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The Placement Dilemma: Leveraging Technology to Improve the Student Teacher Placement Process Through Participatory Action Research

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Clarkson University is home to a 30-year-old, graduate-level teacher education program which includes a student teaching placement. The placement process is one of the most time consuming aspects of the work done in the teacher education program. In order to minimize time spent placing student teachers and increase the level of service provided to those who require additional assistance, the teacher education program designed a prototype optimization software system to match student teachers with mentors. This optimizer is based on programming principles used in popular software applications individuals might use to find a relationship match. Rather than matching individuals for dating purposes, this model matches individuals based on their student teaching attributes. The software considers student teacher preferences, experience, and academic performance. It also accounts for factors related to mentors such as teaching experience, mentoring experience, school setting, and location. In an initial demonstration, the prototype software was tested with a sample of five student teachers and compared to the actual placement decisions made by the program faculty. The initial results showed strong agreement with the decisions made by program faculty. The research team used the Participatory Action Research process to tackle an adaptive problem that required many sets of expertise and an iterative research cycle. This article includes the results of this project along with challenges experienced in its development and next steps.

A central component of teacher education programs is the clinical, or in-school, student teaching experience. The student teaching setting is where future teachers learn from more experienced colleagues and apply what they have learned in their teacher preparation program to the classroom. Education programs, like the one at Clarkson University, spend exorbitant amounts of time building and maintaining relationships with school partners to host and mentor student teachers in educative environments where they will thrive as new teachers.

Education programs often also invest considerable amounts of time to ensure their student teachers are placed into successful settings. Often, even with time and attention paid to this process, placement decisions are not ideal. This article describes the student teaching placement dilemma and one solution, developed at Clarkson University, for reducing the amount of work education programs expend placing student teachers into high quality student-teaching experiences.

Clarkson University is located in Potsdam, New York, with campuses in Schenectady, and Beacon, New York. The graduate-only teacher education programs are located in Schenectady, with a total enrollment of approximately 100 students.

Clarkson's education department assigns student teachers to clinical placements where the student teacher is a graduate student who has completed the required coursework and has been recommended by the chair to begin a student teaching placement. To optimize student teacher placements and success, several aspects need to be taken into consideration, which include the student teacher, mentor, and school district's attributes. It is paramount that the match works for all stakeholders.

The Placement Dilemma

A number of factors help to ensure a good student teaching experience and guide the placement process. These factors include the location of the school where a student teacher completed their fieldwork assignment relative to the student teacher's residence, mentoring strengths and weaknesses of the cooperating teachers, and availability of disciplines (particularly in less-frequently offered curriculum, such as world languages). Additional factors include the number of students in the classroom, the class composition, and the inclusion of special education or English language learners who do not have one-on-one paraprofessionals.

The Setting

The Clarkson program, specifically, needs a large pool of highly qualified mentors in over 25 districts within 50 miles of the campus. Potential mentors include teachers with certification in 15 different subject content areas: all sciences, social studies, mathematics, English, several world languages, business, computer science, and English as a new language (ENL), traditionally known as English as a second language (ESL).

Because the school districts here are generally small (500-5,000 students), and the taxpayers of these communities are not always agreeable to having their children educated by more than one novice, uncertified teacher, many of our school partners are willing to host only a few student teachers per year. Furthermore, to create the best synergy, we seek to align the student teachers' career goals with their placement setting (as recommended by Goldhaber et al., 2017). The preferences of both the student and faculty advisor in terms of school setting, socioeconomic status, and grade level are also considered.

A fundamental reality of this process is that student teaching is a requirement for certification in our state. Yet, the public schools are under no obligation to host student teachers. Thus, university-based teacher education programs are left in a position of needing to create a value proposition for school partners to incentivize schools and teachers to host student teachers.

The program that is the context for the research described here incentivizes schools by matching student teachers with schools that fit their long-term career goals. This incentive presents an opportunity for the school district to become familiar with the student teachers, their skills, and their strengths. In the event that a position opens, the school district has at least one potential applicant who wishes to remain in the school and knows the school and its policies and personnel. If placements are done skillfully, that is, if student teachers are matched well with mentors and school settings, the value proposition becomes easier to sell and sustain, as we are improving the pipeline of well-qualified applicants for the schools. If the match is done poorly, a teacher education program will find that the central requirement for success is in jeopardy.

What Is the Placement Dilemma?

While many factors are technically within a program's control, maintaining current information on the availability of student teacher assignment locations and placing a cohort of student teachers can be a tedious, time-consuming endeavor. Done manually or sequentially, program personnel may choose placements leading to less than ideal student teacher assignments and, in the worst case, failure to place a student teacher. This situation, stated briefly, is the placement dilemma.

Literature Review

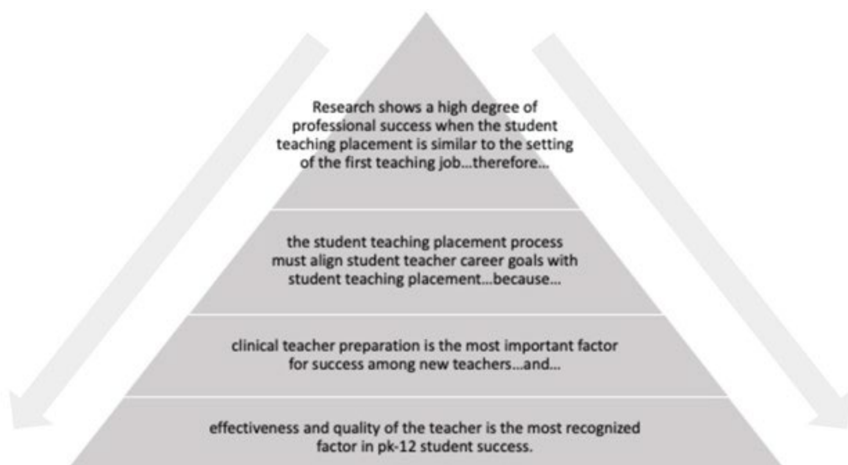
Student Teaching

The purpose of student teaching is to prepare new teachers for the classroom. The most important factor contributing to P-12 student success is the quality and effectiveness of the classroom teacher (American Association of Colleges for Teacher Education, AACTE, 2010; Boyd et al., 2009; National Center for Teacher Residencies, 2015). The student teaching or clinical experience is widely accepted as the most important aspect student teachers undertake within their preparation program for a successful teaching career (AACTE, 2012; Beck & Kosnik, 2002; Hammerness et al., 2005; Haselkorn, & Hammerness, 2008; National

Commission on Teaching and America's Future, 2003; Whitener et al., 1997).

In addition to classroom teaching experiences as a requirement for licensure, research on student teaching has revealed a second trend relevant to the placement dilemma. Most student teachers who pursue part-time or full-time teaching positions do so in the school setting in which they had completed their student teaching experience, which results in the highest retention rates in the profession (Goldhaber et al., 2017; Krieg et al., 2015; Whitener et al., 1997; Williams, 1985). Figure 1 synthesizes these findings into a research-based teacher success pathway. Based on this research, the authors realized that optimizing student teacher placements is integral to our placement software project.

Figure 1
Placement Dilemma Teacher Success Pathway



This goal, however, exists within the constraints experienced by teacher education programs: time, human resources, cooperating teacher skills, and P-12 partnerships. Given these constraints, the question becomes, How do teacher-education programs optimize the student teaching experience within the boundaries of existing resources?

Placement Systems

The research team could find no examples of other teacher education programs using or creating software-based placement programs in the literature. However, similar problems exist in other settings. For example, some school systems use placement mechanisms to decide which students attend which school. The Hong Kong and Singapore public education systems are such examples (Teo et al., 2001). Another well-known setting where the placement dilemma occurs is with newly graduated physicians and pharmacists. The medical field residency placement process is complex, with most institutions employing a national database such as the National Resident Matching Program (Gale & Shapley, 1962; National

Matching Services Inc, n.d.; National Residency Matching Program, n.d.; Roth, 2003). Newly graduated medical-field residents seek to optimize their residency choices by balancing their preferences with their perceived likelihood of acceptance for a particular residency setting. If they receive an offer for a match that suits their needs, it is considered "stable," and if they receive their first choice, it is considered "optimal" (Gale & Shapley, 1962, p. 10). In this case, the residency placement has been *optimized*.

Consider the fact that medical schools and students require thousands of placements annually, with hundreds of medical facilities vying for the best-fit candidates. The factors (i.e., location, student skill level, specialty, and so on) involved in attempting to optimize everyone's placement can quickly overwhelm the most sophisticated software systems. In fact, the process is so complicated even for the individual, there are pay-for optimizing services to help medical-field residents optimize their personal offers and make the most beneficial choice (National Matching Services Inc., n.d.; National Residency Matching Program, n.d.).

Even in situations where students need to be assigned to groups for project work, problems with matching relevant attributes become complex and time consuming when the number of students increases. (Anwar & Bahaj, 2003; Calvo-Serrano et al., 2017; Magnanti & Natarajan, 2018). Optimization problems can be computationally intensive, and there is no universal solution method. A customized solution is needed for each application that exploits particular features of the problem to improve the ability to find a solution in a reasonable amount of time (Eppen et al., 1993).

Methodology

Participatory Action Research

The team involved in this project chose a participatory action research (PAR) methodology to guide their work (Lawson et al., 2015). The project fit naturally into the PAR paradigm for several reasons: The work is cross-disciplinary, requiring collaboration by multiple research experts and stakeholder experts, and the work is, by its nature, solution-seeking with anticipated iterations over time. Additionally, it fit because the team was seeking a local solution to a local problem. These characteristics (i.e., stakeholder involvement, iterative, and local solution-seeking) are all commonly associated with action research and specifically with PAR (Chevalier & Buckles, 2019; Foster-Fishman & Watson, 2011; Lawson et al., 2015; Willis & Edwards, 2014).

Lawson et al. (2015) explained the three levels of complexity into which a PAR project might fit: A "tame" project, typically involving a technical solution (p. 20). An "adaptive" (p. 20) project, typically a problem that can be "named and framed" but without an obvious or easy solution. Finally, a "wicked" problem, typically a problem that may be only partially explained and requires the development of a new argot and systems to solve (p. 21). The placement dilemma project falls neatly into the adaptive PAR project category as a problem that can be named and framed but a problem that no one has yet identified clearly or tried to solve.

Stakeholders

PAR was also determined to be ideal for the placement dilemma project because of the democratic, pragmatic, and future-oriented nature of the methodology. By its very nature, PAR puts the stakeholder at the center of the research process, with the explicit goal of providing solutions to real-life challenges. According to Lawson et al. (2015), stakeholders have specific knowledge of the problem, constraints, and avenues for solutions. Stakeholders "co-generate the specific knowledge and interventions required to meet their own needs and solve their own problems" (p. 19). Successful PAR must include stakeholders for the solutions to be local, a fundamental principle of action research.

The placement dilemma research team consisted of a cross-disciplinary group of academic researchers and program stakeholders who came together on equal footing to tackle this adaptive problem. The research team consisted of two faculty members, a teacher educator, and a statistician with systems analysis expertise. The stakeholders were the clinical site manager (CSM), responsible for student teacher placements, and the education programs data manager, responsible for gathering, organizing, and managing all of the teacher education-related data. Additionally, the largest stakeholder group was the student teachers, themselves, who would participate in preliminary study steps and who would eventually participate in the solution trials.

In addition to the current students, the Alumni Council was asked to participate. (The Alumni Council meets officially twice a year and more frequently informally at networking events throughout the year and consists of alumni from the previous 5 years. The Council's purpose is to provide feedback to the education programs regarding the extent to which the programs prepared them for the classroom.) The Alumni Council formed a focus group to discuss the problem and possible solutions from their viewpoint (as in Jason & Glenwick, 2016).

Combined, the stakeholders took the placement dilemma from "bench to trench" (Hal, 2015, p. 34) as they worked to improve the quality of placements for student teachers and minimize the amount of time it takes to make those placements.

PAR Knowledge Priorities

The PAR process required that four knowledge priorities be considered in the research design:

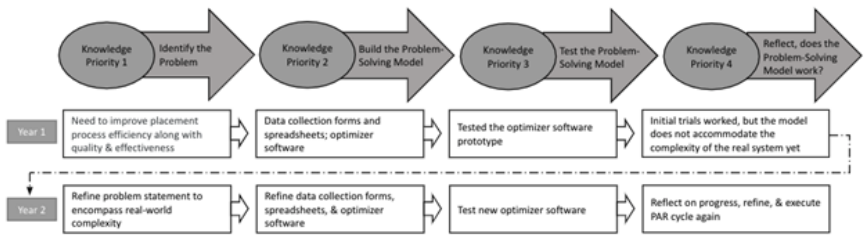
1. A clear explanation of the problem;
2. The creation of a problem-solving model;
3. An analysis of strategies to repeat the desired outcomes; and
4. An explanation of how the derived solution is useful for the local context. (Hal, 2015, p. 14)

This research workflow (see Figure 2) fit the project goals and became the framework for the first phase of the project, the research explained in this article.

Naming and framing (Hal, 2015, p. 20) the dilemma required conversations with the CSM and the program data manager. The student teacher placement process as it existed was thoroughly mapped including internal (university-based) and external (P-12 partners and community organizations) stakeholders, along with the ideal timeline. This process included conversations, joint creation and refinement of the diagrams included here, and observations by the faculty of the placement process in action.

The second knowledge priority consisted of developing a problem-solving model. This aspect of the research involved contributions primarily from the faculty member with the systems analysis training. She created a proof-of-concept software model that could – in theory – match student teachers with mentors by optimizing characteristics that were identified in the naming-and-framing stage of the work.

Figure 2
Placement Dilemma Knowledge Priorities and Participatory Action Research Work Flow



The third knowledge priority involved testing the software model against decisions the CSM would have made. Finally, the fourth knowledge priority consisted of an explanation of whether and how this software might contribute to the placement dilemma by optimizing ideal placements for student teachers while minimizing the amount of time and errors that might be made in the process.

We have completed one PAR cycle. Placements were matched manually through the COVID pandemic as business rules were modified and added to accommodate the COVID protocols at the various schools. It is not yet known whether any of these new rules will persist postpandemic; therefore, we are continuing with a suspension of system testing until the situation stabilizes.

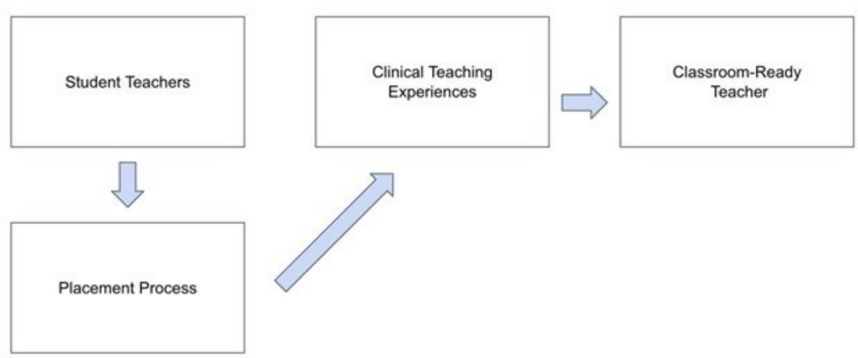
First Knowledge Priority: Problem Definition

As part of the first knowledge priority, identify the problem, an understanding of the requirements and placement process was needed. When the total enrollment of student teachers was less than 20 students, the clinical site manager (CSM) and faculty met with each student individually for a placement interview. Program personnel would then meet frequently to reconcile placements for all student teachers, ensuring that constraints and student teacher preferences were satisfied. During these meetings, faculty members engaged in real-time data acquisition, often using cell phones to find distances between a student teacher's home address and a potential placement site.

The meetings were inefficient, iterative, and time consuming. In addition, information and decisions regarding placements were made sequentially – that is, as opportunities were secured, matches were made. The sequential approach eliminated the possibility of optimizing placements for the cohort of students as a whole. Moreover, relevant data were stored in multiple locations: faculty notes, Google Maps, and spreadsheets.

To manage placements effectively, we needed to centralize the process to include only the CSM to ensure districts would have a single point of contact and to promote consistency. The production model (see Figure 3) was originally one of direct contact with student teachers and school partners, resulting in sequential student-by-student placement. With recent program growth, the student-by-student placement production model was no longer feasible.

Figure 3
The Teacher Production Model

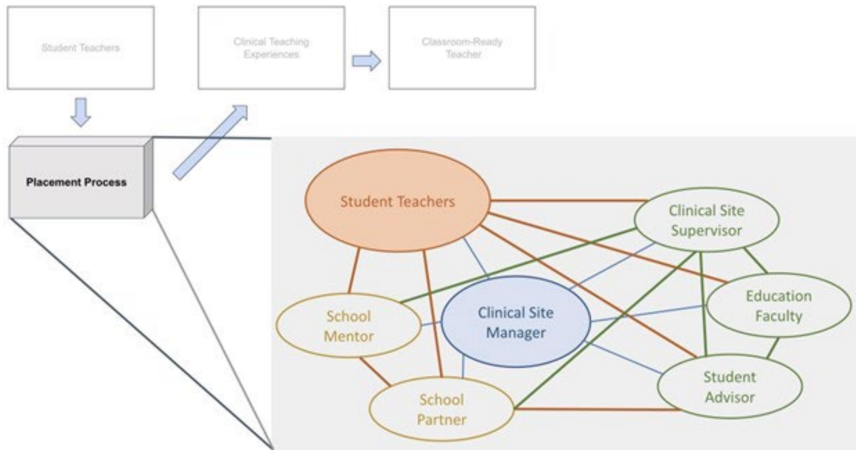


Second Knowledge Priority: Solution Design

To develop the problem-solving model, we invited the faculty member with systems analysis expertise to explore the feasibility of an information technology (IT) solution. The feasibility study started with our colleague observing our meetings to learn how our existing placement process operated, the program values implicit in the placement process, and the centrality of the placement process to the program's success. Following those initial observations, our systems analysis colleague joined the placement project team.

The project team then set to work outlining the process, integrating different program priorities, determining process rules, and identifying and prioritizing constraints. The placement affinity diagram (see Figure 4) graphically depicts the complexity of the placement process. In this complex system the student teacher is connected to all of the individuals who work to create and sustain a student teaching experience and typically has the least amount of decision-making power. One of the project team's central goals was to develop a process in which student teachers have a voice in the placement selection.

Figure 4
The Placement Affinity Diagram



Many of the weaknesses identified in the current placement process can be overcome by judiciously inserting IT to assist the decision makers. The initial solution was envisioned to be similar to the now-ubiquitous online dating apps, where a student teacher would be *matched* to a school mentor. The project team met monthly to define the requirements for such an IT system. This involved identifying the steps in the current workflow and the key information needed at each step to make placement decisions. Simultaneously, a variety of software tools were evaluated as possible system components.

This approach, of simultaneously developing requirements and evaluating potential solution technologies, enabled the users to better envision the possibilities of an automated system and enabled the systems analyst to assess the feasibility of these software tools. In this design phase, student information was protected by restricting file access to research team members only. Protection of student information was an integral part designed into the production system, and it was based on the university policies that implement the *Family Educational Rights and Privacy Act*. Four major capabilities were identified for an IT solution: data collection tools, data storage, user interface, and a solution algorithm.

Questionnaires for Data Gathering

As a first step in developing a problem solution, data collection tools needed to be created. We developed electronic student teacher (see Appendix A) and faculty placement questionnaires (see Appendix B) so the information gathered about student teachers from different faculty was consistent and could be stored in a database for the optimization software. The student questionnaire collected personal data such as physical address during the placement year, content area, and current level of certification. The questionnaire elicited preferences to increase student satisfaction with their placement.

Questionnaires were used to collect data from the student teachers and mentor teachers regarding their availability, location, subjects and grade levels, and preferences. For example, mentors were asked what their anticipated course schedule would be for the following year and if that schedule would be conducive to hosting a student teacher. Student teachers were asked if they had a preference between rural, suburban, and urban settings; middle or high school settings; independent or public school settings; and so on.

The faculty questionnaire increased data consistency and provided a common data format. Questions asked on the faculty questionnaire addressed characteristics that a student teacher would be looking for in their forthcoming school placement, so the information gathered would no longer be anecdotal. In the second year of the project, we asked the faculty members to use these questionnaires to guide their conversations with the future student teachers for data-gathering purposes.

Questionnaire Validation Process

To achieve face validity, the questionnaires were designed and refined using multiple stakeholder groups (as recommended by Cowles & Nelson, 2015, Jason & Glenwick, 2016; Punch, 2003). First, the questionnaires were drafted and reviewed by the PAR team. Following guidelines for questionnaire construction (Groves et al, 2009), the documents were reviewed to ensure there were no leading, confusing, duplicate or superfluous questions (Cowles & Nelson, 2015, Jason & Glenwick, 2016; Punch, 2003).

Once the questionnaires were deemed comprehensive by the PAR team, they were reviewed by the Alumni Council and further refined. The third step was to pilot the questionnaires with student teachers who were already placed into student teaching settings, as well as with the education faculty members and mentor teachers. All of the education faculty members completed the questionnaire. Approximately 60% of the student teachers completed the questionnaire, and five mentors completed the questionnaire (representing 12% of the mentor population). Each stakeholder group provided feedback as part of the questionnaire, which prompted further refinement of the questionnaire language by the PAR team. The same process was followed for the mentors, and the education program faculty members who would use the questionnaires.

The Alumni Council focus group suggested adding a question about distance to be traveled. They explained that given the option for an ideal match, their tolerance for additional travel time would be greater. As a result, the questionnaire was modified to ask student teachers if they would be willing to travel up to an additional 15 minutes (above the existing 30 minute range) for an optimal match.

The majority of the fine tuning had to do with response formats. For example, rather than use short answer formats for questions like, “What subject area do you teach?,” a dropdown menu was provided. This approach allowed for better alignment between the mentor teachers’ and student teachers’ answers. For example, mentor teachers and student teachers may mean the same thing when responding with Biology, Environmental Science, or Life Science. Only one choice, Biology, was provided in the dropdown menu. This solution also improved the consistency of the data.

Following this extensive process, the PAR team was confident that the questionnaires met requirements for face validity (Cowles & Nelson, 2015, Jason & Glenwick, 2016; Punch, 2003). We anticipate that further refinement will take place with additional iterations of the PAR process.

Solution Development

Once the project team settled on an initial set of business rules and objectives that described a successful placement, these rules and objectives needed to be translated into a form that could be implemented in software that would find a matching solution given the problem objectives and constraints. Optimization technology was chosen for the solution, as these methods provide simultaneous solutions to constrained problems. A problem formulation was developed that expressed the business rules and objectives in mathematical terms. This approach is a best practice in developing optimization models (Brown & Dell, 2007), as it documents the logic in a manner that is independent of any particular programming language. The problem formulation is the basis upon which the solution model is coded in software.

In the problem formulation, business rules are represented as constraints that a placement solution must satisfy. As an example, no more than two student teachers can be assigned to a school. The business rules for our placement process are as follows:

- A student teacher can only be assigned to one school.
- A student teacher must be placed in their certification area.
- A maximum number of students allowed in a school cannot be exceeded.
- There must be an approved mentor in the certification area available in the school.
- The student teacher has a grant that requires placement in a high needs school.

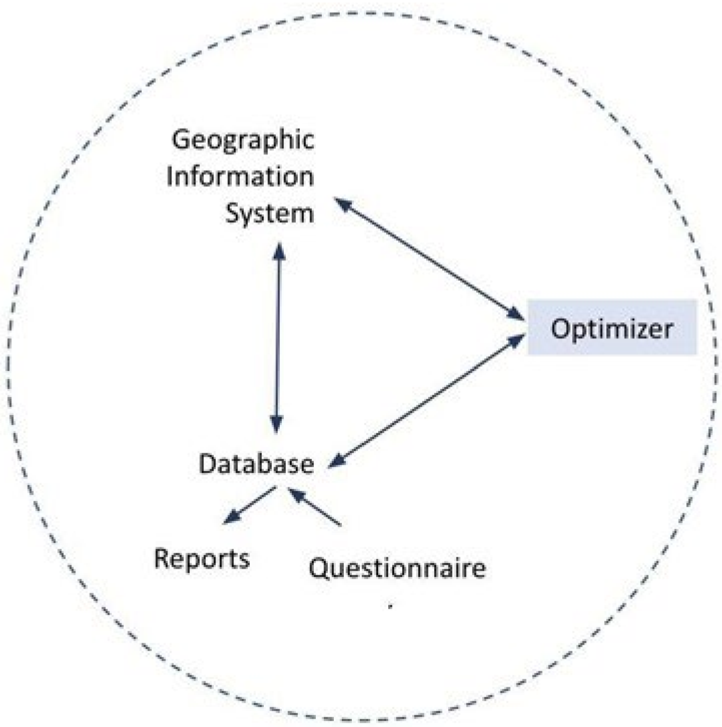
A placement solution for a given set of student teachers and schools results from evaluating an objective function that expresses the desired quality of a good solution. For our application, we sought student teacher placements that minimized the distance the student teacher had to travel from their home to their student teaching placement.

A small-scale software prototype was created in an MS Excel spreadsheet using the Solver add-in. The Solver contains an optimization algorithm that finds the student placements that minimize the objective function while satisfying the constraints. By the end of Year 2, our systems analyst built a proof-of-concept optimization tool with synthetic data to demonstrate to the project team.

Integrated IT System

The optimizer is embedded in an IT infrastructure that includes necessary supporting components, such as a database and a user interface. The application was named the Placement Optimizer for Student Teaching (POST). Figure 5 illustrates the initial conceptual design for an integrated system of three components.

Figure 5
Placement Solver Initial System Design



We integrated a geographic information system (GIS), ArcGIS (2015), into the process to help identify schools located at a distance no more than 50 miles from our campus and 25 miles from our student teachers' homes. The education department uses a cloud-based office productivity suite of software to facilitate working off campus, document sharing, and data storage. The student questionnaire was developed using a survey administration tool and the responses were exported to a spreadsheet. Having centralized data storage allows both standardized and customized reports to be generated for a variety of purposes in the Department.

Third Knowledge Priority: Testing the Software Prototype

To evaluate POST's performance, a test was conducted in which five student teachers were placed with 10 schools having mentors available. This test was based on a subset of historical data for student teachers already in placements. Student privacy was maintained by controlling file access to only the research team. Beginning with a prototype of this size facilitated verification of the results manually and demonstrated the solution method in a way that is easily assimilated by the teacher education personnel. Table 1 shows the results, where cells with values of 1 indicate the school to which that student was assigned. Middle schools are identified with the "MS" prefix and high schools with the "HS" prefix.

Table 1
Placement Solution from the Prototype

School	Student A	Student B	Student C	Student D	Student E
MS-1	0	0	1	0	0
HS-1	0	0	0	0	1
HS-2	0	0	0	1	0
HS-3	0	0	0	0	0
MS-2	0	0	0	0	0
HS-4	0	0	0	0	0
HS-5	1	0	0	0	0
HS-6	0	0	0	0	0
HS-7	0	0	0	0	0
MS-3	0	1	0	0	0

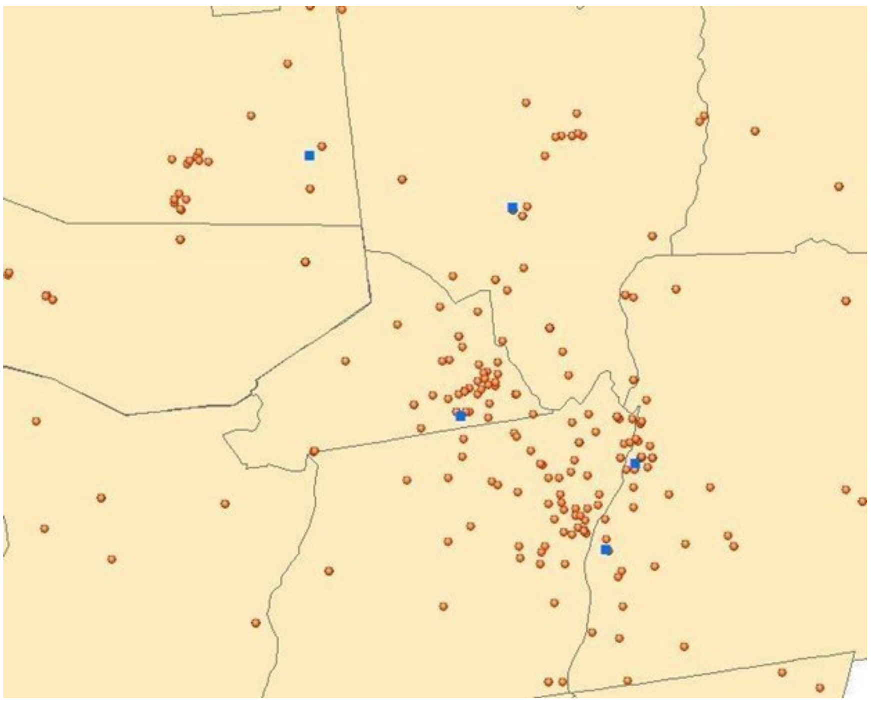
For example, Student C has been assigned to MS-1. In our setting, we do not assign more than two students to a school; this solution satisfied that constraint. The value of the objective function was found to be 48.3 miles, which is the sum of distances for the students to their assigned student teaching schools. This was verified by manual calculation to be the placement with the smallest total distance traveled by the five student teachers.

Figure 6 shows an example of a map where the school locations appear as dots and the student residences as squares.

Fourth Knowledge Priority: Evaluating the Solution and Software Prototype

The optimization solution compared favorably to the placements that we chose as experts; the placement personnel judged the geographic presentation of information to be effective. To date, the development of a centralized database and the small scale demonstrations of the GIS and optimizer helped the project team see the possibilities such a system would offer to improve student teacher placement. The initial deployment provided the team opportunities to evaluate the results and determine usability of the system. The amount of time needed to develop and test POST took approximately 1 year, which represents a full placement cycle. Based on the test results, additional modifications and improvements were planned. This initial success encouraged the team to continue its work to develop POST into a fully functioning application.

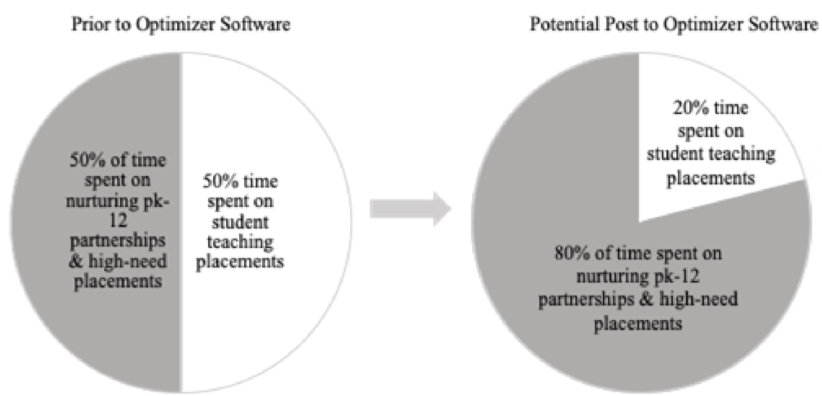
Figure 6
GIS Example Map



After the testing, the team was able to see concretely the additional benefit to the POST software: It could place most of the student teachers into optimal student teaching settings, leaving the majority of personnel time for high-need or unusual placement decisions and partnership building. Prior to the use of POST, the CSM spent half of her time on placements and the balance of her time on the development of P-12 partnerships and support of high-need student teachers. With a software-driven placement system in use, 20% of her time could be spent on placements and 80% of her time on nurturing P-12 partnerships and supporting high-need student teachers (see Figure 7).

From the first year spent working together to solve the student teacher placement dilemma, the team found that many valuable lessons have been learned. Each team member described feeling that they had minimal available time and resources to donate to the project, even though they ranked the importance of the effort highly. We found that creating small tasks and goals were crucial to the process and that small-scale demonstrations were manageable and helped to advance our system development.

Figure 7
Clinical Site Manager Time Allocation



We also learned how important it is for the systems analyst to experience, in real time, the lifecycle of the student teacher placement process to understand its complexity. A key observation from the systems analyst was the sequential nature of student placements that can lead to suboptimal placement for the entire cohort. In other words, when student teachers were placed sequentially, more optimal placement opportunities were eliminated due to commitments already made to schools and mentors.

For example, a student teacher who was placed with what the team thought was an excellent mentor at the beginning of the process may have been more successful with another mentor who emerged later in the placement process. Finally, we learned that it was equally important for the education practitioners and CSM to assimilate the technological advances in small portions to understand how the eventual, overall system would function.

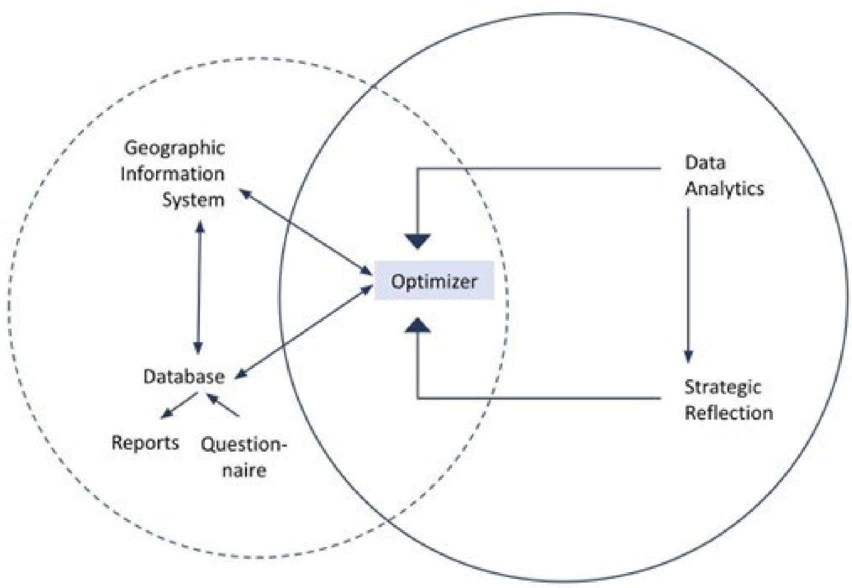
The database and GIS components of the system were familiar to the education personnel; however, the concept of mathematical optimization was not. The optimization offered the opportunity to place student teachers simultaneously, a process not previously possible due to the sequential nature of data acquisition. While it was not necessary for the faculty and personnel of the education department to understand, in detail, how the optimization software worked, it was important that everyone understood the concept of optimization of all placements so that the reliability of the optimizer's results could be properly interpreted.

The systems analyst developed and demonstrated a prototype to show the team. The results showed how the system would work and motivated the team to continue toward full development and implementation. The education professionals also began to see the benefits and importance of the consistency of data that we collect and store. We also learned quickly that educating the rest of the faculty about our process development was integral in getting their cooperation and understanding of the new tasks that they were being asked to do.

Implications for Teacher Education

As we move toward the second year (and cycle) of this research, and with the data collection and storage tool fully implemented in the placement process, we plan to engage education faculty outside of the immediate project team to solicit their feedback on the questionnaire for future improvements. Continuation of this inclusive process will add data analytics and reflective decision making to the system (see Figure 8). Subsequent to the demonstration of ArcGIS, another GIS tool was employed that more easily integrates with the spreadsheets. The small-scale prototype reached the computational limits of the MS Excel Solver; therefore, the problem formulation must next be implemented in specialized optimization software suitable to a larger scale. The project team intends to continue with an iterative development cycle of building and testing that will bring the project to scale.

Figure 8
Placement Decision Making Loop



Using Technology for Student Teacher Placement

Using this technology in service to teacher education has many positive implications. If the project team is successful and the placement dilemma software is brought to scale, it will be shared broadly with the field. This success will produce two immediate benefits. First, student teachers will potentially experience an optimal placement, aligned with their career goals and immediate needs. Second, clinical site managers and program directors will also likely have more time to support teacher candidates and nurture P-12 school relationships, as well as complete other important responsibilities associated with their roles.

PAR and the Student Teachers

This action research project directly impacts a fundamental aspect of our aspiring teachers' coursework, but does so for the most part, in the background. Students who piloted the questionnaire are aware of the research and reasons for it. If the project is successful, future students will complete the questionnaire, which will provide the data the optimizer software will use to suggest optimal student teaching placement options. This does not mean, however, that the placement dilemma PAR plays no role in our student teachers' education. In fact, it will become a central exemplar in the students' capstone course.

The Master of Arts in Teaching Project is a required course for all of the graduate students in teacher education at Clarkson. During this course, students learn the action research process and design, execute, and present their own action research project. The goal of the course is to inspire a problem-solving habit of mind in our graduates as they begin their teaching careers. The placement dilemma PAR project will be an exemplar introduced to the students during the first class. Since the student teaching placement process is familiar to them, the project will provide an understandable model of action research they can use to build their own projects. The exemplar will also have the added benefit of showcasing current faculty research and highlight the value Clarkson places on the multiple project stakeholders: the CSM, the department coordinator, the students, faculty, mentors, and alumni.

PAR for Teacher Education Programs

In the short term, the placement dilemma project serves as an example of how PAR may be used to great effect in the cross-disciplinary field of teacher education. Every year, a milieu of stakeholders work hand in hand to escort new cohorts of novice colleagues into the teaching profession. Each of these stakeholders has a perspective and a voice that should be considered when making programmatic decisions. PAR provides a robust framework for teams to use with confidence.

In the long term, this research and its dissemination should provide a platform to heighten awareness of the importance of student teaching placements. Indeed, the research summarized in this work emphasizes how pivotal the student teaching experience is to novice teachers' training. Whether placements are being made with the aid of software or not, the systematic deconstruction of the process inherent in the placement dilemma work clarifies the priorities and needs of student teachers when program directors are making placement decisions.

The Placement Dilemma and Its Future as a Research Topic

The research team is encouraged by the completion of the first cycle of the placement dilemma PAR project and the prototype results. With no available research on this topic specific to teacher education and student teaching placements, the team plans to continue to build and test the model while leveraging information from other fields, such as medicine, and other settings and school systems (e.g., Hong Kong and Singapore).

During the COVID-19 pandemic student teaching assignments were driven by very different rules and objectives such as preexisting health conditions, students' technology skills and comfort level with online learning, and home access to the Internet. The COVID-19 pandemic forced the research team to pause our work to allocate more time to supporting our students. The team is hoping this was an anomaly in the history of teacher education and that in future years, the rules and objectives that directed the optimization software (student teacher home address, school preference, and so on), will once again be relevant.

This systemizated work has improved our placement process efficiency and allowed us to focus on the dynamic changes experienced during the COVID-19 pandemic. The process has revealed the need to attend to issues of equity when working with individual student teachers and their placement needs. For example, a teacher candidate with young children will benefit from a placement geographically closer to their home. A Black teacher candidate may not benefit from a placement where they are the only teacher of color in the building. These individual needs should be considered in future iterations of this software project.

An additional implication of this work that was caused by the pandemic is the shift in the labor force. Efficiencies need to be created to compensate for the traditionally labor-intensive methods that were used to place student teachers. Traditional methods that relied heavily on paper and in-person signatures are no longer feasible postpandemic as labor shortages require more streamlined solutions. The fully electronic system described here prepared us well to continue placement activities where information is accessible electronically from various locations. This software project is one potential piece of the solution for these and other issues surrounding the placement dilemma.

Finally, over the course of this work, the team encountered other researchers and computer scientists who are also developing solutions. We have joined with one such group to collaborate on improved products and solutions. The development of the placement system has benefited our teacher education program in ways that were not anticipated. This process prepared the program to adapt to the emerging uncertainties in the education landscape and is moving us toward achieving our goals of increased retention and improved student teacher experiences.

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Appendix A
Resident Placement Questionnaire

*Required

1. Personal email address (gmail, yahoo, etc.)*

2. Clarkson email address (if applicable)

3. Last name*

4. First name*

Residency Year Address (Please leave this section blank if you do not yet know where you will be living during your residency year.)

5. Street address (during residency year)

6. Address line 2 (during residency year)

7. City (during residency year, must be in NYS)

8. Zip Code (during residency year)

9. Cell phone number (format: 555-555-5555)

Field Work

10. Field Work District 1*

11. Field Work Host Teacher 1*

12. Field Work District 2*

13. Field Work Host Teacher 2*

14. Field Work District 3*

15. Field Work Host Teacher 3*

16. Field Work District 4*

17. Field Work Host Teacher 4*

Certification Information

18. Certification Area seeking* (Check all that apply)
    ____English 7-12
    ____Social Studies 7-12
    ____Mathematics 7-12
    ____Biology 7-12
    ____Chemistry 7-12
    ____Earth Science 7-12
    ____Physics 7-12
    ____Chinese 7-12
    ____French 7-12
    ____German 7-12
    ____Greek 7-12
    ____Latin 7-12
    ____Russian 7-12
    ____Spanish 7-12
    ____Technology Pk-12
    ____TESOL –PK-12

19. Have you completed student teaching as an undergraduate?

    Yes No

Certification Held

20. Do you already hold a NYS teaching certification?*

    Yes No Skip to question 22

21. What certification do you currently hold?

    Initial Certified in another state Not certified Other: ____________

Current School Employment

22. Are you currently in a position in a school that will continue into next year?

    Yes No

Current School Employment (If you are currently employed by a school, please answer the following questions.)

23. In what capacity are you working in your school?

____TA

____Substitute

____Certified Teacher

____Non-certified Teacher

____Staff

____Fellow

____Other: ____________________________

24. Would you like to stay in this position during your residency year?

Yes No Maybe

12. What is the resident's preferred method of transportation? (Check all that apply)

Walk	Bike	Public	Car

13. Resident's community type preference?*

Rural	Suburban	Urban	No preference

14. Advisor's recommended community type?*

Rural	Suburban	Urban	No preference

15. Resident's School Level preference?*

TESOL PK-12	Middle School	High School	No preference

16. Advisor's recommended School Level?*

TESOL PK-12	Middle School	High School	No preference

17. Resident's preference of School's SES?*

Low need	Medium need	High need	No preference

18. Advisor's recommended School's SES?*

Low need	Medium need	High need	No preference

19. Resident's preference of School type*

Traditional	Alternative	Independent	Project Based Learning	No preference

20. Advisor's recommended School type*

Traditional	Alternative	Independent	Project Based Learning	No preference

21. Resident Requested by (Name of Host Teacher)

22. Interviewer Notes