Abstract

This paper will offer insight into an innovative project developed to provide teachers with valuable data on their students' online learning experiences. In today's post-COVID-19 world, students still experience a significant portion of their learning online. Many projects and design-based learning units require students to research concepts that will assist them with their prototypes. With Chromebooks and laptops at many students' fingertips, teachers are responsible for ensuring students are equipped with research and media literacy skills to verify that students are getting useful and reliable information. Targeted Online Learner Analytics (TOLA) is one tool teachers can use to capture the reality of students' research practices and subsequently inform their instructional practices on research. To leverage this data, Learnics was developed to give teachers a window into their students' TOLA and provide students with a platform to promote self-awareness in their research approaches. Over the past couple of years, this project grew from tracking students' clickstream behaviors on a singular platform to an instructional tool across Learning Management Systems that is vetted by teachers in grades 5-12, allowing them to scaffold their students' research experiences through a dynamic research score. This paper will dive into the innovative project, provide an overview of the research completed to assess the impact of this platform, and highlight the value of this tool specifically for technology and Integrative STEM education.

Introduction

In the Spring of 2020, students and teachers were forced to move to virtual platforms for instruction due to the COVID-19 pandemic. Researchers and practitioners both went into problem-solving mode as they worked to provide teachers with the digital tools needed for virtual instruction across varying content areas and grade levels. Integrative STEM education, an approach to STEM education, traditionally elicits hands-on instruction as students work through integrated technological/engineering design-based learning units (Sanders & Wells, 2006). In one of the studies analyzing how Integrative STEM could be adapted to a virtual setting, Sain & Bowen (2022) identified one of the most pressing needs for elementary STEM teachers was the ability to support students synchronously. While many teachers gained access to digital tools that provided summative data, a gap emerged in providing teachers with formative data while students actively worked on an assignment.

To address the need for broader science and engineering support for the nation, the National Science Foundation continues to pour funding into small businesses (Johnson, 2018). One of the recipients of the National Science Foundation's Small Business Innovation and Research (SBIR) awards was Learnics, a digital tool developed before the COVID-19 pandemic to address the need for real-time data on students online learning experiences to be used for

instructional purposes versus serving as monitoring software. In light of the COVID-19 pandemic, this innovative software worked to provide teachers across content areas with formative data on their students' browsing history and time while working on an online assignment that could be used to drive instruction in research practices. Learnics leverages learner analytics, or data with an established background in education-based research, to close the gap identified in the research on design-based learning in virtual formats by Sain & Bowen (2022).

Learner analytics provides teachers with data on their students' educational journeys specifically to improve learning outcomes (Gašević, Dawson, & Siemens, 2015). Targeted Online Learner Analytics (TOLA) uses students' online learner analytics, or the trace of activity students produce from an online assignment, to optimize instruction by providing teachers with real-time data on students' online behaviors (Cottrell & Resende, 2022). TOLA has significant implications for supporting students with design-based learning in a digital environment as they conduct research or navigate online assignments to work through the design process. Learnics allows teachers to intervene and support where necessary throughout an assignment, versus after, to guide students through the online component of their assignments.

Design

Functionality

In 2018, Learnics was developed as a result of the gap identified in a dissertation completed by Cottrell (2017), bringing timely awareness to students' online behavior and research practices. To use this free program, students and teachers install a Google Chrome extension, and the teachers create an assignment using the Learnics app. Teachers have the option to set requirements for time, sources visited, sources cited, and input assignment questions based on the objectives. As students log their activity, teachers have access to their students' logging data in their dashboard throughout the duration of their active logging. Once students turn in their online activity, they can review, edit, and submit a final MLA bibliography to their teacher. In the app, both the students and teacher receive visualizations of the students' TOLA. The teacher can make instructional decisions, prompt reflection, and cater future assignments based on these learner analytics.

User Experience Research

To ensure teachers are not burdened with additional responsibilities and to conduct user experience research, this project implemented a Teacher Advisory Panel (TAP) to receive ongoing feedback from practicing educators and their students across K-12 subject areas, including elementary STEM. The TAP program allows educators to choose to join collaborative meetings weekly and provides support for teachers as they implement the software in their classrooms. The project also receives input from the Lehigh University Integrated Business & Engineering Honors program, a cohort of students providing perspectives on product development and entrepreneurship based on their coursework and future career aspirations. Through these channels, the project makes improvements that cater to what is needed in K-12 classrooms based on collaborations between teachers, specialists, and programmers, a collaboration that is essential to learner analytics (Krumm et al., 2021; Pelanek, 2021).

Scalability

Through the funding provided by the National Science Foundation, Learnics is increasing its' scalability across platforms with Learning Tools Interoperability. With these efforts, the software can be used as a stand-alone application or can be currently used within the Learning Management Systems Google Classroom or Schoology. The project aims to disseminate beyond its pilot phase to a full-scale public rollout at the end of the Spring 2023 school year, while still maintaining the TAP efforts to continually receive feedback for both the original pilot users and the broader education audience accessing the app through their Learning Management Systems.

Related Research

Several doctoral students analyzed the various iterations of Learnics for their dissertations, resulting in ample research on TOLA with both teachers and students. Cottrell (2017) kicked off the research specific to teachers' benefits, finding that while TOLA pulled from monitoring software does not affect teachers' perceived value of technology overall, the information embedded within it does positively affect teachers' instructional design. The influence of TOLA on teachers' instruction was also reiterated in an additional study conducted by Lottmann (2020) with an early version of the Learnics tool. Resende (2018) and Schoeneberger (2020) also conducted studies on the impact of TOLA on teachers and found with their research there was no effect on teachers' instructional design, but rather on student awareness and teacher reflective practices. Post (2020) researched the use of TOLA with pre-service teachers, finding benefits in both instructional design and student awareness with additional benefits in the pre-service teachers' data usage and their research practices.

Analyzing the impact of TOLA on students, several studies were also conducted to receive data on the effect of students' access to their TOLA. While these studies did analyze the effect of TOLA, more profound findings were revealed including the data gathered from the dissertation completed by Figueroa (2019) where students expressed that they were set free in their research assignments with little to no guidance from their teachers. Quartuch (2018) also studied students' use of TOLA, revealing that students were not affected by whether or not their data was being monitored, and had little exposure to instruction for media literacy skills. Cook (2019) conducted a parallel study with Schoeneberger (2020) from the students' perspective, finding that while TOLA did positively influence students' reflection, their teacher's influence and what they chose to do with the students and their TOLA remained greater. An additional study was conducted with higher education students, finding that with the use of an early format of the Learnics software, higher education students' information-seeking practice improved with TOLA and peer-to-peer discussions (Bruch, 2020).

Discussion

The Learnics project is founded on and continues to evolve based on the needs of educators and students. The research synthesized in the results helped to mold this software into the current iteration based on the findings of its effect on teachers' instructional design, student awareness, and self-reflection. The software was also adapted to encourage students' awareness of their digital footprint and self-reflection to touch on the dissertation findings for students specifically (Figueroa, 2019; Quartuch, 2018; Cook, 2019). While the tool has yet to approach the higher education market, it is evident that this may be beneficial to college students looking to refine their research skills (Bruch, 2020).

In terms of Integrative STEM education with design-based learning, this research builds upon many of the skills used as K-12 students work through the design process. Teachers can use this tool to cater their instruction as students work through their research and designs, allowing the teacher to intervene where necessary if they see student(s) missing key sources to guide them through their design-based learning unit. TOLA could also bring awareness to the teacher if they see students are not using their resources or are having difficulty navigating or synthesizing them. From a student's standpoint, TOLA provides an opportunity for students to self-reflect on their research skills and online progress as they navigate through a unit that utilizes online platforms or the internet. Learnics' capabilities spread across content areas, allowing for true integration between subjects for a technological/engineering design-based learning unit.

Conclusion

With the research conducted on TOLA, its intentional design, and its iterative nature, this project could have a significant impact on educators and students who continue to work on assignments and conduct research online after the COVID-19 pandemic. Real-time TOLA allows teachers to intervene where necessary or cater their instruction to meet the needs of students as they work through an assignment, versus waiting until after the assignment is complete. Learnics' ongoing research on TOLA allows this project to fine-tune what it currently offers K-12 education for free to give teachers and students a resource that they can use to improve their online learning experiences and outcomes. This project benefits education across content areas and grade levels, including its potential for Integrative STEM education.

As a result of the COVID-19 pandemic, teachers expressed the need for a way to support students in their online assignments as they work through them (Sain & Bowen, 2022). Using design-based learning in a virtual format created barriers that were felt across content areas and grade levels. Projects like Learnics are aiming to eliminate those barriers to education as schools continue to use virtual and blended learning in their classrooms. While the pandemic created many hurdles for educators, the resources put into improving digital tools for educators and students continue to emerge and fill the gaps that were identified in the immediate switch to virtual K-12 education in the Spring of 2020.

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