Teacher Perspectives on Using the Web-based Classroom Diagnostic Tool to Gather Student Specific Assessment Data during the COVID-19 Pandemic

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Across many educational contexts, educators have access to a wide variety of student-specific assessment data (SSAD) but often do not use the information to implement data-informed instruction (DII). The purpose of this study was to understand teacher perspectives on the web-based Classroom Diagnostic Tool (CDT) as a means of gathering reliable data from which to modify instruction to support individual learners.

The study took place in the midst of the COVID-19 pandemic when access to students in the physical building was inconsistent. To ensure teachers had access to SSAD, the web-based CDT was implemented so students could take the assessment from any location. After students completed the assessment, two surveys were provided to nine teachers at a Mid-Atlantic suburban high school to assess their perceptions of the reliability and usefulness of the data and to understand if they used the data to modify instruction. The results showed that the web-based CDT did provide student-specific assessment data despite students not consistently being in the physical building. Additionally, seven of nine teachers responded that they believed the data accurately reflected student knowledge. However, only three of the nine modified their instruction as a result.

The results of this study suggest that the web-based CDT is an effective tool to gather data, regardless of where learning occurs. Additionally, it suggests that the CDT provides data that teachers believe accurately reflects student knowledge. However, with only three teachers making

modifications to instruction, the study suggests there are more factors that must be in place to support properly teachers' implementation of DII. Additional research is needed to understand which factors most affect a teacher's use of SSAD to modify instruction for individual students. This research could help teachers and school leaders to leverage the right resources and opportunities to support a culture of DII.

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Preface

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1.0 Introduction to the Problem of Practice

With the passage of the "Every Student Succeeds Act" (ESSA) by the Obama administration in 2015, the era of school accountability through high stakes testing moved to its next phase. Empirical data, such as state standardized test scores, increasingly determines the public perception of a school's success. The reliance on a singular test to determine the success, or lack thereof, of a school makes these assessments extremely important to schools and communities as a means of accountability to ensure the success of individual students. Although using achievement data for accountability has a role in the educational system, using empirical student achievement data to improve the *quality* of instruction is more important and central to the objectives of the educational system: to improve student achievement.

To make instructional changes that meet the needs of learners, teachers need real-time formative assessment data that identifies student progress toward goals and standards. With this information, teachers can implement interventions to support student needs before the year-end assessment. Data informed instruction (DII) involves a system in which various stakeholders analyze and interpret assessment results to create actionable information to improve instruction, student achievement, and schools (Gelderblom et al., 2016; Lai & McNaughton, 2016). Decision makers (i.e., administrators, teachers, students, and families) use their interpretation of the data to create a hypothesis to explain the achievement levels of students (e.g., achieving learning goals, making expected levels of progress, demonstrating skills). Teachers can better support students by using student specific assessment data (SSAD) to question their instruction and consider it as a possible reason for the achievement levels of students, both high and low (Schildkamp et al., 2017).

Educators can improve instructional approaches by combining research-based best practice knowledge with ongoing formative assessment of student response to instruction (Gelderblom et al., 2016).

Formative assessments are measures of student acquisition of knowledge/skills *as* students learn new information or skills. This information is individual student level data (SSAD) about their progress within a lesson or curriculum to achieve the teacher identified learning goals/objectives. Formative assessment plays a significantly different role in the learning process than summative assessment. Summative assessment is a final measurement of knowledge or skills developed by a student. Educators use summative assessments to draw conclusions and judgements about a child's ability or development of an identified skill. While summative assessments can contribute to improving student learning, often they serve only as an indicator of whether it occurred and to what degree (Dixson & Worrell, 2016). Succinctly, summative assessments are assessments OF learning where formative assessments are assessments FOR learning. This distinction is key to understanding why formative assessments play a vital role in using DII. As Wiggins (1998) says, "the aim of [formative] assessments is primarily to educate and improve student performance, not merely to audit it" (p. 7). Formative assessments are the building blocks of information that teachers can use to modify instruction to improve their instruction to increase student learning.

Implementing ongoing changes to instruction based on assessment data is not a simple adjustment. Research by Schildkamp et al. (2017) and Prenger and Schildkamp (2018) suggests that using DII is a challenge in educational settings throughout the world. The authors based their research of data use and DII in the Netherlands. Alotaibi's (2018) research of teacher perception of DII in schools in Saudi Arabia demonstrated this problem exists even in schools within countries

with drastically different cultures than the United States. Throughout the various contexts, the research repeatedly reveals a disconnection between the amount of available student achievement data and its use to improve instruction.

Often in the United States schools are accustomed to reviewing and analyzing summative student assessment data a few times at the beginning of the school year as a type of post-mortem on the previous school year. Prenger and Schildkamp (2018) found a similar pattern of minimal data analysis in their study; on average the teachers surveyed responded that they only review student assessment data "yearly" or "a few times a year" (p. 250). Inevitably, the rearview mirror use of these tests has pushed school leaders and teachers to make instructional decisions for their current cohort of students based on information about the previous cohort of students. While reviewing student data from previous cohorts may be useful to identify underdeveloped curriculum for specific standards, it does not provide student achievement data that teachers can use to modify and best customize instruction to meet the needs of their *current* students. Even if a teacher is using their current cohort of student data (achieved during the previous school year), the data are up to five months old because states like Pennsylvania test during April/May. To make instructional changes that meet the needs of learners, teachers need real-time SSAD that identifies student progress toward goals and standards. SSAD may include classroom formative assessments, benchmarking data (e.g., MAP, STAR, CDT), or standardized test data (i.e., summative).

The COVID-19 pandemic presented new challenges to assess students and analyze the assessment results. Because schools did not resume in-person classes full time or only met with students in-person a fraction of the time, educators had to consider alternative methods to assess students. While traditionally educators have found ways to develop a myriad of on-going assessment data, it was unclear how teachers would assess students and access the data during the

pandemic. Additionally, without investigation it was not possible to determine if the newly developed methods to assess and analyze SSAD provided teachers with actionable data that they then used to make instructional changes.

This problem occurred in school districts across the state of Pennsylvania, including one Mid-Atlantic suburban high school that traditionally used Classroom Diagnostic Tool data to modify Algebra I and Biology instruction. The Classroom Diagnostic Tool (CDT), created by the Pennsylvania Department of Education, provides diagnostic feedback to teachers and students about student progress toward state standards and the learning objectives in a number of content areas including Algebra I and Biology. Both courses, Algebra I and Biology, are assessed as part of Pennsylvania's federal accountability assessments. The CDT assesses student knowledge in four domains that tie directly to the year-end Keystone exam. Teachers receive both numerical and graphical data on individual student and whole class progress. The assessment, taken three to four times throughout the year, is one of few tools that connect directly to the Keystone exam and provides a window into student learning while time is still available to make adjustments. Although this tool was used in the past as a software-based assessment that was installed on school computers, the uncertainty of whether students would return to the physical building because of COVID-19 required an innovation to how teachers assess students. The innovation was the web-based CDT, which students completed from any location as long as they had access to the internet.

As standardized testing continues throughout the world, the issues of not having access to and/or not using student-specific data to improve instruction presents a barrier to meaningful changes to student achievement. Because students were not in their physical school buildings consistently during the 2020-21 school year because of the COVID-19 pandemic, this intervention focused on the application of the web-based CDT assessment to gather student data for teachers to

use to modify instruction. The main inquiry questions were (a) To what degree does the web-based CDT provide data that teachers believe accurately reflects student knowledge? (b) To what degree does the web-based CDT provide data that teachers believe they can use to modify future instruction? and (c) Do teachers use the SSAD provided by the web-based CDT to modify instruction?

2.0 Literature Review

2.1 Uses of Student Specific Assessment Data and the Value of Data Informed Instruction

Both individual schools and governments in the United States and around the world have increased the use of SSAD to promote accountability, to increase student achievement, and to support school improvement efforts (Alotaibi, 2018; Cosner, 2014; Katz & Dack, 2014; Mandianch, 2012; Prenger & Schildkamp, 2018; Schildkamp et al., 2017; Stosich & Bocala, 2018; Talbert et al., 2010). By creating measures of progress, governments and local constituencies can monitor and track student performance and make policy or financial decisions to enhance learning opportunities for children. As the professionalism of teachers continues to grow, expectations rise to ensure teachers are making decisions based on more than their observations and intuition (Schildkamp et al., 2017). Analyzing, interpreting, and using SSAD can support educators' work of increasing academic achievement for all learners.

There are three main purposes for SSAD: accountability, school development, and instructional improvements (Schildkamp et al., 2017). Teachers, school leaders, and governments use SSAD as an accountability tool. Using these data for accountability is the most controversial of the uses of data in schools. While accountability data can be used to identify schools that are failing to meet their students' learning needs and thus signal a need for additional resources, it also has drawbacks. The potential negative effects of an overemphasis on accountability include: (a) a narrowing of the curriculum to teach only the information on the standardized assessment, (b) focusing the majority of effort on students who are close to passing at the expense of students

significantly ahead or behind the learning standard, and (c) possibly causing educators to cheat to improve their scores (Carlson et al., 2011). However, SSAD can provide a means of ensuring consistency across courses and teachers. Effectively used, SSAD should signal the effectiveness and ineffectiveness of a school to spur internal probing and questioning that leads to meaningful changes that improve student learning.

Data used for school development may be SSAD, for instance, student satisfaction questionnaires, or questionnaires that monitor the utilization of a resource room to ensure the maximum benefit for the stated goal. In addition, schools can use SSAD to determine curricular gaps that exist as demonstrated by consistent underachievement by students. Schools can use this information to increase collaboration amongst staff to make necessary adjustments or determine the allocation of instructional time to students (Schildkamp et al., 2017). Carlson et al. (2011) studied the effects of using data for school development by implementing district-wide, data-driven reform efforts in over 500 districts in seven states. The three authors found that the benchmarking testing had positive effects on mathematics scores achieved on state assessments. While not statistically significant, the results indicated possible increases in reading achievement as well (p. 393). Carlson et al. (2011) believed their study supported school development through the use of data-driven reform efforts, stating those efforts "can not only have a statistically significant effect on achievement but a substantively meaningful impact as well" (p. 393).

Instructionally, teachers can use SSAD to customize approaches to learning for students. Prenger and Schildkamp (2018) used the work of Gelderblom et al. (2016), Hattie (2009), and Marzano (2000) to define instruction as “the goal-oriented actions of the teacher in a classroom that focuses on explaining a concept or procedure, or on providing students with insights that will

initiate or sustain their learning process" (p. 736). To instruct using SSAD effectively, teachers should set appropriate learning targets, assess acquisition of knowledge/skills and modify pedagogical techniques as appropriate for a variety of learners, provide different ways to demonstrate learning, increase access to challenging work, and accelerate (or decelerate) the pace of instruction (Prenger & Schildkamp, 2018). All of these examples comprise effective DII.

One study by Gelderblom et al. (2016) used a mixed-method design to survey and interview Dutch primary school teachers to understand how teachers used DII. The authors identified four areas that teachers could use data to adapt instructional goals: purposeful teaching, adaptive instruction, feedback, and learning time. They defined purposeful teaching as intentionally setting high and realistic learning goals. Purposeful teaching through monitoring and analyzing student data allows a teacher to adjust pacing, rigor, or instructional techniques to support student acquisition of the necessary skills/knowledge to complete the established goals. The research defined adaptive instruction as the teacher's willingness to modify instruction to meet the differing needs of learners. Teachers can use SSAD to assess the variability amongst learners to provide differing materials or alternative instructional methods to support all students. They can also provide feedback that is more meaningful. Gelderblom et al. (2016) defined feedback as "information about the gap between that which the students have mastered (learning outcomes) and that which the students should have mastered (objectives and standards)" (p. 4). The main purpose of feedback is to provide students with information that they can combine with the knowledge to take action to improve their learning.

Although the findings of Gelderblom et al. (2016) surveys and interviews reveal that 96% of teachers believe they use data for DII and purposeful teaching, they do so in a "superficial" way (p. 9). The teachers did not seem to have a clear purpose with the data, and their analysis mostly

extended to identifying which students are not reaching the learning goals, but not deeper into the specifics of which standards/goals individual students do not understand. Further, even though teachers reported that data affects their adaptive instruction, it was not clear what changes they made. The authors cited an example when a teacher believed she used DII because she used small groups for students who demonstrated a deficiency in a learning goal. However, it was not clear how her instruction changed within that small group. It likely involved re-teaching rather than using an analysis of individual learning deficits to modify instruction to meet individual needs. For those reasons, the authors stated, "It is not likely that the use of data actually affected student outcomes. The data only affected the level of awareness" (p. 11).

As the word data becomes an increasingly popular term in the world of education, it is important to keep in mind the ways it is useful. The literature identifies three main ways to use data: accountability, school development, and DII. Each use is important to consider as stakeholders work to improve learning opportunities for students. Specifically, DII holds potential to affect the learning environment our students experience within the classroom each day significantly. However, that potential is difficult to realize without educational leaders creating an ideal culture for DII to thrive.

2.2 Creating a DII Culture: The Role of the School Leader

Although school leaders do not deliver instruction to students, they have a vital role in creating the larger school culture and supporting the alignment of curriculum and assessment with content standards and state assessment measures. If properly aligned, DII can be successful and

schools can use SSAD to inform decisions to improve individual and large group instruction (Abrams et al., 2016). The most effective systems closely tie daily instruction with the above specifications to ensure teachers have more timely data to use to modify instruction. As a formal authority in the school, leaders create a DII culture by setting expectations, creating a culture of collaboration, providing adequate resources (e.g., tools to gather assessment data, money, time), and monitoring the progress of implementation (Abrams et al., 2016; Bernhardt, 2017; Farley-Ripple & Buttram, 2014; Gerzon, 2015; Luo, 2008; Prenger & Schildkamp, 2018; Schildkamp et al., 2017; Wayman et al., 2009). Abrams et al. (2016) found that a school's data use culture was significant in determining whether teachers used DII.

School data use culture examines the differences (i.e., concerning data) in the policies, expectations, leadership, and collaboration amongst colleagues. It is likely that data-use approaches are similar and consistently used in buildings with similar data-use culture (Abrams et al., 2016). In fact, principal leadership has a positive impact on data use practices within schools (Wayman et al., 2009). One important display of leadership from a building principal is developing a system that teachers can use to gather SSAD and then setting the expectation for appropriate DII that focuses on supporting student growth by modifying instruction to meet their needs best (Cosner, 2014). This avoids the commonly found problem of using SSAD only as a means to identify student weaknesses and misconceptions rather than using data to assess pedagogical approaches for each student or group of students.

Communicating the expectations for data use is critically important. School leaders can communicate through various means, including faculty meeting presentations, policy documents, and modeling best practices (Gerzon, 2015). Without administrative expectations that teachers implement DII, the resulting “change” in instruction is not individualized but is often whole group

interventions or generically created remediation plans. In contrast, when expectations are clear and a system is highly integrated, improvements happen because teachers (a) have data readily available, (b) use data to alert themselves to gaps in individual learning, (c) determine standards tied to the learning gap, (d) decide and implement an appropriate instructional approach to support acquisition of the knowledge or skill, and (e) assess whether the intervention was successful (Abrams et al., 2016). In addition to developing a clear expectation for DII, it is important that leaders support the development of a growth mindset with the staff.

Carol Dweck's (2008) work studied the significance that an individual's mindset can have on positive outcomes. She differentiated two distinct frames of mind, growth and fixed. Individuals with fixed mindsets believe that knowledge and skills are finite and do not grow or develop over time. They avoid difficult tasks because they view an inability to complete the task as a sign of lesser ability or weakness. Conversely, individuals with growth mindsets view knowledge and skills as able to develop and increase over time (with effort). These individuals take on challenging tasks because they value the struggle as evidence of learning. While it is important to point out that no individual always has either a growth or fixed mindset, the distinction does have important implications on an individual's willingness to learn new tasks. Because using data to modify instruction may be an uncomfortable and new skill to teachers, it is important that leaders create opportunities for teachers to find comfort in not knowing, to see learning as a central part of their job, and to use data sources constantly to reflect on their understandings and teaching practices (Katz & Dack, 2014). Additionally, leaders should create cultures that use data as a tool to support student and professional growth rather than an accountability tool used to identify weak teachers. By creating this culture, administrators can increase affective attitudes (i.e., feeling or emotion

created by potential use) and perceived control concerning data use to increase teacher use of DII (Prenger & Schildkamp, 2018).

An important part of creating a culture that supports DII is ensuring that individuals within the organization have the necessary resources in the form of assessment tools, time, space, and instructional supports to both analyze data and modify instruction. The COVID-19 pandemic made it difficult to predict where and how students learned throughout the year. Traditional methods of data gathering were, at times, inadequate because students were not present in the school building. If school leaders expect teachers to use data, then teachers must have data readily available, and it is critical that leaders find ways to provide the aforementioned resources (e.g., time, space for collaboration). Leaders and teachers can find solutions that allow teachers to assess students consistently from whatever location they are learning (in the physical building, at home, or in a blended model).

A central role of an administrator is the creation of the master schedule. A schedule that prioritizes databased decision-making provides educators with consistent and predictable times to analyze data and make adjustments. Included in this time is the availability of colleagues working towards similar goals or using similar data. This leads to more collaboration amongst staff, which the literature indicates is an important component in improving instruction (Abrams et al., 2016; Bernhardt, 2017; Farley-Ripple & Buttram, 2014; Luo, 2008; Prenger & Schildkamp, 2018; Schildkamp et al., 2017; Wayman et al., 2009). Protecting the time against other identified needs (e.g., class coverage needs, state-mandated training requirements) is a necessity for the building administration. Administrators who develop schedules that promote time for teacher reflection and collaboration demonstrate their commitment to the use of DII practices (Wayman et al., 2009).

Another important resource that building leaders can make available is the instructional support staffs (e.g., instructional coaches, curriculum directors) who are pedagogical experts. These individuals are integral to supporting teachers to make instructional adaptations based on SSAD. While coaches and others can help teachers analyze the data, their most important role is facilitating data to instructional action (Farley-Ripple & Buttram, 2014). By allocating limited resources to create or maintain instructional support staff positions, leaders exhibit determination in supporting teachers to use DII.

Finally, leaders demonstrate commitment to DII by following up with staff and holding them accountable for using DII. The focus of accountability in this sense is not about determining the quality of instruction provided by a teacher (although high-quality instruction is the expectation); rather, it is monitoring instruction to ensure teachers modify instruction based on the SSAD. If adequate culture and resources are available, leaders demonstrate an expectation of changing instructional practices through their presence in the classroom. School principals can hold members of the school leadership team and teachers accountable for using data by modeling appropriate practices and providing timely feedback. By completing classroom walk-through observations, the building leadership team can monitor the implementation of an identified intervention to support student learning. If collected, walk-through data (observational or quantitative) demonstrates teachers are not implementing an intervention or that the intervention is not having the intended outcome, members of the leadership team must work with the teacher to make necessary adjustments (Bambrick-Santoyo, 2019; Bernhardt, 2017). When leaders and supervisors monitor the adjustments teachers make to instruction, teachers know the classroom walk-through observations matter and see an administrative team using data to improve

the school and individual student learning. The literature suggests a systemic approach to create a DII culture; teacher skills and attitude toward DII are also important to consider.

2.3 Teacher Skills and Attitudes towards Data Informed Instruction

While there is no doubt that practitioners must learn how to turn data into actionable knowledge, it is important that researchers consider their needs as learners as well (Mandianch, 2012). Three factors significantly influence whether teachers use DII: school organizational characteristics (discussed in a previous section), user characteristics (i.e., attitudes and skills), and collaboration (Schildkamp et al., 2017).

While most teachers report that they use data, making the distinction of using it for DII severely decreases the number of teachers who use data (Gelderblom et al., 2016). To start, teachers must have data readily available and believe that data about individual student strengths and weaknesses can help them improve instruction. Teachers who hold this belief are more likely to use DII intentionally to support students to achieve the stated learning goals (Luo, 2008; Prenger & Schildkamp, 2018). However, educators, especially veteran staff, have many experiences with instructional approaches that work and those that do not. They view instruction as a very personal activity that develops over time, and asking them to use DII is unsettling for some (Prenger & Schildkamp, 2018).

Two additional important indicators of whether teachers will use DII are their perception of the ease of implementation or "instrumental attitude" and "perceived control" (Prenger & Schildkamp, 2018). The concept of instrumental attitude has two components. The first component

is about the actual tool used to collect the data. For instance, teachers who do not believe the tool will accurately reflect student knowledge will be less likely to investigate the data thoroughly to determine student strengths and weaknesses (Datnow et al., 2012). Also, included in the instrumental attitude is the comfort level educators feel about making an instructional change based on the data. Do they have enough instructional approaches in their repertoire to incorporate into classroom activities? Can they seamlessly move students or groups of students to a different task? To make changes, teachers need sufficient pedagogical content knowledge (PCK) to improve instruction. Shulman (1986) defined PCK as content knowledge that is "germane to its teachability" (p. 9). As Schildkamp et al. state, "data can help teachers to identify the conceptions and misconceptions of students, but teachers still need their PCK to determine how to alter their instruction accordingly" (2017, p. 253). In addition, teachers have to feel like they have control over the choices they make in their classrooms. Truly using DII may mean that teachers have to spend more time on a topic within the curriculum than initially expected. The ability to make those choices represents teacher control.

In addition, teachers have to intend to use SSAD actively. Prenger and Schildkamp (2018) used the term "behavioral intention" to mean a teacher's preparedness and intention to use data in the future. They studied whether an individual's attitude, subjective norms, perceived control, self-efficacy, collective efficacy, and behavioral intentions had an impact on data use. Instrumental attitude, perceived control, and behavioral intentions predicted 24% of the difference between teachers who used data to improve instruction and those who did not (p. 746).

Further, Schildkamp et al. (2017) suggest that many teachers do not understand how to use data to improve instruction (p. 250). This indicates that although more data are readily available, teachers still do not know how to make it useful. The authors also explain that teachers, as well as

leaders, may see data as only usable for school accountability instead of “using data for accountability AND school development AND instruction” (p. 252). Unfortunately, the authors found that teachers use SSAD for accountability purposes more than for school development and instruction. Multiple respondents of their survey answered, "I do not know,” on questions about using data for all three areas. Additionally, Kippers et al. (2017) completed a mixed-method approach by using pre- and post-test data-literacy tests, interviews, and evaluations of team meetings to determine how well professional development supported teacher learning concerning data literacy. Specifically, they reviewed teachers’ ability to set a purpose, collect data, analyze data, interpret data, and take instructional action. Their study identified a lack of data literacy as a barrier to DII. While teachers were able to grow in these areas after professional development, the research demonstrated a lack of understanding in those key areas.

Finally, the literature is consistent on the importance of teacher collaboration on the effective use of DII (Abrams et al., 2016; Bernhardt, 2017; Cosner, 2014; Farley-Ripple & Buttram, 2014; Gelderblom et al., 2016; Katz & Dack, 2014; Lai & McNaughton, 2006; Prenger & Schildkamp, 2018; Schildkamp et al., 2017; Wayman et al., 2009). Because data are not an answer but rather a means to question practice, it is difficult to leverage data’s potential without a diverse collection of opinions. To question the data effectively and derive possible hypotheses for further investigation, educators need the vast skill set, knowledge base, and experiences that they AND their colleagues possess. The diversity and wealth of knowledge help to dissect data fully to develop meaningful hypothesis rather than jumping to an immediate and potentially not thoroughly considered solution (Katz & Dack, 2014). Collaborative groups can hold each other accountable to ensure data analysis and the conversations that arise from the analysis are about improving instruction rather than accepting self-preserving theories or shifting blame onto students (Little,

2012). As a result, teachers who collaborate are more likely to consider a solution that best supports student learning.

The dispositions and skills teachers need to support their use of DII are numerous. Along with an administration supported strong culture, teachers who believe in DII, have strong PCK to select different activities to support learners, feel control over instructional decisions in the classroom, understand the difference between SSAD for accountability and SSAD for DII, and collaborate fully and often have the best chance of effectively using DII. Developing all of the components of effective DII requires a shift in thinking for leaders and teachers, as well as significant professional development to increase educators' instructional repertoire.

2.4 Summary of Findings

The literature base is clear on the many positive uses of SSAD including DII. Administrators play a significant role in establishing a culture of DII, developing clear expectations, and providing the necessary resources to gather and analyze data (including proper tools to gather data and time for collaboration amongst teachers). For their part, teachers need access to quality data that they believe is representative of their student knowledge/skills, well developed PCK, and data analysis skills. The intervention for this study will focus on the tool used to gather the data (i.e., the web-based CDT as required by administration) and the usefulness of the data gathered (from the teachers' perspectives) to support instructional changes.

The next section of this paper will examine my theory of improvement, identify primary and secondary drivers, and assess whether I met the aim of my study. The *theory of improvement*

is a working theory that examines the complete system and considers which factors, if modified, will likely improve the system toward an identified and measurable *aim* (i.e., goal). Within the theory of improvement are specific *drivers* (both primary and secondary) which are forces within the system believed to be "high leverage to effect intended changes" (Mintrop, 2016, p. 116). By considering a more complete conception of the problem and identifying the most significant drivers, I can consider various change ideas that may improve the system. Additionally, assessing *leading* and *process measures* allows me to determine if my *change idea* affected the drivers or something else effected the system. A leading measure is a predictor of the ultimate outcome but is more readily available. A process measure considers how processes (such as giving the web-based versus software-based CDT) are performing under different conditions (Carnegie Foundation for the Advancement of Teaching, n.d.). Lastly, by selecting and assessing the effectiveness of a newly implemented change idea, I can determine if I have met the aim, or attainable goal, of the study.

3.0 Theory of Improvement and the Change

A theory of improvement is a narrative form of a driver diagram. Its purpose is to make clear the aim, primary and secondary drivers, and specific change ideas incorporated into an improvement science process. The aim of this improvement process is as follows: by December 2020, Algebra I and Biology teachers will modify their instruction at least one time as result of analyzing SSAD provided by the web-based Classroom Diagnostic Tool (CDT). I have identified three primary drivers to meet my aim: time for teacher collaboration with colleagues, resources and tools to collect and analyze data to change instruction, and teachers' access to SSAD and skills to analyze data. The literature identified all three components as being hugely important to supporting teachers in using Data Informed Instruction (DII) (Schildkamp et al., 2017).

Providing opportunities to collaborate with colleagues is the most discussed topic across the literature to support DII (Bernhardt, 2017; Cosner, 2014; Farley-Ripple & Buttram, 2014; Gelderblom et al., 2016; Katz & Dack, 2013; Lai & McNaughton, 2006; Prenger & Schildkamp, 2018; Schildkamp et al., 2017). In addition to the literature, I interviewed two teachers within my place of practice about the lack of DII. Both individuals discussed the importance of collaboration with colleagues to develop different instructional approaches to address deficits made clear by data. The secondary drivers to improving collaboration with colleagues are an increase in time to collaborate with colleagues and support to develop highly effective teams. To address an addition of time, a specific change idea is to allocate 45 minutes of professional time to teachers who are using DII. These 45 minutes would come from time already set aside during the school day for teacher planning/preparation. To support the development of high-quality teams, a specific change

could be the creation and use of Professional Learning Communities (PLCs). PLCs help to establish group norms, identify clear objectives, and institutionalize the process of DII (Farley-Ripple & Buttram, 2014). Lastly, providing incentives to teachers who are completing this work can help improve the quality of teams. For example, providing compensatory time, release time, and/or providing for increased schedule flexibility are all ways to incentivize members of the Math and Biology department to want to work on PLCs to support DII. Although fostering collaboration with colleagues is extremely important to helping teachers modify their instruction, so is developing resources and tools to change instruction.

One barrier to teachers using DII is a deficit in what Shulman (1986) called pedagogical content knowledge (PCK). The author defines PCK as content knowledge that is "germane to its teachability" (p. 9). One key to supporting the development of PCK is increasing collaboration amongst colleagues (Schildkamp et al., 2017). Another secondary driver to increasing PCK is a data management system that allows for the creation and storage of alternative methods for instruction (created during collaborative time with colleagues). If teachers have an easily accessible system to gather resources to support DII, they will be more likely to modify their instruction. A specific change idea is to create Google drive folders organized by content specific anchors/standards/objectives. By organizing the information in this way, teachers can analyze data to identify gaps/weaknesses and efficiently and effectively identify another means to instruct that specific content. Teachers' ability to analyze data is critical to their ability to choose the best alternative method of instruction. Developing this skill is a secondary driver to the primary driver of resources and tools to change instruction, as well as the final driver of analyzing data.

Kippers et al. (2018) identified a lack of data literacy as an additional barrier to teachers implementing effective DII. For that reason, a change idea is to provide professional development

to teachers to support their ability to analyze and interpret data produced by the assessment tool, the Classroom Diagnostic Tool (CDT). While the literature suggests providing this professional development, interviews with multiple teachers involved with CDT testing said it was not needed for the Algebra I and Biology teachers. The majority of those interviewed, described how data analysis is central to the work of mathematicians and scientists; therefore, it is a skill math and Biology teachers possess. They did suggest devoting more time for the analysis of data. One change idea is to reduce the amount of duty periods for each teacher by one each week. Teachers would receive 47 additional minutes a week for data analysis by implementing this change. The final secondary driver that effects the primary driver of analysis of data is developing a clear purpose/goal for the analysis. Abrams et al. (2016) suggest that when leaders provide clear expectations, purposes, and end goals for data analysis, teams of teachers are more likely to have success implementing DII techniques. A specific change idea to provide clear expectations is a meeting with teachers before the start of the process. Additionally, an administrator would meet with teachers periodically to hear teacher feedback on their progress and reestablish expectations.

Lastly, it is necessary to have data available to use information gathered from analysis to develop/select alternative instructional methods to customize supports for individual or small groups of students. While seemingly obvious, to effectively use SSAD to drive DII, teachers need access to timely and accurate data (Abrams et al., 2016; Bernhardt, 2017; Cosner, 2014; Farley-Ripple & Buttram, 2014; Gerzon, 2015; Luo, 2008; Prenger & Schildkamp, 2018; Schildkamp et al., 2017; Wayman, et al., 2009). Additionally, teachers need to believe that the assessment tool is valid and reliable in assessing student understanding (Datnow et al., 2012). In the current context of the COVID-19 pandemic where it is unclear whether students will reenter the building for the 2020-21 school year, a change idea to ensure teachers have access to valid and reliable data is to

use a web-based version of the CDT, as compared to the traditionally used software version. The benefits allow students to complete the assessment from any location or device as long as they have internet. Teachers then have access to that data immediately to make instructional decisions.

The aim of increasing the number of times a teacher modifies their instruction based on SSAD has three primary drivers: collaboration with colleagues, resources and tools to change instruction, and teachers' access to SSAD and ability to analyze data. Each primary driver has a number of secondary drivers that work in conjunction to support or hinder the effectiveness of the primary driver. To move the system forward to achieve the aim, I developed specific change ideas to affect the secondary drivers. I will need to implement the specific change ideas and measure the impact of each change. Based on that assessment, I can determine the most appropriate next step to achieve my desired outcome. See Figure 1 for the complete Driver Diagram.

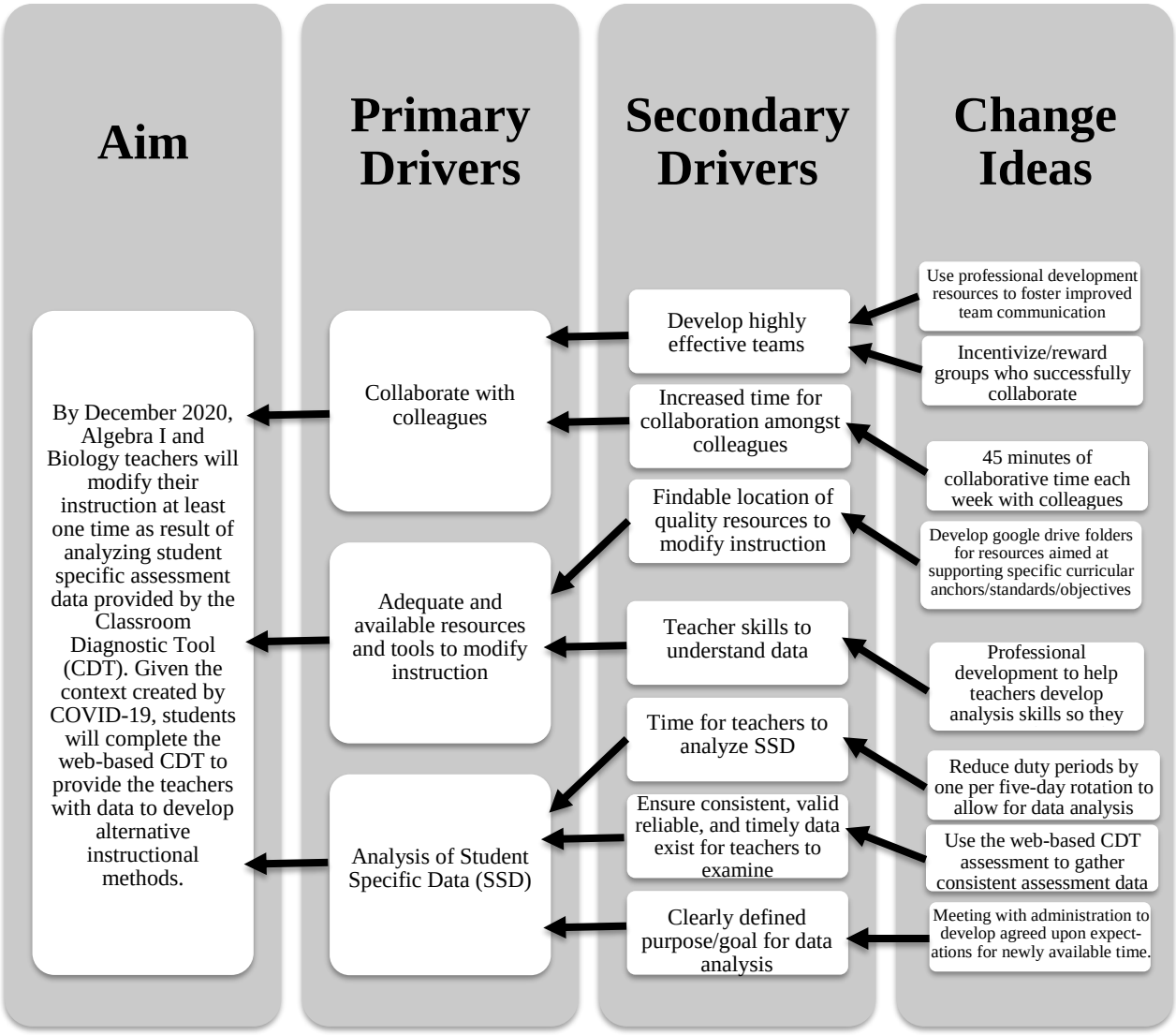

Figure 1. Driver Diagram

3.1 Inquiry Intervention

The literature from the field identified the limited time for collaboration among educators, teachers' lack of PCK, and underdeveloped data analysis skills amongst teachers as the primary

barriers to DII. While those factors are clearly important, the context in which this intervention took place was a global pandemic where schools did not consistently meet inside the school building throughout the entire year. Because of the unprecedented circumstances caused by the COVID-19 pandemic, to date, the literature has not examined how a change of this magnitude will influence teachers' use of DII.

Because students were not consistently in the physical building during the 2020-21 school year, this intervention focused on the application of the web-based CDT assessment to gather student data. The main inquiry questions were (a) To what degree does the web-based CDT provide data that teachers believe accurately reflects student knowledge? (b) To what degree does the web-based CDT provide data that teachers believe they can use to modify future instruction? and (c) Do teachers use the SSAD provided by the web-based CDT to modify instruction?

The innovation, moving from the software-based CDT to the web-based CDT, allowed students to complete the assessment from any location. This change idea aligns with one of my primary drivers, "analysis of student specific data." More specifically, this addressed the secondary driver of teachers having access to timely, valid, reliable, and consistent SSAD. I used a survey as my method to obtain information to answer my inquiry questions. The survey had a driver measure embedded to ask teachers if they felt the web-based CDT provided them the data they needed to modify their instruction. Another consideration for this inquiry was the scalability of the learning to apply to new settings. This intervention was scalable because, if the web-based CDT provides SSAD that teachers find reliable and usable to modify instruction, this Mid-Atlantic Suburban High School could move to web-based versions of the Literature, Geometry, Algebra II, and Chemistry CDT. By expanding to the other areas, more teachers will have access to data that can eventually help more students learn.

Because the CDT offers specific diagnostic categories that focus on a chunked segment of the curriculum, students could take the assessment up to five times in an academic year. This allows me to analyze the results of the survey to determine any changes I would need to make for the next CDT assessment. In this way, this intervention allowed for the iterative process required in Improvement Science (Bryk et al., 2015). Each iteration of the process would take two to three months for teachers to provide the CDT assessment, complete the initial survey, and complete the follow-up survey. Table 1 provides a timeline for the intervention, including a second PDSA cycle beginning in February. The intent is to use the results and learnings from the initial PDSA cycle to make modifications to improve outcomes during the next CDT assessment.

Table 1. Intervention Timeline

Content	Diagnostic Category	Intervention (Web-based CDT)	Measure effectiveness of intervention – Teacher Survey	Measure effectiveness of intervention – Follow-up Survey	Data Analysis
Algebra 1	Operations with real numbers and expressions	October 2020	Mid-November	December	December
Biology	Basic biological principles – Chemical basis for life	October – November 2020	Mid-November	December	December
Algebra 1	Data analysis	January	Mid-February	March	April
Biology	Bioenergetics – homeostasis and transport	January	Mid-February	March	April

3.2 Participants

This intervention focused on nine teachers from a Mid-Atlantic Suburban High School. Those nine individuals were chosen because (a) they teach in a state-tested subject area (i.e., Biology and Algebra I), (b) they have never used the web-based Classroom Diagnostic Tool (CDT) before, and (c) the web-based CDT is offered for both subject areas. Those factors improved the validity of responses because this was the only group of teachers assessing students through the CDT. Additionally, this group of teachers used the software-based CDT in previous years. Their general familiarity with the CDT provided credible feedback on the intervention.

In October, I met with these nine teachers via Google Meet to outline our 2020-21 assessment plan. Because this high school has used the software-based CDT in the past, the meeting was unremarkable to the nine teachers involved. During that meeting, I explained to the teachers that the high school is moving to the web-based CDT to address the uncertainty wrought by the COVID-19 pandemic including our daily access to students in the physical building.

3.3 Measures

To measure my proposed intervention, I used two surveys. In October, I met virtually with the group of nine teachers to review the plan for the web-based CDT and additional surveys. Teachers were made aware that the surveys are part of a doctoral dissertation. I read the following script to the teachers:

> *The purpose of this research study is to determine the effectiveness of the web-based Classroom Diagnostic Tool (CDT) to gather student specific data to support*

teachers in using data to modify their instructional approaches. To test the effectiveness of this new tool, I am asking Algebra I and Biology teachers who implement the web-based CDT to complete a brief (approximately 15 minutes) survey about their experience and the quality of the data provided by the web-based CDT. Those who participate will be asked about student participation rates, ease of implementation, issues associated with the web-based CDT, trust in the reliability of the data, and usefulness of the data. There are no foreseeable risks or benefits to you for participating. Your responses will not be identifiable in any way and results will be kept on a password protected Excel spreadsheet. Your participation is voluntary, and you may withdraw from this project at any time.

The initial survey (found in Appendix D) consisted of thirteen questions and the follow-up survey (found in Appendix E) had three questions. The survey questions were a mix of Likert scale questions using the same seven-point scale (Strongly Disagree, Disagree, Somewhat disagree, Neither agree nor disagree, Somewhat agree, Agree, and Strongly agree) and open-ended questions. The seven-point scale provided space for each participant to reflect their thoughts accurately, which was likely along a gradual continuum thus making the results reliable.

The intention of the surveys was to answer three main inquiry questions: (a) To what degree does the web-based CDT provide data that teachers believe accurately reflects student knowledge? (b) To what degree does the web-based CDT provide data that teachers believe they can use to modify future instruction? (c) Do teachers use the SSAD provided by the web-based CDT to modify instruction?

These questions derived from both the literature and the COVID-19 pandemic conditions. Pre-pandemic attempts to use the software-based CDT did yield data that led to changes (albeit minor, anecdotal, and not scientifically tested) to teachers' instruction. Given the pandemic circumstances, it is important to know whether the new web-based method provided enough reliable data for teachers to modify instruction. Additionally, the literature suggests that having access to SSAD is important, but it is not the only barrier to teachers using DII. For that reason, I

wanted to know what specific changes teachers made to instruction. And if they did not make changes, what barriers prevented them from the changes? If the web-based CDT provides sufficient data but teachers did not change instruction, the "why" becomes the focus of the following iterations of this intervention. As Table 2 indicates, each item was analyzed separately.

While the Mid-Atlantic Suburban High School did not, at the time, have any processes to capture this type of information from teachers, the use of a survey was practical. Within a few weeks of students completing the web-based CDT, I emailed the nine teachers a link to complete the initial survey. Teachers used the link provided to access the Qualtrics survey. The survey took approximately 15 minutes to complete. I asked that teachers submit their responses as soon as possible after they received the survey. Once teachers completed the survey, they submitted it. I had immediate access to their responses to begin my analysis.

4.0 Analysis of Data

Data analysis consisted of descriptive statistics and summaries, due to the small sample involved in this study. All nine teachers who received the survey completed Survey 1. However, although all nine completed Survey 2, only seven of the nine respondents used a pseudonym to connect responses in Survey 1 to their follow-up responses in Survey 2. This is important because one of the study questions pondered whether teachers made modifications to instruction based on the data received. Knowing how a teacher responded on Survey 2 allows consideration of which factors (valid data, reliable data, intentionality of respondent, etc.) may affect whether a teacher makes modifications to instruction. What follows is the description of the analyses.

4.1 Survey 1

Table 2 reviews the analysis for each survey item.

Table 2. Description of Analysis for Survey 1

Item Number	Question asked in the survey	Description of analysis
1	To keep people anonymous, please select and write your pseudonym (research nickname to keep you anonymous) here. Then enter it into your phone so you can use it on the follow-up survey, too!	The pseudonym will be used to determine patterns in responses between the initial and follow up survey.
2	What percentage of your students completed the entire Classroom Diagnostic Tool assessment?	Percentage data
3	How many students reported to you that they experienced technical problems while trying to complete the web-based Classroom Diagnostic Tool assessment? Examples of technical problems: log-in did not work, internet would not connect, questions would not load, etc.	Description of ratings
4	What was the most common technical problem students experienced?	List problems in order of frequency.
5	Select your response that best applies to this statement: The web-based Classroom Diagnostic Tool provided me student-specific data in a timely manner.	Description of ratings
6	Select your response that best applies to this statement: The web-based Classroom Diagnostic Tool provided me student-specific data that I believe accurately represents the students understanding.	Description of ratings
7	Select your response that best applies to this statement: The web-based Classroom Diagnostic Tool provided me student-specific data that I **can** use to modify my future instruction to support individual students.	Description of ratings
8	Select your response that best applies to this statement: The web-based Classroom Diagnostic Tool provided me student-specific data that I **will** use to modify my future instruction to support individual students.	Description of ratings

Table 2 (continued)

9	Did you experience problems accessing the student specific data provided by the Classroom Diagnostic Tool? If yes, explain the problems you experienced.	Content analysis of responses
10	Select your response that best applies to this statement: The web-based Classroom Diagnostic Tool provided me student specific data that I did not have prior to using the assessment.	Description of ratings
11	Select your response that best applies to this statement: The information provided by the web-based Classroom Diagnostic Tool was worth the class time used to complete the assessment.	Description of ratings
12	Please explain the reason for your answer to the question above.	Content analysis of responses
13	What changes would you like to see when students complete the Classroom Diagnostic Tool assessment again during this school year?	Content analysis of responses

One analysis that I used to determine if the intervention was successful is the percentage of students who completed the CDT assessment, as reported by their teachers. Of the nine respondents, seven answered between 76% and 100% of students were able to complete the CDT assessment. The remaining two respondents noted that between 51% and 75% of students completed the assessment. Of the two respondents who had between 51% and 75% students complete the CDT, one responded in question two of the second survey that they did make modifications to instruction. Of the seven who had between 76% and 100% of students complete the CDT, only two modified their instruction (as reported in question two of the second survey).

Another analysis was to examine the major problems with accessing the web-based CDT: did students experience more problems than they expected, and what were the most common problems students faced? According to the responses, 33% of the teachers felt students experienced a similar number of technical problems as they expected. Twenty-two percent felt students experienced less problems than they expected while 44% believed students experienced "much more" than they expected. The most common issues that teachers reported were login/password issues as seven of nine provided responses that were coded as login issues. For example, teachers responded, "Couldn't log in," "Inability to login," "Link/login wasn't working. We had to issue them a new password," etc. The focus of this process measures whether the web-based CDT allowed all students to participate by considering the percentage who complete the assessment. Teachers who had three quarters or less of their students complete the CDT would have less data and be less likely to modify their instruction.

Analysis of the data also considered the leading measures to determine if teachers found the data valid, reliable, or usable. Of the nine respondents, seven either agreed or somewhat agreed with the statement, "The web-based Classroom Diagnostic Tool provided me student-specific data

that *I believe accurately* represents students understanding." Only one strongly disagreed with that statement and one neither agreed nor disagreed. Three of the seven who agreed eventually said in the second survey that they modified their instruction because of the CDT. The above question assessed the validity and reliability (from the teacher's perspective) of the CDT data.

Additionally, when asked to select the response that best applies to this statement, "The web-based Classroom Diagnostic Tool provided me student-specific data that *I can use* to modify my future instruction to support individual students," four respondents agreed with the statement while two somewhat agreed. Of the remaining responses two strongly disagreed that they could use the data to modify instruction and one somewhat disagreed. Of the six who agreed or somewhat agreed, three responded in Survey 2 that they did make modifications to instruction while three stated they did not. Of the three respondents who could not use the CDT data to modify instruction, all replied to Survey 2 that they did not modify instruction.

Interestingly, when asked to rate their response to this statement, "The web-based Classroom Diagnostic tool provided me student-specific data that *I will use* to modify my future instruction to support individual students," seven agreed or somewhat agreed and only one disagreed (one neither agreed nor disagreed). Of the seven who agreed or somewhat agreed, three eventually answered Survey 2, saying they did modify instruction.

Another consideration is the balance measure, that is, how did this intervention affect the entire system by reallocating resources (e.g., time, money) from other areas. To assess the balance measures, respondents were asked to select the response that best applies to the statement, "The information provided by the web-based Classroom Diagnostic tool was *worth* the class time used to complete the assessment." Six of the nine respondents agreed or somewhat agreed with that statement. When asked to explain their responses, examples of responses were, "Knowing the

specific content that students struggle with allows me to incorporate specific review as we move forward through the content" and "It will help guide the planning to help the students do their best on the Keystone exam." Although three respondents strongly disagreed, disagreed, or neither agreed or disagreed, when asked to explain their answer, the responses were more negative.

For example, when asked to explain their response, teachers answered, "We have limited time in class and already use assessments that are tools to assess understanding. No specific data regarding content knowledge was provided to use in order to make it worth anyone's time"; "It is difficult to cater lessons towards individual students using the information obtained by the CDT. The data received isn't detailed enough," and "It is a good thing in theory; however, in practice, between the technical problems and the confusion in accessing specific student data, I have found it an inefficient use of time . . . not worth the time spent troubleshooting and attempting to search for meaningful data" (Survey 2).

Table 3 identifies each question in the follow-up survey and the analysis performed.

Table 3. Description of Analysis for Survey 2

Item Number	Question asked in the survey	Description of analysis
1	In the first survey you were asked to select and write down a pseudonym, please enter the pseudonym you selected below. It is very important that they match so please use the pseudonym you selected.	The pseudonym will be used to determine patterns in responses between the initial and follow up survey.
2	Did you change your instruction (either for an individual student or a group of students) based on data you received from the Classroom Diagnostic Tool?	Description of ratings
3	If you answered yes to the previous question, please provide an explanation of the instructional change you made. If you answered no to the previous question, please explain the barriers that prevented your from making the change.	Content analysis of responses

The second follow-up survey asked teachers about the specific changes they made to instruction and, if they did not make any changes, what barriers prevented them from modifying instruction. The survey was both a process measure to help me understand if the change idea is an improvement and a balance measure to see if the changes require system scarce resources (time, cognitive attention, etc.). Six of the nine respondents said that they did not change their instruction (either for an individual student or a group of students) based on the data they received from the web-based Classroom Diagnostic Tool. Three of the nine said that they did make changes. Of those who made changes their responses indicated the modifications they made were for the whole group of students rather than individual students.

For instance, teachers remarked, “There were some topics that needed to be covered in more depth, and I made a note of them for next year. I will also review those topics more thoroughly closer to the actual exams,” and “I quickly reviewed a few of the topics that students seemed to struggle on. I will review these topics again throughout the rest of the school year.” Of the six who did not make changes, only two provided an explanation for why they did not modify their instruction. Both responses indicated the data was difficult to interpret for an individual student and not specific enough to make actual changes. Additionally, both indicated an issue of available time to analyze the data and make changes. One asked what the most efficient way would be while the other discussed the many challenges teachers were facing this year stating, “Truly, I'd love to be able to use this information, but right now due to our terrible COVID year, I'm pulling 10-12 hour days rewriting activities for both courses I'm teaching in addition to new assessments and holding meeting during planning periods and assisting the new teacher . . . I'm so incredibly swamped and just barely keeping my head above water.”

The responses from teachers in both surveys provide significant information and insight in to the three main inquiry questions: (a) To what degree does the web-based CDT provide data that teachers believe accurately reflects student knowledge? (b) To what degree does the web-based CDT provide data that teachers believe they can use to modify future instruction? and (c) Do teachers use the SSAD provided by the web-based CDT to modify instruction? Further analysis and the most important findings are in the section that follows.

5.0 Discussion

Throughout this paper we have considered student specific assessment data (SSAD) and the ways that it is useful to support data informed instruction (DII). The literature provided evidence that DII (supported through SSAD) can positively affect student learning. This study used the available knowledge base about DII to consider whether the web-based Classroom Diagnostic Tool (CDT) proved effective for supporting teachers in modifying their instruction to improve student achievement during the pandemic. Specifically, this study sought to understand three questions: (a) To what degree does the web-based CDT provide data that teachers believe accurately reflects student knowledge? (b) To what degree does the web-based CDT provide data that teachers believe they can use to modify future instruction? and (c) Do teachers use the SSAD provided by the web-based CDT to modify instruction?

5.1 Limitations

Before considering the implications of the study's findings, it is important to understand this study's limitations. First, this study did not happen in a vacuum unaffected by the ongoing global pandemic. While the specific tool examined in the study was selected to address some issues caused by the pandemic, it did not and could not address the ongoing uncertainty and changing learning environments wrought by the pandemic. Issues like where learning occurred (remote, hybrid, in person, etc.), abrupt changes to the learning schedule, and ongoing safety and procedural changes added to an already full cognitive and emotional load for students and teachers. The

feeling from teachers of having to do “one more thing” could have been very real during the 2020-21 school year. This feeling may have affected teacher perspectives of the web-based CDT and their ability to use it.

The second notable limitation is the number of participants. Although all nine of the participants answered Survey 1 and 2, the number nine is not large enough for significant statistical analysis. We can consider each individual for their own responses, but drawing large reaching conclusions from this study without further study and consideration is problematic.

Although all nine teachers responded to both surveys, the third limitation is the fact that two of the nine did not include a trackable pseudonym in their responses. Without a pseudonym to connect their responses in Survey 1 to Survey 2, it is impossible to draw conclusions about whether their answer correlated in any way. For instance, question six in Survey 1 asked whether they believed the data accurately represented student understanding. Without a pseudonym to connect, I cannot determine how their response correlates with question two of Survey 2, which asked if they changed their instruction.

5.2 Interpretation of Findings

With those limitations in mind, this study did provide insights into the three main areas of inquiry. Though, before considering the identified inquiry question, it is important to reestablish why it was necessary to move to this unstudied tool, the *web-based* CDT. This study occurred during the COVID-19 pandemic. The web-based tool was needed because the classroom-based tool could not be used due to the infrequency with which students attended school in person (as a result of the tightening of restrictions around the virus). Based on the responses, it appears that the

tool adequately met the needs of the moment. Seven of nine teachers responded that between 76% and 100% of students completed the CDT. This shows that the tool is capable of providing the flexibility needed when students are required to learn online.

The first inquiry question considered the degree to which the web-based CDT provided data that teachers believe accurately reflected their student knowledge. Seven of nine participants responded that they do believe the data accurately reflected student knowledge. Only one disagreed entirely with the statement. This finding is significant as it demonstrates that this group of teachers trusts the results provided by the CDT. Research by Datnow et al. (2012) identifies this trust in the data as being a factor that will impact whether a teacher uses DII to modify their instruction. Prenger and Schildkamp (2018) also acknowledged the importance of a teacher's "instrumental attitude" or trust in the reliability of the data and ability to interpret the data to make instructional changes. However, in this study, it is unclear if there is a direct correlation between the teachers' belief that the data accurately reflect student knowledge and modifying their instruction as a result. Of the seven who responded that they trusted the data, only three responded in Survey 2 that they, in fact, modified their instruction according to their interpretation of the data. Perhaps teachers require additional or different professional development opportunities to support their understanding of how to take reliable data and appropriately modify instruction to meet the needs of individual learners. For teachers, differentiating instruction proves to be quite challenging and complex because, to extend student learning, they must use SSAD to determine students' present levels of performance and decide how to instruct each learner (or small groups of learners) in a manner that will grow them academically (Tomlinson & Allan, 2000). Based on the findings in the literature, the most helpful professional learning opportunities could focus on data literacy, data analysis skills, or differentiated instruction techniques (Kippers et al., 2017; Schildkamp et

al., 2017; Shulman, 1986). While, according to the literature and this study's findings, trust in the reliability of the data is important, it is not the only factor in whether teachers implement DII.

The study also provided insights into the second research question: to what degree does the web-based CDT provide data that teachers believe they can use to modify future instruction? This question was addressed in two of the questions in Survey 1 (i.e., questions seven and eight). The survey questions asked respondents to rate their level of agreement with the following statements, "I can use" and "I will use" the data provided by the CDT to modify instruction. The question of "can" versus "will" derived from the literature. Specifically, "can" connected back to the work of Prenger and Schildkamp (2018), who identified teachers' "instrumental attitude" as a trust in the reliability of the data (previously discussed) *and* comfort/ability in their instructional repertoire to make actual changes reflecting their trust in the data. The two authors built on the work of Shulman (1986) in suggesting the importance of pedagogical content knowledge (PCK) in teachers. PCK is the overlap between considerable knowledge of the content and well-developed instructional approaches to make necessary changes. Six of the nine agreed or somewhat agreed that they could use the data. Of those six, only three eventually used the data (per their response on Survey 2 question two). Perhaps more telling is that, of the three who disagreed that they could use the data, none made instructional changes. This indicates that "can" is a necessary component of DII; teachers must feel they can use the data before they entertain the thought of modifying their instruction based on their understanding of the data. However, this finding does not represent a relationship of causality (i.e., if they believe they can, they definitely will).

Additionally, the work of Prenger and Schildkamp (2018) identified "behavioral intention" as a factor that determined whether a teacher would use DII. Behavioral intention relates to the "I will," or the intention of the teacher to make changes to instruction based on data. Although the

authors found it an important factor, this study suggested otherwise. Of the nine respondents, only one "disagreed" that they would use the data. However, of the remaining eight, only three actually modified their instruction (per question two of Survey 2). It leads one to wonder what caused the discrepancy between the literature and the findings of this study. Perhaps the implementation of collaborative work opportunities, such as Professional Learning Communities (PLC), could help move the "I can" and "I will" to actual modifications. PLCs that are purposeful and have a clear outlined end goal can support teachers in developing additional insights into possible alternative instructional solutions to support students (thus further developing teacher PCK) (Farley-Ripple & Buttram, 2014). Additionally, a supportive group of willing (i.e., "I will") colleagues often forms powerful relationships that support the completion of the agreed upon goal.

Lastly, this research study provided a better understanding of whether teachers used the web-based CDT to modify instruction. Three of the nine respondents indicated that they did make changes to their instruction. The changes focused mostly on whole-group review of concepts rather than adaptations for individuals. The other two-thirds of teachers responded that they did not modify instruction. The lack of adjustment may be related to the difficult and time-consuming task of creating alternative instructional materials that support a modification to instruction based on identified deficits. This may present an opportunity to reallocate professional development time to focus teachers on creating a warehouse of alternative materials aimed to support specific deficit areas. This warehouse should be web-based and well organized by deficit area so all teachers could access the resources and identify those that best meet the need of the student (based on their CDT results). While the pandemic is likely to relent, the web-based nature of the resource warehouse aligns with the reality that the pandemic has changed our learning and work environments and that remote schooling and working will remain in some capacity into the future. This idea continues to

work off the literature base, which identified the need for well-developed PCK and collaboration amongst colleagues to support the implementation of DII.

If the hope of the research was to find the web-based CDT as 100% effective in supporting teachers to use DII, then the evidence dashes that hope. However, there are larger implications to consider that require further research to determine if this tool can help teachers to implement DII.

5.3 Areas for Future Research

The overall results of this study are inconclusive as to the larger consideration of whether the web-based CDT is an effective tool to support teachers' implementation of DII and requires additional study. Based on the findings discussed above, the researcher is left with the following questions, which he might explore through further investigation.

First, this study does suggest that the web-based CDT is effective in gathering data from students who may not be physically present in a school building. This means the tool could be used in the event of other issues that prevent physical attendance in school, such as student illness or more broad interruptions such as pandemics, tornados, or fires. Additionally, the study suggests that the web-based CDT does provide reliable data (from the teachers' perspective) that teachers believe they can use to inform instruction. The literature identifies both ideas (reliability of data and belief in the ability to use it) as key components in a teacher's willingness to use DII. Further, evidence within the study suggested that those components must be present for teachers if they have any chance of using DII. However, the inconsistent correlation between the above factors and actual modification to instruction suggest further study is necessary to determine which factors are most important and which beyond those identified play a crucial role in the implementation of

DII. In sum, to know the factors prompting teachers, who consider the data reliable, to take the leap from "I can and may," to "I can and will," is worthwhile for educators interested in improving student achievement.

Lastly, this study did not focus on other factors identified in the literature as important to teachers implementing DII, such as collaboration amongst colleagues and the larger school data culture. The field needs further study and consideration to help untangle the tangible factors (such as the tool used) and the intangible factors (like collaboration and culture).

5.4 Conclusion

This dissertation sought to understand how well the web-based CDT supported teachers to use student specific assessment data (SSAD) to implement data informed instruction (DII). While the study showed the web-based CDT supported teachers in acquiring data they believed accurately reflected student knowledge, having the data did not, in all cases, lead to modification of instruction to support the individual learner. This aligns with the body of research on DII, which identifies multiple factors that contribute to the use of SSAD for DII; this study did not examine all factors. Although not conclusive, this study contributes to the research base by validating the web-based CDT as effective in providing SSAD for teachers during a pandemic while acknowledging the need for further research about the most important factors in supporting teachers to implement DII.

Appendix A Intervention Protocol

October 2020:

- I will hold a meeting (virtual) with Algebra I and Biology teachers to review our assessment plan for the 2020-21 school year. Part of our assessment plan will be the Classroom Diagnostic Tool at four points throughout the year.
- During the meeting, I will explain to teachers my dissertation study and read the prepared script.
- I will create test rosters for each teacher with the CDT website. This process will create individual student logins and password to complete the assessment. I will email all teachers their student information.
- Teachers will communicate login information to students.
- Teachers will be asked to have their students complete the CDT by the end of October.

November 2020:

- By mid-November once all teachers have given the CDT and received the student specific assessment data, I will send them the first survey via email.
- Teachers will be asked to complete the survey within one week.

December 2020:

- I will send teachers the follow-up survey to determine if they made instructional changes. Teachers will be asked to complete the survey within one-week of me sending it.
- As soon as I receive all of the teacher survey information, I will begin my analysis of data.

Appendix B Introductory Script

The purpose of this research study is to determine the effectiveness of the web-based Classroom Diagnostic Tool (CDT) to gather student specific data to support teachers in using data to modify their instructional approaches. To test the effectiveness of this new tool, I am asking Algebra I and Biology teachers who implement the web-based CDT to complete a brief (approximately 15 minutes) survey about their experience and the data provided by the web-based CDT. Those who participate will be asked about student participation rates, ease of implementation, issues associated with the web-based CDT, trust in the reliability of the data, and usefulness of the data. There are no foreseeable risks or benefits to you for participating. Your responses will not be identifiable in any way and results will be kept on a password protected Excel spreadsheet. Your participation is voluntary, and you may withdraw from this project at any time.

Appendix C Survey 1

To keep people anonymous, please select and write your pseudonym (research nickname to keep you anonymous) here. Then enter it into your phone so you can use it on the follow-up survey, too!

What percentage of your students completed the entire Classroom Diagnostic Tool assessment?

- 0-25%
- 26-50%
- 51-75%
- 76-100%

How many students reported to you that they experienced technical problems while trying to complete the web-based Classroom Diagnostic Tool assessment? Example of technical problems: log-in did not work, internet would not connect, questions would not load, etc.

- Less than you expected
- About the same that you expected
- Much more than you expected

What was the most common technical problem students experienced?

Select your response that best applies to this statement: The web-based Classroom Diagnostic Tool provided me student-specific data in a timely manner.

- Strongly Disagree
- Disagree
- Somewhat disagree
- Neither agree nor disagree
- Somewhat agree
- Agree
- Strongly agree

Select your response that best applies to this statement: The web-based Classroom Diagnostic Tool provided me student-specific data that I believe accurately represents the students understanding.

- Strongly Disagree
- Disagree
- Somewhat disagree
- Neither agree nor disagree
- Somewhat agree
- Agree
- Strongly agree

Select your response that best applies to this statement: The web-based Classroom Diagnostic Tool provided me student-specific data that I **can** use to modify my future instruction to support individual students.

- Strongly Disagree
- Disagree
- Somewhat disagree
- Neither agree nor disagree
- Somewhat agree
- Agree
- Strongly agree

Select your response that best applies to this statement: The web-based Classroom Diagnostic Tool provided me student-specific data that I **will** use to modify my future instruction to support individual students.

- Strongly Disagree
- Disagree
- Somewhat disagree
- Neither agree nor disagree
- Somewhat agree
- Agree
- Strongly agree

Did you experience problems accessing the student specific data provided by the Classroom Diagnostic Tool? If yes, explain the problems you experienced.

- Yes

- No

Select your response that best applies to this statement: The web-based Classroom Diagnostic Tool provided me student specific data that I did not have prior to using the assessment.

- Strongly Disagree
- Disagree
- Somewhat disagree
- Neither agree nor disagree
- Somewhat agree
- Agree
- Strongly agree

Select your response that best applies to this statement: The information provided by the web-based Classroom Diagnostic Tool was worth the class time used to complete the assessment.

- Strongly Disagree
- Disagree
- Somewhat disagree
- Neither agree nor disagree
- Somewhat agree
- Agree
- Strongly agree

Please explain the reason for your answer to the question above.

What changes would you like to see when students complete the Classroom Diagnostic Tool assessment again during this school year?

Appendix D Survey 2

In the first survey you were asked to select and write down a pseudonym, please enter the pseudonym you selected below. It is very important that they match so please use the pseudonym you selected.

Did you change your instruction (either for an individual student or a group of students) based on data you received from the Classroom Diagnostic Tool?

- Yes

- No

If you answered yes to the previous question, please provide an explanation of the instructional change you made. If you answered no to the previous question, please explain the barriers that prevented your from making the change.

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