









analyzed with the use of factor analysis to determine whether each set of items in each part of the survey inter-correlated in the way they should have.

A second purpose for the use of factor analysis is in data reduction, or to condense a large number of variables, such as the nine items in Part B, Knowledge of Characteristics of Students with ASD, in the survey used for this study, into a fewer number of variables, in this case, two variables represented by two factor scores. Further details about the creation of factors and latent variables are described in the following sections.

## 5.2. Results of Factor Analysis on Part B, Characteristics of Students with ASD

The exploratory principal components analysis on the Part B, Perceived Knowledge of Characteristics of Students with ASD subscale items using varimax rotation method yielded two components. Table 1 shows descriptive statistics for the characteristics items that were analyzed using factor analysis. Descriptive statistics are based on completed surveys; therefore the number may differ from the number of participants.

Table 1. Descriptive Statistics for Part B, Characteristics( N=79)

Item	Mean	Standard Deviation
Cognitive Functioning (1)	4.19	.74
Communication Skills (2)	4.43	.78
Language Development (2)	4.14	.89
Social Differences (2)	4.28	.82
Behavioral Challenges (2)	4.43	.67
Auditory Processing (1)	3.84	.94
Visual Processing (1)	3.90	.96
Sensory Processing (1)	4.13	.93
Praxis (Motor) Difficulties (1)	3.68	1.04

After examining the grouping of the nine characteristics items into the two factors, the following descriptions for each factor were constructed.

- *Sensory Processing (Factor 1)*. The items in this factor described the participants' perceived knowledge of the degree to which sensory processing affects the ASD student's ability to respond to instruction. The specific items that loaded on this factor are noted with (1) in Table 1.
- *Communication/Social Skills (Factor 2)*. The items in this factor described the participants' perceived knowledge of the degree to which communication and social skills affect the ASD student's ability to

respond to instruction. The specific items that loaded on this factor are noted with (2) in Table 1.

Appendix A shows the results from the factor analysis that prompted the descriptions of each factor. Eigenvalues greater than 1 were used to determine the number of factors in the characteristics variable because they represent the percentage of variance accounted for in that variable by the factor being measured. The larger a factor's eigenvalue, the more variance that particular factor accounts for in the variable. In this case, 71.39% of the variance in the characteristics variable was accounted for by these two factors. It was noted that the first factor, *sensory processing*, represented 54.24% of the variance in the characteristics variable. Of additional interest was the substantial difference between the eigenvalue of the first factor (4.88) and the eigenvalue of the second factor, *communication/social skills* (1.54). This finding will be kept in mind when choosing factors for future multiple regressions on the variable of characteristics. The remaining variance in the subscale of characteristics was unidentifiable and yielded eigenvalues of less than 1.

## 5.3. Results of Factor Analysis on Part C, Evidence-Based Practices

The exploratory principal components analysis on the Part C, Perceived Knowledge of Evidence-Based Practices subscale items using varimax rotation method yielded nine components. Table 2 shows descriptive statistics for the evidence-based practices items that were analyzed using factor analysis.

Table 2. Descriptive Statistics for Part C, Evidence-Based Practices Items (N = 68)

Item	Mean	Standard Deviation
Antecedent		
Knowledge (2)	4.18	.77
Observation (3)	3.66	1.05
Practice (2)	3.94	.84
Behavioral Packages		
Knowledge (7)	4.16	.80
Observation (7)	3.78	1.17
Practice (7)	3.96	.87
Comprehensive Behavioral Treatments		
Knowledge (1)	3.34	1.05
Observation (1)	2.96	1.31
Practice (1)	3.16	1.13
Joint Attention Intervention		
Knowledge (1)	3.38	.90

Observation (1)	2.91	1.19
Practice(1)	3.15	.98
Modeling		
Knowledge (2)	4.21	.84
Observation (3)	3.72	1.18
Practice (9)	3.93	.98
Naturalistic Teaching Strategies		
Knowledge (8)	3.85	.97
Observation (3)	3.32	1.31
Practice (8)	3.54	1.07
Self-Management Interventions		
Knowledge (4)	3.90	.87
Observation (4)	3.44	1.10
Practice (4)	3.60	.88
Peer Training Packages		
Knowledge (4)	3.40	1.01
Observation (9)	2.84	1.18
Practice (9)	3.18	1.18
Story-Based Intervention Packages		
Knowledge (6)	3.66	1.19
Observation (6)	3.15	1.34
Practice (6)	3.40	1.24
Pivotal Response Treatment (PRT)		
Knowledge (1)	3.29	1.12
Observation (1)	2.78	1.13
Practice (1)	2.96	1.13
Schedules-based Intervention		
Knowledge (5)	4.01	.92
Observation (5)	3.69	1.20
Practice (5)	3.79	1.07

After examining the grouping of the 33 evidence-based practices items into the nine factors, the following descriptions for each factor were constructed.

- *Overall knowledge, observations, and ability to implement widespread interventions (Factor 1).* The items in this factor described the participants' perceived knowledge, observations, and ability to implement pivotal response treatment (PRT) to increase widespread improvement in a wide range of areas, such as motivation to engage in social communication, self-initiation, self-management, and responsiveness to multiple cues. The items in this factor also described the participants' perceived knowledge, observations, and ability to implement joint attention interventions, which build on foundational skills that regulate interactions with others. Finally, the items in this factor described the participants' perceived knowledge, observations, and ability to implement early intensive behavioral in-

terventions. Specific items that loaded on this factor are noted with (1) in Table 2.

- *Knowledge and practice in antecedent interventions and knowledge in modeling (Factor 2).* The items in this factor described the participants' perceived knowledge and practice of the degree to which they can help ASD students to modify situational events that precede the occurrence of a problem behavior. One item in this factor described the participants' perceived knowledge of modeling interventions. The specific items that loaded on this factor are noted with (2) in Table 2.
- *Various observations of antecedent, modeling, and naturalistic teaching strategies (Factor 3).* The items in this factor described the participants' perceived observations of antecedent interventions, modeling, and naturalistic teaching strategies. The specific items that loaded on this factor are noted with (3) in Table 2.
- *Knowledge, observations, and practices of self-management interventions (Factor 4).* The items in this factor described the participants' perceived knowledge, observations and practices of self-management interventions as well as knowledge of peer training packages. The specific items that loaded on this factor are noted with (4) in Table 2.
- *Knowledge, observations, and practices of schedules-based intervention (Factor 5).* The items in this factor described the participants' perceived knowledge, observations, and practices of schedules-based intervention. The specific items that loaded on this factor are noted with (5) in Table 2.
- *Knowledge, observations, and practices of story-based intervention (Factor 6).* The items in this factor described the participants' perceived knowledge, observations, and practices of story-based intervention. The specific items that loaded on this factor are noted with (6) in Table 2.
- *Knowledge, observations, and practices of behavioral packages (Factor 7).* The items in this factor described the participants' perceived knowledge, observations, and practices of behavioral packages, which refer to interventions that are designed to teach functional alternative behaviors or skills to replace problem behaviors. The specific items that loaded on this factor are noted with (7) in Table 2.
- *Knowledge and practices of naturalistic teaching strategies (Factor 8).* The items in this factor described the participants' per-

ceived knowledge and practices of naturalistic teaching strategies. The specific items that loaded on this factor are noted with (8) in Table 2.

- *Practice of modeling and peer-training packages, and observations of peer-training packages (Factor 9).* The items in this factor described the participants' perceived practice of modeling and peer-training packages, and observations of peer-training packages. The specific items that loaded on this factor are noted with (9) in Table 2.

Appendix B shows the results from the factor analysis that prompted the descriptions of each factor. Once again, eigenvalues greater than 1 were used to determine the number of factors in the evidence-based practices variable because they represent the percentage of variance accounted for in that variable by the factor being measured. In this case, 85.43% of the variance in the evidence-based practices variable was accounted for by these nine factors. It was noted that the first factor, *overall knowledge, observations, and ability to implement widespread interventions*, represented 40.00% of the variance in the evidence-based practices variable. Of additional interest was the substantial difference between the eigenvalue of the first factor (14.40) and the eigenvalues of the second factor, (3.87), the third factor, (3.19), and the fourth factor (2.20). This finding will be kept in mind when choosing factors for future multiple regressions on the variable of characteristics. The last five factors yielded eigenvalues ranging from 1.87 to 1.09. Finally, the remaining variance in the subscale of characteristics was unidentifiable and yielded eigenvalues of less than 1.

#### 5.4. Results of Factor Analysis on Part D, Teaching Students with ASD

The exploratory principal components analysis on the Part D, Teaching Students with ASD subscale items using varimax rotation method yielded only one component. The solution therefore could not be rotated. The nine items in the teaching subscale seemed to be conceptually similar in that they all described the perceptions of participants' ability to assess, analyze data, collaborate with professionals and families, and individualize instruction to meet the needs of various students with ASD in the nine areas they were queried about. The nine items were therefore merged into the variable we called *teaching*. Table 3 shows descriptive statistics for the nine teaching items.

Table 3. Descriptive Statistics for Teaching Items (N=80)

Item	Mean	Standard Deviation
Teaching Students with ASD:		
Unique Need	4.20	.72
Communication Needs	4.16	.68
Language Needs	4.04	.80
Social Interactions	4.33	.71
Behavior Challenges	4.21	.82
Structured Learning	4.18	.85
Schedules/Routines	4.45	.61
Visual Strategies	4.33	.73
Positive Learning Env.	4.40	.69

Once again, eigenvalues greater than 1 were used to determine the number of factors in the teaching variable. In this case, 66.67% of the variance in the teaching variable was accounted for by all nine items in the teaching subscale. The eigenvalue was 7.33, which is a substantial eigenvalue. This larger eigenvalue will be kept in mind when computing multiple regressions with the teaching variable. The rest of the variance in the subscale of teaching was unidentifiable and yielded eigenvalues of less than 1 (See Appendix C).

#### 5.5. Results of Factor Analysis on Part E, Collaborating with Other Professionals

The exploratory principal components analysis on the Part E, Collaborating with Other Professionals subscale items using varimax rotation method yielded two components. Table 4 shows descriptive statistics for the characteristics items that were analyzed using factor analysis.

Table 4. Descriptive Statistics for Part E, Collaboration Items (N=78)

Item	Mean	Standard Deviation
Understanding of Roles/Responsibilities of:		
Psychologist (1)	4.29	.97
Pathologist (1)	4.46	.78
Occupational Therapist (1)	4.23	.98
Physical Educator (1)	4.32	.89
Paraprofessional (1)	4.63	.65
Outside Agencies (1)	3.82	1.02

Skills/Strategies for Collaboration with:

Service Providers (2)	4.37	.76
Families (2)	4.42	.66
Recommendations (2)	4.31	.78

After examining the grouping of the nine characteristics items into the two factors, the following descriptions for each factor were constructed.

- *Roles of Service Providers (Factor 1)*. The items in this factor described the participants' perceived understanding of the roles and responsibilities of various service providers, such as psychologists, speech-language pathologists, and adapted physical educators. The specific items that loaded on this factor are noted with (1) in Table 4.
- *Collaboration Skills and Strategies (Factor 2)*. The items in this factor described the participants' perceived confidence in their skills and knowledge of strategies to collaborate with service providers and families, including those from diverse backgrounds. One item in this factor also described the participants' confidence in their abilities to integrate the recommendations from multidisciplinary teams to build effective programs for ASD students. The specific items that loaded on this factor are noted with (2) in Table 4.

Appendix D shows the results from the factor analysis that prompted the descriptions of each factor. Once again, eigenvalues greater than 1 were used to determine the number of factors in the collaboration variable. In this final case, 74.46% of the variance in the collaboration variable was accounted for by these two factors. It was noted that the both of the factors, were closer in their representation of the total amount of variance in the collaboration variable, with *roles of service providers* providing an eigenvalue of 3.98 and *collaboration skills and strategies* providing an eigenvalue of 2.72. This finding will be kept in mind when choosing factors for future multiple regressions on the variable of collaboration. The remaining variance in the subscale of characteristics was unidentifiable and yielded eigenvalues of less than 1.

In summary, the factor analysis on Part B, Perceived Knowledge of Characteristics of ASD Students, yielded two factors, with the first factor, *sensory processing*, accounting for most of the variance when compared to the other factor, *communication/social skills* (see Table 1 and Appendix A). The factor analysis on Part C, Perceived Knowledge of

Evidence-Based Practices, yielded nine factors with the first factor, *overall knowledge*, accounting for most of the variance when compared to the other eight factors (see Table 2 and Appendix B). The factor analysis on Part D, Perceived Knowledge of Teaching Students with ASD produced only one factor, *teaching*, which accounted for most of the variance in that variable (see Table 3 and Appendix C). Finally, the factor analysis on Part E, Perceived Knowledge of Collaborating with Other Professionals produced two factors, with both factors, *roles of service providers* and *collaboration skills and strategies* producing comparable amounts of the variance in that factor (see Table 4 and Appendix D).

## 6. Conclusion & implications

The factor analysis that was computed in this study did indeed determine the construct validity of the survey. In other words, it determined whether the survey used measured that which it was designed to measure: 1) pre-service teachers' and interns' perceived knowledge of ASD and interventions; 2) whether they had observed the application of these treatments in a school setting; and 3) their degree of confidence in carrying out these interventions. This was seen in the characteristics of the factors created from the items in the various subscales of the survey.

The factors produced by each factor analysis of the survey's subscales reflected the constructs that the subscales were created to measure. For example, in Part B, which was constructed to measure the perceived knowledge of characteristics of students with ASD, the constructs that emerged were the interns' perceived knowledge of the characteristics of *sensory processing* and *communication/social skills* of students with ASD.

Part E, produced a more complex and somewhat ambiguous set of factors, except for the first factor. The remaining factors were more numerous than in the other subscales. This was interpreted as meaning that fewer items in this particular subscale loaded on any one factor, except for the first factor, which measured the interns' perception of their overall knowledge, observations and ability to implement a wide variety of interventions. Although this factor produced a large eigenvalue (14.40) and accounted for 40.00% of the total variance in this variable, the other eight factors produced collectively accounted for 45.43% of the total variance in the evidence-based practices variable, yet were more difficult to characterize (see Table 2). This led us to believe that perhaps the items in this subscale of the survey need to be further refined in a future version of the survey to better reflect the interns' perception of their knowledge, prior observations of, and ability to im-



plement, or put into practice, specific types of treatments or interventions they were queried about.

The results of this survey shed some interesting light on how pre-service teachers gain knowledge of the different treatments. Some strategies appear easier to observe than others, or perhaps master teachers are more efficient at implementing certain treatments over others. This was observed in the results from this survey. Treatments with clearly defined observable steps (e.g. Modeling, Schedule-based and Self-Management interventions) received higher observation and practice scores than treatments that are embedded in instruction and perhaps difficult to readily observe (PRT, Joint attention). Comprehensive treatments that target preschoolers also score low on observation by the pre-service special education teachers.

Teaching students with ASD is a task of monumental proportions. The increase in the number of students with ASD, coupled with the complex needs of students with ASD and wide range of characteristics requiring an individualized approach for each student, is putting an enormous strain on the education system. Preparing special education teachers to be effective interventionists in eleven treatments is an untenable and unrealistic goal, given the limitations of service hours and the expertise of university faculty and master teachers.

The preliminary results of this validation study suggest that, teacher preparation programs may be wise to identify treatments that are observable and implemented well by master teachers in their area and focus on these in their program while providing information about other available treatments. Prior research has demonstrated that pre-service teachers benefit from observing expert practitioners and hands on practice [19]; options that are only available if that treatment is being carried out in the classroom. In light of this, proficiency in a limited number of treatments may provide a sufficient base for special education teachers to build upon. This survey may be valuable in helping teacher preparation programs identify the treatments that are employed in local classrooms. Hands on assignments may be designed to provide an in-depth study of a particular treatment leading to a pre-service teacher who has the knowledge and confidence to work with students with ASD.

### 6.1. Future research

The results of the exploratory factor analyses will be used in a future study to help determine latent variables for demographics and perceived levels of confidence in carrying out established treat-

ments for students with ASD. The exploratory factor analyses will be used in the process of conceptual modeling to design a model for regression analysis. A set of predictor variables will be selected using the latent variables with factor scores as dependent variables rather than raw scores from individual survey items. This further analysis will help to answer the questions of 1) pre-service teachers' and interns' perceived knowledge of ASD and interventions; 2) whether they had observed the application of these treatments in a school setting; and 3) their degree of confidence in carrying out these interventions.

## 7. References

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### Appendix A

#### Results of Factor Analysis on Part B, Characteristics Subscale

<i>Component</i>	<i>Eigenvalue*</i>	<i>Cumulative Percentage of Variance</i>
Sensory Processing	4.88	54.24
Communication/ Social Skills	1.54	71.39

\*Eigenvalue greater than 1 was used as a criterion to determine the number of factors.

### Appendix B

#### Results of Factor Analysis on Part C, Evidence-Based Practices Subscale

<i>Component</i>	<i>Eigenvalue*</i>	<i>Cumulative Percentage of Variance</i>
Overall Intervention Knowledge, Observations, and Practice	14.40	40.00
Knowledge and Practice of Antecedent Interventions	3.87	50.74
Various Observations	3.19	59.59
Self-Management Interventions	2.20	65.70
Schedules-Based Interventions	1.89	70.94
Story-Based Interventions	1.57	75.30
Comprehensive Behavioral Treatments	1.45	79.32
Naturalistic Teaching Strategies	1.11	82.40
Peer-Training Packages And Modeling	1.09	85.43

\*E

igenvalue greater than 1 was used as a criterion to determine the number of factors.

### Appendix C

#### Results of Factor Analysis on Part D, Teaching Students with ASD, Subscale

<i>Component</i>	<i>Eigenvalue*</i>	<i>Cumulative Percentage of Variance</i>
Teaching	7.33	66.67
Unidentifiable	.94	75.22
Unidentifiable	.74	81.99
Unidentifiable	.43	85.88
Unidentifiable	.35	89.07
Unidentifiable	.30	91.82
Unidentifiable	.27	94.29
Unidentifiable	.23	96.38
Unidentifiable	.19	98.13
Unidentifiable	.11	99.10
Unidentifiable	.10	100.00

\*Eigenvalue greater than 1 was used as a criterion to determine the number of factors.

### Appendix D

#### Results of Factor Analysis on Part E, Collaborating with Other Professionals, Subscale

<i>Component</i>	<i>Eigenvalue*</i>	<i>Cumulative Percentage of Variance</i>
Roles of Service Providers	3.98	44.27
Collaboration Skills/Strategies	2.72	74.46

\*Eigenvalue greater than 1 was used as a criterion to determine the number of factors.