Online Teacher Professional Learning: An Approach to Foster Personalized Pathways

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Introduction

Teachers tend to be lifelong learners, motivated to pursue professional learning that is meaningful to their particular needs. In 2013, Marrongelle et. al., noted "it is incumbent on the field to capitalize on emerging technologies in the design and delivery of effective professional development." (p. 208). While the past decade has seen an increase in development of opportunities for personalized learning for mathematics teachers online (e.g., Silverman & Hoyos, 2018), more work is needed to provide additional research-based opportunities. Our work will contribute to the much needed body of literature on the instructional design and underlying psychological mechanisms of effective online teacher learning (e.g., Dede et al., 2009). More broadly, the work will contribute to how teachers and other learners can be properly supported in self-directed online educational environments (Terras & Ramsay, 2015; Wiebe et. al., 2015).

The InSTEP professional learning platform aims to support grades 6-12 teachers' professional learning in teaching statistics and data science through a personalized online learning platform. While statistics and data analysis are included in standards for both mathematics and science (Common Core State Standards for Mathematics, 2010; Next Generation Science Standards, 2013), there are also many states across the country envisioning high school course pathways that include a heavier emphasis on statistics and even stand alone courses on data science (Drozda, 2022). In this brief research report, we aim to share how we have designed supports for teachers to personalize their professional learning and results from a collective case study of 37 participants engaged in a field test of the platform in Fall 2022.

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Design of the Online Platform

The InSTEP learning platform is unique in several ways. First, we personalize learning to meet teachers' professional needs through customized recommendations, allowing teachers to select learning activities based on these recommendations or other goals and interests (Gamrat et al., 2014). Second, the platform provides opportunities for teachers to build skills in data investigations and innovative teaching approaches based on practices of data professionals and research on students' learning with data (Lee et al., 2022). Third, the platform supports teachers in expanding their professional collection of lessons, resources and technology vetted by statistics and data science education experts.

Overall Structure of Platform

A major goal of InSTEP is to support teachers' growth in knowledge and confidence to create effective statistical and data learning environments where all students are learning about important statistical and data ideas and engaging in key practices and processes to make sense of data. Central to our approach is building teachers' expertise in understanding interrelated dimensions of statistics and data learning environments (Ben-Zvi et al., 2018; Garfield & Ben-Zvi, 2009) that support students' reasoning about statistics and data (see diagram on left side in Figure 1). Teachers have opportunities to engage with materials through two primary opportunities: 1) engaging in a data investigation structured to help teachers learn 6 phases of a data investigation process (Lee et al., 2022), and 2) learning with materials organized in modules (see Figure 1).

Modules are organized by 7 dimensions (Figure 1) to support teachers in using well-designed tasks to support statistical thinking by engaging students in key data and statistical practices and processes to develop central statistical ideas about statistics and data. This approach involves using real data to engage in investigations using technology tools that allow learners to enact statistical and data practices and develop skills. Our approach helps teachers to learn to establish practice that promotes productive argumentation and discourse, which includes making and supporting data-based arguments, and use of assessment of students' thinking about statistics and data to inform instructional decisions (not visible in Figure 1). Learning activities within modules are organized by *essential* resources, foundational materials to understand key ideas, and *extended* resources, materials that go beyond and may include classroom-ready resources. Another learning opportunity included in the platform are microcredentials, but these are not discussed in this session. Table 1 includes the breakdown of all learning activities [30.2 hours] available during the Fall 2022 field test study. Each page in a data investigation or

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module has time estimates assigned to help users guide their learning when they log in with limited time available for the learning that day.

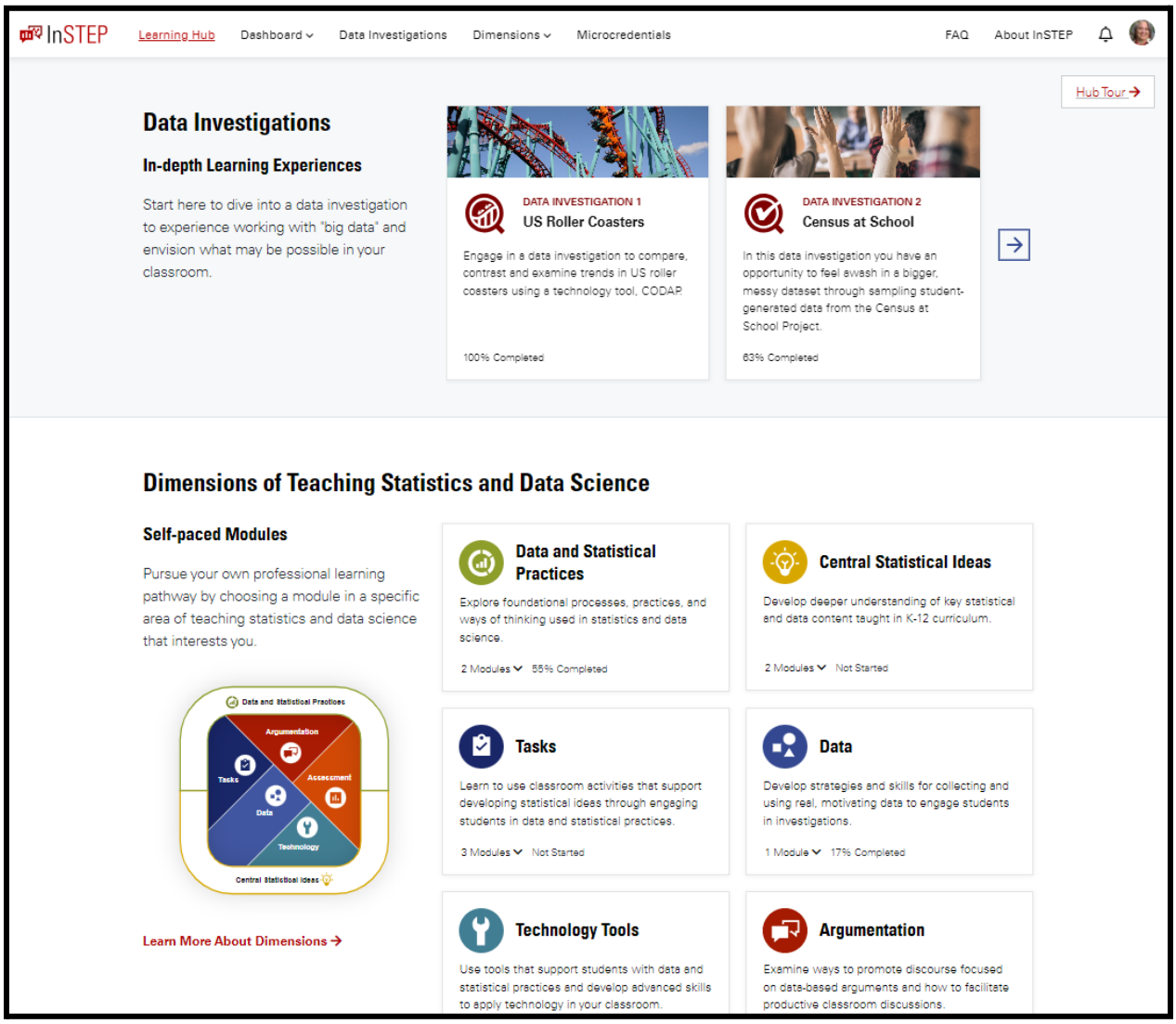

Figure 1. Learning materials organized on the Learning Hub

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Table 1. Learning Activities and Time for Completion Available During Fall 2022 Field Test

Learning Activity and Hours needed for completion	*Brief Title and Description*
Data Investigation Essential Resources Hours: 1.9 Extended Resources Hours: NONE	*Roller Coasters.* A data investigation to compare, contrast and examine trends in US roller coasters.
Data and Statistical Practices Module 1 Essential Resources Hours: 1.8 Extended Resources Hours: 2.8	*What is Statistics and Data Science? (S&DS)* Learn about the big ideas, habits of mind and dispositions of statistics and data science.
Data and Statistical Practices Module 2 Essential Resources Hours: 1 Extended Resources Hours: 2.2	*Investigation Process.* Introduction to a 6-phase data investigation process that incorporates processes and practices of data scientists.
Central Statistics Ideas Module 1 Essential Resources Hours: 1.75 Extended Resources Hours: 3.75	*Big Ideas in Statistics.* Introduction to the key ideas in statistics and how they are foundational for learning statistics.
Central Statistics Ideas Module 2 Essential Resources Hours: 1.4 Extended Resources Hours: 4.7	*Comparing Distributions.* Consider important concepts related to comparing distributions and its important role within statistics.
Tasks Module 1 Essential Resources Hours: 2 Extended Resources Hours: .5	*Worthwhile Tasks.* Explore what it means to identify and select worthwhile Statistical and Data Tasks.
Data Resources Module 1 Essential Resources Hours: 2.1 Extended Resources Hours: 2.4	*Data for Classrooms.* Learn strategies and some good places to get started for collecting and using real, motivating data to engage students in data investigations.
Discourse and Argumentation Module 1 Essential Resources Hours: 2.9 hrs Extended Resources Hours: 1.5 hrs	*Discourse.* Introduction to components of effective classroom discourse and different ways to promote and support discourse while teaching statistics or data.

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Supporting Personalized Learning

The platform is designed such that users can choose to engage in any materials that interest them *in whatever order* they choose. We have three primary design features that can assist teachers in making informed decisions for their learning and to keep track of what they have already completed. The first design towards personalization is to provide recommendations to a participant. Our recommendation engine was initially designed to give all users the same first two recommendations that would allow them to experience one of each of the primary means of learning--a data investigation and a learning module since many teachers have limited experiences investigating real, large data as learners themselves and also have limited experiences with key practices related to statistics and data science. For the field test there was only one data investigation available. The learning module we chose as a second recommendation was based on material found in other studies to be highly influential in impacting teachers' beliefs and practices in teaching statistics through data (Lee, Mojica, & Lovett, 2020). The next recommendations are based on their results from taking four personalization surveys. The order of importance in recommendations are an individual's: 1) reported learning goals, 2) self confidence in teaching statistics (with validated SETS survey, Harrell-Williams et al., 2019), and 3) statistics understanding as measured through the LOCUS test (Jacobbe, 2014).

The second design for personalization is an internal tracking system and user Dashboard which keeps track of progress made on investigations, modules, and microcredentials. The Dashboard (Figure 2) allows an easy way for a user to resume their learning in a set of materials they started but not yet completed. With regard to tracking, users get credit for completing a module if they finish (and mark as complete) all Essential Resources within a module (i.e., Extended Resources contribute to hours earned but not module completion). Also, the Dashboard displays their personalized recommendations and provides easy access to their earned certificates, saved resources, playlists, and discussions. The third design to support personalization is a profile page where users see a report of survey results that includes details about their goals, scores on SETS and LOCUS, and their recommendations for learning.

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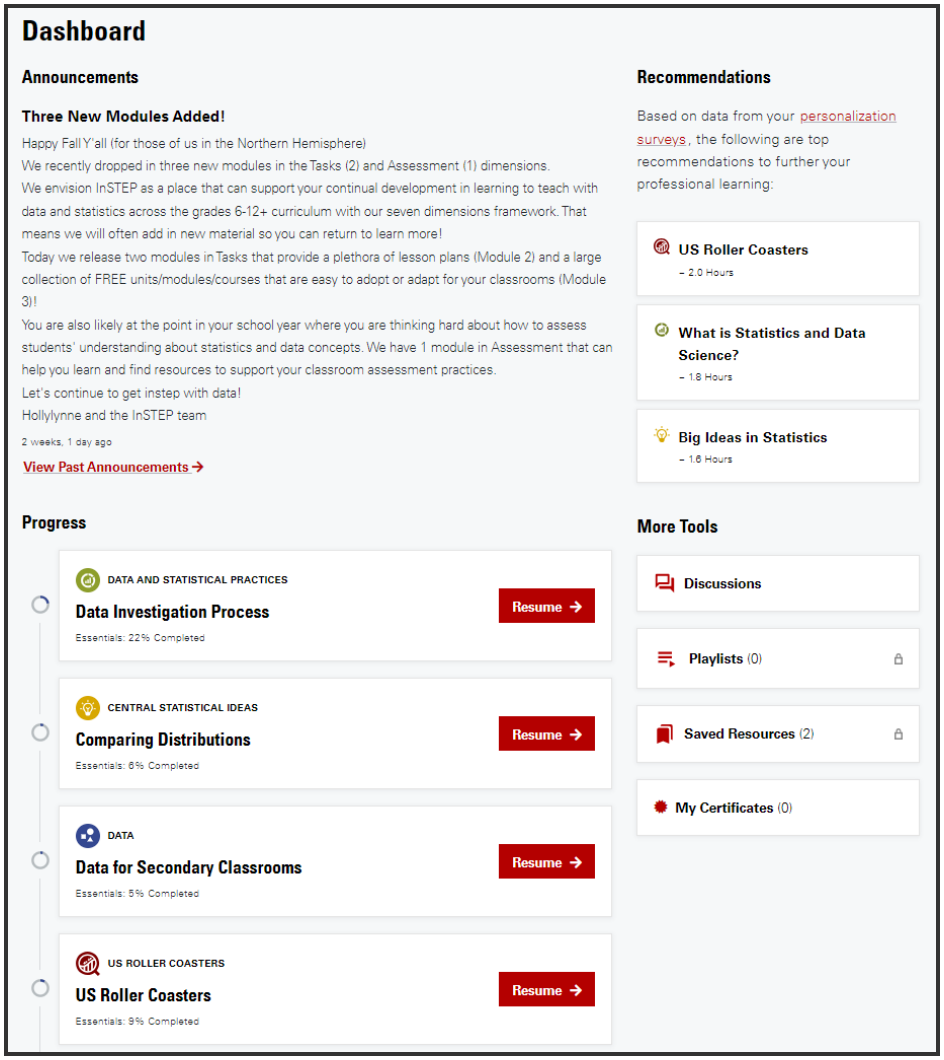

Figure 2. User's personalized Dashboard showing progress tracking and recommendations.

Results from a Collective Case Study

The focus of our mixed methods research (Creswell & Clark, 2017) is on ways in which teachers utilized different features and supports to personalize their learning. Thus, from the field test in Fall 2022 (n=82), we focus on a collective case study of 37 participants who met the following criteria by completing: 1) all personalization surveys, 2) at least 20 hours of professional learning (tracked activity with data logs), and 3) the post user experience survey. Several of these educators also participated in a post interview about their experiences. Our collective case consists primarily of female identifying participants

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(78%) and includes 27 mathematics/statistics teachers (16 high school, 9 middle school), two district-level math coaches, seven science teachers (5 high school, 2 middle school), two middle school math and science teachers, and one middle school social studies teacher. These educators are highly experienced with a mean of 17.6 years (5-31 years) in teaching/coaching and were employed in California, Iowa, Maryland, or North Carolina.

Recommendations and Pathways

Based on results of personalization surveys, most participants had 5-6 recommended learning experiences, with 1 participant having 4. In fact, in the post user experience survey, 76% of participants reported these surveys were effective or very effective in supporting their professional learning pathways. For this proposal we are focusing on comparing participants' initial pathway which we define as the first six learning activities fully completed (marked all essential learning resources as completed). This decision was made to align the completion pathways with our recommendation model that only gave 6 recommendations. Thus, references to a participants completion is bound to them completing an activity as part of their first set of six completed modules or investigation. There were four learning activities recommended to all users and at least 30 participants completed these activities, but none had a 100% completion rate (see Figure 3). All users are recommended to start with the *Roller Coaster* investigation, and indeed 65% of these 37 users completed this learning experience first, with an additional 14% completing this second (Figure 4). There were, however, two high school science teachers that did not complete *Roller Coaster*. The second recommendation, *What is Statistics and Data Science*, was the first or second experience completed for 54% of participants, with four users, three high school math teachers and one high school science teacher, not completing this module. As shown in Figure 2, there were three modules (Investigation Process, Comparing Distributions, and Discourse) in which completion rate was higher than the recommendation rate. In general, in the post user survey 78% of users indicated the recommendations effectively or very effectively supported their professional learning with 8.1% (n=3) reporting not using recommendations.

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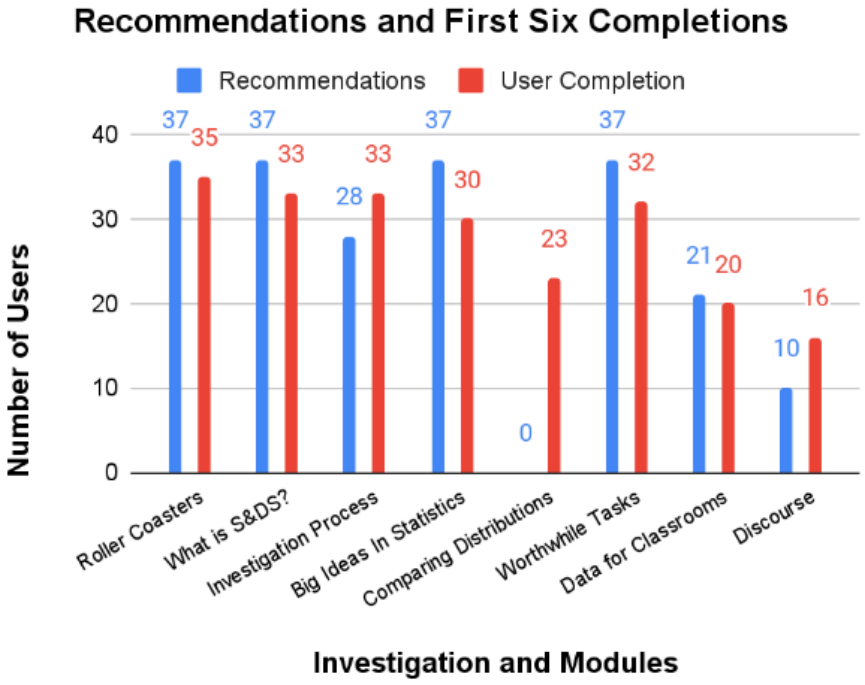

Figure 3. Bar chart comparing recommendations to user completion of activities.

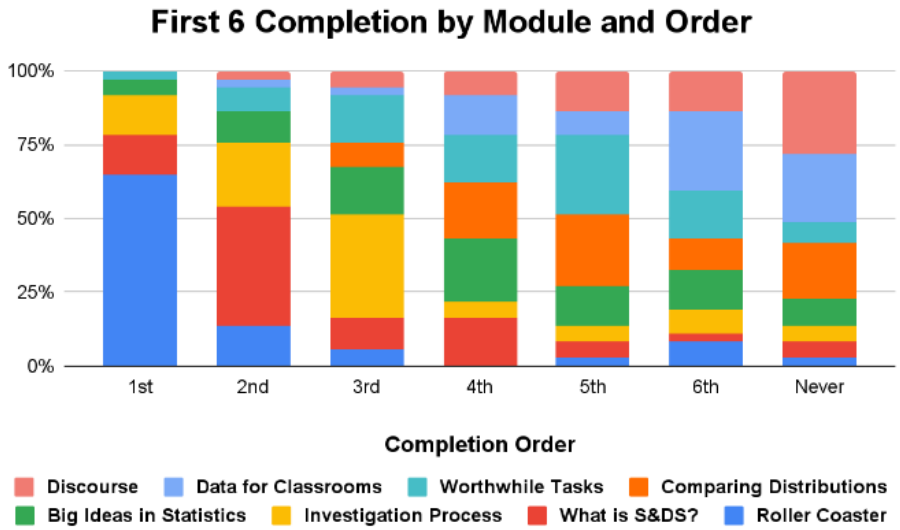

Figure 4. Segmented chart of proportion of users completing activities by order of completion.

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Use of Tracking, Dashboard and Profile Page

The completion pathways indicated that within our two dimensions that contain two modules (Data and Statistics Practices and Central Statistical ideas), many participants would complete both modules in a linear order and in interviews, participants told us they used the tracking features to pick up where they left off. Specifically, within modules users noted that they progressed linearly through resources and used the left side-bar tracking to confirm "Yes, you did all of these things". Almost all of our users (about 90%) reported that the tracking capabilities within modules and on the dashboard were effective or very effective in supporting their learning. For example, one user reported "It took me awhile to understand that I got to pick and choose [their own activities]", but that "the progress things helped a lot". Users were less enthusiastic about how results from their personalization surveys displayed on their profile page, and profile page in general, supported their learning, with only about 68% saying this was effective or very effective.

Lessons Learned About a Personalized Approach

From this collective case study, we learned that teachers appreciate guidance in how to pursue professional learning, as many seemed to follow our initial recommendations and cited them as supportive of their learning. Teachers also valued having choices. Providing structure to modules also seems to be useful and allows teachers to dive deeper into materials. We have some initial evidence that suggests that our initial recommendation model could be better informed using characteristics of learners such as the subject they teach (science or math). In addition, in future research we can dig deeper into the typical pathways of users that includes all activities they completed (included extended resources and microcredentials) to better understand their choices and how these might inform ways we enhance our recommendation model to be informed by users' choices. For example, since many users complete modules within a dimension, we may add a recommendation to a second module once a user completes the first module. As we add data investigations, we could consider doing the same type of additional recommendations.

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