INCLUDE: A Suite of Computational Tools to Increase Academic Inclusion of K-6 Students with Autism in Self-Contained Classrooms Across Urban and Rural School Districts in Utah

Michael Ryan Hunsaker
Special Education Department
University of Utah

PROJECT SUMMARY

INCLUDE: A Suite of Computational Tools to Increase Academic Inclusion of K-6 Students with Autism in Self-Contained Classrooms Across Urban and Rural School Districts in Utah.

Topic and Goal Autism Spectrum Disorders (ASD); Development and Innovation
Purpose: This project was designed to develop a cloud-based suite of computational tools to guide teachers in making decisions regarding student academic inclusion based on proven computational algorithms. These tools will be called an ***INC****lusion* ***L****re* ***U****nbiased* ***DE****cision (INCLUDE)* and will directly address challenges faced by administrators, special educators, and general educators that curtail students with autism and other disabilities from accessing an inclusive education.
Activities: The research team will use a feedback-informed, iterative

$$\textit{Development} \longmapsto \textit{Pilot} \longmapsto \textit{Scale Up} \longmapsto \textit{Evaluate} \longmapsto \textit{Implement} \longmapsto \textit{Expansion}$$

process to develop a cloud-based suite of computational tools, *INCLUDE* that is targeted for special education teachers and administrators to improve educational outcomes for students with autism receiving special education services. In the first two years, the research team will focus on the necessary training, implementation and evaluation of *INCLUDE*. In the final two years, *INCLUDE* will be field tested to elucidate efficacy across school districts, race/ethnic groups, and socioeconomic status.
Products: The products of this project will include a data-driven, empirically validated cloud-based suite of computational tools that is readily scalable to fit the needs of individual school districts - the first suite of computational tools designed to provide critical data needed by IEP teams making educational decisions regarding student placement. Further products include findings from the evaluation of these tools for usability, feasibility, and promise of efficacy; professional development curricula and materials for teachers and district/school-level administrators.

STRUCTURED ABSTRACT

Setting: This project will take place in two urban, one suburban, and two rural school districts in Utah with minority populations representing 20-30% of the student body and 25-50% qualifying for reduced fee or free school lunch, a measure of socioeconomic status.
Sample: This research will target ***K-6th grade students (5-12 y.o.) with a primary special education classification of autism*** educated in self-contained classrooms. Across ≈100 self-contained classrooms,we anticipate N=1300-1400 students across disability categories (≈35% female) and n=600-750 students with autism in this study (≈53% of the anticipated sample, 15-25% female).
Intervention: *INCLUDE* development involve collecting data pertaining to adaptive function, socioemotional well being (anxiety, behavioral symptoms index), academic achievement, and full scale IQ scores from psychoeducational evaluations from *all students with disabilities* in self-contained classrooms and evaluating their readiness for academic inclusion. Information regarding socioeconomic status, English language needs, chronic absenteeism, and race/ethnicity will be collected. *INCLUDE* will then be extended to two rural school districts. Candidate students will receive academic inclusion. In a pilot study, we verified *INCLUDE* correctly identified students with autism and other disabilities from 46 self-contained classrooms (*sensitivity 98.4%, specificity 94.3%, positive predictive value 87.8%*).
Research Design and Methods: In the first two years of this mixed-methods study, we will iteratively scale and refine *INCLUDE* with stakeholder feedback for implementation in two urban and one suburban school district and evaluate efficacy. ***Year one*** will involve data collection and refinement of *INCLUDE* for larger datasets (≈1300-1700 students receiving special education services from ≈100 self-contained classrooms). ***Year two*** will continue this process as well as development of professional development materials to maximize teacher participation and buy-in. In ***Year three***, *INCLUDE* will be implemented throughout the urban and suburban school districts in Utah. Year three will be a full-scale Implementation of *INCLUDE* throughout ≈100 self-contained classrooms. In ***Year four***, *INCLUDE* will be expanded to two rural school districts. At the end of Year four, the research team along with all relevant stakeholders will initiate a feasibility analysis for a potential state-wide implementation of *INCLUDE* to all 41 school districts.
Key Measures: For students receiving academic inclusion, data will be collected during inclusion regarding student academic independence, 2)student behavioral independence, 3)levels of academic and behavioral accommodations necessary for success, and 4) classroom behavior. Academic data will include 1) Beginning, middle, and end of year ELA and math formative benchmarks and 2) end of year state *RISE* summative testing. Observational checklists will be used to collect 1) Usability, 2) feasibility, and 3) fidelity of implementation will be collected throughout the study. A field tested and validated researcher-developed survey will measure 1) Parent, 2) administrator, 3) teacher, and 4) student satisfaction with *INCLUDE*. Surveys will be anonymous and web-based using REDCap Surveys to maximize participation and encourage disclosure of concerns. All data will be used to iteratively improve *INCLUDE*.
Data Analytic Strategy: Implementations of *INCLUDE* will be analyzed by k-fold cross validation. As increasing data improve predictive value, Bayesian methods will be employed to confirm and validate results. Comparisons of computational and manual candidate selection by an unbiased expert using de-identified data will be used to elucidate accuracy. Student transition to a

less restrictive setting will be used as a measure of predictive accuracy of *INCLUDE*.

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General Background

While federal policy mandates students served in special education settings be given access to general education settings (IDEA, 2004; National Council on Disability, 2018b; Office of Special Education Projects, 2015), current practices within the US educational system perpetuates seclusion and self-containment of students with autism and other disabilities over education in inclusive settings. These practices have led to discussions regarding the impact of IDEA and the (un)intentional segregation of disabled and non-disabled students within the public education system (Ferri & Connor, 2005; McCarthy, Wiener, & Soodak, 2012; National Council on Disability, 2018b; Nolan, 2004). These challenges are compounded by a rapid increase in autism diagnoses in Hispanic/Latino and African American populations (Rubenstein et al., 2018). These students with autism present unique challenges for teachers, since owing to cultural differences white students with autism provide an inexact starting point for developing interventions, particularly when language barriers exist (Becerra et al., 2014, 1; Zuckerman et al., 2014).

Novel assumptions and new methodologies must be created to overcome the often challenging misconceptions teachers, parents, and administrators report regarding access to inclusive education for students with autism (*cf.*, Table C.1 in Appendix C; Hodkinson, 2006; TASH, 2014). Unbiased methods are needed to promote equality and provide fair access for students with autism to an inclusive education.

Truly successful inclusion, wherein students with autism and other disabilities are fully included in the general education classroom and have a fair opportunity to demonstrate grade and age-appropriate academic and social growth is required to generate the novel assumption that all students benefit from students with autism receiving academic inclusion. ***The following challenges provide a snapshot of the current issues facing administrators and special educators when they set out to provide an inclusive education for students with autism***.

Challenge 1 - Students with Autism are Disproportionately Placed in Restrictive Settings

Every year in the United States, ≈40,000 students with autism diagnoses are qualified to receive special education services. As of 2015-2016, students with autism comprised 9.2% of the total US special education population, totaling over 576,000 students (National Center for Education Statistics, 2017b). Based on survey data collected from 2002-2010, Rubenstein et al. (2018) determined that autism classifications have increased by 3.6% as Intellectual Disability (ID) classifications had been concomitantly reduced by 4.6%. Furthermore, the greatest increase in autism classification is among Hispanic/Latino populations, with an increase of 15.4% and a decrease in ID of 14% over the same period. All other special education categories have not shown similar increasing fluctuations and trends, but have rather remained relatively consistent during the last decade.

In the US, students with autism are more likely to receive a special education designation and placed in less inclusive classroom settings than youth with other, often more educationally disruptive, psychiatric diagnoses (Spaulding, Lerner, & Gadow, 2017). In Utah only 33% of students with autism receive >80% of their education in a general education setting, 24% receive 40-79% of their education in a general education setting (the other percentage in a pull-out Resource setting), and 35% receive <40% of their education in an inclusive setting (*i.e.*, they are in a self-contained classroom). Nationwide the trend is similar, with greater than 33% of students

with autism receiving <40% of their education in an inclusive setting (National Center for Education Statistics, 2017a; National Council on Disability, 2018b).

To compound this issue, once students with autism are placed in these more restrictive placements/self-contained classrooms, they remain in those settings long after they no longer require the individualized special education services to achieve academic progress (Hyun, Bal, & Lord, 2017; Morningstar, Kurth, & Johnson, 2017; Olsen, Croydon, Olson, Jacobsen, & Pellicano, 2018; Rubenstein et al., 2018; Spaulding et al., 2017; Waddington & Reed, 2016). The negative impact of this lack of mobility toward less restrictive placements is compounded for students that were initially placed in special education settings for behavioral, rather than academic, interventions at a very young age, but do not require services for academics. For example, in Utah 36% of 3-5 year old children with classifications of autism attend a separate special education class from peers, are placed in a separate school, or are educated in a residential facility. Nationwide this value is 49% (National Center for Education Statistics, 2017a, 2017b). These students with autism are not given the opportunity to access grade level material taught by highly qualified grade level teachers with their peers.

Challenge 2 - The Education System is Not Prepared to Anticipate the Needs of Students with Autism that also require ELL Services or come From Low Socioeconomic Strata

Students with autism of different race/ethnicities have unique presentations of their disability that require varying intervention approaches (Becerra et al., 2014, 1; Zuckerman et al., 2014). Largely because of these differences across cultures, children with autism in Hispanic/Latino and African American populations have been historically less likely to receive a diagnosis of autism (National Council on Disability, 2018b), and are underrepresented in the educational system compared to white students (Travers & Krezmien, 2018). Values for multiracial, Pacific Islander, and Asian students do not yet have sufficient data to draw conclusions regarding trends in diagnosis, but it can safely be assumed similar issues exist.

These data and increased attention being given to classification and provision of special education services to underrepresented minorities (National Council on Disability, 2018a; Nowell, Brewton, Allain, & Mire, 2015), suggest it is likely there will be an increase in the number of racial minority students and students from low socioeconomic strata receiving special education services under an autism classification in the coming years. The special education needs of these students will be complicated by an increased need for concurrent services for English Language Learners (ELL-formerly called ESL) as a compliment to special education services.

Challenge 3 - Educational Culture and Implicit Assumptions Inhibit Teachers from Giving Students with Autism Access to Inclusive Educational Settings

The need for inclusive education is evident, but both special education and general education teachers often find it difficult to transition students with autism into more inclusive settings (Anglim, Prendeville, & Kinsella, 2018; Kaufman, Felder, Ahrbeck, Badar, & Schneider, 2018; Lubke, Pinquart, & Schwinger, 2018; National Council on Disability, 2018b; Sanz-Cervera, Fernandez-Andres, Pastor-Cerezuela, & Tarraga-Minguez, 2017). The dominant implicit assumptions present in the US educational system regarding educating students with autism are 1) students with autism cannot be educated in the general education setting until the impact of the disability is mitigated, 2) it is a legal (or district) requirement that students with

autism require behavioral interventions designed by an ABA professional, and 3) an assumption that all special education services should be delivered in a separate environment - so as to minimize impact on other students in the classroom (Cassady, 2011; Kirby, 2017; Rodriguez, Saldana, & Moreno, 2012). The result of these practices and implicit assumptions is that students with autism and other disabilities receiving special education miss out on access to instructional materials used in the general education classroom as well as core instruction from grade level teachers (Brownell, Sindelar, Kiely, & Danielson, 2010; Gersten & Dimino, 2006; Hyun et al., 2017; Morningstar et al., 2017; Spaulding et al., 2017; Waddington & Reed, 2016).

Table 1
***Measures Collected for INCLUDE**: Critical Values in Psycho-Educational Evaluation to be Considered for Special Education Services, data from Appendix C*

Measure	Cutoff Values	Value Defn	Range
Adaptive	SS <60	SS 0-59 = 0 SS >60 = 1	[0, 1]
FSIQ	SS <70	SS 0-70 = 0 SS 70-100 = 1 SS >100 = 2	[0, 1, 2]
SocioEmotional	T>70	T 0-70 = 0 T>70 = 1	[0, 1]
WJ-IIINU	SS <70 & RPI 0-18	SS 0-70 & RPI 0-18 = 0 SS 70-100 & RPI 18-34 = 1 SS>100 = 2	[0, 1, 2, 3]
Curriculum Based Measures	<25%ile	<35%ile = 0 >35%ile = 1	[0, 1]

Development of a Solution to Address These Challenges

We developed computational tools using the R statistical computing language (R Development Core Team, 2017) to classify students receiving special education services in self-contained classrooms into groups. During a pilot study we were able to identify students with autism and other disabilities that were statistically likely to succeed in the general education setting and placed them in a separate grouping than those students that had not yet developed the necessary skill set (*cf.*, Figure 1 for algorithm efficacy and visualization of data and Table 1 for statistical cutoff values for special education services based on psychoeducational evaluations; Hunsaker, 2018). As a major component of this project, the collection of computational and

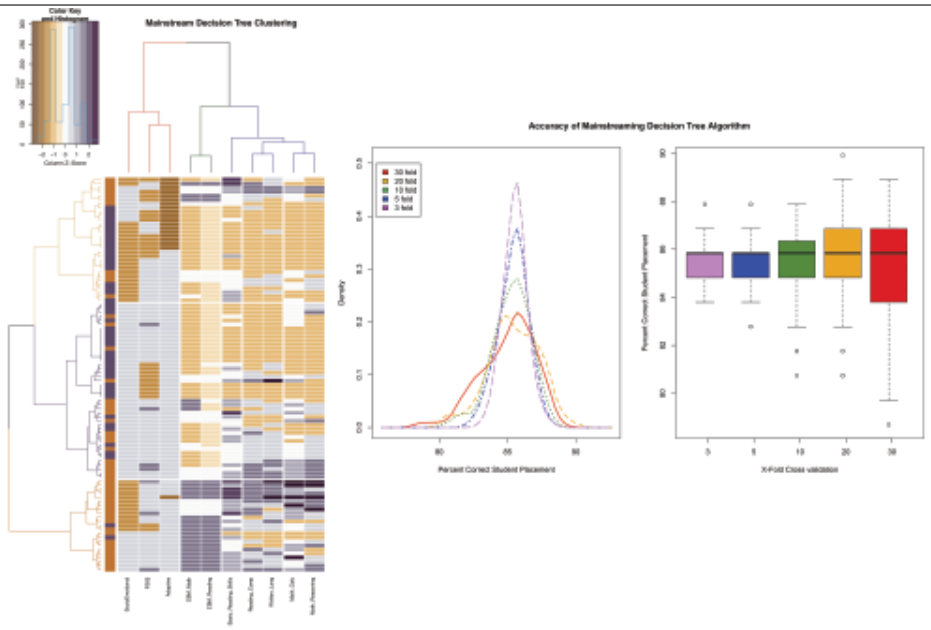

Figure 1. ***Visualization of the Sorting Output of INCLUDE****. The bottom, dark orange cluster corresponds to students that successfully entered a general education placement. The top, light orange cluster corresponds to students that were assigned to >75% mainstreaming. The middle purple cluster are students that were allocated to a group receiving social inclusion.* ***Predictive Validity*** *The plot on the left shows the probability density of each support vector machine prediction trained by K-fold cross validation. Plot on the right contains each of the 1000 training sessions for the k-fold cross validation and are presented as Tukey boxplots. From Hunsaker (2018)*

associated methods will be combined into a suite of computational tools called an ***INC****lusion* ***L****re* ***U****nbiased* ***DE****cision (INCLUDE).*

These technological tools were designed to specifically provide teachers and administrators a tool to overcome any implicit and explicit assumptions they they have that prevent students with autism from accessing an inclusive education (*e.g.*,teachers often express anxiety regarding student success because of the student's earlier challenges that they have since overcome; *cf.* Table C.1 in Appendix C). The methods underlying *INCLUDE* were designed to allow special education teachers to take a step back and identify candidate students and elucidate successful placement in general education. This is achieved by providing the teacher a tool that can make recommendations in an explicitly data-driven manner - thus mitigating any influence of implicit assumptions or teacher/administrator anxieties (Hunsaker, 2018).

During the pilot implementation of these cloud based suite of computational tools district-wide in an urban school district, Hunsaker (2018) identified 114 student candidates across all disability categories for inclusion from self-contained classrooms (out of 490 total students whose data were included). Of these candidates, 44 were classified as autism (39% - 9 more had diagnoses of autism but were served for special education under different classifications), 29 as specific learning disability (SLD; 25%), 15 as emotional disturbance (ED; 13%; three had diagnoses of autism), 10 as speech and language impairment (SLI; 9%; four had diagnoses of

autism), seven as developmental delay (DD; 6%; 2 received diagnoses of autism), six as other health impairment (OHI; 5%; one had a diagnosis of autism), one each as intellectual disability (ID), traumatic brain injury (TBI), and orthopedic impairment (OI) (each 1%).

The primary implication from this pilot study is that *students with autism that are identified as candidates for academic inclusion have a high probability of academic and social success in the general education setting*. For example, of 44 candidate students with autism, 37 (84%) met criteria set by the LEA to transition to a less restrictive environment, and 33 (75%) transitioned into general education settings.

Objectives

In order to facilitate the transition of students with autism from self-contained special education classrooms into less restrictive environments, is critical that data-driven, evidence-based transenvironmental programming methods be developed and refined. Hunsaker (2018) demonstrated the utility of these tools to sort and classify students in self-contained classrooms into those that are statistically more likely to succeed in a general education setting from those that had yet to develop the necessary skills.

In moving forward, the algorithms and methods developed by Hunsaker (2018) will be developed into a suite of computational tools called *INCLUDE*. The planned feedback informed, iterative development of *INCLUDE* has been explicitly designed to react to changes in data and new student populations. The simplified process for development is (see Figure 2):

Development $\longmapsto$ ***Pilot*** $\longmapsto$ ***Scale Up*** $\longmapsto$ ***Evaluate*** $\longmapsto$ ***Implement*** $\longmapsto$ ***Expansion***

We verified over the 1st year of methods Development and 1st year of the Pilot phase that the individual computational methods that make up *INCLUDE* were able to effectively scale up from 2 to 46 self-contained classrooms. An effect of scaling up by adding data during the Pilot phase, the algorithm increased in sensitivity from 84.9% to 98.4%, specificity from 86.8% to 94.3%, and positive predictive value from 85.6% to 87.8%.

Building on our expertise in developing both computational tools and methods of increasing inclusion of students in self-contained classrooms, over a 4 year period we will use an iterative refinement process to address the following objectives:

Year 1: Scale Up$\longmapsto$Evaluate: Race/Ethnic Diversity

Challenge. How can *INCLUDE* be refined to increase sensitivity, specificity, and positive predictive value to identify the increasing number of students with autism receiving special education services from underrepresented minorities and populations from low socioeconomic status within special education?

Objective 1. *We will scale INCLUDE by using data originating across two urban and one suburban school districts comprised of 20-30% racial/ethnic minority students and that serve students from all socioeconomic strata.*

Approach. To meet Objective 1, we will increase predictive validity by developing a REDCap database and importing adaptive, socioemotional, academic achievement, and full scale IQ values from psychoeducational evaluations from students with autism in self-contained settings from White (not Hispanic), Hispanic/Latino, Black or African American, Asian, American Indian or Alaska Native, Native Hawaiian or Other Pacific Islander, and declared

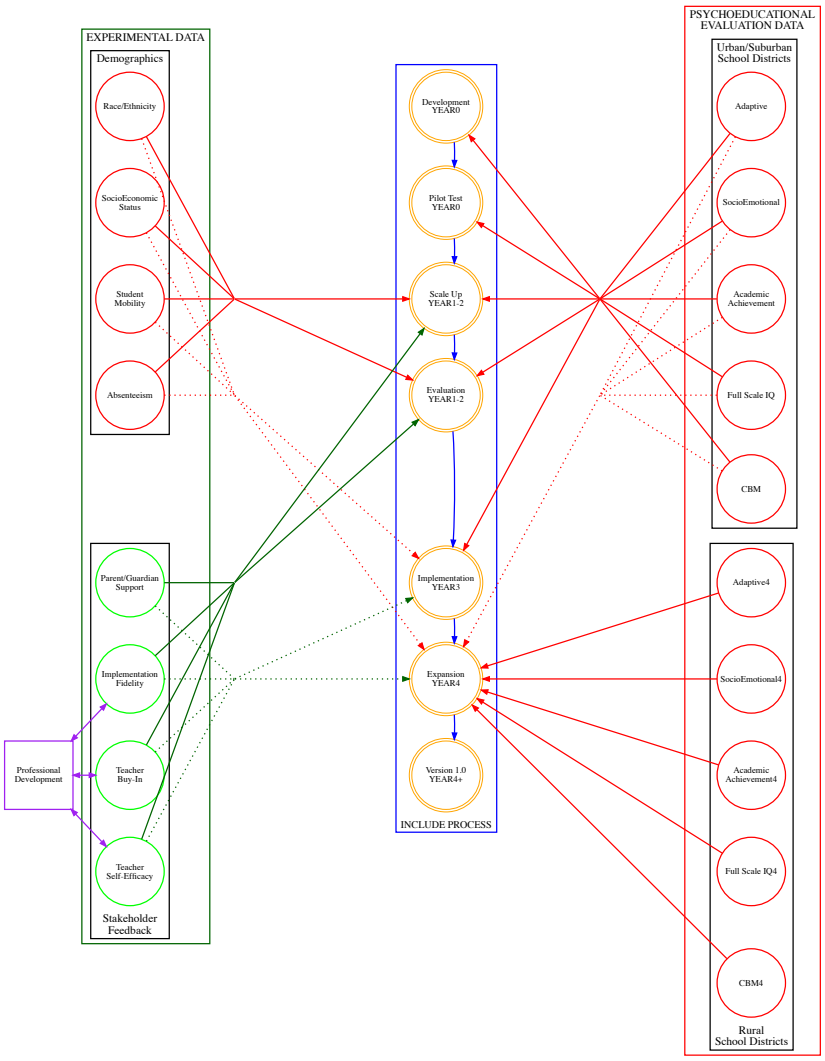

Figure 2. Diagram of *INCLUDE* design process, with each data type being applied each year demonstrated. Green lines represent qualitative data collected from stakeholders and red lines represent quantitative data collected regarding student demographics. Solid lines represent data input during each phase and dotted lines represent the data will influence implementation of *INCLUDE*

multiracial backgrounds. We also will collect data regarding whether these students with autism receive free or reduced fee lunch services as a proxy measure for socioeconomic status.

Impact. *INCLUDE* will facilitate implicit bias-free identification of candidate students with autism for inclusion and transition from self-contained to general education settings bridging socioeconomic and race/ethnic backgrounds. When data from racial/ethnic minority students are added into the models underlying *INCLUDE*, the resulting classifications will better account for

cultural differences and better predict student inclusion success.

Year 2: Scale Up⟼Evaluate: Professional Development

Challenge. How can teacher buy-in and implementation fidelity be maximized when using *INCLUDE* across special education and general educational settings?

Objective 2. *We will engage district administrators, special education teachers, and general education teachers on the specifics of INCLUDE and seek stakeholder input to quantify and improve any implementation gaps across schools and districts.*

Approach. To meet Objective 2, a professional development program and associated materials will be prepared, implemented, and revised based on feedback. Implementation fidelity and feasibility of *INCLUDE* will be assessed. Data will be collected monthly on fidelity of implementation, teacher's self-efficacy, and teacher's perceived barriers. Further surveys regarding the inclusion process will be solicited from all stakeholders working or involved with students with autism. An explicit transdisciplinary approach is emphasized by *INCLUDE*, which will foster cooperation and increase implementation fidelity. All participants in the IEP process will be given a specific report and interpretation of the outputs of *INCLUDE*.

Impact. Professional development will increase the teacher and administrator buy-in for *INCLUDE* and increase fidelity of use. Additional confidence in the inclusion process will be fostered through open surveys with all stakeholders working with or involved with these students with autism. Classroom Ecological Surveys (*cf*., Appendix C) will be used in the selection process for general education settings for inclusion. The increase in cooperation and confidence from all stakeholders in the IEP and inclusion process will start to minimize the effect of any implicit assumptions regarding student capability that would otherwise interfere with full inclusion.

Year 3: Evaluate⟼Implement

Challenge. How can *INCLUDE* be used to identify candidate students across race/ethnicity and socioeconomic categories? Scaling up of any computation regarding student success needs to be able to account for geographical and urban-rural differences in socioeconomic status.

Objective 3. *We will begin a full-scale implementation of INCLUDE across multiple urban and suburban school districts that contain students from race/ethnic and socioeconomically diverse populations*

Approach. To meet Objective 3, we will increase predictive validity for minority and disadvantaged populations by initiating a full-scale implementation of *INCLUDE* in ≈100 self-contained classrooms that are made up of ≈25-30% race/ethnic minorities, individuals from different socioeconomic status, and gender. In this full implementation across 2 urban and 1 suburban school district, candidate students will enter a pre-designed inclusion process involving selection of general education classroom, data collection, and finally how to make the final transition out of special education self-contained placements in favor of more inclusive ones.

Impact. *INCLUDE* will facilitate implicit bias-free identification of candidate students with autism for inclusion and transition from self-contained to general education settings bridging socioeconomic and race/ethnic backgrounds. The extension of *INCLUDE* to ≈100 self-contained classrooms across 3 school districts will demonstrate the feasibility of expanding *INCLUDE*

statewide, as well as providing a first-of-a-kind detailed profile of students with autism from different race/ethnic minority populations.

Year 4: Implement⟼Expansion

Challenge. How does one overcome the challenges seen in rural school districts that have too few students with autism to provide a comparison group? What is the utility of tolls like *INCLUDE* for the elucidation of candidate students for academic inclusion in rural settings?

Objective 4. *We will refine INCLUDE after applying it to urban and suburban school districts and apply it in two rural school districts*

Approach. To meet Objective 4, we will use data collected from implementing *INCLUDE* with data from 2 urban and 1 suburban school district to correctly identify candidate students in self-contained settings in rural settings.

Impact. Providing *INCLUDE* with larger and less homogeneous comparison samples (*i.e.*, increasing race/ethnic diversity and spanning socioeconomic status) will improve the likelihood of identifying students with autism in self-contained classrooms in rural settings as inclusion candidates. The data from this expansion will justify further expansion to include more LEA and district entities. These results will also inform the utility of a cloud-based system such as *INCLUDE*.

Methods

Year 1: Scale Up⟼Evaluate: Student Diversity

To scale up, we will implement *INCLUDE* with increasingly large and race/ethnically diverse data sets (N=1300-1400 students across all disability classifications, n=600-750 students with autism). The results will determine if the computational methods underlying the machine learning algorithm can reliably be automated and centralized in an on-line, cloud based repository. The long term utility of such an on-line system such as this would be a quick screen for students with autism that are candidates for moving to inclusive settings. District administrators and IEP teams could use these data as a factor among many to guide placement decisions once the IEP goals are outlined. A cloud-based system will further facilitate data-based decision making by rural LEA that lack sufficient data from students with autism to develop or implement these computational algorithms to predict student success within their limited population. Giving these LEA access to a broad, diverse dataset may help the teams in designing instructional programs for individual students.

Data collected during this study will be either captured by or manually entered into a REDCap database, which uses a MySQL database via a secure web interface with integrated data checks used during data entry to ensure data quality (Harris et al., 2009). REDCap includes a complete suite of features to support HIPAA and FERPA compliance, including a full audit trail, user-based privileges, and integration with the institutional LDAP server. The MySQL database and the web portal will both be housed on secure servers operated by the University of Utah Biomedical Informatics Core (BMIC) of the Center Clinical and Translational Science (CCTS). The BMIC servers provide a stable, secure, well-maintained, and high-capacity data storage environment, and both REDCap and MySQL are widely-used, powerful, reliable, well-supported

systems. Access to the study's data in REDCap will be restricted to the members of the study team by user name and password.

This REDCap database would require access to special education data that crosses socioeconomic, gender, and race/ethnic divides to guarantee the system is maximally unbiased. Implementation will require a system capable of protecting identifiable information from any uploaded data to prevent FERPA or HIPAA violations. These security protocols are available as a feature of REDCap. For implementation of *INCLUDE*, REDCap is capable of exporting directly into formats compatible with SPSS, SAS, and R statistical computing environments.

To facilitate implementation of *INCLUDE* across schools and districts, all computational and statistical analyses will be performed on an AzureML server(SaaS model) capable of receiving data securely from REDCap and rapidly performing computations on datasets upwards of 30 GB in size at any given instance. To maintain HIPAA and FERPA compliance, all transactions will be restricted by user name and password and data being removed from REDCap for analysis will be de-identified within REDCap prior to being sent. Version control will be implemented wherein any changes on the server will be identified and logged so information from past sessions and implementations can be queried and used as comparisons.

Year 2: Scale Up$\longmapsto$Evaluate: Professional Development

During Year 2 of this project, the research team will focus on professional development and feasibility testing. Special education teachers, general education teachers, and administrators of schools that include self-contained classrooms will participate, along with relevant personnel from district offices. Through separate focus groups with educators and administrators, development of *INCLUDE* and associated fidelity measures will be informed by an iterative input process.

During this phase, a professional development program and materials will be prepared, implemented, and revised based on feedback, and implementation feasibility will be assessed. Data will be collected monthly on fidelity of implementation, teacher's self-efficacy, and teacher's perceived barriers. Teachers' self-efficacy will be assessed using the Teacher Sense of Efficacy Scale-Short Form-Adapted (reliability and validity α0.90-0.94; Tschannen-Moran and Hoy, 2001) and informal web-based surveys.

Parent, administrator, teacher, and students satisfaction with *INCLUDE* and the inclusion process will be measured using a researcher-developed web-based survey using REDCap Surveys. Usability, feasibility, and fidelity of implementation data will be collected using observational checklists throughout the study, supplemented by an online implementation checklist.

Year 3: Evaluate$\longmapsto$Implement

To train *INCLUDE* on a diverse data set, 2 urban and 1 suburban school district in Utah will be included in a full implementation of *INCLUDE*. These school districts are located in and around Salt Lake City, UT, and $\approx$20-30% of the student body represent minority populations. Similarly, $\approx$25-50% of the students in these schools receive reduced fee or free school lunch, a proxy measure of socioeconomic status. These school districts also have academic, behavioral, and life skills self-contained classroom settings.

Data for *INCLUDE*, including the addition of race/ethnicity and whether or not students receive reduced fee or free school lunch will be collected in REDCap. These specific factors will

not be used in any computations, but rather they will be linked to the resulting records and thus will be query-able.

Upon beginning to attend the general education classroom for full inclusion, the special education teacher begins data collection on student independence using a standardized data sheet (Appendix C). Data collection on independence, levels of accommodation necessary for student success, and classroom behavior will also be collected by district personnel. Behavioral data sheets used during this implementation are available for download at https://github.com/mrhunsaker/BehavioralFirstAid/. All student data will be included in the REDCap database an used as dependent variables for analyses of student success.

Student time is increased in the general education class until they independently participate ≈90-100% of the time in the general education classroom and/or Resource classroom *prior to* moving toward a re-evaluation/placement change. Any increases of student time in general education classroom or movement in the direction of transitioning toward change of placement are based on the following factors: 1) Student independence in the general education setting, 2) Classroom observations, 3) Work completion, and 4) Academic progress, primarily referring to how much accommodation the student needs (*i.e.*, whether or not the student completes coursework with the same assignments as peers receiving only part time special education/resource services). This final criteria is important because the majority of students transitioning out of self-contained classrooms will *continue to need part time special education/resource services* to achieve long-term academic success.

Year 4: Implement⟼Expansion

To field test *INCLUDE*, two rural school districts in Utah that have special education self-contained classrooms will be studied. Using only the data collected during the first 3 years of scaling up and implementing *INCLUDE*, students with classifications of autism will be evaluated. Students with autism identified as candidates for academic inclusion from these rural school districts will enter the same pre-determined inclusion methodologies used in the urban and suburban school districts.

INCLUDE will be introduced to the teachers and administrators of participating schools in the rural school districts using the professional development program and materials refined during Year 2. The research team will be available to the teachers and administrators in the rural school district in person or by video conference to resolve any implementation issues.

The same outcome and statistical measures will be used for this implementation as were used in other phases of the project.

Data Analysis

Year 1: Scale Up⟼Evaluate: Student Diversity

All implementations of *INCLUDE* will be analyzed by k-fold cross validation. A series of test sets will be generated and used to test the algorithm. 30, 15, 10, 5, and 3-fold cross validation will be employed to test the model. Values of >85% accuracy in sorting will be used as validation *INCLUDE* is valid. Appropriate Frequentist and Bayesian inferential statistics will be applied to assess the outputs of *INCLUDE*. All outputs will be plotted and graphical representations visually scrutinized.

Comparisons of *INCLUDE* and manual candidate selection by an unbiased expert using de-identified data using cutoff values and a decision-making flow chart (Appendix C) will be performed as well to elucidate accuracy. Selectivity, specificity, positive predictive value, and negative predictive value will be calculated for each implementation as a measure of efficacy.

Year 2: Scale Up⟼Evaluate: Professional Development

During Year 2 of this project, data will be collected monthly on fidelity of implementation, teacher's self-efficacy, and teacher's perceived barriers. Teachers' self-efficacy will be assessed using the Teacher Sense of Efficacy Scale-Short Form-Adapted and informal web-based surveys.

Parent, administrator, teacher, and students satisfaction with *INCLUDE* and the inclusion process will be measured using a researcher-developed web-based survey using REDCap Surveys. Usability, feasibility, and fidelity of implementation data will be collected using observational checklists throughout the study, supplemented by an on-line implementation checklist.

All survey data will be analyzed by two independent researchers blinded to identity and position of the individual that completed the surveys. Responses will be classified into categories based on patterns of responses. Trained personnel will analyze the surveys and develop methods to reconcile any discrepancies until the observed κ for inter-rater concordance is $\kappa \geq 0.70$.

Data regarding implementation fidelity will be collected, plotted, and shared with school teams. Fidelity data across classroom types, schools, and districts will be analyzed by multi-factorial analyses of co-variance (MANCOVA) if data meet assumptions or nonparametric equivalents as necessary.

α for statistical significance will be defined as $\alpha<0.05$ after correction for multiple comparisons to control for Type I error. Statistical Power (1-β) will be set at 0.90 to control for potential Type II error. Predictive and confirmatory power analyses will be performed for all analyses.

Data from *INCLUDE* will be analyzed as described above in Year 1.

Year 3:Evaluate ⟼Implement

Upon beginning to attend the general education classroom for full inclusion, the special education teacher begins data collection on student independence using an experimenter designed data sheet (Appendix C). Data collection on independence, levels of accommodation necessary for student success, and classroom behavior will also be collected by district personnel. All student data will be included in the REDCap database an used as dependent variables for analyses of student success.

Data regarding student performance will be collected, plotted, and shared with school teams and the student.

Data from *INCLUDE* will be analyzed as described above in Year 1.

Year 4: Implement⟼Expansion

Upon beginning to attend the general education classroom for full inclusion, the special education teacher begins data collection on student independence using an experimenter designed data sheet (Appendix C). Data collection on independence, levels of accommodation necessary for student success, and classroom behavior will also be collected by district personnel. All

student data will be included in the REDCap database an used as dependent variables for analyses of student success. Student data will be

Data from *INCLUDE* will be analyzed as described above in Year 1.

Anticipated Results

We previously verified that *INCLUDE* was able to effectively scale up from 2 to 46 classrooms without losing predictive validity. In fact, as mentioned above, *INCLUDE* increased in sensitivity, specificity, and positive predictive validity with the addition of more data.

Data Collected During Years 1,2,3,4

We anticipate *INCLUDE* will become more specific and selective as we scale up implementation.. Our prediction is that the algorithm will be able to identify candidate students with an increasing positive predictive value than previous implementations. The current implementation positive predictive value = 0.87, we anticipate an increase in positive predictive value to 0.90 - 0.93.

Data Collected During Years 1,2,3

We further predict the *INCLUDE* will identify 5-10% candidate students with autism that are missed by traditional methods. This is because the algorithm is capable to identifying statistical patterns within data that may be too complex for teachers scrutinizing evaluative data. Additionally, by assessing patterns of data from entire psychoeducational evaluations, the need for "cutoff" values are overcome by *INCLUDE*.

Data Collected During Year 4

When extended to rural school districts, we anticipate *INCLUDE* will be able to effectively classify students with autism that are ready for academic inclusion without the necessity of comparison data from peers in special education with classifications other than autism. This is because *INCLUDE* will contain data for >2000 students in self-contained classrooms as a reference sample to draw from. Of these students, we anticipate data from 600 - 750 students with autism in self-contained classrooms as a comparison sample.

Impact of Collected Data

These data will by and large support optimistic classroom decisions undertaken based on the outputs of *INCLUDE*. These data-driven decisions favor moving students into less restrictive, more inclusive, environments, when they are *approaching* being "ready", rather than waiting until there is no doubt regarding student success in a new setting. The major impact of this expansion of *INCLUDE* is that both the spirit and letter of the least restrictive environment (LRE) requirements of IDEA will be more easily met by providing IEP teams data from an unbiased tool that can help understand student potential.

Limitations

The primary limitation of extending any analytical process across school districts is that the criteria for being placed in self-contained classrooms differ slightly across school districts (*e.g.*, differences in criteria applying the discrepancy model, Response to Intervention model [RTI], and Patterns of Strengths and Weaknesses model[PSW]). These discrepancies could theoretically alter the structure of the data and impact the algorithm by decreasing negative predictive value by decreasing specificity. To account for this potential limitation, focus will be placed on a strict application of the 68-95-99 rule for making classification decisions based on standardized data in the psychoeducational evaluation. Additionally, whenever there is a discrepancy among *INCLUDE* and a human rater, the more optimistic option will be implemented (*e.g.*, the one that most reflects LRE as described in IDEA IDEA, 2004).

We anticipate to be able to computationally correct for these discrepancies by comparing inclusion and exclusion criteria for self-contained classrooms across school districts. If the differences are systematic, a correction factor will be applied to the models. If the differences appear random, then they will be reflected in the resulting model.

Broader Educational Impact

The broad research impact of this research is that *INCLUDE* the first example of a computational tool that can reduce human bias and minimize error in educational decisions regarding student placement and FAPE within special education. *INCLUDE* also provides quantitative data that can be used to support IEP team decisions regarding student placement.

The long term educational impacts of this pipeline are clear. For the cascading system of special education service provision to work, efforts need to be made to challenge students and offer the opportunity for students to move toward less restrictive placements. *INCLUDE* is a suite of tools designed to facilitate such a transition.

Given the decision in the case of US (2017), it is imperative that special education teams and LEA consider the meaning of goals and settings being "appropriately ambitious". In our interpretation, *INCLUDE* is uniquely capable of identifying the students that would receive maximal benefit from full academic inclusion.

Since students with autism classifications in self-contained settings often comprise a higher-grade level group than their peers, the opportunity to engage in evidence-based pedagogical methods will increase when these students are receiving full inclusion. The reduction in class size has been shown to improve teacher efficacy and morale among both students and staff (Mathis, 2017). When *INCLUDE* identifies the candidate students for full inclusion, the class size is reduced in the special education classroom - improving outcomes for the other students.

At present, the vast majority of adults with autism are unemployed and for those who do have gainful employment, underemployment is common (Hendricks, 2010). The increased prevalence of ASD coupled with unique social, communication, and behavioral characteristics translate into the need for services to help them achieve employment success. Consideration of individual characteristics including strengths, needs, as well as specific interests, coupled with implementation of proper supports can result in successful and ongoing employment. The first step to facilitating individuals with autism accessing employment is to provide an education that focuses on college and career readiness. *INCLUDE* provides a reliable, unbiased method to provide access to full academic inclusion to students classified as autism.

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Appendices

Table C.1
Teacher/Administrator Reported Barriers to Academic Inclusion for Students in Self-Contained Settings that are Overcome by using INCLUDE. After Hunsaker (2018)

Desire to keep student in self-contained class as a "good example"
Behavioral data from the self-contained classroom
Past lack of success in mainstreaming
Past lack of school skills necessary for mainstreaming
Anecdotal reports of any kind not supported by data
Requirement for para-educator time or increased classroom resources
Student idiosyncrasies/peculiarities
Student personality
Parent concerns about academic abilities
Parent concerns about behavioral abilities
Social skills deficits
Student mobility issues
Requirement for Orientation & Mobility Services
Use of assistive technology
Special education classification
Information regarding disability severity
Status as a non-native English speaker/Need for ELL services
Student speech issues
Selective Mutism
Aphasia
Apraxia
Stuttering
Prosody Errors
Medical/Psychiatric diagnoses
Autism
ADHD
Epilepsy
Tic Disorders
Tourette’s
Anxiety/Depression status
Sensory Impairments
Visual Impairment/Blindness
Deaf-blindness
Hearing Impairment/Deafness
Need for a Sensory Diet
Current or past medications
Medication compliance or noncompliance
Hesitation of parents to pursue psychiatric help for student
Quality of Relationship Teacher has with Parent
"Red Flag" or helicopter parent

Specific Learning Disability Eligibility Combination Method

What is the Problem?

Target Academic Area: _____ **Date of IEP Team Meeting:** _____

Student Name: _____ **DOB:** _____ **Grade:** _____

Why Is It Happening?

Impact on Learning	Minimal	Mild	Moderate	Severe
1) Summary of Discrepancy Information: (FSIQ v. Achievement)	The difference between the student's expected achievement score and obtained achievement score represents no discrepancy to a mild discrepancy ☐		The difference between the student's expected achievement score and obtained achievement score represents moderate discrepancy to a severe discrepancy ☐	
2) Pattern of Cognitive Strengths and Weaknesses (FSIQ or PRI) Test: _____ Date:	Evenly developed index scores; no significant weaknesses ☐		Scatter of index scores; one or more significant weaknesses ☐	
3) Achievement Standardized Test Scores (WJIIINU, WJIV): Test: _____ Date:	SS = 90 or above Average ☐	SS = 80 - 89 Low Average ☐	SS = 70 - 79 Low ☐	SS = 69 or below Very Low ☐
4) Relative Proficiency Index: (WJIII-NU, WJIV)	68/90 and above Limited to Average ☐	34/90 to 67/90 Limited ☐	19/90 to 33/90 Very Limited to Limited ☐	0/90 to 18/90 Negligible to Very Limited ☐
5) SAGE Data (most current): Yearly Summative Assessment	Highly Proficient (4) ☐	Proficient (3) ☐	Approaching Proficient (2) ☐	Below Proficient (1) ☐
Progress Monitoring Data: Student performance data used to identify or measure progress towards instructional and grade level goals. Attach most recent data and graphs from benchmark and progress monitoring data.				
6) Benchmark Data (performance level)	At or above grade level benchmark ☐	Approaching grade level benchmark ☐	Below grade level benchmark ☐	Well below grade level benchmark ☐
7) Benchmark/Screener Data: General Ed Peer Comparison	0-24% of peers are at or above grade level benchmark ☐	25-49% of peers are at or above grade level benchmark ☐	50-74% of peers are at or above grade level benchmark ☐	75-100% of peers are at or above grade level benchmark ☐
8) Progress Monitoring Data (rate of progress): Review of progress monitoring data (Over 4-6 week period)	Rate of growth demonstrates adequate trend towards grade level benchmark ☐	Rate of growth demonstrates somewhat adequate trend towards grade level benchmark. ☐	Rate of growth demonstrates inadequate trend towards grade level benchmark ☐	Rate of growth shows no growth towards grade level benchmark ☐
9) Intervention Tier required to attain rate of progress above: In what Tier and for what amount of supplemental time has student received intervention?	**Tier 1-General Ed/Whole or Small Group** Core Instruction Only ☐ Provided by:	**Tier 1 PLUS Tier 2** (additional 30 min sessions multiple times per week of homogeneous small group in target academic area) ☐ Provided by:	**Tier 1 PLUS Tier 3** (additional 45 min sessions, multiple times per week of homogeneous small group in target academic area Provided by:	**Tier 1 PLUS Tier 4** (additional 90+ min sessions, multiple times per week of homogeneous small group in target academic area ☐ Provided by:

What Should Be Done?

At least 7 of 9 check marks appear in the "Moderate" or "Severe" columns: YES ☐ ☐ NO

AND at least 5 of the above 7 check marks appear in the "Severe" column: YES ☐ ☐ NO

Eligibility Team has ruled out "considerations" as substantially impacting the student's educational performance: YES ☐ ☐ NO

Eligibility Team has determined that the student has a Specific Learning Disability in this area: YES ☐ ☐ NO

Special Education Mainstreaming Plan

Name: _____ Grade: _____ Teacher: _____
School: _____ Classification _____ Date of Review: _____

Formal Assessments		Informal Assessments	
Cognitive		Reading	
Achievement		Writing	
Adaptive		Math	
Communication		Behavior	
Behavior		Related Services	
Other		Other	

Mainstreaming Expectations	Developing	Expanding	Independent	Needed Instruction/Support
Follows Classroom Routines and Rules				
1. Complies with directions				
2. Follows classroom routines				
3. Handles transitions and accepts change to rules, routines and/or procedures				
Academic Learning				
1. Actively participates in learning tasks				
2. Volunteers answers (raise hand and wait to be called on)				
3. Completes assignments				
4. Reads orally				
5. Asks for help				
6. Participates in partner or group work				
Social Emotional Learning				
1. Communicates and interacts with peers				
2. Ability to respond to frustration(s)				
3. Ability to problem solve				
4. Stays in seat or assigned area				
Organizational Skills				
1. Able to utilize a planner or calendar to track assignment				
2. Utilizes and manages necessary materials (notebook, binder, pencil pouch, etc.)				
3. Completes and turns in assignments (in class and/or homework)				
4. Written work legible and neat				

Note: Provide the minimum supports necessary for success then gradually fade to increase independence.

Special Education Mainstreaming Plan

Mainstreaming Plan

Start Date	Subject	Teacher/Classroom	Time

Notes

Monitoring

Who will be responsible for monitoring progress: _____

How frequently will monitoring take place? Daily_____ Weekly _____ Bimonthly _____ Monthly_____

How implementation and outcomes be evaluated?

Teacher Monitoring:

Student Monitoring:

Signature of Team Members:

_____ _____

_____ _____

_____ _____

_____ _____

Mainstream Review - Mainstreaming data review and changes to mainstreaming schedule.

Date: _____

Classroom Ecological Inventory

General Education Teacher _____

Special Education Teacher _____

Principal _____

School _____

Answer the following questions to best describe your classroom and teaching practices

Grade/s Taught (mark all that apply)

- ☐ 1st grade
- ☐ 2nd grade
- ☐ 3rd grade
- ☐ 4th grade
- ☐ 5th grade
- ☐ 6th grade

I am a _____ teacher

- ☐ Core
- ☐ Elective
- ☐ Resource
- ☐ Self Contained
- ☐ PE
- ☐ Other

At minimum I expect students to be at a _____ grade reading level

- ☐ Pre-Kindergarten
- ☐ Kindergarten
- ☐ 1st-2nd
- ☐ 3rd-4th
- ☐ 5th-6th
- ☐ No expectation

At minimum I expect students to be at a _____ grade writing level

- ☐ Pre-Kindergarten
- ☐ Kindergarten
- ☐ 1st-2nd
- ☐ 3rd-4th
- ☐ 5th-6th
- ☐ No expectation

Answer the following questions to best describe your classroom and teaching practices

At minimum I expect students to be at a _____ grade math level

- ☐ Pre-Kindergarten
- ☐ Kindergarten
- ☐ 1st-2nd
- ☐ 3rd-4th
- ☐ 5th-6th
- ☐ No expectation

At minimum I expect students to bring assigned materials_____% of the time

- ☐ 0-9%
- ☐ 9-24%
- ☐ 25-49%
- ☐ 50-74%
- ☐ 75-100%
- ☐ No expectation

At minimum I expect students to stay in their seat_____% of the time

- ☐ 0-9%
- ☐ 9-24%
- ☐ 25-49%
- ☐ 50-74%
- ☐ 75-100%
- ☐ No expectation

At minimum I expect students to stay quiet_____ % of the time

- ☐ 0-9%
- ☐ 9-24%
- ☐ 25-49%
- ☐ 50-74%
- ☐ 75-100%
- ☐ No expectation

At minimum I expect students to work w/o teacher attention _____ % of the time

- ☐ 0-9%
- ☐ 9-24%
- ☐ 25-49%
- ☐ 50-74%
- ☐ 75-100%
- ☐ No expectation

Answer the following questions to best describe your classroom and teaching practices

Most worksheets in my class are:

- ☐ Fill In the Blank
- ☐ Multiple Choice
- ☐ Short Answer
- ☐ Long Answer
- ☐ Essay
- ☐ Show Work

Most quizzes in my class are:

- ☐ Fill In the Blank
- ☐ Multiple Choice
- ☐ Short Answer
- ☐ Long Answer
- ☐ Essay
- ☐ Show Work

Most tests in my class are:

- ☐ Fill In the Blank
- ☐ Multiple Choice
- ☐ Short Answer
- ☐ Long Answer
- ☐ Essay
- ☐ Show Work

Homework, worksheets, and assignments are accepted:

- ☐ Not accepted late
- ☐ Within 1 week
- ☐ Within 2 weeks
- ☐ Within the term
- ☐ Until end of year
- ☐ No expectation

Quizzes and Tests are accepted:

- ☐ Not accepted late
- ☐ Within 1 week
- ☐ Within 2 weeks
- ☐ Within the term
- ☐ Until end of year
- ☐ No expectation

Answer the following questions to best describe your classroom and teaching practices

I collect Homework by:

- ☐ Calling for it during class
- ☐ Collect from students
- ☐ Remind student to turn in
- ☐ No prompts
- ☐ Back and forth folder
- ☐ No expectation

I collect quizzes by:

- ☐ Calling for it during class
- ☐ Collect from students
- ☐ Remind student to turn in
- ☐ No prompts
- ☐ Back and forth folder
- ☐ No expectation

I collect tests by:

- ☐ Calling for it during class
- ☐ Collect from students
- ☐ Remind student to turn in
- ☐ No prompts
- ☐ Back and forth folder
- ☐ No expectation

I collect in class worksheets by:

- ☐ Calling for it during class
- ☐ Collect from students
- ☐ Remind student to turn in
- ☐ No prompts
- ☐ Back and forth folder
- ☐ No expectation

Students are requires to take notes from lecture by:

- ☐ Free hand
- ☐ Copy from board
- ☐ Fill in blanks
- ☐ Graphic Organizer
- ☐ Notes provided
- ☐ No expectation

Answer the following questions to best describe your classroom and teaching practices

Students are required to take notes from movies by:

- ☐ Free hand
- ☐ Copy from board
- ☐ Fill in blanks
- ☐ Graphic Organizer
- ☐ Notes provided
- ☐ No expectation

Chromebooks or iPads are used in my classroom _____ % of the time

- ☐ 0-9%
- ☐ 9-24%
- ☐ 25-49%
- ☐ 50-74%
- ☐ 75-100%
- ☐ No expectation

If you feel an important skill or expectation concerning transition was not addressed, please comment here:

_____

_____

_____

_____

_____

_____

For office use only:

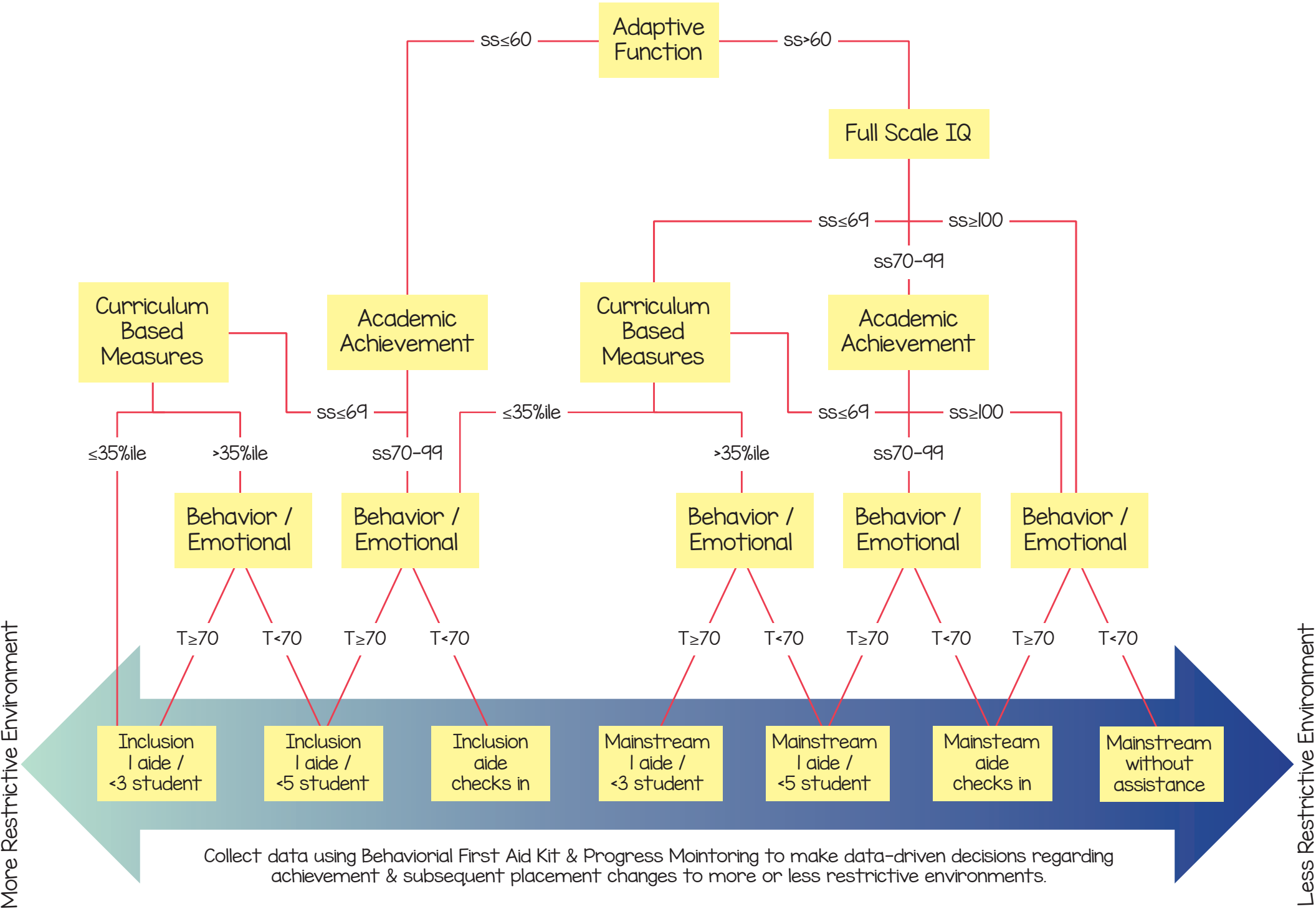
Date of completion _____

Data input _____

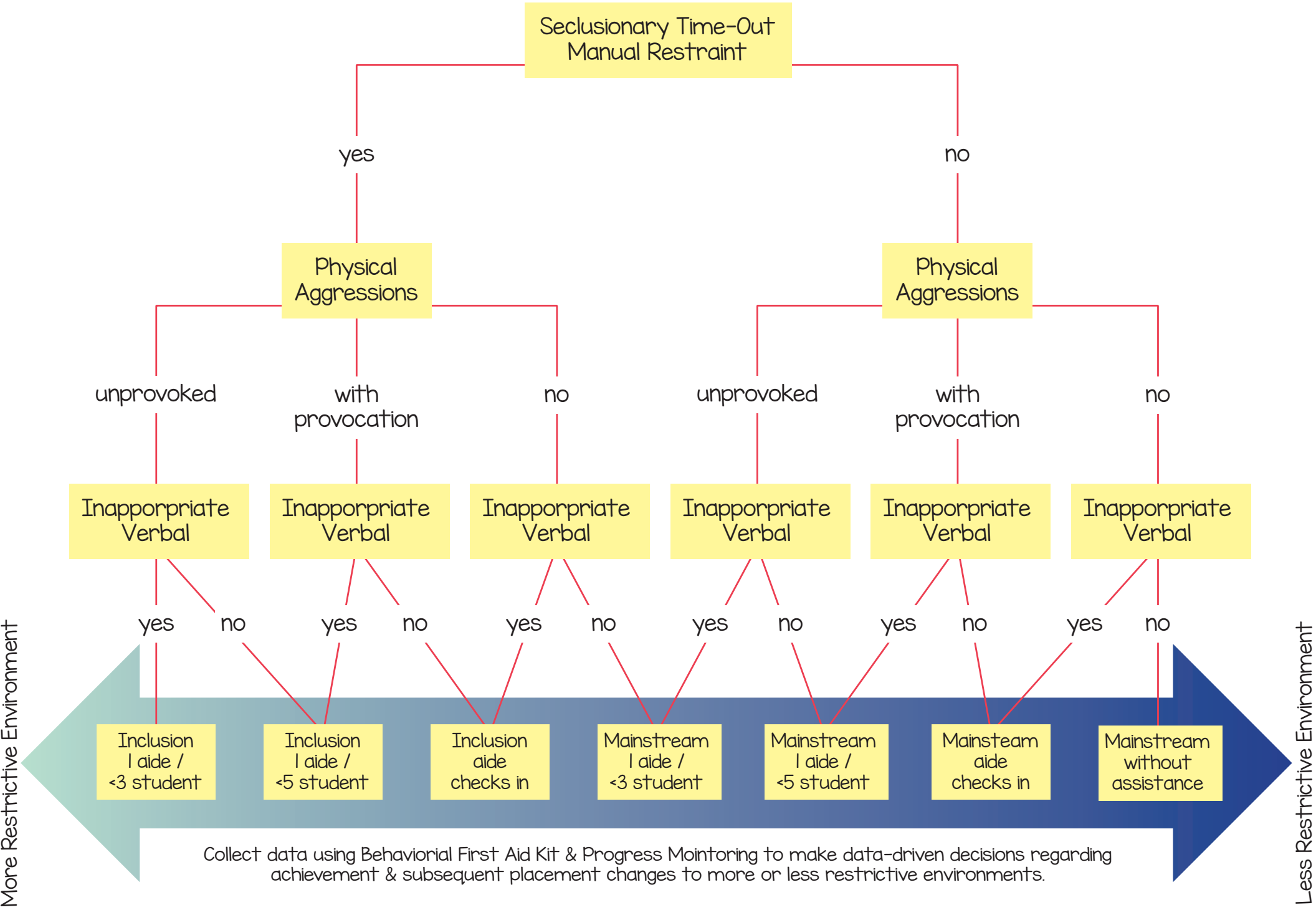
Reconciliation meeting date _____

Next Steps _____

Inclusion / Mainstream Initial Placement Decision Tree



Behavior Mainstreaming Progress Decision Tree



Teachers' Sense of Efficacy Scale[1] (long form)

Teacher Beliefs Directions: This questionnaire is designed to help us gain a better understanding of the kinds of things that create difficulties for teachers in their school activities. Please indicate your opinion about each of the statements below. Your answers are confidential.	How much can you do? Nothing		Very Little		Some Influence		Quite A Bit		A Great Deal
1. How much can you do to get through to the most difficult students?	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
2. How much can you do to help your students think critically?	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
3. How much can you do to control disruptive behavior in the classroom?	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
4. How much can you do to motivate students who show low interest in school work?	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
5. To what extent can you make your expectations clear about student behavior?	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
6. How much can you do to get students to believe they can do well in school work?	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
7. How well can you respond to difficult questions from your students ?	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
8. How well can you establish routines to keep activities running smoothly?	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
9. How much can you do to help your students value learning?	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
10. How much can you gauge student comprehension of what you have taught?	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
11. To what extent can you craft good questions for your students?	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
12. How much can you do to foster student creativity?	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
13. How much can you do to get children to follow classroom rules?	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
14. How much can you do to improve the understanding of a student who is failing?	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
15. How much can you do to calm a student who is disruptive or noisy?	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
16. How well can you establish a classroom management system with each group of students?	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
17. How much can you do to adjust your lessons to the proper level for individual students?	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
18. How much can you use a variety of assessment strategies?	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
19. How well can you keep a few problem students form ruining an entire lesson?	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
20. To what extent can you provide an alternative explanation or example when students are confused?	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
21. How well can you respond to defiant students?	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
22. How much can you assist families in helping their children do well in school?	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
23. How well can you implement alternative strategies in your classroom?	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
24. How well can you provide appropriate challenges for very capable students?	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)

Teachers' Sense of Efficacy Scale[1] (short form)

	Teacher Beliefs	How much can you do?								
	Directions: This questionnaire is designed to help us gain a better understanding of the kinds of things that create difficulties for teachers in their school activities. Please indicate your opinion about each of the statements below. Your answers are confidential.	Nothing		Very Little		Some Influence		Quite A Bit		A Great Deal
1.	How much can you do to control disruptive behavior in the classroom?	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
2.	How much can you do to motivate students who show low interest in school work?	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
3.	How much can you do to get students to believe they can do well in school work?	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
4.	How much can you do to help your students value learning?	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
5.	To what extent can you craft good questions for your students?	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
6.	How much can you do to get children to follow classroom rules?	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
7.	How much can you do to calm a student who is disruptive or noisy?	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
8.	How well can you establish a classroom management system with each group of students?	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
9.	How much can you use a variety of assessment strategies?	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
10.	To what extent can you provide an alternative explanation or example when students are confused?	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
11.	How much can you assist families in helping their children do well in school?	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
12.	How well can you implement alternative strategies in your classroom?	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)

Directions for Scoring the Teachers' Sense of Efficacy Scale[1]

Developers: Megan Tschannen-Moran, College of William and Mary
Anita Woolfolk Hoy, the Ohio State University.

Construct Validity

For information the construct validity of the Teachers' Sense of Teacher efficacy Scale, see:

> Tschannen-Moran, M., & Woolfolk Hoy, A. (2001). Teacher efficacy: Capturing and elusive construct. *Teaching and Teacher Education, 17,* 783-805.

Factor Analysis

It is important to conduct a factor analysis to determine how your participants respond to the questions. We have consistently found three moderately correlated factors: *Efficacy in Student Engagement, Efficacy in Instructional Practices*, and *Efficacy in Classroom Management*, but at times the make up of the scales varies slightly. With preservice teachers we recommend that the full 24-item scale (or 12-item short form) be used, because the factor structure often is less distinct for these respondents.

Subscale Scores

To determine the *Efficacy in Student Engagement, Efficacy in Instructional Practices*, and *Efficacy in Classroom Management* subscale scores, we compute unweighted means of the items that load on each factor. Generally these groupings are:

Long Form

Efficacy in Student Engagement:	Items 1, 2, 4, 6, 9, 12, 14, 22
Efficacy in Instructional Strategies:	Items 7, 10, 11, 17, 18, 20, 23, 24
Efficacy in Classroom Management:	Items 3, 5, 8, 13, 15, 16, 19, 21

Short Form

Efficacy in Student Engagement:	Items 2, 3, 4, 11
Efficacy in Instructional Strategies:	Items 5, 9, 10, 12
Efficacy in Classroom Management:	Items 1, 6, 7, 8

Reliabilities

In Tschannen-Moran, M., & Woolfolk Hoy, A. (2001). Teacher efficacy: Capturing and elusive construct. *Teaching and Teacher Education, 17,* 783-805, the following were found**:**

	Long Form			Short Form		
	Mean	SD	alpha	Mean	SD	alpha
OSTES	7.1	.94	.94	7.1	.98	.90
Engagement	7.3	1.1	.87	7.2	1.2	.81
Instruction	7.3	1.1	.91	7.3	1.2	.86
Management	6.7	1.1	.90	6.7	1.2	.86

[1] Because this instrument was developed at the Ohio State University, it is sometimes referred to as the *Ohio State Teacher Efficacy Scale*. We prefer the name, *Teachers' Sense of Efficacy Scale*.