Teaching the Teacher: Co-Designing a Visual Tool to Support Teacher Educators' Mentorship of Novice Teachers

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Thesis Submitted in Partial Fulfillment of the Requirements of the Degree of Master of Design in Integrative Design

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PREFACE

This work is situated in the structures of public education and teacher education systems prior to the COVID-19 pandemic arriving in the United States in mid-March 2020. The participatory prototyping process was interrupted and the project came to an earlier than expected conclusion. At the time of writing, parts of the country are still in lock-down due to public health measures to mitigate the spread of the virus. Additionally, during this period protests, in response to another incidence of race motivated police brutality, are also spreading throughout the country. The weight of this moment, this period in time is impossible to ignore. Physical spaces such as classrooms will need to be re-designed to accommodate social distancing. Public life and how we interact with each other will be significantly altered. At the same time, teacher education needs to be re-designed to center discussions about bias, race, and systemic racism. No one can predict where we will be in two months, two years, or two decades. We do know that designers need to place justice at the center of their work and in the design of all types of spaces.

ABSTRACT

Within the first 5 years of teaching, approximately 50% of teachers leave the profession entirely. The literature consistently identifies the experience of isolation and lack of support as primary drivers of novice teachers' decisions to leave the profession. The state of Michigan has consistently higher rates of overall teacher attrition than the national average, with some of the worst rates occurring in Detroit Public School and Community District (DPSCD) schools. To address the challenges of isolation and lack of support for novice teachers, the University of Michigan School of Education (UM SOE) and DPSCD have partnered to create a Teaching School, which includes a three-year residency program for novice teachers inspired by the medical model of physician education.

This work explores how to learn from the medical training model to reduce novice teachers' experiences of isolation and lack of support. The project collaborators co-designed and developed a tool to be used in the new setting of the Teaching School to support the knowledge transfer from experienced teachers to novice teachers. Through participatory prototyping, we designed a tool that visualizes teachers' movement patterns and creates a snapshot for use as a reflection and training aid to build awareness of their practice in novice teachers.

The participatory prototyping process demonstrated immediate short-term value and potential long-term value of using visualization to support the education of the novice teacher. In the short term, the prototype generated a record, facilitated conversation, and cultivated awareness. For long term value, the prototype visualizes patterns, creates comparisons, and builds a shared vocabulary. The potential future applications of this tool include additional iterations to test the tool's ability to surface teacher bias in the classroom.

GLOSSARY

Conversation facilitator

For the purposes of this project, an object that functions as a focal point for effective communication.

Experienced teacher

A teacher of record with more than 3 years of classroom instruction. Also referred to as a veteran teacher.

Isolation

The unpleasant experience that occurs when a person's network of social relations at work is deficient in some important ways.

Knowledge transfer

How knowledge acquired in one situation applies (or fails to apply) to another.

Lack of support

For novice teachers this is experiencing the absence of "school-based professional development, guided by expert colleagues responsive to their teaching, throughout their early years in the classroom to feel part of a supportive community that sees them as both teachers and learners" (Staudt et al, 2013).

Mapping tool

A tool is an instrument or product used for a specific purpose. A map is a spatial visualization of content. For this project a mapping tool supports the creation of a visual image illustrating a teacher's movements around a classroom.

Medical residency

Medical education beyond the undergraduate medical school and the attainment of the professional degree, leading to eligibility for certification in a specialty.

Novice teacher

A teacher with three years or less of experience.

Pre-service teacher

Students in a teacher education program, at a college or university, preparing for professional-level teaching positions.

Real-time feedback

Feedback is information that a system uses to make adjustments in reaching a goal. In-the-moment feedback is also called real-time feedback, just-in-time feedback, or informal feedback. In education, in-the-moment feedback is useful because it is timely, it is based on observation, it is based on that day's occurrences, and it is regular.

Reflection aid

Reflective practices are methods and techniques that help individuals and groups reflect on their experiences and actions in order to engage in a process of continuous learning. A reflection aid is a tool that supports this process.

Tacit pedagogical knowing

Defined as a process in interactive teaching situations, through which a teacher finds solutions to surprising and challenging situations, pedagogical moments, so that the lesson continues.

Teacher

For the purposes of this thesis, teacher refers to a teacher in a public K-12 school in the United States.

Teacher attrition

The number or percentage of teachers who leave the profession in a given year, diminishing the teacher supply.

Teaching intern

An enrolled undergraduate student of an approved teacher education institution who observes in the classroom under the supervision of the staff of the institution and of the employing school district in order to gain exposure and insight into teaching.

Teacher residency

The Teaching School Residency is a model of teacher training that extends University of Michigan School of Education program support for new teachers from pre-service teacher preparation through the first three years of novice teachers' careers.

Teaching hospital

A teaching hospital, or academic medical center, is a hospital that partners with medical and nursing schools, education programs and research centers to improve health care through learning and research. Residents and medical school students provide patient care under the direct supervision of either the patient's attending doctor or the resident physician responsible for training the next generation of physicians.

Teaching School

The concept of a "teaching school" is inspired by the "teaching hospital," a place where students learn to be medical practitioners under the watchful eye of more experienced physicians, nurses, and other medical professionals. Similarly, a teaching school provides support and guidance to novice teachers from more experienced teachers.

The School at Marygrove

Cradle-to-career public school located on the Marygrove College campus in northwestern Detroit with a dual emphasis on social justice and design. Site of the nation's first Teaching School, which includes a novel three-year residency program for novice teachers inspired by the medical model of professional education. The result of a collaboration with multiple partners and stakeholders, including Detroit Public Schools Community District, The Kresge Foundation, Starfish Family Services, and the Marygrove Conservancy.

Visualization

The act of externalizing ideas, thereby making ideas concrete in a shareable form. Visualization allows for comparison, conveys changes over time, and describes spatial relationships. It bypasses limitations of short-term memory, allowing the creation of connections between disparate ideas.

INTRODUCTION

Teacher attrition is defined as the number or percentage of public school teachers who leave the profession in a given year (Behrstock-Sherratt, 2016) and the national rate has been growing over the past three decades. Within the first five years of teaching, approximately 50% of teachers leave the profession entirely. What is causing a high rate of teacher attrition? The literature consistently identifies the experience of isolation and lack of support as primary drivers of novice teachers' decisions to leave the profession. Education scholars refer to isolation as "the unpleasant experience that occurs when a person's network of social relations at work is deficient" (Nehmeh and Kelly, 2018). Appropriate support for novice teachers includes "school-based professional development, guided by expert colleagues responsive to their teaching, throughout their early years in the classroom to feel part of a supportive community that sees them as both teachers and learners" (Staudt et al, 2013). Teacher attrition is not experienced equitably across the United States. It is disproportionately experienced by schools serving minority and low socio-economic student populations. The higher rates of teacher attrition can lead to vacancies being filled with under-qualified individuals, who negatively impact student learning and who are twice as likely to leave (Garcia and Weiss, 2019). This cycle contributes to perpetuating barriers to equitable access to quality public education.

The state of Michigan consistently has higher rates of overall teacher attrition than the national average, with some of the worst rates occurring in Detroit Public School and Community District (DPSCD) schools (Higgins, 2019). To address the challenges of isolation and lack of support for

novice teachers, the University of Michigan School of Education (UM SOE) and DPSCD have partnered to create a Teaching School, which includes a three-year residency program for novice teachers inspired by the medical model of physician education. This Teaching School is based at The School at Marygrove (TSM), a new cradle-to-career public school located on the Marygrove College campus in northwestern Detroit. The mission of the Teaching School is to create a professional environment that offers consistent support by experienced teachers and other education experts in the form of mentorship, regular feedback, curricular materials and guidance, embedded coursework, strong models of expert practice and co-teaching. The leaders developing the Teaching School are Elizabeth Moje, PhD, who is the Dean of the School of Education, and Alistair Bomphray, PhD, who is Detroit P-20 Curriculum, Teaching, and Teacher Education Coordinator.

For this project I've collaborated with Dean Moje and Dr. Bomphray to investigate how we might learn from the medical training model to reduce novice teachers' experiences of isolation and lack of support. A critical aspect of the physician training model is the transfer of knowledge through a residency, a time period after medical school when physicians are considered as both practicing medical professionals and developing learners. These resident physicians are closely supervised by experienced physicians, known as attending physicians, who offer support and guidance during clinical encounters. Residents begin by observing an attending physician and overtime they increasingly take the lead as they develop certain skills and competencies. In order for residents to develop these skills, attending physicians must make their decision-making visible.

Practicing medicine involves "the use of intuition, experience, and holistic perceptions in making clinical judgements and in the delivery of humane care" (Sternberg and Horvath, 1999). This aspect

of clinical decision-making falls under tacit knowledge which is knowledge that is “difficult to communicate and acquired through practice and experience rather than through language” and “related to individual skills while embedded in context” (Kothari et al., 2012). Through the residency structure, attending physicians are able to transfer some of this knowledge to resident physicians through context-specific interactions and close supervision. The transfer of knowledge often occurs during real-time feedback, also referred to as in-the-moment or informal feedback. The definition of feedback is “information that a system uses to make adjustments in reaching a goal” (Ende, 1983) and real-time feedback is “useful because it’s timely, it’s based on observation, it’s based on that day's occurrences, and it’s regular” (Balmer et al., 2018). This approach can combat isolation and offers support through interactions with experienced physicians rooted in context, so resident physicians do not make critical decisions alone until they are ready to do so.

Similar to medical education, the context-specific approach to the transfer of tacit knowledge is critical in teacher education:

> “Since tacit knowledge of teaching is inherently tied to action in context, examinations of teachers’ tacit knowledge require either observation of the use of this knowledge in actual teaching or some vicarious immersion in action, for example, by involving practitioners in tasks that include some representations of instruction.”
>
> Herbst and Kosko, 2014

For an experienced teacher, tacit knowing includes being able to act quickly and skillfully in classroom interactions that occur simultaneously and shift suddenly. These actions and responses may appear effortless when observed by novice teachers and when they do, the novice teacher loses an opportunity to identify, understand, and practice the underlying decision-making. This knowing is the result of the accumulation of years of teaching experience in the classroom. However, an

important difference between medical and teacher training is the role of the tacit knowledge of the novice. In teacher education, tacit knowledge of novice teachers influences them, but it is tacit knowledge gained from years as a student in childhood, not as a teacher. Teacher education is tasked with making both the novice teacher's and experienced teacher's tacit knowledge visible during a limited time frame in order to cultivate effective teaching practices.

> "The PCK (Pedagogical Content Knowledge) of expert teachers has become implicit; highly personal and hard to formalize although it can be seen in their actions and is quite difficult to communicate to others —it has become tacit knowledge (Loughran et al., 2012)."
>
> Fraser et al., 2019

Informed by these and other insights from the medical model, our objective for this work was to co-design and develop a tool to be used in the new setting of the Teaching School to support knowledge transfer from experienced teachers to novice teachers. Co-design refers to "the creativity of designers and people not trained in design working together in the design development process" (Sanders and Stappers, 2008, p.6). The co-design process took place in a seminar for pre-service teachers during their first semester of training and we were tasked with making the teaching practice accessible. At this stage, pre-service teachers can easily observe movement of an experienced teacher. This process led us to developing a tool for generating a means of mapping and discussing teachers' movement[1] around a classroom as well as activating memory around interactions in the classroom. The most frequently under-addressed aspects of teaching practice in teacher education are related to non-verbal communication (Smith, 1979) despite that "upwards of

[1] For the purposes of this project, movement is defined as the change in position of the individual being observed. Movement and motion are often used interchangeably. In the education literature, the term movement is used more frequently than the term motion. These two terms are distinct concepts, but for this project the term movement has been chosen.

65% of the meaning derived in interactions comes from non-verbal communication" (Barmaki and Hughes, 2015).

Non-verbal communication is communication without words and consists of two main categories: paralanguage and body language. Paralanguage refers to the vocal aspects of non-verbal communication (tone, pitch, volume, etc.) and body language refers to the non-vocal aspects such as facial expressions, gestures, and movements. In the classroom environment, body language plays a significant role since teaching consists of numerous interactions with students. Historically, teacher education emphasizes what is said, not how teachers move their bodies around the classroom: "Novice teachers rarely receive explicit instruction in how to manage voice, body, expression, and other aspects of their expressive performance when interacting with children" (Curren-Preis, 2018, p.15).

How teachers move around the classroom can support or contradict their verbal communication and thus impact the effectiveness of their instruction (Miller, 2005).

New teachers frequently hear the conventional wisdom "circulate" or "move" around the room. For first semester pre-service teachers, they are not yet leading lessons and instead they are focusing on developing relationships with students. In order to do so, pre-service teachers are often told to circulate around the room without knowing why or the underlying tacit pedagogical knowledge that informs circulation.

Movement is one of the most visible modes of non-verbal communication in the classroom, easily observable to others whether that be an experienced teacher or a peer. How can novice teachers begin to understand the important role movement plays in teaching practice? This project has demonstrated that this can happen through a tool that builds self-awareness of their movement in the classroom and creates the opportunity to track the movement of experienced teachers' around

the classroom. In their work "Unspoken Messages", O'Hair and Ropo discuss the importance of addressing nonverbal communication early in teacher training:

> "Nonverbal communication is a basic skill requiring continuous self-awareness and development. Pre-service teachers must be introduced to the nonverbal communication knowledge base and practice appropriate and culturally specific nonverbal communication behaviors in early field and student teaching experiences"
>
> O'Hair and Ropo, 1994, p. 107

This tool visualizes teachers' movement patterns and creates a snapshot for use as a reflection and training aid to build awareness of their practice in novice teachers. An observer draws on a paper template (the tool) the movement of the subject (the teacher) and notes any interactions with students (see Figure 1 for example). The tool includes a key to prompt the user to take notes of certain interactions as they occur. It can be used throughout the development of teachers from the stage of a novice teacher through an experienced teacher. It also can be used as a starting point to establish a shared vocabulary in the beginning of the relationship between a novice teacher and an experienced teacher. Use of the tool focuses attention on teachers' movements which otherwise would be overlooked. It creates a quick visual record that is a reflection aid, a conversation facilitator, and a means of comparing cases. Potentially it could act as a means of accelerating the development of tacit knowing in novice teachers.

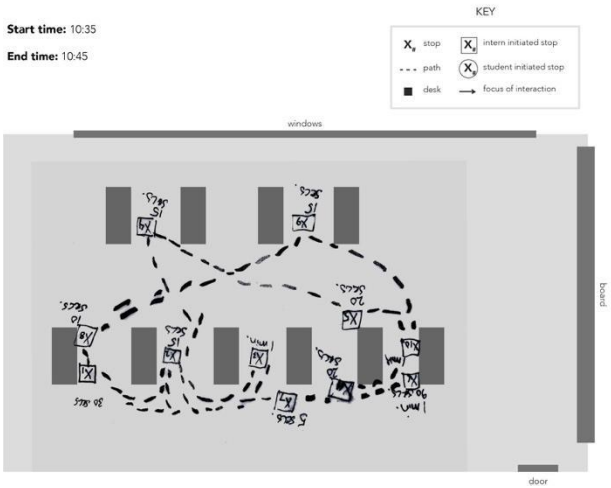

Figure 1: Map generated by a teaching intern using prototype v3

The generation of a visual record that prompts reflection and facilitates conversation creates an opportunity for a novice teacher to better understand their own patterns of teaching and those of experienced teachers. If novice teachers can receive guidance in understanding the more invisible, critical aspects of teaching, they will feel much more confident and prepared when they are independently in charge of a classroom: "When mentors are able to explain the reasons for their teaching decisions, new teachers are able to see clear connections between teaching behaviors and the impact of those behaviors on students. This, in turn, helps new teachers become more intentional in their teaching" (Toom, 2019). Such tools help to make expert, tacit knowledge more accessible to novice teachers, which increases their confidence and self-efficacy, and may, ultimately, influence their decision to whether or not to stay in the classroom. This decision impacts teacher attrition, a significant barrier to equity and access to quality public education.

RATIONALE

This thesis project is informed by my previous work as a designer embedded in a teaching hospital where I directly observed the successes and challenges of physician training. I witnessed how we design physician education and how the systems they operate in impact patient outcomes. In this setting and as a classically trained dancer, I also have experienced and observed how powerful non-verbal communication and movement can be. These professional and personal experiences combined contribute significantly to my qualifications to work in this problem space. In the summer of 2019, I worked with Dean Elizabeth Moje and Dr. Alistair Bomphray to visualize the build-out of the Teaching School. This began my embedded approach to this work. The summer allowed me to

understand the ecosystem and to build a basic vocabulary for the field of education, particularly teacher education.

The opening of the Teaching School offers an important and unique opportunity to design and test tools to support the school's mission of supporting teachers during the early stages of their careers. This is occurring during a dire time for public education in the United States and especially in the city of Detroit. The problem of novice teacher attrition needs to leverage the expertise of designers because they hold skill sets that uniquely equip them to tackle complex issues:

> "Designers […] hold highly developed skills that are relevant at larger levels of scope and complexity. By selection and training, most designers are good at visual thinking, conducting creative processes, finding missing information, and being able to make necessary decisions in the absence of complete information."
>
> Sanders and Stappers, 2008, p.15

The Teaching School has the potential to be a model for other urban settings around the country. In order to inform the design and development of the Teaching School, the inspiration for the foundation and structure of the school needed to be further explored. As a designer, I conducted exploratory research to investigate the medical model and strategies used during the process of real-time feedback to support resident physicians during their training. My findings then allowed the design process to be rooted in this understanding. The tool that was subsequently developed can be used to facilitate real-time feedback to novice teachers about their interactions with students and how they move around the classroom.

Why does teachers' tacit knowing need to be not only visible but also visual? As humans we are wired to think and work visually. This is reflected in our neuroanatomy since approximately 75% of our sensory neurons are visual neurons (Brand, 2017). When working visually, patterns and links become clearer (for example connecting a teacher's movements with student actions), a topic can become more approachable (such as teacher bias), and information (like tacit knowledge) becomes more accessible. Gestalt theory supports this phenomenon: "Gestalt theory explains how we perceive visual organization, giving us principles for organizing individual parts as a whole" (Flieder and Mödritscher, 2006, p. 774). Gestalt theory can be used to explain the way patterns are recognized (Chang and Nesbitt, 2006).

As novice teachers progress through their training, the tool can assist with assessing their ability to utilize the space of the classroom during instruction. The tool generates records that can compare a teacher's movements at different points in their training. Through the act of drawing while using this tool, "visual practice makes the fleeting and ephemeral" become concrete (Agerbeck, 2016, p.1). These records additionally offer a starting point for a conversation about decisions made during instruction as reflected by movement patterns, or lack thereof. For novice teachers, movement is one of the most easily observed behaviors in themselves and of experienced teachers. Novice teachers can begin to build awareness of their movements early in their training and when they gain awareness of the tacit aspects of teaching, they transition more easily from trainee to full time teacher (Toom, 2019).

CONTEXTUAL REVIEW

The Teaching School was created to reduce teacher attrition by addressing isolation and lack of support. Its teacher residency and some of its structures are inspired by the teaching hospital model. A teaching hospital, also referred to as an academic medical center, is a hospital that partners with medical schools, education programs, and research centers to improve health care through learning and research[2]. The teaching hospital model addresses the challenges of isolation and lack of support that plague teacher training. Within this model, medical training scaffolds learning by underscoring the close relationship between theory and practice, by explicitly situating the resident physician as both practitioner and learner.

> "In the scaffolding model, the role of teachers is to support the learner's development and to provide support structures to help the learner get to the next stage of entrustment and competence. Achieving a balance is essential to providing the best patient care now and in the future."
>
> Hoffman, 2015, p.1

Medicine emphasizes frequent support of novices by experts during hands-on training that features an integration of domain knowledge and application. A medical student progresses through four years of medical school and three to seven years of residency before becoming a senior physician, referred to as an "attending physician". During residency, trainees treat patients under supervision by attending physicians. The supervising physician can step in to prevent potential harm (Ende, 1983; Paukert et al., 2002). If a resident is uncertain about a decision, the attending will provide immediate feedback to guide the novice's decision-making and actions. Generally, medicine is practiced as a team, comprised of practitioners with varying levels of experience, working side by side. The frequency and timeliness of this type of support is critical to physician skill development

[2] https://www.mottchildren.org/about-us/teaching-hospital

and overall learning (Balmer et al., 2018; Knowles, 1966). Striking a balance of trainee development and patient outcomes is integral to the design of a teaching hospital.

FACTORS CONTRIBUTING TO EXPERIENCES OF ISOLATION AND LACK OF SUPPORT

In teacher education, undergraduate students begin their practicums as interns (also referred to as the "pre-service years") and they are usually placed individually at field sites, separated from their peers. During their university course discussions following placement, students are unable to draw upon the same experiences since they are placed at different schools. Pre-service teachers face the disorienting experience of navigating drastically varied contexts by going between teacher preparation courses and field experiences. This phenomenon is referred to as the "two-worlds pitfall, where practices, norms, expectations, tools, and other aspects of teaching can be jarringly different" (Braaten, 2018). Bain and Moje argue that there are three disconnected "lands" in teacher education: "colleges of arts and sciences, schools of education, and K-12 classrooms" (Bain and Moje, 2012). Figure 2 illustrates this concept.

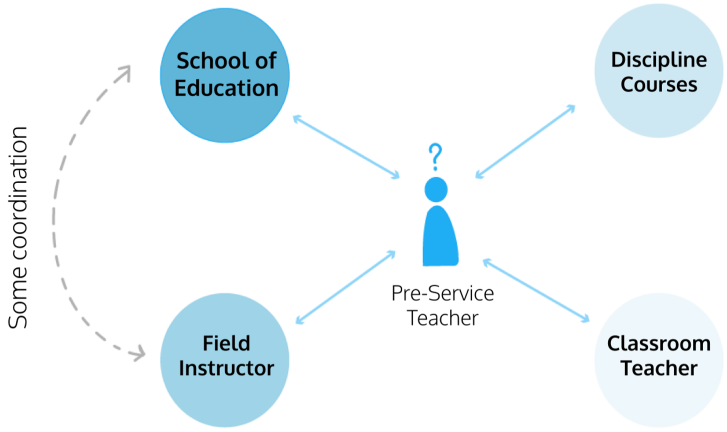

Figure 2: Illustration of the conventional, fragmented approach to teacher education

The current approach does not include a familiar and experienced mentor who can be a guide to bridge these distinct worlds or lands leaving the new teacher isolated as an intern. Therefore, the design of teacher education requires "the person least equipped to navigate among and across these different sites has the task of coordinating disparate experiences, concepts, and discourses into a meaningful and useful whole" (Bain and Moje, 2012). After completing their semester as interns, and prior to entering the workforce, undergraduate pre-service teachers receive at most four months of in-classroom instruction practice as student-teachers. As a result, once these individuals become certified and teachers of record, they often learn through trial and error, at the expense of both their students and themselves (Mavroulis, 2012). To address this pattern, many school districts across the country implemented induction programs that aim to provide a systematic structure of support for new teachers. Such programs have been found to have mixed results. Research data shows vast variance in the kinds and amounts of support (Ingersoll, 2012). Some research has discovered that often these programs do not address school context (Hammerness and

Matsko, 2012) and all learning needs of novice teachers (Staudt et al., 2013). Despite these types of interventions, the teacher attrition rate remains consistently high.

REAL-TIME FEEDBACK IN TEACHER EDUCATION

Through its teacher residency and providing various forms of support, the Teaching School strives to produce prepared and effective teachers. To achieve this goal, teacher educators can adapt the practice of real-time feedback. In education research, feedback strategies have recently been explored as one way to cultivate effective teaching practices:

> "Teacher preparation programs are under scrutiny for their role in the troubled American educational system. Thus, teacher educators must encourage teachers to use effective teaching practices. One technique for increasing use of effective practices is providing feedback to teachers on both newly acquired and ingrained teaching behaviors."
>
> Scheeler et al., 2004

Feedback is especially critical during pre-service training and early years of teaching, both of which are training stages targeted by the design of the Teaching School (Bjorndal, 2016; Scheeler et al., 2004). Preventing ineffective teaching behaviors during this early time period is significantly easier than attempting to change these behaviors later on in a teaching career (Scheeler et al., 2004).

NON-VERBAL COMMUNICATION

As stated previously in the Introduction Section (see page 10), non-verbal communication is broadly defined as communication without words. Research has established that approximately 65% of "meaning derived in interactions comes from nonverbal communication" (Barmaki and

Hughes, 2015). In the classroom environment, non-verbal communication plays a significant role since teaching consists of numerous interactions with students. How teachers move around the classroom can support or contradict their verbal communication and thus impact the effectiveness of their instruction. How teachers negotiate physical distance with students at different points in instruction can influence students' behavior and learning as well as teacher-student relationships.

TEACHER MOVEMENT IN THE CLASSROOM

For teachers and teacher educators, perhaps the most initially identifiable and visible non-verbal communication in the classroom is body movement (O'Hair and Ropo, 1994). Teachers must consider space from two perspectives: personal space and environmental space (see Figure 3). Personal space is also referred to as proxemics or the distance between two communicators, which can be considered in quantifiable metrics (ex: inches or feet) or in how comfortable the distance makes the communicators feel (O'Hair and Ropo, 1994). Teachers also can unknowingly send messages of "acceptance or rejection simply by the distance they maintain" (Miller, 2005, p. 30) between themselves and students. In terms of environmental space, how teachers are able to arrange furniture in the classroom determines the possible pathways and opportunities for teacher's body movements.

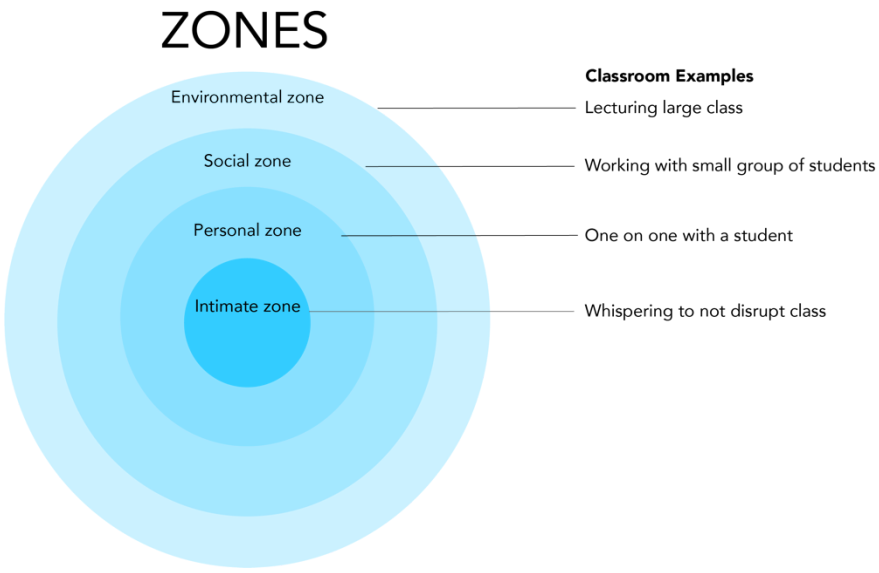

Figure 3: Personal space zones with classroom examples as discussed by O'Hair and Ropo

However, this critical aspect of teaching is under-addressed in teacher education. O'Hair and Ropo discuss the importance of general nonverbal communication during pre-service training: "Nonverbal communication is a basic skill requiring continuous self-awareness and development. Pre-service teachers must be introduced to the nonverbal communication knowledge base and practice appropriate and culturally specific nonverbal communication behaviors in early field and student teaching experiences" (O'Hair and Ropo, 1994, p.107). Yet despite this recognition of how essential non-verbal communication skills are to effective teaching, many teacher education programs do not integrate developing these skills into their curriculum (Curren-Preis, 2018).

VISUALIZATION

The main modes of learning in teacher education are reading, writing, observation, video-recording, and discussion, with minimal time spent on generating and using visualizations. A visualization is the act of externalizing ideas in a visual format, thereby making ideas concrete in a shareable form

(Kolko, 2011). Visualizations allow for comparison of concepts, capturing changes over time, and describing spatial relationships. Perhaps most importantly visualizations create an opportunity to synthesize information and make new connections: "Visualization helps us to essentially offload the data from working memory so other ideas can enter working memory and be 'mingled' and synthesized" (Kolko, 2011. p. 56). Agerbeck discusses how the process of drawing "gives you distance and separation from the problem you are trying to solve" (Agerbeck, 2016, p. 9). The result creates an object to which participants can respond. Gestalt theory supports the power of visual perception: "Gestalt theory explains how we perceive visual organization, giving us principles for organizing individual parts as a whole" (Flieder and Mödritscher, 2006, p. 774). Gestalt theory can be used to explain the way patterns are recognized (Chang and Nesbitt, 2006) and connections are made as described by Kolko. Visual working memory is "active maintenance of visual information to serve the needs of ongoing tasks" (Luck and Vogel, 2013). Gestalt principles include concepts such as similarity (objects that look similarly function similarly), grouping (if different looking objects are grouped together they function similarly), and closure (objects that are partially obscured become complete in the mind). Studies have demonstrated that Gestalt principles allow individuals to store information in visual working memory: "Thus, bottom-up information from the visual input can influence the transfer of perceptual information into working memory" (Woodman et al., 2003, p. 86).

The use of visualization-based tools in teacher education has not been widely studied in the literature. This is surprising considering how increasingly complex our world has become and the correspondingly complex challenges facing teaching and teacher education: "We muddle through with old tools and methods that don't support us" (Agerbeck, 2016, p.7). As radical changes to teacher education are being made, as in the Teaching School in Detroit for example, so must the

tools that accompany these changes. Visualization can help experienced teachers to communicate and facilitate conversation with novice teachers about tacit pedagogical knowledge that is otherwise difficult to articulate.

TIME CONSTRAINTS IN TEACHER EDUCATION

An additional challenge is to prepare effective teachers within a very short time period. Even in teacher preparation programs that include a scaffolded clinical placement, the length of time that students are in the program typically does not extend beyond four semesters. And during these semesters, teacher educators are only allotted a few hours per week (see Figure 4). Teacher educators must prioritize which skills are emphasized and generally mastering content knowledge and its delivery in instruction is viewed as the most critical. However, non-verbal communication can either strengthen or contradict the delivery of content as well as influence the process of building relationships with students. Teachers' cultural and racial biases might surface through non-verbal communication. Considering the majority of meaning of interactions being derived from non-verbal communication and the countless interactions teachers have with students throughout the course of a school day, non-verbal communication is essential to effective teaching. This becomes even more important in an environment where the majority of students are Black and the majority of pre-service teachers are White, as is the case at the Teaching School in Detroit.

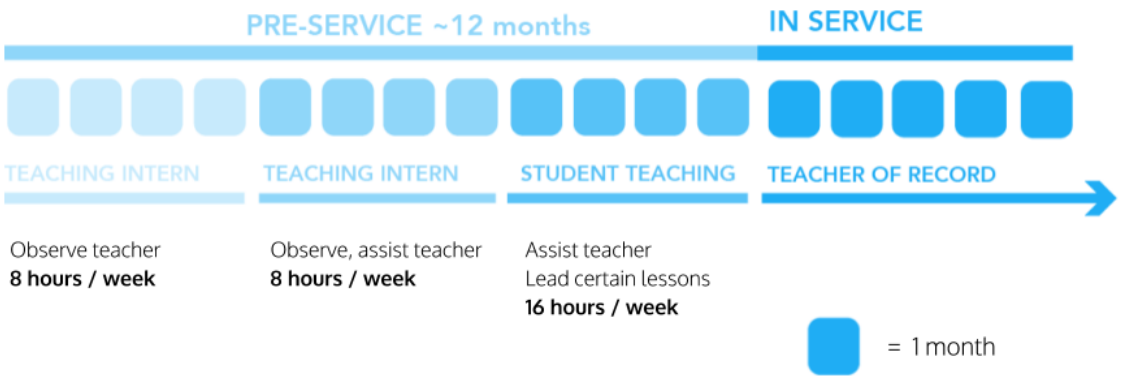

Figure 4: Stages of Teacher Training

REAL-TIME FEEDBACK STRATEGIES IN TEACHER AND PHYSICIAN TRAINING

By critically examining recent strategies in facilitating real-time feedback in both teacher and physician training, we can identify potential approaches to inform the design of tools for the Teaching School. The characteristics considered for each strategy are below:

Training Stage (pre-service teacher, medical student, resident, etc.)

Initiator (trainee or supervisor)

Platform (paper, email, app, etc.)

Mode (virtual, remote, or in-person)

Timing (during or after an interaction)

Data Recorded (yes or no: was information captured?)

Minimally Disruptive (yes or no: did the process interrupt the interaction or event)

These characteristics emerged from the literature and semi-structured interviews with physicians and teacher educators (see Results section page 43) and formed the basis for the analytical framework used to evaluate each example. The examples are briefly described and compiled into

Tables 1, 2, and 3 on pages 25, 30, and 34. Each example will also be evaluated based on design requirements based on the needs of the Teaching School.

Perhaps most importantly, the tool must not negate one of the goals of the Teaching School: student learning. The tool needs to be able to integrate into the cadence of a lesson and not disrupt the learning process. This requirement will be required to be "minimally disruptive". The Teaching School and its teacher residency is an experimental approach to teacher education and will be in constant iteration. In order to design tools to facilitate the Teaching School accomplishing its objectives, we need to consider how to design for this type of context since the school is in its early stages. The tools will need to be adaptable and have the capacity to change quickly. As the school expands and iterates, the tools need to evolve alongside it and adjust accordingly. Accessibility will be critical – accessible in terms of time, finances, cognitive load, and other types of resources. Teachers at all stages of training have limited time and Detroit Public Schools have a limited budget. Each strategy will be placed on the matrix below (see Figure 5) based on its degree of adaptability and accessibility.

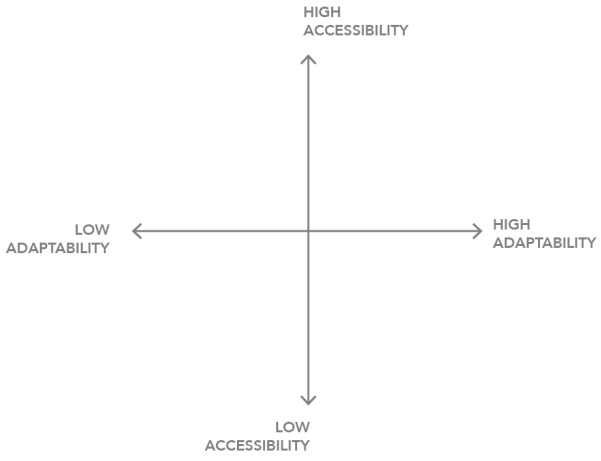

Figure 5: The matrix structure for assessing accessibility and adaptability

The following table (Table 1) summarizes the relevant characteristics for each teacher training strategy critically reviewed. Based on Pugh's matrix (Curedale, 2013), the table provides a high-level overview and comparison of these strategies. Pugh's method has two primary goals: "1) a 'controlled convergence' on a strong concept that has promise of out-competing the current market leader; and 2) a shared understanding of the reasons for the choice" (Frey et al., 2009, p.4).

Table 1: Real-Time Feedback Strategies in Teacher Training*

Criteria	**Real-Time Coaching** (Sharplin et al., 2016)	**Teacher Time Out** (Gibbons et al., 2017)	**Gestures** (Barmaki and Hughes, 2015)
Training Stage (pre or in-service)	Both	In-service	Pre-service
Initiator (novice or experienced)	Experienced	Experienced	Novice
Platform	Bluetooth	N/A	Interface
Mode (in person or virtual)	Either	In-person	Virtual
Timing (real-time or virtual)	Real-time	Real-time	Real-time
Data Recorded (yes or no)	No	No	Yes
Accessible	No	Yes	No

(yes or no)			
Adaptable (yes or no)	No	Yes	No
Minimally Disruptive (yes or no)	Yes	No	Yes

*adapted from Pugh's Matrix (Curedale, 2013)

In teacher education, if any feedback is given, it is historically delivered after instruction. Recent strategies have begun to explore the potential of real-time feedback in teacher training. Education scholars have discovered that "feedback is particularly effective when provided immediately, during task acquisition, rather than deferred" (Sharplin et al., 2016).

One example of implementing real-time feedback is the Real-Time Coaching model, developed by educators in Australia. This model involves a novice teacher wearing a Bluetooth headset while instructing. An experienced teacher, called a coach, is in the back of the room with a walkie talkie providing instructions directly into the ear of the teacher. It is used throughout Australia and currently being studied for its effectiveness. Bug-in-the-ear coaching is a similar concept except coaches are not physically present and instead observe virtually. This adaption is to allow many schools to share resources across geographic distances and currently is being implemented in schools in approximately a dozen states in the United States.

These strategies allow for timely feedback and support in the moment of instruction, thus addressing a gap in current teacher education. However, such approaches require access and

investment in additional technology and training, two significant barriers for the majority of American public schools, as well as increase cognitive load. Novice teachers are already overwhelmed by the extensive mental multi-tasking that occurs without implementing such an approach. For these reasons, I placed this strategy low on both accessibility and adaptability on the matrix (see Figure 7).

A model that relies less on technology but is still resource intensive is Teacher Time Outs. This strategy is centered around a routine that is enacted "when teachers and school leaders design and enact lessons together with students present, pausing regularly within the lesson to think aloud, share decision-making, and/or determine where to steer instruction" (Gibbons et al., 2017, p.28). An educator calls a "time out" and pauses a lesson to pose a what-if type of question such as "What would have happened if we had done…" (Gibbons et al., 2017). This allows for real-time investigation of these questions and collective experimentation in the classroom instead of post-instruction evaluation.

Teacher Time Outs do not require certain materials or technology so it is more accessible than Real-Time Coaching. It is flexible enough to adapt to changes at both the school level and individual classroom level. Such a strategy requires a certain number of educators to not only be present in the classroom at the same time but also to be involved in co-planning the specific lesson during which Teacher Time-Outs will occur. Additionally, this approach does not generate a record of the instruction and the resulting feedback. It occurs in the moment but vanishes once the conversation and time-out conclude. If not implemented thoughtfully, this strategy has great potential to be disruptive to student learning.

An approach that focuses on the non-verbal aspects of novice teacher and student interactions uses the power of a virtual environment called TeachLIVE (Barmaki and Hughes, 2015). This platform enables pre-service teachers to practice certain skills: "TeachLIVE employs a digital puppetry paradigm as its core technology. Individuals walk into this virtual environment. In this approach, novice teachers can practice skills such as classroom management content delivery" (Barmaki and Hughes, 2015, p.531). Barmaki and Hughes designed an interface to assist in training novice teachers in assessing their body language, specifically gestures and postures. Postures are considered to be bodily positions, while gestures are bodily movements (Bull, 1987). When participants exhibited closed, defensive postures a screen went from green to orange to indicate the need to change their posture as illustrated in Figure 6. The study found that after participating, individuals reported being "more mindful of their body postures while teaching" (Barmaki and Hughes, 2015, p.537). This work demonstrates that non-verbal aspects of teaching are important and can be introduced early on in teacher training through the use of visual cues.

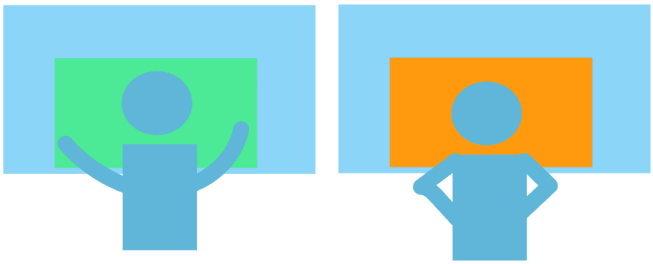

Figure 6: Adapted from Barmaki and Hughes, 2015

This strategy requires extensive technology and access to the TeachLIVE virtual environment, thus not adaptable to other settings. Additionally, this strategy was designed to be used in a rehearsal setting, not during real-time instruction. It is low on the accessibility axis for the same reason (see Figure 7).

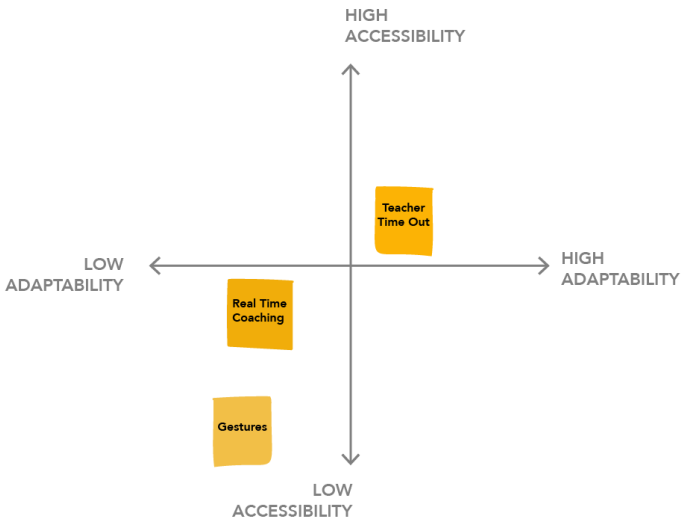

Figure 7: Real-Time Feedback Strategies in Teacher Training

The Real-Time Coaching model, Teacher Time Out, and Gestures approaches shared similar objectives in supporting novice teachers: facilitate rapid skill development, promote self-confidence, and create opportunity for reflective practice. These strategies demonstrate that real-time feedback during teacher training has only recently been explored, and there are many different approaches to designing its implementation. The examples described above each require extensive resources such as substantial investment in time and technology. This identifies a need to support novice teacher tools that require minimal resources and are easy to use. Since real-time feedback in teacher

training is not a common practice, there is ample opportunity for additional tools and strategies to be designed and tested.

As a field, physician education has more of a history with critically examining the importance of real-time feedback. The physician training model allows for feedback to occur naturally. As seen in the following examples (summarized in Table 2), recent strategies have emphasized how to capture this feedback for trainee reflection and development.

Table 2: Real-Time Feedback Strategies in Physician Training*

Criteria	**Encounter Card** (Hatala and Norman, 1999; Paukert et al., 2002; Bandiera and Lendrum, 2008)	**Minute Feedback System** (Hughes et al., 2017; Shaughness et al., 2017)	**SIMPL App** (George et al., 2019; Eaton et al., 2019)
Training Stage (medical student or resident physician)	Medical student	Medical student	Resident
Initiator (novice or experienced)	Trainee	Trainee	Trainee
Platform	Paper based	Email based	Mobile app
Mode (in person or virtual)	In-person	Virtual	Virtual
Timing	Post	Post	Post

(real-time or post encounter)			
Data Recorded (yes or no)	Yes	Yes	Yes
Accessible (yes or no)	Yes	Yes	Yes
Adaptable (yes or no)	Yes	No	No
Minimally Disruptive (yes or no)	Yes	Yes	Yes

*adapted from Pugh's Matrix (Curedale, 2013)

In contrast to the technology-based strategies used in teacher education as described previously, some teaching hospitals have designed and implemented a daily paper-based encounter card system to facilitate the capturing and delivery of real-time feedback. The encounter card system utilizes pocket sized paper cards that trainees hand to assessors before a clinical encounter (Hatala and Norman, 1999). Afterwards the assessor fills out the card and gives additional written or verbal feedback. Trainees then add a description of the encounter and related details on the back of the card. This system was identified as being of potential value because Bandiera and Lendrum found that, even with the physical proximity between supervising and resident physicians afforded by the medical model, supervising physicians can only assess two or three different aspects of a trainee's development within one encounter (2008), resulting in other potential teaching moments being missed.

In a series of studies on different encounter card systems (Paukert et al., 2002), supervising physicians reported that the system was easy to use and took less than one minute to complete. The system was effective in empowering students to seek feedback to support their development. Its design allowed for feedback to be captured in a way that was accessible and minimally burdensome for both supervising physicians and medical students. Due to its format, the encounter card system is flexible and adaptable to changes in content and use. For these reasons, it is placed high on the accessible and adaptable axes (see Figure 8).

A similar strategy called 'Minute Feedback System' has been designed and successfully implemented to address the issue of lack of feedback given to medical students during surgery rotations at Michigan Medicine, which is the academic medical center at the University of Michigan (Hughes et al., 2017). The system is initiated by the medical student shortly after an interaction and is designed to supplement in person feedback. The student pushes a request via email to the attending physician asking for specific feedback. The physician is prompted to fill out a brief form and the student is informed immediately when it is complete. The critical characteristics of this strategy are that it is timely and requires minimal effort by both parties.

Hughes et al discovered that this approach also captured the differences between effective and non-specific feedback. For example, effective feedback is "delivered using neutral, nonjudgmental language and identifies specific actions or plans for improvement" (Shaughness et al., 2017, p. 175) while non-specific feedback does not identify "actionable information for the learner" (Shaughness et al., 2017, p.175). Hughes was able to use the feedback provided using his system to train other attendings on delivering effective feedback. Although this strategy does incorporate technology, it is based in email, a resource that is widely accessible, and took into account general usability.

Another initiative at Michigan Medicine, called the System for Improving and Measuring Procedural Learning (SIMPL) app, focuses on delivering feedback from attending physicians to residents in surgery training. This app consists of four components. The first asks for the respondent to indicate the degree of complexity of the case: easiest ⅓, average ⅓, or hardest ⅓. The second is based on the Zwisch scale which measures the degree of guidance used during a procedure, from the 'show and tell' stage when each step is verbalized for the trainee to 'supervision only' when the attending is only needed to ensure safety (Rekman et al., 2016). The third component asks for a rating on performance on a five-point scale ranging from unprepared or critical to practice ready and exceptional. The final task is to record approximately one minute or less audio message. Attending physicians are able to dictate their feedback. The three quantitative components create an opportunity for longitudinal tracking and aggregate data for analysis. The qualitative audio component captures actionable, immediate feedback for the resident to revisit (George et al., 2019). There is generally a time limit such as 24 hours when this process must complete after a procedure.

One study of the SIMPL app identified barriers to use of the app. Such barriers included being too busy, forgetting to use it, and lack of response (Eaton et al., 2019). The same study also identified suggestions for iteration of the app to include reminders as well as "decreasing the administrative burden by linking SIMPL to a pre-existing resident chore such as case logging to limit the number of things residents need to do on a daily basis" and "favorites list to simplify case entry and allowing written feedback instead of dictated" (Eaton et al., 2019). The app collects meaningful data but was viewed as somewhat burdensome. These barriers make it less accessible than the Minute Feedback System and Encounter Cards (see Figure 8). It is also slightly less adaptable than the Minute

Feedback System since it is tied to an app; email can be accessed on phone and desktops. This app is a mobile application only and less adaptable.

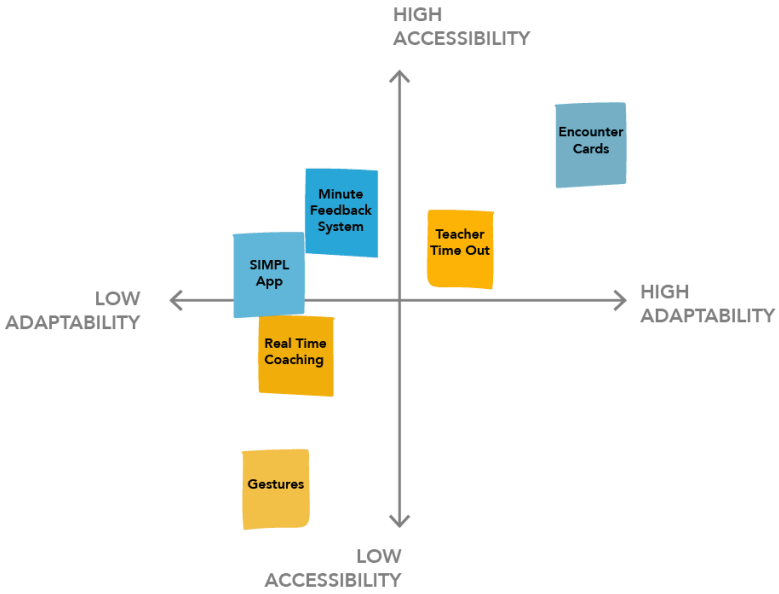

Figure 8: Real-Time Feedback Strategies in Physician Training

The Encounter Card, Minute Feedback System, and SIMPL app all require initiation by the trainee, record data for longitudinal tracking, and facilitate delivery of feedback after a clinical encounter or procedure. They focus on specific and rapid skill development as well as attempt to require minimal effort in order to use. These strategies demonstrate the importance of considering the work environment of the user and in empowering the trainee to initiate the feedback process. Although the discussed examples did not collect feedback in real-time, they are based on immediate feedback given after a supervised event, where real-time feedback most likely was given but not recorded.

Table 3: Real-Time Feedback Strategies in Teacher and Physician Training*

Criteria	**Encounter Card** (Hatala and Norman, 1999; Paukert et al., 2002; Bandiera and Lendrum, 2008)	**Minute Feedback System** (Hughes et al., 2017; Shaughness et al., 2017)	**SIMPL App** (George et al., 2019; Eaton et al., 2019)	**Real-Time Coaching** (Sharplin et al., 2016)	**Teacher Time Out** (Gibbons et al., 2017)	**Gestures** (Barmaki and Hughes, 2015)
Training Stage	Medical student	Medical student	Resident	Both	In-service	Pre-service
Initiator	Trainee	Trainee	Trainee	Experienced	Experienced	Novice
Platform	Paper based	Email based	Mobile app	Bluetooth	N/A	Interface
Mode	In-person	Virtual	Virtual	Either	In-person	Virtual
Timing	Post	Post	Post	Real-time	Real-time	Real-time
Data Recorded	Yes	Yes	Yes	No	No	Yes
Accessible	Yes	Yes	Yes	No	Yes	No

Adaptable	Yes	No	No	No	Yes	No
Minimally Disruptive	Yes	Yes	Yes	Yes	No	Yes

*adapted from Pugh's Matrix (Curedale, 2013)

Based on the above critical review of real-time feedback strategies (see Table 3) to support trainees in both teacher training and physician training, the following insights guided the design process to create a tool for the Teaching School. The tool should:

- Promote rapid skill development, reflective practice, and self-confidence in novice teachers
- Require minimal effort and not increase cognitive load ("easy to use")
- Capture actionable, immediate feedback
- Create an opportunity for longitudinal tracking and to aggregate data for analysis
- Be minimally disruptive

Additionally, to address the specific needs of the Teaching School, the tool must be adaptable and accessible. Looking at the matrix (see Figure 9), there is a clear area of opportunity to design a tool that is highly adaptable and accessible.

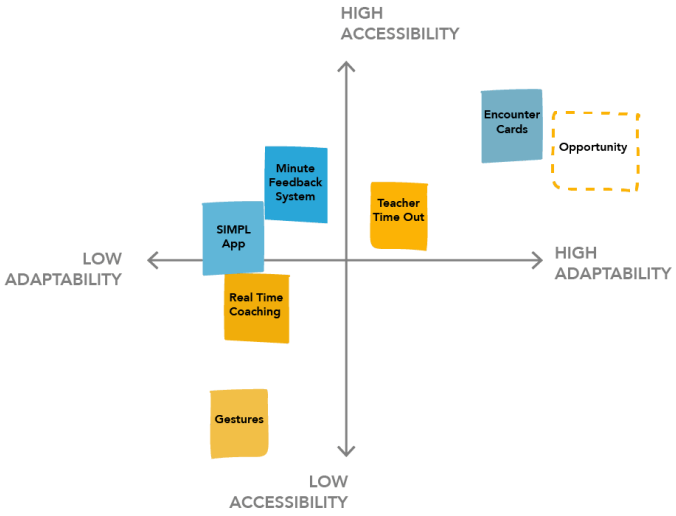

Figure 9: Identifying area of opportunity among reviewed strategies

The previous sections explored the background for the project, rationale for addressing the problem space, and a critical contextual review. I will now discuss the methods I used to explore and establish a foundational understanding of the specific environment, co-design a prototype, and conduct analysis.

METHODOLOGY

PROJECT AIM

This aim of this project is to design a tool to support the knowledge transfer from experienced teacher to novice teacher at the Teaching School. In order to design for this context and to support the Teaching School mission, a participatory design (PD) approach was adopted. Simonsen and Robertson define PD as “a process of investigating, understanding, reflecting upon, establishing,

developing, and supporting mutual learning between multiple participants in collective 'reflection-in-action'" (Simonsen and Robertson, 2013, p. 2). The context of the origins of PD is important to understand because it is integral to the design methods and processes that evolved from it. PD is based in the philosophy of giving workers a role in determining how to incorporate new technology into their daily tasks (Spinuzzi, 2005). This concept was popularized during the 1970s in Scandinavia in response to the invention of the computer, its debut in the workplace, and the hope that this invention could lead to better devices to support workers.

Since the tool is to be used by teacher educators and novice teachers at the Teaching School, stakeholder representatives from these groups were involved throughout the design process as illustrated in Figure 10. The project scope was co-defined by the project partners: Dean Moje, Dr. Alistair Bomphray, and me. The tool itself was co-designed with a current teacher educator, Rachael Gordon, at The Teaching School. Synthesis happened throughout the project with Dr. Bomphray and his colleague, Dr. Maher.

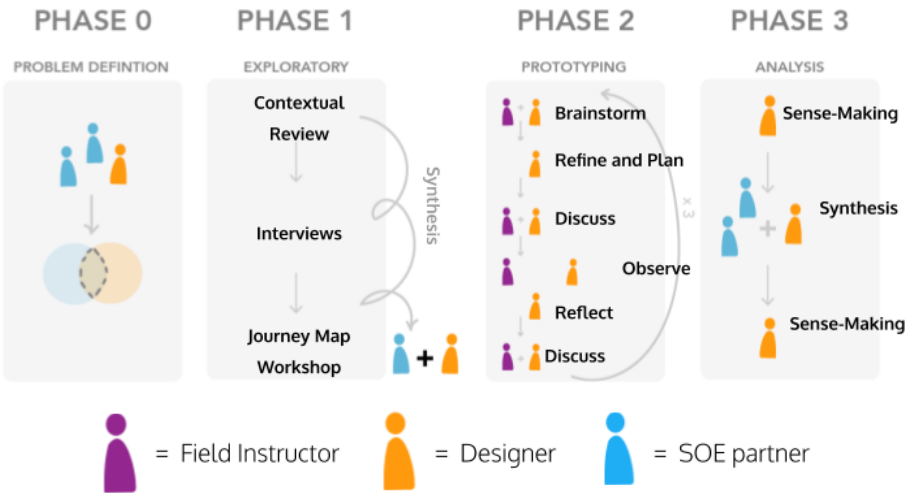

Figure 10: Project Process Overview

Co-design is a term used to indicate the application of participatory design. I will refer to this term as defined by Sanders and Stappers: “We use co-design in a broader sense to refer to the creativity of designers and people not trained in design working together in the design development process” (Sanders and Stappers, 2008, p.6). Kleinsmann and Valkenburg add additional information to their definition and emphasize mutual learning: "Co-design is the process in which actors from different disciplines share their knowledge about both the design process and the design content...in order to create shared understanding on both aspects...and to achieve the larger common objective: the new product to be designed” (Kleinsmann and Valkenburg, 2008, p. 370).

The Teaching School itself is in its first year and is a dynamic context in which to co-design. The dynamic environment and resulting challenges make it even more important to use co-design methods. In order to understand the complexities of the new environment, I needed to establish a foundation in understanding the inspiration for the Teaching School: the teaching hospital. Simultaneously, I needed to learn about the current state of teacher education and existing approaches to providing real-time support to novice teachers. This exploratory work enabled the design process. I will describe how I used the following methods: semi-structured interviews, journey mapping, participatory prototyping, and sense-making.

SEMI-STRUCTURED INTERVIEWS

In order to gain insights into the existing states of real-time feedback and support in both physician and teacher training, I conducted semi-structured interviews. Merriam and Tisdell state semi-structured interviews are “guided by a list of questions or issues to be explored and neither the exact wording nor the order of the questions is determined ahead of time” (Merriam and Tisdell,

2016, p. 110). I completed nine interviews with general surgery physicians at Michigan Medicine and nine teacher educators at the University of Michigan (see Table 4). The interview participants were identified utilizing snowball sampling, an approach based on the "selection of participants or sources of data to be used in a study, based on referrals from one source to another" (Yin, 2016, p.340). This method allows gaining insights directly from individuals with lived experience and expertise. These insights will be based on the subjective perspective of the participants as well as who was contacted and able to take the time to complete the interview.

Table 4: Semi-Structured Interviews

Career Stage	Michigan Medicine	UM SOE
Trainee	5	1
Experienced	4	9
Total	9	10

An alternative method that would have been appropriate is participant observation, which is "a qualitative method of social investigation, whereby the researcher participates in the everyday life of a social setting, and records their experiences and observations" (Jupp, 2006). Observing general surgery residents and attending physicians in the operating room, as well as novice teachers being supervised by experienced teachers in the classroom, would also provide critical insights. This method was not feasible to use within the project timeline due to the lengthy process of gaining

access to highly regulated and protected spaces, such as healthcare procedures and public school classrooms. Additionally, the method would have provided understanding for the one interaction, instead of several interactions, experienced by an individual over a training period, which is possible with the interview method.

Participant observation is the primary data collection method for ethnography. Ethnography encompasses "both a process and a product…interviews, formal and informal, and the analysis of documents, records, and artifacts also constitute the data set, along with a fieldworker's diary of each day's happenings, personal feelings ideas, impressions, or insights with regard to those events" (Merriam and Tisdell, 2016, p. 30). Ethnography would have been appropriate for this work due to its ability to understand the culture and belief system of a group through full immersion. The same barriers to participant observation as previously discussed apply to ethnography: access to sites and the restrictions of the academic calendar.

JOURNEY MAPPING

With the barriers of access and time in mind and to dig deeper into the knowledge held by experienced teacher educators, a workshop focused on the design method of journey mapping was implemented. A journey map is a visualization of the process a person goes through in order to accomplish a goal. It tells a story about an individual's actions, feelings, perceptions, and frame of mind, including the positive, negative, and neutral moments during this process (Stickdorn and Schenider, 2011; Kalbach, 2016). Since one of the values guiding participatory design is "the importance of making participants' 'tacit knowledge' come into play in the design process" (Binder et al., 2011, p.163), utilizing a design method that aims to make the invisible visible was

appropriate. A journey map helps teams pinpoint distinct moments to redesign and improve while also developing a shared vision.

UM SOE leaders organized a series of working sessions to establish the foundational vision and strategy for the Teaching School. At one of these sessions, I led a design workshop with senior leaders from UM SOE who were involved in developing the Teaching School. In the session, I began with a brief description of the MDes program and purpose of a journey map. I gave examples of the journey map in relation to patients' experiences in healthcare settings and then asked the participants to individually map out a time when they observed a novice teacher's lesson, using a simple journey map template. I asked the participants to identify low points and if/how they intervened.

The purpose of this warmup activity was to prompt the participants to think of teaching in terms of a journey map. Completing a simple template through which to begin to identify the type of opportunities where an experienced teacher could provide in-the-moment support to the novice teacher demonstrated the use-value of journey maps. Next, I introduced the participants to a more nuanced journey map template in order for them to work in groups to co-design a visual tool for mentor teachers. I provided examples of traditional elements of journey maps used in medicine (ex: steps, goals, sources of information, emotional journey, stakeholders, performance indicators, etc.) to be a starting point for brainstorming the appropriate elements and labels to be used on the template as a potential tool for mentor teachers.

PARTICIPATORY PROTOTYPING

Prototyping is a critical phase of the design process. As defined by Sanders and Stappers, a prototype is an "artifact created to explore a (design) question" (Sanders and Stappers, 2012, p. 302) and the act of prototyping refers to "the mutual learning process that takes place in a cooperative design setting" (Brodersen et al., 2007, p. 20). Through the use of participatory prototyping, this project aims to envision possible tools for real-time support of novice teachers. Participatory prototyping is "a collaborative identification of possible futures, rooted in current practice but with the purpose of introducing change" (Brodersen et al., 2008). This method allows for stakeholders to externalize thoughts and ideas in the form of physical artifacts, which offer insight into possible futures (Brandt et al., 2013).

SENSE-MAKING

To derive meaning from the data generated by the prototypes, the method of sense-making was used. Sense-making is "an action oriented process that people automatically go through in order to integrate experiences into their understanding of the world around them" (Kolko, 2010. p. 18). Sense-making as a methodology originated with Brenda Dervin in the 1980s and has evolved over time by various theorists with different units of analysis (Jones, 2015). For the purposes of this project, the following definition of sense-making informed by Dervin's writing is used: "a process that describes the patterns one sees, the constraints one applies, and the mental models one forms about his or her design problem" (Kolko, 2011, p. 172). Dervin conceptualizes sense-making as an internal activity and thus highly subjective:

> "Sense-Making assumes that reality is partly ordered and partly chaotic, it also assumes that reality is always subject to multiple interpretations because of changes across time and space, because of differences in how humans see reality arising from different perspectives

> or positions in time-space, and because of how humans construct bridges over a gap-filled reality."
>
> Dervin, 2003, p. 16

Sense-making was employed as a method for individual work and synthesis as an "collaborative, external process" (Kolko, 2010, p. 18) with my project partner. These are distinct stages in this project's methodology.

RESULTS

SEMI-STRUCTURED INTERVIEWS: THEMES AND INSIGHTS

Each subject matter expert interview was transcribed using Rev.com services and analyzed using open coding. The coding process "refers to the steps the researcher takes to identify, arrange, and systematize the ideas, concepts, and categories uncovered in the data" (Given, 2008, p.2) as captured in Image 1.

Image 1: Process of sorting insights from interviews with teacher educators

Below are the themes that emerged from the interviews with Michigan Medicine general surgery residents, attending physicians, and physician educators. According to these experts, feedback needs to be:

- Immediate and actionable
- Re-enforced after the event
- The result of, and based on, shared expectations
- Captured and used to track a resident's progress over time

Interviews with experienced teacher educators and teacher educators in training generated the following insights:

- There are few models for making the tacit knowledge that is part of teaching practice communicable and visual.
- Teacher educators lack tools and methods to facilitate real-time feedback.
- Ethical considerations, such as disrupting student learning and personally offending the instructing teacher, are perceived barriers to providing real-time feedback.
- Teacher educators lack shared expectations and vocabulary with novice teachers.

JOURNEY MAP DESIGN WORKSHOP: LIMITATIONS AND INSIGHTS

The journey map workshop was conducted with faculty and staff from UM SOE who are designing the Teaching School. I gained valuable insights through this activity. Participants vocalized resistance to the format of the journey map. The responses by the participants revealed that I did not completely comprehend the degree of the complexity inherent to the teaching practice and that directly importing a design tool that was created for a completely different context would not work. However, the introduction of journey mapping did bring value to the teacher educators.

In reflecting upon these statements, I realized that journey maps are effective and popular in healthcare and business because they have defined and clear positive and negative outcomes for the 'user'. For example, a patient's health will either improve or decline. Their experience with the healthcare system is either positive or negative. The same applies for a customer's experience with a business product or service. Teaching has many components and students are rarely all experiencing the teaching in the same way, rendering teaching impossible to map on the dimensions of "better" or "worse". For the more nuanced journey map template, the participants found it difficult to identify elements that track over time for both the students and the teacher. The responses by the participants revealed that I did not completely comprehend the degree of the complexity inherent in the teaching practice. Also, directly importing a design tool that was created for a completely different context would not work. The novelty of using a visualization approach situated within a radically different approach to teacher training through the creation of the Teaching School would require a more ground up oriented co-design approach. However, the introduction of journey mapping did bring value to the teacher educators.

The journey map demonstrated to the participants the value of a different approach to organizing information and how to illustrate the relationships between events during a set time period. One workshop attendee who observed the activities expressed interest in the journey map as a potential reflection tool for students, especially in the context of socio-emotional learning, which is "the capacity to recognize and manage emotions, solve

problems effectively and establish positive relationships with others" (Zins and Elias, 2006, p. 1). Journey mapping could be used to connect teacher actions with student reactions. Students could take notes and then map them their experiences to reflect on how their learning did or did not progress. The form and structure of the journey map was not the appropriate fit, but the positive response to the visual activity demonstrated the opportunity for co-designing a tool for this type of reflection.

PROJECT PIVOT: ACCESS TO STAKEHOLDERS

The relationship that this project initially aimed to address is the relationship between the attending teacher and the resident teacher or the attending teacher and a student teacher. At The School at Marygrove, the first year resident teacher is receiving a lot of support already and does not currently have an assigned 'attending' teacher. There is one student teacher placed at the school; however, due to various reasons it was deemed inappropriate timing to test prototypes during her instruction. The remaining possible testing opportunity was with the first semester teaching interns taking their practicum seminar at the school. As part of the first year of the Teaching School, teaching interns from UM SOE are taking their Practicum I course on site at The School at Marygrove (see Figure 11).

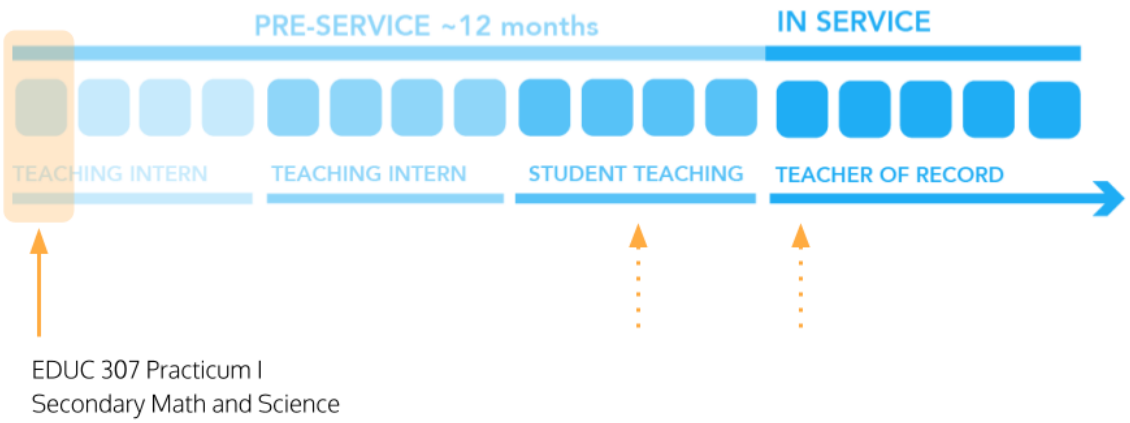

Figure 11: The project focus shifted to earlier stages of teacher training

By attending seminars at their field site, the interns will have theory and practice integrated at the same location and avoid experiencing the "two worlds" dilemma (see Contextual Review section page 16 and see Figure 12) that is characteristic of traditional teacher training. Since this approach of teacher education is more embedded, the teacher educators, field instructors, and veteran teachers will need additional mechanisms for discussing and connecting novice teachers' real-time observations to their understanding of the teaching practice. The seminar offers a testing ground to design and iterate tools to accomplish this objective. Ideally, a series of such tools could support pre-service teachers throughout their training at The Teaching School. The seminar, titled EDUC307 Practicum I Secondary Math and Science, has the following objectives: “This course is designed to develop critical observation and reflection skills in secondary math and science classrooms, as well as begin to prepare interns for designing and implementing meaningful instruction. The course is centered around four main themes, though other topics will be covered as well: Teacher belief and bias; School and community context; Students’ STEM-related interests and identities; Planning for instruction”. The instructor for the course is Rachael Gordon, a current doctoral student at UM SOE

and former Detroit public school science teacher. I partnered with the instructor to co-design prototypes for the first iteration of a tool.

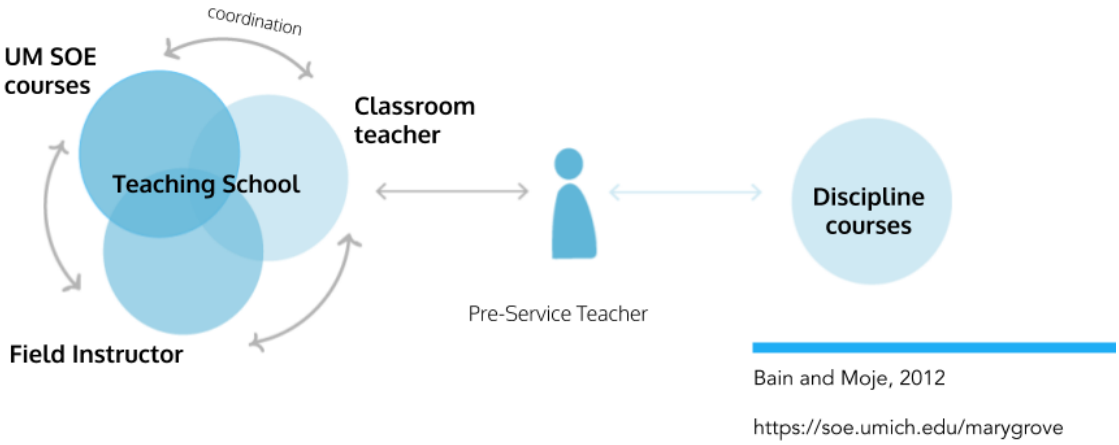

Figure 12: The Teaching School addresses the fragmented system of teacher education

PROTOTYPE V1: RATIONALE

For the teaching interns, it was their first semester at a field site. Since interns are not leading lessons, they focus on developing relationships with students. In order to do so, pre-service teachers are often told to circulate around the room without knowing why or the underlying tacit pedagogical knowledge that informs circulation. With this in mind, Rachael and I chose movement as the focus of the prototype. Movement is one of the most visible modes of non-verbal communication in the classroom, easily observable in others, whether that be the attending teacher or a fellow intern. How can novice teachers begin to understand the important role movement can play in teaching practice? Rachael and I hoped that through prototyping we could design a tool that builds self-awareness of interns' movement in the classroom and creates the opportunity to track the movement of experienced teachers' around the classroom.

On a weekly-basis, throughout the semester, the interns have to submit hand-written field notes from each observation. The interns rotate classrooms in cohorts of three. We decided to create an activity that would fit within the expectations of the seminar and take

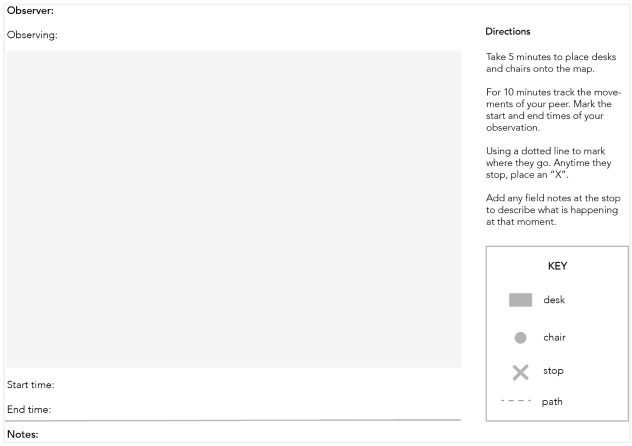

Image 2 (Left): Prototype v1 blank template;

Image 3 (Right): A teaching intern adding the classroom layout

advantage of the cohort structure. The purpose of field notes is to "record things now" as "they won't be there later" and to create an "opportunity to recognize patterns, are there things that people say or do, for example, that appear to suggest consistencies or relationships that are patterned" (Hoey, 2014, p.4).

Considering the findings from the Contextual Review (see page 15) and the purpose of field notes, the design needed to fit within the natural workflow of the interns, similarly to the design of the Minute-Feedback System or the SIMPL app. We designed a simple paper-based, 8x10" map template

with a limited key for the interns to use to map each other's movements and interactions in the classroom for a duration of ten minutes. The dimensions allowed the template to fit neatly onto a clipboard to make it easy for the interns to bring to the classroom. The design objective for this prototype was to test the ability to capture movement in real-time using a visualization method involving paper and pen. Drawing adds value to the interns' learning in a similar manner as field notes: "In the semiotic tradition, drawings are understood as texts – systems for exploring, constructing, and communicating meaning (Brooks, 2005; Kress, 1997; Wilson, 1985; Wright, 2007), and all drawings have their own agency (Dinham, 2014; Rose, 2012)" (Dinham et al., 2016).

The seminar objective was to prompt the interns to reflect on their behaviors and surface movement patterns in the classroom and what drives these actions. The instructor hoped these maps would lead to a discussion of teacher belief and bias. The interns were instructed to mark the arrangement of the desks in their respective classrooms. Then they were to record each other's movement using the key to indicate when their peers stopped and when they were in motion. A week after they completed the activity, we conducted a de-brief. Rachael and I co-wrote a reflection worksheet. The interns first completed individual portions and then answered questions in small groups and then came back together for collective discussion.

PROTOTYPE V1: FINDINGS

Based on the responses (see Table 5), interns described that most interactions and conversations with students were related to the students' task (such as an assignment) or degree of focus. Some interns identified the need to know students better on a personal level, by realizing they need to learn their names or details about students. Through small group discussion, the interns discovered they had different individual approaches for circulation but an unspoken understanding of a collective circulation strategy.

Table 5: Teaching Intern Individual Reflection Responses

Question	**Response**
What do you notice about your map? What was happening during the ten minutes?	● I noticed there was one table that I didn't stop or even walk close to. I was mainly walking by and stopping at the tables that weren't settled in and starting their work since the class had a substitute teacher. ● Direction of movement, path ● Where stopped, where did not stop ● Strategy behind route or path taken ● Movement limited by cramped space
What was the nature of your conversations with the students? What did you ask or say to them? What did they ask or say to you?	● Checking if students were on task ● Asked students to explain their thought process ● Asked if students understood the task ● Answered students' clarifying questions ● Help students understand the task ● Students asked questions about problems (associated with longer stops) ● Asked students their names ● Asked if students had questions; most work-based questions

	● Wanted to ask students personal questions
How did you decide to go from one group of students to the next? What specifically informed these decisions?	● Took a circular route, checked on each table an even number of times ● More likely to approach a table if students waved or smiled ● Asked for names of students to increase comfort level ● Up and down the aisle; stopped if students had question or if observed they were off task ● Interacted intentionally with students who seemed disengaged and not talking with each other ● Spent equal time at each table ● Wanted to seem accessible ● Move on cues: head down working, not looking around, work looks correct ● Stop cues: Hand raised, talking, not doing work, incorrect work, explicit ask for help

The field instructor stated that generating and discussing the maps was a helpful activity: “The interns learned to see patterns of which students they checked-in with. The maps reveal how the interns were organically working together by going to different tables, this was an unspoken decision.” The interns identified additional observations. They noticed a relationship between interns’ movement (or lack thereof) and the attending teacher’s instruction. If the attending teacher was speaking to the entire class, interns usually stood still. When students were working on assignments, the interns discovered through discussion that they all tried to not overwhelm the students with their presence. They all agreed that their maps felt more rooted in evidence than their field notes, but they emphasized that their maps don’t capture nuances of the interactions in the

classroom. The first prototype met the design objective of recording real-time information by generating a visualization in the form of a movement map.

PROTOTYPE V1: LIMITATIONS

The majority did not explicitly connect bias to movement. Although some interns did express feeling more comfortable based on certain student characteristics, the group discussion did not lead to explicitly identifying potential bias. The interns did feel limited by the map's design, in that it did not prompt them to capture the context of the lesson or details of interactions (see Image 4). Typically, the interns use field notes to record observations.

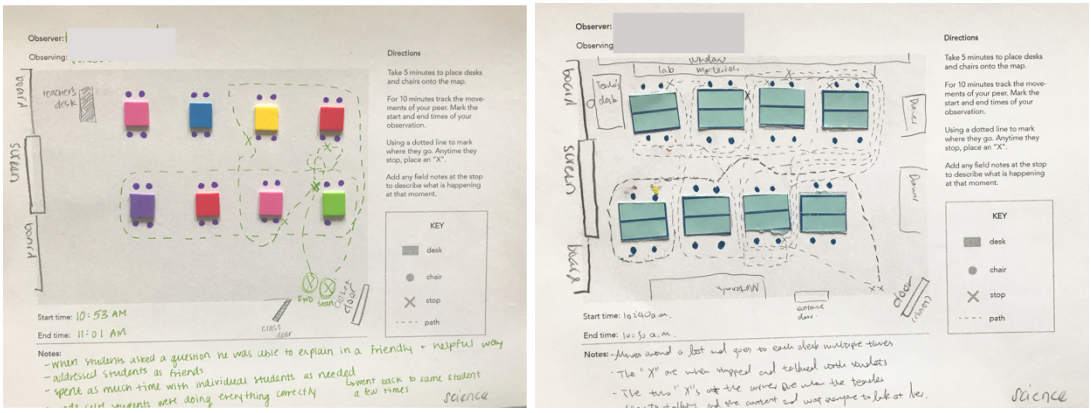

Image 4: Maps generated by two different teaching interns using prototype v1

Based on the reflection worksheets, seminar discussion, follow-up interview with the field instructor, and observations, I learned that the next iteration needed to capture more information about specific interactions in the classroom.

PROTOTYPE V2

Each week, the interns were to focus their field notes on a particular competency (see Table 6 for two of the competencies) based on an assessment tool created by the School of Education. This weekly assignment acted as a constraint on the prototyping process meaning that each week's focus was predetermined.

Table 6: Competency 1 and 5 Sub-Categories

Competency #1	Competency #5
Fosters a Relationship-Centered Learning Environment Based on Knowledge about Students, their Communities, Cultures and Literacies to Teach Responsively 1A. Investment in Getting to Know Students, School, and Community 1B. Leverages Knowledge of Students for Learning 1C. Builds Relationships and Rapport 1D. Assesses Students	Engage in Ethical and Professional Practices 5A. Attends to Professional Expectations and Standard 5B. Serves Needs of All Students 5C. Effectively Meets Ancillary Functions of Teaching 5D. Communicates Effectively 5E. Constructively Engages in Reflection and Uses Feedback 5F. Participates as a Member of the Professional Community 5G. Professional Accountability and Self-Care

The next iteration of the mapping activity was designed to integrate the mapping exercise with field notes, the standard way interns record their observations in written sentence form. Again, the interns mapped each other's movements using the updated tool for the same duration of ten minutes. They were to use the peer-generated maps to complete a self-assessment of how they are

developing certain skills. The following week, the same design was used but this time the interns mapped the movement of the experienced teacher for ten minutes.

The maps this time were 11x17” in order to have enough room for notetaking and to be easily folded up, with the two competencies listed on the back so the interns could easily reference them as they mapped the movements and took notes. The v2 template also included sections designated for commentary, evidence of competencies, and questions (see Figure 13).

Figure 13: Template used for prototype v2 and v3

The third iteration sought to answer, “How can mapping an attending teacher's movement in the classroom facilitate teaching interns' understanding of practice?” The design of the tool remained the same since the interns were familiar with it and we wanted to compare their use of it when observing teachers with when they used it to observe each other. Each teaching intern was instructed to map the motion of the attending teacher for ten minutes using the same key and template as in the second iteration of the prototype. The field instructor and I co-designed a new

key for prototype v2 (see Figure 14) in order to facilitate the interns' capturing more information about the interactions in the classroom.

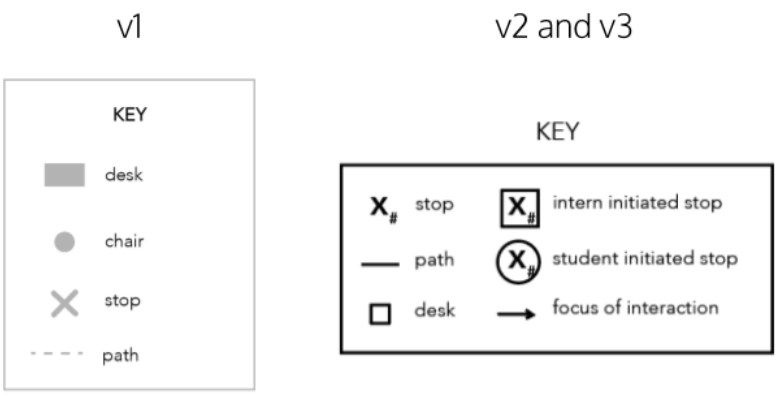

Figure 14: Keys co-designed for v1, v2, and v3

PROTOTYPE V3

For the third iteration, the design of the tool remained the same but the source of motion differed. This iteration sought to answer how can mapping an attending teacher's movement in the classroom facilitate teaching interns' understanding of practice. The design of the tool remained the same since the interns were familiar with it and we wanted to compare their use of it when observing attending teachers with when they used it to observe each other. Each teaching intern was instructed to map the motion of the attending teacher for ten minutes using the same key and template as in the second iteration of the prototype. Each classroom cohort mapped the attending teacher's motions around relatively the same time, despite not being given explicit instructions to do so.

Prototype v2 and v3 did not include individual reflection and group debrief discussion due to restrictions on time. This is a significant limitation of these two iteration cycles since the reflection worksheets and group discussion provided insight into what the teaching interns learned from generating from the maps. In order to address this gap in insights for prototype v2 and v3, I attempted to conduct semi-structured interviews with the interns. One intern agreed to participate in an hour-long interview.

PLAN FOR PROTOTYPES V4 and V5

The next iteration of the prototype was to utilize a video recording of an attending teacher instructing a math class. This particular recording of the lesson was used at the start of the semester for an activity for the interns to introduce how to take field notes through practicing together, based on their observations of the video. The field instructor and I had hoped by using a familiar lesson and focusing the interns' attention on motion, we would be able to discuss the maps collectively as they were being generated. We hypothesized that by simultaneously mapping the same attending teacher, the interns would learn from each other's observations as well as the field instructor's observations. The fifth iteration of the prototype was to have the field instructor map the teaching interns' movements. She additionally would provide feedback in real-time using the map of the interns' movements to guide conversation.

These planned fourth and fifth tests of the prototype did not happen due to the teaching interns' repeatedly expressing 'map-making fatigue'. They reported that generating and discussing the maps was a helpful exercise but completing them on a weekly basis felt overwhelming and did not yield new insights for them. The field instructor decided, based on this feedback, to no longer pursue

map-making and give additional time to other items on the course syllabus. This pause in the iteration cycles created an opportunity for me to conduct analysis and sense-making of the data generated by the prototypes thus far.

PROTOTYPE ANALYSIS

After three iteration cycles, the teaching interns generated a total of 24 maps. To conduct sense-making of this data set, I re-created each map by tracing the movement pathways and typing up notes (see Image 5). This allowed insight into the experiential nature of the prototype and to sequentially follow the teaching interns' observations.

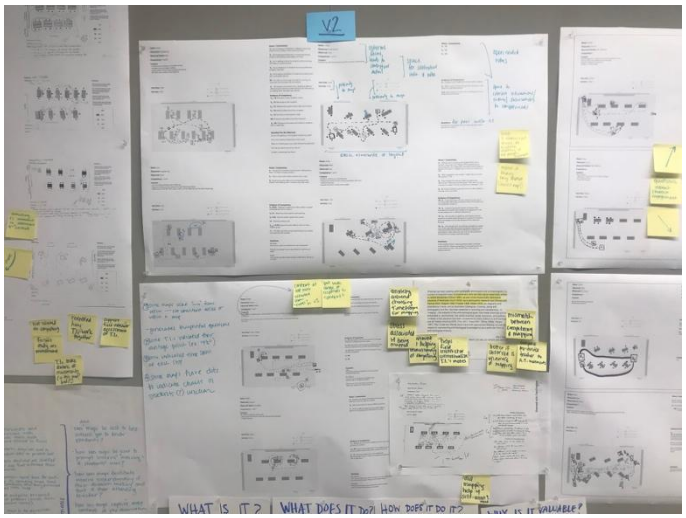

Image 5: Process of sense-making of re-created maps

The interns differed in how closely they adhered to the instructions and the use of symbols in the provided key on the maps. Some interns filled in gaps by creating their own symbols. The act of re-tracing surfaced these discoveries which otherwise might have been overlooked and are

important pieces of information for future iterations of the prototype. The interns also listed interesting questions in their notes that were related to the time period they observed, thus indicating an opportunity for post-observation discussion using the map.

The one intern who agreed to an interview shared that she did not use v2 to support the completion of her own self-assessment because the competency was misaligned with the mapping tool. She did find v3 insightful and shared that when she and her peers mapped a teacher's movements, they used the maps to facilitate a debrief discussion with the teacher after the class and asked her why she didn't approach a certain table of students (see Image 6). She had not realized she missed an entire group of students and this realization, prompted by the maps, led to an important discussion about in-the-moment decision-making. These insights reveal the potential of the tool to assess movement patterns and establish the connection of the patterns to effective teacher development. This critical connection is among the most central features of the tool and it can help to address teacher bias in an accessible way.

Image 6: Map showing the table that the teacher missed circled in red

DISCUSSION

This prototype surfaces and makes visible implicit aspects of the teaching practice. The three iterations demonstrated immediate short-term value and potential long-term value of using visualization to support the education of the novice teacher. In the short term, the prototype generated a record, facilitated conversation, and cultivated awareness. For long term value, the prototype visualizes patterns, creates comparisons, and builds a shared vocabulary.

PROTOTYPE: GENERATES A RECORD

After the first iteration, the teaching interns repeatedly commented on how the tool generated a map that felt more "evidence based". The tool captures the ephemeral and creates a snapshot in time that can be immediately reviewed. One of the teacher educators who participated in a synthesis activity stated:

> "The tool is a useful conversation generator in the way it activates memory. It forces a more text-based conversation about teaching rather than trying to remember what you saw, look at the text you created that represents what you just saw, and point to places and it feels more rooted in evidence".
>
> Teacher Educator
>
> School of Education, University of Michigan

PROTOTYPE: FACILITATES CONVERSATION

The above insight shared by the teacher educator quote indicates the map also facilitates conversation. The anecdote shared by the teaching intern (see Results section, page 58) about using the map after the class to discuss the teacher's decision-making supports this claim. The iterations showed how this tool can be used in this type of debrief between pre-service teacher and attending

teacher, between pre-service teacher and field instructor, and between peers. This area of opportunity will be discussed in the Future Directions section.

PROTOTYPE: CULTIVATES AWARENESS

The tool cultivated different levels of awareness among the learner, field instructor, and teacher educator. Interns expressed that knowing they were being observed influenced their actions. However, this demonstrates that it made them more aware of how they were moving in the classroom and focused their attention on the movements of their peers or the teacher. Rachael, the field instructor, expressed the tool helped her awareness of how the interns were developing in their learning: “These designs have not only helped pre-service teachers in making their thinking visible, but it has also allowed me, as the teacher educator, to better assess my students' thinking and better inform my own practice.” When reviewing the maps, teacher educators commented on how quickly they could gather insight into the observed teacher’s instruction style.

Image 7: Map generated by a teaching intern observing the math teacher's movements

For example, when reviewing a map that illustrated an attending teacher's frequent movements, (see Image 7) a teacher educator commented, "Wow this teacher moves around a lot, and clearly he has priority placed on circulating around the room. This is significant in terms of instruction." The teacher educator admitted that he would not know the reasoning behind the teacher's movements without a direct discussion with the teacher, but within a few seconds he was became aware that the teacher prioritizes circulation. The tool also has potential to cultivate self-awareness in attending teachers by supporting them in articulating the nuanced and implicit aspects of their practice.

PROTOTYPE: VISUALIZES PATTERNS

The tool visualizes patterns and creates an opportunity for a novice teacher to better understand their own patterns of teaching and those of experienced teachers. If novice teachers can receive

guidance in understanding the more invisible, critical aspects of teaching, they will feel much more confident and prepared when they are independently in charge of a classroom:

> "When mentors are able to explain the reasons for their teaching decisions, new teachers are able to see clear connections between teaching behaviors and the impact of those behaviors on students. This, in turn, helps new teachers become more intentional in their teaching."
>
> Toom, 2019

The frequent movement by the attending teacher surfaces a pattern in his teaching that interns discovered quickly when mapping his movements (see Image 7). One intern expressed map-making fatigue when observing this specific teacher: "We all know he moves around a lot; we get it. We don't need to make another map with lines all over the place." Did this intern understand the why behind the teacher's movements? Or how this movement facilitated understanding of students and of the progression of the lesson? The tool can be used to deepen the intern's level of understanding by helping them to discover what they really are 'seeing' when they are observing. This prototype has the potential to showcase intentional teaching practice, as highlighted in Figure 15 and described by Toom, quoted above.

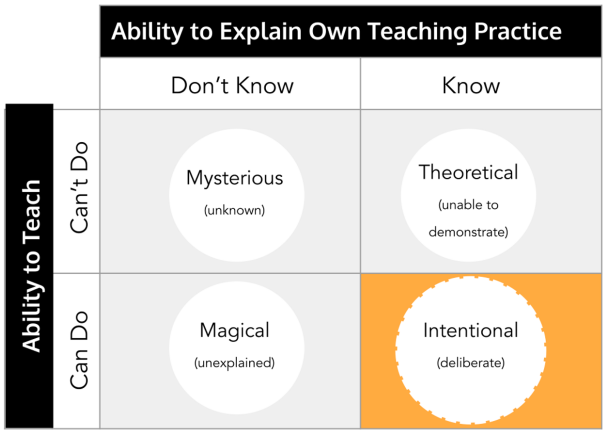

Figure 15: Adapted from Newton et al., 1994

PROTOTYPE: CREATES COMPARISON

As a record, the tool can be used in longitudinal tracking to compare stages of teacher development. Seeing as the Teaching School has the capacity to train teachers from the pre-service stage of teaching interns through the completion of a teacher residency, being able to compare points in time in different formats will be important. One specific example would be to use the tool to connect students' learning goals with teacher movement. In the third iteration of the tool, one teaching intern commented on how the more open-ended nature of projects in the engineering course was reflected in how the teacher circulated around the room when compared with the more frequent movements of the math teacher.

This project barely touches the surface of the role of movement, motion, and other forms of non-verbal communication in teacher education. But it is a step in the direction of building a vocabulary to articulate the interactions that occur in the classroom, primarily between environmental space and personal space and the implications of these interactions (see Figure 3). These maps begin to document when a teacher shifts from occupying environmental space to personal space and vice versa.

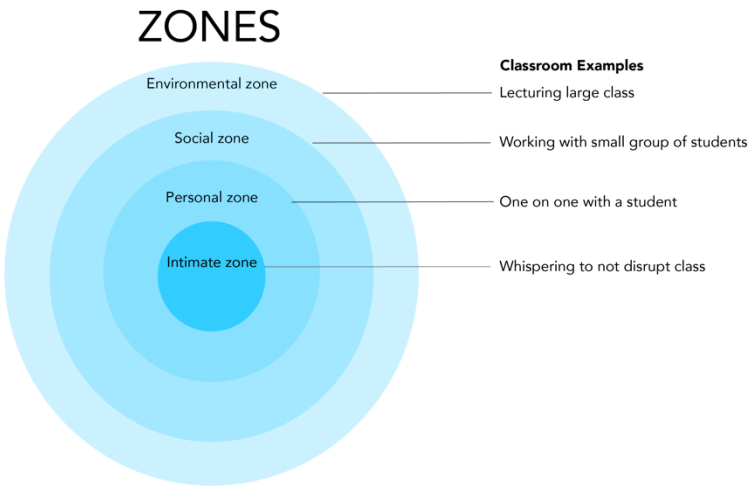

Figure 3: Personal space zones with classroom examples as discussed by O'Hair and Ropo

Future iterations could explore the invisible and cognitive work involved in a teacher shifting between the space zones. Observing these shifts and surfacing patterns could potentially reveal teacher bias.

If I were to place this prototype back on the matrix from the contextual review, it is certainly high on accessibility and adaptability since it is paper based and does not require hardware or software. The ability to alter the key makes it easily adaptable to specific circumstances. Teacher educators can use different visual indicators to focus the information collected. For example, what is happening in the rest of the classroom when a teacher is involved with a small group of students? How does a teacher use eye contact and other forms of non-verbal communication with verbal communication? A very recent work featured by Computer-Human Interaction (CHI) conference discussed "the design of Dandelion Diagram: a synthesized heatmap visualization which combines teachers' positioning and orientation (i.e., heading direction) data,

to depict both their whereabouts and attention allocation in one frame ….also enables the representation of teachers' mobility pattern (their trajectories in the classroom)… Dandelion Diagram contains an open-ended color coding layer that can be used to represent temporal pattern (i.e. during which period of the class session the teacher stayed at a location), or other information labels of the data points (e.g. which classroom activities the teacher was engaged in at a location)" (An et al., 2020, p.2). Such work provides inspiration for the types of information the next iteration of the prototype could capture.

The tool is also minimally disruptive as it does not require instruction to be interrupted. It captures contextual information in real time, in addition to the other characteristics described above.

Table 7: Prototype Assessment Based on Contextual Review

Criteria	**Movement Maps**
Training Stage (pre or in-service)	Both
Initiator (novice or experienced)	Either
Platform	Paper based
Mode (in person or virtual)	In person
Timing	Real-time

(real-time or virtual)	
Data Recorded (yes or no)	Yes
Accessible (yes or no)	Yes
Adaptable (yes or no)	Yes
Minimally Disruptive (yes or no)	Yes

FUTURE DIRECTIONS

In order to tell a more complete story, the map key needs to capture more nuances of interactions and behaviors in the classroom since the tool presents an opportunity to record more contextual information quickly. This needs to be co-designed closely with Dr. Bomphray and Dean Moje. For example, a key could focus the mapping of certain observations in alignment with the competencies from the SOE teacher assessment tool called the Learning To Teach Growth Charter. Although the tool could be used in a wide range of contexts, three different scenarios will be proposed: conversation guide for pre-service teacher, data collection for field instructor, and novice teachers preparation of space.

As discovered organically through the iterative participatory prototyping process, teaching interns were able to use the tool to have a conversation with a teacher they observed. In a future iteration, this should be a more structured and intentional activity. An attending teacher will prompt a teaching intern to use the tool to map their movement throughout the classroom and specify which key to use (i.e.: what type of information to focus on collecting). They will prompt the intern to write down questions using the tool related to the interactions and events they observe. Following instruction, the intern will then use the map and accompanying questions to guide a conversation with the attending teacher. For example, an intern might ask "At this point in the lesson, you decided to help this group instead of the other group. Why?" or "I noticed that you stayed at the computer while students were working on the assignment. Why did you decide to position yourself there instead of circulating?". The prototype attempted this type of structure by integrating a question section into the tool, but it was not widely used in discussion with attending teachers. If attending teachers prompt the interns to use it and then attending teachers are aware of the type of information teaching interns will be observing it will hopefully contribute to a meaningful and effective post-instruction conversation.

A second possible use of the tool is by field instructors (and other teacher educators) to start conversations about bias. Upon learning about the tool, one field instructor not involved in the project stated: "This seems to be a tool that could possibly influence field instruction observation, leading to analyzing relationships to student achievement (affective and cognitive) with respect to biases in teacher mobility throughout a classroom." The field instructor would use the tool to observe a student teacher leading a lesson. The student teacher should not know the tool is being used until the debriefing conversation following the instruction. The field instructor can use the tool to ask the student teacher questions about their decision-making as well as offer alternatives. Using

the tool over the course of different lessons could be used collectively to compare how the student teacher navigates the classroom and to surface bias. For example, after the first iteration of the prototype a teaching intern commented on how she is more comfortable approaching female students. If her movements have been mapped to record data about which students she was interacting with the most, it would probably reveal that she gravitated towards female students. This would provide an entry point for a conversation about bias and the impact it has on building relationships with students and developing effective teaching practices.

A third scenario is to use the tool in a completely different way than the previous two scenarios. The tool could be part of the lesson planning process, especially for pre-service teachers. In order to build spatial awareness, pre-service teachers could map out how they anticipate moving around the classroom as they are giving a lesson. Instruction rarely go according to plan, but by adding a visual and spatial element to the planning process, the novice teacher might be more intentional of the use of space especially in relation to instructional goals.

The tool can be iterated upon in several different directions. The Teaching School can adapt the tool to its needs as it continues to develop. This project demonstrated that designers can support teacher education reform efforts by co-creating visual tools to support the knowledge transfer from experienced teachers to novice teachers.

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