Evaluating Teacher Access to Online Professional Development: Establishing Access Patterns from User and Server Analytics

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Abstract

The COVID-19 pandemic has forced K-12 schools to seek professional development with online resources that address their professional needs while keeping health and safety in mind. In Missouri, approximately 250 school districts in the Network for Educator Effectiveness (NEE) have 24/7 access to the EdHub Library that provides more than 500 online self-paced professional development resources (Network for Educator Effectiveness, n.d.-a). Due to the pandemic, the EdHub Library has seen increased web traffic; this study identifies the most accessed resources by analyzing user and server web analytics to improve resource access. This study also identifies resource access patterns using the Apriori algorithm for association rule mining. The results pointed out that approximately 40% of the web traffic occurred among the EdHub Library homepage, Dyslexia activities, and resource page for Teaching Standard 1 (i.e., Content Knowledge and Appropriate Instruction). Along with the findings, recommendations for resource optimization by the Word Wide Web Consortium (W3C) are explored. The visualizations can be found on Tableau Public (Leung, n.d.).

Keywords: Teacher Professional Development, Educational Data Mining, COVID-19

Introduction

As the World Health Organization (WHO) declared the novel coronavirus (COVID-19) outbreak a global pandemic on March 11th, 2020, this study reports on the evaluation efforts for optimizing online resources for teacher professional development (World Health Organization, 2020). Since the beginning of the pandemic, 1.3 billion learners are still affected by school and university closures as institutions implement entirely online and hybrid solutions (UNESCO, 2020). As K-12 educators adapt their face-to-face curricula to distance and hybrid formats, the professional development needs of teachers have been neglected since the beginning of the pandemic. All in-person teacher professional development (PD) opportunities came to a halt, whereas fully online PD provided teachers access to online self-paced resources and synchronous webinars through web conferencing tools (e.g., Zoom).

In Missouri, the EdHub Library is an online professional development platform for K-12 teachers and school administrators as part of the Network for Educator Effectiveness (NEE), which is a comprehensive education assessment system (Network for Educator Effectiveness...
n.d.). While the EdHub Library provides teachers with 24/7 access to over 500 online resources, the platform has experienced increased web traffic since the beginning of the pandemic. The purpose of the study is to evaluate and improve access to online resources by analyzing user and server web analytics requests.

**Literature Review**

The following literature review describes the components of teacher professional development and recommendations for effective implementation. Research studies support positive outcomes and perceptions of online teacher professional development.

**Understanding the Needs of Teacher Professional Development**

Research studies have been conducted to examine the components of teacher professional development. Desimone (2011) described the core features of effective teacher PD in terms of (a) content focus, (b) active learning, (c) coherence, (d) duration, and (e) collective participation. Garet et al. (2001) examined the relationship between the characteristics of teacher professional development and teachers’ self-reported outcomes. Three recommendations emerged from integrating effective professional development and self-reported outcomes: form, duration, and participation. Form refers to how PD activities are structured either as a “form” or “reform” type of activity. The first type of activity describes traditional workshops as episodic events, whereas “reform” activities are collaborative workshops. The second recommendation is the duration of these activities. When teachers are expected to participate in longer sessions, follow-up and continuous support are essential to effective PD. The third recommendation is participation. The researchers recommended that teachers and support staff be included in the activities that promote everyday teaching tasks. Garet et al. (2001) findings agree with similar studies on effective PD delivery in terms of (a) sustained time, (b) collaborative and active participation, (c) content-driven, and (d) situated activity (Archibald et al., 2011; Borko, 2004; Darling-Hammond & Bransford, 2006; Desimone et al., 2002; Elmore, 2002; Guskey & Huberman, 1995).

**Effects and Perceptions of Online K-12 Teacher Professional Development**

Yoo (2016) examined the effects of online professional development on 148 teachers’ self-efficacy twice with a five-week gap after completing a learning module. In the analysis of the survey results, teachers reported professional enhancements through goal setting and concrete learning strategies, adjustments of their frame of reference in terms of their evaluation and understanding of a certain level of helplessness, and uncertainty in dealing with student and school factors, such as aptitude scores and curriculum guidelines. Whitaker et al. (2007) studied the effectiveness of an online platform called MyTeachingPartner (MTP) using web server logs, teacher evaluation survey responses, and focus groups on teachers’ beliefs. The researchers reported that teachers looked for practical activities by understanding the needs of their students. Although the MTP materials were useful, teachers said that materials needed to be practical for their teaching. Rice and Dawley (2009) analyzed survey responses of 259 teachers using the online K-12 platform called “Going Virtual!” to understand the practices and models of online teacher PD. Despite well-established national guidelines, school administrators were aware of these guidelines but implemented procedures based on their teachers’ needs.
The Need for Evaluation in oTPD

Studies have explored teacher professional development as a critical factor that impacts student achievement (Campbell et al., 2004; Darling-Hammond & Bransford, 2007). With the growth of educational technologies and teachers having less time for professional development, the rise of online teacher professional development (oTPD) allows for professional engagement in continuing education systems. Numerous research studies examined face-to-face teacher professional development. However, a few studies on oTPD examine online professional development programming and technical components behind educational systems.

Problem Statement

Dede et al. (2009) identified the lack of empirical evidence on effective online teacher professional development design. Current research on oTPD examines four aspects in terms of (1) program design, (2) effectiveness, (3) technical design, and (4) learner interactions. Program design refers to the evaluation of content and best practices in methods of delivery. Program effectiveness explores the short-term outcomes provided by oTDP, which are generally teachers’ self-reports. Program technical design evaluates the effect of communication tools on specific goals. Learner interactions refer to the quality of participation in online communication and collaboration. While present studies explore the program design and effectiveness aspects of online teacher professional development, this study evaluates the use and access patterns of resources with web analytics for assessing the technical and learner interactions aspects of oTPD.

Purpose & Significance of the Study

This study seeks to identify the most accessed resources and develop user and server access patterns in online teacher professional development resources. The significance of this study involves providing improved access to resources, especially to rural regions in Missouri school districts. The study explores the following research questions:

- **RQ 1**: Which resources do users access the most based on Page Depth and Time On Page?
- **RQ 2**: Which resources have the highest Server Response Time, Document Content Loaded Time, and Page Loaded Time?
- **RQ 3**: What access patterns exist for users and server document requests?

Methods

This study uses exploratory analysis of 164,772 web resource transaction records from May 2018 - May 2021 using user and server web analytics metrics to identify the most accessed resources and develop navigation patterns using association rule mining. First, the study explores the most accessed resources using Google Analytics user metrics, including Page Depth and Time On Page. According to Google Developers, Page Depth refers to the average number of pages users visited within a 30-minute session. Time On Page is calculated by the time difference between the user’s starting point on a particular resource and when the user moves on to the following resource (UA Dimensions & Metrics Explorer, n.d.). The study also uses Google
Analytics server metrics, including Server Response Time, Document Loaded Time, and Page Loaded Time to identify the most requested resources from the web server. To investigate resources that need to be optimized, Server Response Time, Document Loaded Time, and Page Loaded Time allow identifying specific elements (e.g., video, animation, text, scripts, and documents) in web resources that are highly requested in the server and loaded onto users’ browsers. Server Response Time refers to the total time that the server takes to respond to the user’s request. Document Content Loaded Time describes the total time that the user’s browser and server take to render the documents with their respective style sheets and scripts. Page Loaded Time is the total time that it takes to render the whole resource page. To further explore user and server metrics, visualizations are published on Tableau Public (Leung, n.d.).

Second, the Apriori algorithm is a popular method for association rule mining that allows establishing patterns between antecedent (i.e., if) and consequent (i.e., then) components of frequent user and server resource access based on support, confidence, and lift measures (Harikumar & Dilipkumar, 2016). The support measure is the percentage in which web resource transactions contain a given web resource access combination. The confidence measure looks at the conditional probability in which a web resource is accessed. The lift measure describes the likelihood of web resource transactions occurring in pairs. For this particular study, the lift and support measures will be examined to determine the most accessed resources by users and requested server resources (e.g., HTML, CSS, images, videos, and PDFs) from the hosting server. Average user and server metrics are reported in milliseconds (ms). Because association rule mining is a computationally expensive method, the analysis considers all user types, including new and returning users.

Results & Discussion

RQ 1: Which resources do users access the most based on Page Depth and Time On Page?

In terms of Page Depth, the most accessed resources by users were related to exemplary teaching practices videos and classroom observation practice scenarios. The search engine function was also used to look for content associated with Teaching Standard 1.1 (i.e., Content Knowledge and Academic Language) and its scoring video examples, as shown in Figure 1. The most accessed content regarding Time On Page was the instructor-led principal calibration training and building instructional skills modules. Also, the most searched content included research-based practices, professional development processes, technology integration, and data-driven decision-making, as shown in Figure 2.
**RQ 2:** Which resources have the highest *Server Response Time, Document Content Loaded Time, and Page Loaded Time*?

In observing Google Analytics server metrics, curriculum implementation, word problems, kindergarten, math problem-solving, technology integration, and physical education were the most solicited search functions for *Server Response Time, Document Content Loaded Time, and Page Loaded Time*, as shown in Figures 3, 4, and 5.
Figure 3

Average Server Requests by Server Response Time

Figure 4

Average Server Requests by Document Loaded Time

Figure 5

Average Server Requests by Page Loaded Time
RQ 3: What access patterns exist for users and server document requests?

User and server access patterns to online professional resources and search functions can be established by lift measure or the probability in which web resources are accessed together, and support measure or the percentage in which web resource transactions occurred in a specific combination.

User Web Analytics Metrics

In examining user web analytics metrics, specific patterns for *Page Depth* and *Time On Page* were found for all four Dyslexia activities sorted by the highest lift measures. In terms of the support measure, all four Dyslexia activities and the EdHub Library with a sitemap listing all resources related to Teaching Standard 1 (i.e., Content Knowledge and Appropriate Instruction) showed around 40% of users performed the given access patterns, as shown in Table 1 and 2.

Table 1

<table>
<thead>
<tr>
<th>Antecedent</th>
<th>Consequent</th>
<th>Support</th>
<th>Confidence</th>
<th>Lift</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dyslexia introduction</td>
<td>Dyslexia literacy activity 2</td>
<td>0.404</td>
<td>0.983</td>
<td>2.187</td>
</tr>
<tr>
<td>activity 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dyslexia literacy activity 2</td>
<td>Dyslexia intervention process activity 3</td>
<td>0.409</td>
<td>0.973</td>
<td>2.099</td>
</tr>
<tr>
<td>Dyslexia intervention process activity 3</td>
<td>Dyslexia technology integration activity 4</td>
<td>0.402</td>
<td>0.900</td>
<td>2.039</td>
</tr>
</tbody>
</table>

Table 2

<table>
<thead>
<tr>
<th>Antecedent</th>
<th>Consequent</th>
<th>Support</th>
<th>Confidence</th>
<th>Lift</th>
</tr>
</thead>
<tbody>
<tr>
<td>EdHub Library homepage</td>
<td>Dyslexia module page</td>
<td>0.486</td>
<td>0.534</td>
<td>1.09</td>
</tr>
<tr>
<td>EdHub Library homepage</td>
<td>Sitemap Standard 1</td>
<td>0.401</td>
<td>0.440</td>
<td>1.03</td>
</tr>
</tbody>
</table>

Server Web Analytics Metrics

Even though the highest lift measures could be found between the EdHub Library homepage and the dedicated listings of online resources, the support measures for *Server Response Time* and *Page Loaded Time* were around 1% of access to the resources as mentioned earlier, as shown in Table 3 and 5. In terms of *Document Loaded Time*, 40% of the navigation access could be found among the EdHub Library homepage, Standard 1, and Dyslexia module, as shown in Table 4.
Table 3

Server Average Response Time

<table>
<thead>
<tr>
<th>Antecedent</th>
<th>Consequent</th>
<th>Support</th>
<th>Confidence</th>
<th>Lift</th>
</tr>
</thead>
<tbody>
<tr>
<td>EdHub Library homepage</td>
<td>Sitemap Standard 1</td>
<td>0.017</td>
<td>0.088</td>
<td>5.156</td>
</tr>
<tr>
<td>EdHub Library homepage</td>
<td>Sitemap Standard 2</td>
<td>0.012</td>
<td>0.062</td>
<td>5.156</td>
</tr>
<tr>
<td>EdHub Library homepage</td>
<td>Sitemap Standard 4</td>
<td>0.018</td>
<td>0.093</td>
<td>5.156</td>
</tr>
<tr>
<td>EdHub Library homepage</td>
<td>Sitemap Standard 5</td>
<td>0.014</td>
<td>0.072</td>
<td>5.156</td>
</tr>
</tbody>
</table>

Table 4

Server Average Document Loaded Time

<table>
<thead>
<tr>
<th>Antecedent</th>
<th>Consequent</th>
<th>Support</th>
<th>Confidence</th>
<th>Lift</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sitemap Standard 1</td>
<td>Dyslexia module page</td>
<td>0.405</td>
<td>0.760</td>
<td>1.354</td>
</tr>
<tr>
<td>EdHub Library homepage</td>
<td>Dyslexia module page</td>
<td>0.406</td>
<td>0.423</td>
<td>1.042</td>
</tr>
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</table>

Table 5

Server Average Page Loaded Time

<table>
<thead>
<tr>
<th>Antecedent</th>
<th>Consequent</th>
<th>Support</th>
<th>Confidence</th>
<th>Lift</th>
</tr>
</thead>
<tbody>
<tr>
<td>EdHub Library homepage</td>
<td>Sitemap Standard 1</td>
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<td>0.088</td>
<td>5.129</td>
</tr>
<tr>
<td>EdHub Library homepage</td>
<td>Sitemap Standard 2</td>
<td>0.012</td>
<td>0.062</td>
<td>5.129</td>
</tr>
<tr>
<td>EdHub Library homepage</td>
<td>Sitemap Standard 4</td>
<td>0.018</td>
<td>0.093</td>
<td>5.129</td>
</tr>
<tr>
<td>EdHub Library homepage</td>
<td>Sitemap Standard 5</td>
<td>0.014</td>
<td>0.072</td>
<td>5.129</td>
</tr>
<tr>
<td>EdHub Library homepage</td>
<td>Sitemap Standard 7</td>
<td>0.014</td>
<td>0.072</td>
<td>5.129</td>
</tr>
</tbody>
</table>

Discussion

For user requests, the most accessed resources were (1) the dedicated page related to Standard 1.1 (Content Knowledge and Academic Language), (2) principal scoring practice videos, (3) teaching best practices videos, and (4) walkthrough examples of classroom observation data collection videos. For server requests, the most requested resources were (1) search queries related to curriculum implementation, student motivation, kindergarten materials and word problems, (2) collaboration and technology, (3) NEE implementation, and (4) integration of technology tools.

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Based on association rule mining, support and lift measures indicated approximately 40% of web resource transactions occurred on the EdHub Library homepage, sitemaps for Standard 1, and Dyslexia activities. Because of my current responsibilities as an Instructional Designer who has maintained and published online materials since 2014, I take into consideration seven best practices that allow resources to be accessible, including (1) avoiding unnecessary redirects of resources, (2) reducing the size of files, (3) designing for a variety of interaction methods (mobile and desktop) and internet speeds, (4) using adequate text size with minimal Cascading Style Sheets (CSS), (5) implementing high-quality graphics with a smaller footprint, (6) using cookies when necessary, and (7) reducing the size of HTML pages in terms the Document Object Model (DOM) to avoid rendering errors (Mobile Web Application Best Practices, n.d.).

Video materials from teaching best practices and walkthrough examples of classroom observation videos are heavily accessed by users. Based on the frequent requests found in server metrics, video materials can be optimized for different screen sizes. While video materials are already optimized for the web, a recommendation would be presenting three versions of the video for mobile, tablet, and desktop that accommodate different internet speeds and screens. The ideal scenario would be hosting video materials in a streaming server that automatically adjusts video quality based on the user’s internet speed and device. Due to the high cost of streaming services and an extensive collection of video materials, these videos use progressive download to transfer digital media between the server and client before the user can render the full video. Because the length of the videos is on average less than 10 minutes, the progressive download occurs quickly.

Implications & Future Research

Based on user and web metrics, users performed generic keyword searches using the search engine from the EdHub Library homepage (e.g., “Teaching Standard 1,” “real world,” and “word problems”). It is also unknown if users were successful or unsuccessful in their searches based on the current dataset. The future direction of this study is to examine the users’ keyword searches further from the search engine service, including the queries or keywords performed by users, the number of searches performed, unique searches, results presented to users, and clickthrough rates. Based on the user behavior when using the search engine, a recommendation would be generating curated lists of professional development materials for high-frequency search terms.

Conclusion

This study establishes navigation patterns using user and server web analytics data from 250 school districts in the Network for Educator Effectiveness. Based on association rule mining, almost half of the web traffic is attributed to the EdHub Library homepage, Dyslexia module, and Teaching Standard 1. After analyzing 164,772 web analytics transactions from May 2018 - May 2021, the study provides internal stakeholders with recommendations for improving generic keyword searches with curated lists of resources and optimizing current multimedia resources to reduce load times.
References


UNESCO. (2020, April 29). *1.3 billion learners are still affected by school or university closures, as educational institutions start reopening around the world, says*. https://en.unesco.org/news/13-billion-learners-are-still-affected-school-university-closures-educational-institutions

