that course textbooks could not. (TD)

Weaknesses. Forty-three participants shared their concerns that decreased the PU of OER. A lack of quality assurance and sustainable maintenance were the main concerns. Participants complained that some OER contained inaccurate information or broken links. Other participants stated that sustainable maintenance was required, otherwise OER became unavailable or outdated.

We found some neat activities to review and then realized that there was no way to see them due to broken links. This was very disappointing. (SG)

In my experience, I had a difficult time finding an OER to use in my assessment because the standards are new for the grade level, and there are many resources out there to meet the need. When I thought I had found something to use, I was unable to access it because it turned out to be very outdated and the site was no longer supported. (KB)

I found that OERs can be limited when it comes to certain topics such as {topic}. OERs can also be inconsistent when it comes to quality of the source. Most OERs that we found could have been created by anyone who wanted to post to the website. This makes it difficult for teachers to use some sources because they may not be of high quality thus reducing the amount of OERs that could be available for that subject. (JW)
Relationship between each determinant

**PE affected PU, AT, and IN.** Twenty of the 68 participants agreed PE positively affected PU of OER ($H_0$). For example, participant JH’s perceived ease in reusing/revising/remixing OER increased his PU of OER. Eight participants stated PE positively influenced their AT of OER ($H_1$). Participant JW felt positive about OER adoption because integrating OER in K-12 classrooms was easy for her. Furthermore, ten of the participants discussed the positive relationship between PE and their IN to use OER ($H_3$).

I believe the use of OERs can be very beneficial to educators. They can provide materials and resources to teachers to use so they do not have to recreate material. It provides a world of sharing for teachers where they do not have to have fears of copyright laws. (JH on PE influenced PU)

I believe that we could do more to integrate OERs throughout the year into our lessons. OERs provide us with resources that we can easily integrate in the classroom. (JW on PE influenced AT)

Seeing how easy OERs were to create and use, I plan on using them more in the future. I will present the analysis plan to my PLC so that we can work on OERs together. (AR on PE influenced IN)

**PU affected AT and IN.** Eight participants indicated PU had a positive effect on their attitude toward OER ($H_2$). For instance, participant SG indicated her positive AT resulted from the perception of using OER could improve her teaching practices. Nine participants wrote PU positively affected their IN to adopt OER ($H_4$). Participant CR published her OER to benefit other teachers because she believed using OER had improved her teaching skills.

As educators, we all need to do our part and contribute to OERs to save one another prep time, learn new ideas from colleagues that could help us differentiate our instruction, and allow our budgets to go further to meet other needs in our schools. (SG on PU affected AT)

Using OERs throughout the semester has improved my teaching and learning skills... I would also share the OER with all teachers on my grade level. We would have a chance to work collaboratively in a professional learning community to share ideas to better improve instruction. (CR on PU influenced IN)

**AT affected IN.** Sixteen participants remarked AT positively influenced their IN to use OER. For example, participant AS expressed her intention to adopt and even recommend OER to colleagues due to her positive attitude toward OER ($H_5$).

I think OERs are a great resource for teachers.... My hope is to be able to share my knowledge and show my peers how they can use these resources to engage students in a deeper connection to a lesson. I hope that I can also find new and better ways to integrate these into my lessons. (AS on AT influenced IN)

**Discussion**

This mixed methods inquiry filled the gap in understanding K-12 teachers’ acceptance of open educational resources (OER) after performing a series of OEP. This inquiry identified factors affecting teachers’ intention to adopt OER and explored their perceptions of OER adoption based on the TAM. The findings of the quantitative phase confirmed PE and PU predicted K-12 teachers’ intention to adopt OER (IN), with attitude toward OER (AT) mediating the effect. PE also determined PU, and both variables influenced teachers’ AT toward OER. The qualitative phase presented supplemental insights into the quantitative findings by discussing teachers’ perceived strengths and weaknesses through the lenses of PE and PU and also the relationship among each TAM variable. By integrating the quantitative results with the qualitative findings, this research revealed significant implications for OER adoption in K-12 settings.
This research confirmed that teachers’ PE determined their PU, AT, and IN to adopt OER, validating and extending previous findings on how PE affected OER adoption (Jung & Lee, 2020; Kelly, 2014; Kim et al., 2015). Our interpretation is that K-12 teachers need to teach beyond traditional textbooks for differentiated instruction (Kimmons, 2015), so technology that is easily integrated in classrooms might be more applicable. When advocating the use of OER in K-12 settings, convincing teachers of the ease of using OER is important. Qualitative findings showed that teachers perceived OER were easily accessible and easy to use with open licenses, low costs, and plentiful resources. However, concerns over the limitations of some OER repositories, and teachers’ insufficient expertise in manipulating OER, would also need to be addressed. OER repositories as a central hub afford easy access to a rich collection of open-licensed resources, but we need to improve the design of OER repositories by enabling functions of removing duplicated resources and labeling the resources by grade/subjects/states to make searching easier. In addition, providing teachers with training on efficiently finding and adapting OER is another option to improve their PE because it helps resolve teachers’ personal barriers in the lack of expertise to efficiently use OER (Kimmons, 2016). Specifically, implementing OEP to provide teachers with authentic practices of selecting, adapting and redistributing OER can enhance their self-efficacy about using OER (Wiley et al., 2017) and then, hopefully improve teachers’ PE of OER.

Teachers’ PU was validated as a significant predictor of their AT and IN of adopting OER. Limited TAM studies investigated OER adoption and their findings attributed PU as a trivial factor in relation to influencing IN (Jung & Lee, 2020; Kelly, 2014; Kim et al., 2015). Our findings contradicted prior studies by underlining the significance of PU for OER adoption. Going back to the concern of insufficient generalizability of TAM research findings (Granić & Marangunić, 2019; Scherer et al., 2019), this might result from the difference in teacher samples and their understanding of OER between our studies and prior investigations.

Our participants’ experience with OEP consolidated their understanding of OER and the merit of openness, and might further improve their PU altogether with AT and IN of using OER (Kimmons, 2016). Moreover, qualitative findings described a lack of quality assurance, especially given some OER contained inaccurate information and outdated resources, as a barrier that decreased teachers’ PU of OER. This finding also endorsed Kimmons’ (2016) concern regarding the limited availability of high-quality open-licensed resources for teachers. To resolve this macro-level barrier, we echo Wiley et al. (2017) advocating OEP in K-12 settings in order to empower a large community of students and teachers as content creators and curators in open scholarship activities such as maintaining or updating existing OER. In addition, we speculate that expanding the #GoOpen campaign or launching other national OER initiatives might also help when more school districts and teachers participate in the production and publication of high-quality OER. To this end, teachers are more likely to access high-quality OER and further strengthen their PU of OER and thereby motivate them to implement OER in their classrooms.

Attitude toward OER was verified as a mediating variable among PE, PU and teachers’ intention to adopt OER. Teachers’ PE and PU both significantly determined their attitude toward OER. Our findings corroborated those of prior TAM research in teacher education and professional development settings (Scherer et al., 2019). As addressed in the Synthesize Qualitative Data model, teachers’ satisfaction about technology usage can be improved when teacher educators become role models and when they are afforded an authentic experience with technology (Tondeur et al., 2012). In our study, teachers with authentic experiences of personalizing and implementing OER via OEP might engender positive attitudes toward OER. Therefore, teachers believed OER saved teachers’ time, allowed teachers to network with peers, and conserved the budget for other purposes. Thus, they would like to act as key personnel for OER adoption in their local school districts.
Recommendations
This research offers practical implications for educators, administrators, and practitioners on reinforcing K-12 educators’ acceptance of OER in this setting. First, OER repository designers need to improve its design and optimize its function to reinforce teachers’ perceived ease of using OER. Teachers prefer easily accessible resources, so simplifying the searching process such as automatically filtering duplicated information and recommending age/grade/subject appropriate resources might help. Second, stakeholders need to collaboratively establish the quality assurance of OER to strengthen teachers’ perception that OER are useful. Third, teacher educators can reinforce the sustainability of OER by implementing OEP to engage teachers in the curation and creation of open-licensed resources for K-12 students. Integrating OER training in teacher education and professional development supports OER adoption in K-12 education (Kelly, 2014). This would help especially if pre-service and in-service teachers undergo OEP training in creating/adapting and redistributing OER so that their PE, PU and AT can be strengthened. Fourth, the government or local educational authorities can advocate the #GoOpen campaign or other nationwide OER initiatives to engage school districts and K-12 teachers in producing and publishing high-quality OER for this setting.

Limitations and future research
With these findings and recommendations in mind, it is important to note some of the limitations of this study so as to show where further research would be beneficial. For example, the TAM is a comprehensive framework for understanding OER adoption in K-12 settings, but the linkage between intention and usage is often neglected in TAM-based research studies (Granić & Marangunić, 2019). Whether teachers’ belief variables contributed to their actual usage of OER in this research still invited further investigation. In addition, the instrument used in this research was adopted from Kim et al. (2015). The target audience of that instrument was actually adult learners, rather than K-12 educators. Some items were not geared toward educators’ use of OER for teaching purposes such as item 2.1 (“use of OER will improve academic productivity,” see Table S2). For future research, generating a validated instrument assessing K-12 teachers’ acceptance of OER is necessary. Furthermore, like other TAM studies, the generalizability of our findings might be limited (Granić & Marangunić, 2019; Scherer et al., 2019), especially given that our participants developed a more comprehensive understanding of OER than the general teacher population, thus the factors that influenced their intention to adopt OER might not work for teachers who lack such an understanding (Kimmons, 2016). Moreover, the research was conducted in one class with a relatively small sample size. Future research might also consider validating the findings of this study in multiple research sites with a larger sample size.

Acknowledgements
This research was completed as a part of the OER Fellowship honored to the first author by the Open Education Group. We thank Dr. John Hilton III for his support with this research.

Statements on open data, ethics and conflict of interest
To protect participants’ privacy, the dataset used in this study is not available openly.

The study was performed following the BERA Ethical Guidelines. No personal identifiers were reported in the study.

There is no potential conflict of interest in this work.
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Supporting Information

Additional supporting information may be found online in the Supporting Information section at the end of the article.