UNIVERSITÉ DU QUÉBEC À MONTRÉAL

INTEGRATED SPECIALIZED LEARNING APPLICATION (ISLA) FOR TEACHING ADDITION TO HIGH FUNCTIONING CHILDREN PRESENTING AUTISM SPECTRUM DISORDER (ASD)

A DISSERTATION
SUBMITTED
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DOCTORATE OF COGNITIVE INFORMATICS

BY
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SEPTEMBER 2016

UNIVERSITÉ DU QUÉBEC À MONTRÉAL

APPLICATION SPÉCIALISÉE INTÉGRÉE POUR L'APPRENTISSAGE DE L'ADDITION CHEZ LES PERSONNES AYANT DES TROUBLES ENVAHISSANTS DE DÉVELOPPMENT DE HAUT NIVEAU

THÈSE
PRÉSENTÉE
COMME EXIGENCE PARTIELLE
DU DOCTORAT EN INFORMATIQUE COGNITIVE

PAR
AYDÉE LIZA MONDRAGON

SEPTEMBRE 2016

This research is dedicated to my children, Sébastian, Maria, and Stéphen. Thank you for the light you have brought into my life. You have been my inspiration. I love you. God bless you.

REMERCIEMENTS

Ce projet de recherche me tient à cœur. Il fait partie de ma vie et de la vie de ma famille proche. Depuis ses débuts, beaucoup de personnes ont contribué à sa réalisation. Je veux remercier Alejandro pour son endurance et son soutien inconditionnel. Je dois absolument remercier mes enfants autistes qui sont ma source de motivation et d'admiration. Leurs réussites sont ma source d'inspiration et leurs difficultés sont ma source d'apprentissage. Ils m'ont appris à vivre un jour à la fois.

Le domaine de l'éducation spécialisée pour les personnes autistes est un défi. Je veux remercier mes directeurs de recherche, M. Roger Nkambou et M. Pierre Poirier, de vos encouragements, de votre patience, de m'avoir écoutée et d'avoir soutenu mes idées ainsi que d'avoir façonné mes apprentissages pendant ce long parcours. Merci d'y avoir cru.

Mes remerciements spéciaux vont aux enfants autistes pour leur participation extraordinaire à cette recherche. C'est un honneur et un privilège pour moi de vous avoir rencontrés et d'avoir eu la chance de jouer avec vous le «*Chalkboard Game*.» Mes remerciements vont aussi aux parents que j'ai eu l'opportunité de rencontrer en entrevue. Merci d'avoir cru à cette recherche.

Je dois remercier M. Michel Léonard du LICEF de sa disponibilité et de ses commentaires judicieux, ainsi que Mme. Aude Dufresne de l'Université de Montréal d'avoir répondu à mes questions et d'avoir bien voulu m'accorder de son précieux temps de retraite et l'emploi des équipements pour la validation de cette recherche.

Je remercie Dr. Reski Lounnas, Dr. Correa, ainsi que Mme. Irene Whist pour leur collaboration à ce projet. J'aimerais aussi remercier, mes professeurs et professionnels en autisme, Dr Sylvie Bernard et Dr. Normand Giroux, pour leurs précieux commentaires.

ACKNOWLEDGMENTS

This research project is close to my heart. Since its inception, it is part of my life and of the life of my immediate family. Many people have contributed to its realization. I want to thank Alejandro for his endurance and his unconditional support. I must thank my autistic children who are my source of motivation and admiration. Their success is my source of inspiration; their difficulties are my source of learning. They taught me to live one day at a time.

The field of specialized education related to teaching autistic children is challenging. I want to thank my research directors, Mr. Roger Nkambou and Mr. Pierre Poirier for their encouragement, for their patience, for listening and for supporting my ideas. You have shaped my learning during the course of this project. Thank you for having believed in me.

My special thanks go to the autistic children for their extraordinary participation in this research. It has been an honor and privilege for me to have met you and to have had the opportunity to play 'The Chalkboard Game.' with you.

I want to thank the parents who I had the opportunity to meet and interview. Thank you for believing in this research.

I have to thank Mr. Michel Leonard from the LICEF for his availability and his insightful comments, as well as Mrs. Aude Dufresne from the University of Montreal for having responded to my questions and for kindly granting me her precious retirement time and the provision of equipment for the validation of this research.

Thank you to Dr. Lounnas, Dr. Correa, as well as to Mrs. Irene Whist for their precious time and collaboration in this research. I am grateful to my teachers and professionals in autism, Dr. Sylvie Bernard, and Dr. Normand Giroux for their support.

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ABSTRACT

Autism spectrum disorder (ASD) is "*A neurological disorder affecting the way the brain processes information and which can affect all aspects of the development of a person. Autism is four times more common in boys than in girls. The Autistic Spectrum Disorders (ASDs) are characterized by impairments in language and communication, in social interaction, in imaginative ability and by the presence of repetitive and restricted patterns of behavior.*" (DSM-IV).

This research contributes to the advancement of intelligent tutoring systems by proposing an affective intelligent tutoring system in the field of specialized education in order to overcome the lack of individualized intervention, such as in the field of specialized education for individuals with autism. The affective intelligent tutoring system ISLA is an adaptive application evolving along with the learner's needs. ISLA is unique and its contribution entails the model of accompaniment to help autistic children manage their emotions by analyzing the learning trace and considering the student's current performance in order to respond accordingly to it during a mathematical learning situation such as addition.

RÉSUMÉ

L'autisme est: '*A neurological disorder affecting the way the brain processes information and which can affect all aspects of the development of a person. Autism is four times more common in boys than in girls. The Autistic Spectrum Disorders (ASDs) are characterized by impairments in language and communication, in social interaction, in imaginative ability and by the presence of repetitive and restricted patterns of behavior'*. (DSM-IV).

Cette recherche contribue à l'avancement des systèmes tutoriels intelligents affectifs en proposant un système tutoriel intelligent affectif pour surmonter le manque d'intervention personnalisée dans le domaine de l'éducation spécialisée visant les personnes ayant des troubles envahissants du développement. ISLA est une application adaptative dans le domaine de l'éducation spécialisée qui évolue avec les besoins de l'étudiant. ISLA est unique et sa contribution comporte le modèle d'accompagnement pour aider les enfants autistes à gérer leurs émotions en analysant la trace d'apprentissage de l'étudiant et en permettant de répondre en conséquence afin d'aider l'étudiant autiste à calibrer ses émotions durant une situation d'apprentissage de mathématique telle que l'addition.

CHAPTER I

INTRODUCTION

1.1. Motivation

My motivation and inspiration to pursue this research project comes from my own experiences as a mother of three autistic children whom I deeply love and admire. Each of them has different special needs that have to be addressed. Despite the challenges that they face in their daily lives, they are continuing to persevere and demonstrate remarkable courage and progress. My journey along the spectrum of autism started with the diagnosis of my son at the age of 36 months. The signs of autism became apparent at the age of 18 months. He had no verbal skills, poor eye contact, and severe behavioural difficulties interfering with his learning. School integration was not an option because of his behaviour issues. Then my daughter was diagnosed with autism. In contrast to her brother, her language skills had been preserved. My oldest son was diagnosed at age 4 with severe dysphasia, but at age 10, he was diagnosed with autism. While science is trying to figure out what causes autism, parents are left alone on this difficult journey to figure out how to support and help their children to deal with their challenges on a daily basis. When having children with learning disabilities, one has to choose one's own battles. Though it does not mean denial, my children are a blessing. I believe in their potential and I chose the battle of educating them. My question was: How do I teach them? My professional background has been in information technology as an analyst in business process reengineering. I studied autism to be able to help my children and I hold a "Diplôme d'études supérieures spécialisés" (Diploma of specialized graduate studies). I remember, when my oldest son at the age of 5 years old said to me in French: "Je ne comprends pas les mots" (I cannot understand the words). He made a drawing for his teacher and said to her: "J'aimerais avoir le cerveau d'une tortue, ça va trop vite. Je comprends les numéros" (I wish I could have the brain of a turtle, it goes too fast, I understand numbers). My second son, after countless hours of intervention in ABA and speech therapy to teach him French, by age 6, his total French vocabulary was about 15 words. At the age of 6 years old, services were terminated at the readaptation center. His prognosis was that he might not be able to speak. I modeled his behaviour and I reengineered his curriculum by breaking it down to the smallest learning unit. He started to talk at the age of 8 years old only in English. With the use of technology, I developed a simple application through the use of computerized flash cards to teach him English. Though he is not a receptive or an expressive learner, he is visual.

The reason for this research is the hope that education will bring light to their lives and opportunities to overcome the challenges faced by children on the spectrum of autism. Children living with autism spectrum disorders are genuine and unique in their skills and abilities. They deserve to be educated to their full potential. They need to be integrated with respect and dignity into our society, not isolated.

1.2. Various Components of the Thesis

Individuals with ASD usually display particular communication and social deficits (Diagnostic and Statistical Manual of Mental Disorder, 2000). These characteristics cover a wide spectrum, with individual differences in terms of age of onset, levels of functioning, challenges with social interactions, and particular kinds of symptoms ranging from mild to severe. In the educational system, the lack of one-on- one intervention as it pertains to the domain of specialized education related to autism pose a "complex multi-factor" problem. Emotions and learning have been broadly recognized as challenging among individuals diagnosed with autism. The socio-cognitive and behavioural problems experienced by individuals with ASD are considered to stem from the difficulty of understanding others' mental states (Baron-Cohen, Leslie et al., 1985; Frith, 1999). The lack of joint attention displayed by individuals with ASD is regarded as a necessary 'precursor' to a 'developmental building block' (Tomasello, 1995). Thus generalization of gains is difficult to maintain for children on the spectrum (Green, Charman et al., 2010). Within the domain of intelligent tutoring systems, Azevedo (2009) points out that the companion agent has the potential of providing students of all ages with information that will help the student to become self-regulated and to consequently become independent learners. Here, we present an affective intelligent tutoring system (ISLA) to overcome the problem of one- on-one intervention with the purpose of helping the ASD learner to calibrate his/her emotions during mathematical learning.

This paper is divided into seven sections. Chapter I covers the introduction. Chapter II explains the Autistic Spectrum Disorder (ASDs) and different types of autism are described, such as Pervasive Developmental Disorder (PDD-NOS), Autism, and the Asperger's Syndrome (Diagnostic and Statistical Manual of Mental Disorder, 2000). Then, we address the self-regulated learning theory consisting of three main components: cognition, metacognition, and motivation (Schraw, Olafson et al., 2002). In the following chapter, we present intelligent tutoring systems (ITS) and affective intelligent tutoring systems (AITS) literature, focusing on the student model and learning process. Several techniques and approaches will be presented regarding the study, detection, and induction of emotions using sensors and smart interfaces. Cognitive diagnosis (CD) and adaptation within the framework of the affective intelligent tutoring systems (AITS) and specialized education related to autism will also be addressed.

Chapter V is devoted to the specific architecture of the Integrated Specialized Learning Application (ISLA) presenting the domain model and the model of accompaniment of ISLA. The learner model and the pedagogical model, as well as the conception and development of ISLA are presented. Chapter VI deals with the methodology, the preliminary study, and the implementation of ISLA, and the prototype is also presented. The prototype was validated with a larger group of twelve participants with high functioning autism in which, one controlled group of six students interacted without the pedagogical agent Jessie, while the test group of six participants interacted with the pedagogical agent Jessie. Finally, Chapter VII deals with the conclusion, limitations, and contribution of this study in the field of AITS which pertains to the domain of specialized education.

1.3. The Research Question

The very question being addressed in this study is:

How do we develop a virtual companion capable of establishing the affective state of an autistic child in a mathematical situation such as addition so as to respond effectively to it?

1.3.1 Two important questions are considered:

1) *What is the affective state and performance of the ASD student during a learning situation such as addition without the use of a pedagogical agent such as ISLA?*

2) *What is the affective state and performance of the ASD student during a learning situation such as addition with the use of a pedagogical agent such as ISLA?*

CHAPTER II

AUTISM SPECTRUM DISORDER

2.1. The problem

As reported in literature, autism is considered to be a 'heterogeneous' condition because no two children or adults on the spectrum have exactly the same profile (Diagnostic and Statistical Manual of Mental Disorders, 2000). This is because every child diagnosed with an autism spectrum disorder is unique. As such, teaching techniques should be 'individualized' and one-on-one intervention should be tailored to meet each child's special needs (Seip, 1994). Research carried out in the United States and in Canada pertaining to the prevalence of autism spectrum disorder (ASD) reveals an increasing trend in the occurrence of autism. For instance, in Canada, the recent estimate (March, 2014) by the Centre for Disease Control (CDC) and Developmental Disabilities Monitoring (ADDM) suggest that 1 in every 68 children is born with an Autism Spectrum Disorder (ASD). According to Woolf, Arroyo et al., (2010), learning disabilities pose a "complex multi-factor" problem in the educational system, as most educational institutions do not have the necessary tools to provide extra time for learning-related tasks or cost-effective instruction tailored to each individual. In fact, studies suggest that individuals with learning disabilities (LD) who require extra resources comprise 13% percent of all students in the USA (NCES 2009). The problem stems from the fact that in the educational system, one-on-one intervention is difficult to implement due to budgetary and human constraints. As a result, students are not being educated to their full potential. Students with LD develop more negative feelings towards math, choose less advanced math classes in high school, and are later under-prepared for science and math careers (Woolf, Arroyo et al., 2010). The outcome is that of a significant negative impact not only on the lives of these students, but on society as a whole.

2.2. Autism Spectrum Disorder (ASD)

The term "autism" originates from the Greek word "*autos*" for "self." It was introduced around 1911 by Swiss psychiatrist, Dr. Paul Eugen Bleuler to describe a group of symptoms of "schizophrenia." For many decades, researchers and professionals believed that "autism" and "schizophrenia" were linked together (Autism and PDD Support Network: History of Autism; Neurodiversity.com: Library of the History of Autism Research; Behaviorism & Psychiatry). In his article, "Autistic Disturbances of Affective Contact" Leo Kanner (1943) from Baltimore Johns Hopkins University in the United States, used the term "autism" to explain the introverted behaviour or social problems among several children (Wing, 1981). Similarly, Hans Asperger (Asperger & Frith, 1991) published, in Vienna in 1944, a definition of the "autistic psychopathic." He identified patterns of behaviour and abilities in four boys, similar to those described by Leo Kanner (1943) which included 'a lack of empathy, little ability to form friendships, one-sided conversations, an intense absorption in a special interest as well as clumsy movements' (Attwood, 1997; Autism Society of America). English researcher Lorna Wing (1981) took the position of challenging Leo Kanner's model of autism, which he presented in 1943, and described conditions related to Asperger's Syndrome in her article: *"Asperger's syndrome: a clinical account."* In 1991, German psychologist Utah Frith published a scientific translation on the topic of Asperger's (Frith, 1991). His work, along with Lorna Wing's research, jointly contributed to the inclusion, in 1993, of "Asperger's Syndrome" in the International Statistical Classification of Diseases and Related Health Problems (ICD-10) and in the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) in 1994, both of which served as foundation to the modern study of autism.

2.3 Pervasive Developmental Disorders (PDD)

The term "spectrum" refers to a continuum of severity or developmental impairment as it pertains to ASD. It is characterized by delays in socialization and communication (DSM-IV). As illustrated in Figure 2.1, there are, in fact, five Autism Spectrum Disorders, described under this diagnostic category of Pervasive Developmental Disorders (PDD), which appear in the (Diagnostic and Statistical Manual of Mental Disorders 2000). For the purpose of this research project, we will focus on the three primary categories of Autism Spectrum Disorder (ASD), namely PDD-NOS, Autism and Asperger Syndrome.

2.4. What is the Autism Spectrum Disorder (ASD)?

In literature, autism is considered a heterogeneous condition because no two children or adults in the spectrum have exactly the same profile. Children and adults with ASDs usually display particular communication and social deficits (DSM-IV, Lord, Cook et al., 2000). These characteristics cover a wide spectrum, with individual differences in terms of: age of onset, levels of functioning, and challenges with social interactions, and particular kinds of symptoms varying from mild to severe. Figure 2.1 shows the areas of the brain affected by autism. According to the Diagnostic and Statistical Manual of Mental Disorders of the American Psychiatric Association (DSM 5, as of May 2013*)*, autism is: "*A neurological disorder affecting the way the brain processes information which can affect all aspects of the development of a person. The Autistic Spectrum Disorders (ASDs) are characterized by impairments in social interaction, communication, and the presence of restricted repetitive, and/or stereotyped patterns of behavior.*"

2.5. Types of Autism

As shown in Figure 2.2, when speaking of Autism Spectrum Disorders, most people are referring to three of the most common PDDs, which we briefly present below.

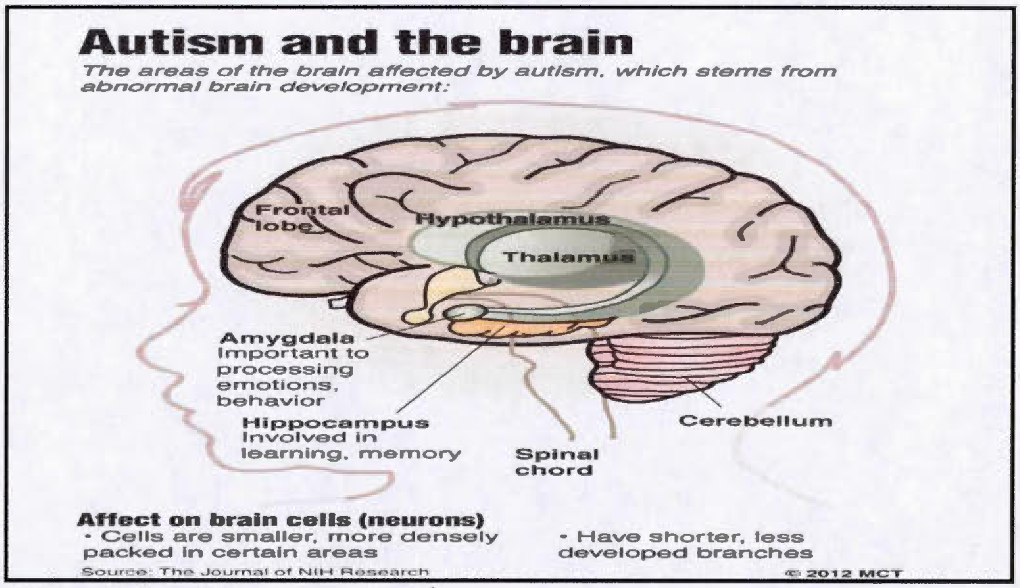

Figure 2.1 Autism and the brain[1]

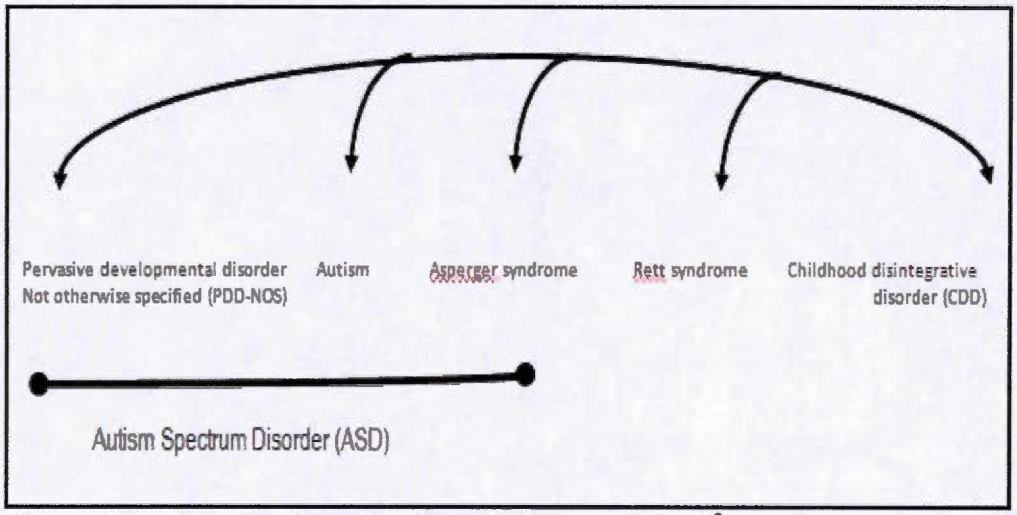

Figure 2.2 Pervasive Developmental Disorders (PDD) [2]

[1] Source: The journal of National Institute of Health (NIH) Research

[2] Source: Diagnostic and Statistical Manual of Mental Disorders (DSM-IV)

2.5.1. Pervasive Developmental Disorder - Not Otherwise Specified(PDD-NOS)

PDD-NOS is often called atypical autism because the criteria for an autistic disorder are not met due to a late age of onset, atypical "symptomatology", sub- threshold "symptomatology" or because of all three of these (National Dissemination Center for Children with Disabilities, October 2003, Lord, Cook et al., 2000).

Although PDD-NOS is considered in some individuals with ASD, to be a "milder" condition than typical autism, this is not always the case. Indeed, research has revealed that even though some characteristics of PDD-NOS may be milder than those of ASD, others may be more severe (National Autism Resources). PDD-NOS is a diagnosis which is given when a patient displays "severe and pervasive impairment" in the development of reciprocal social interaction, verbal and nonverbal communication skills, or when stereotyped behavior, interests and activities are present. However, these criteria are not met for a specific 'PDD' or for several other disorders (Autism Society of America; Council on Children with Disabilities, 2007).

2.5.2. Autism

The second disorder described under the diagnostic category of Pervasive Developmental Disorders (PDD) appearing in the (DSM-IV) is autism. The diagnostic and Statistical Manual of Mental Disorders indicates that generally the symptoms become apparent before a child reaches the age of 3. In some cases, the child shows "normal development" early on and then starts regressing between the ages of 12 and 24 months. Autism affects the way that information is processed in the brain by altering the connection and organization of the nerve cells and their synapses. Many researchers and professionals define it as a "disorder of neural development." Others describe it as "Une autre intelligence" (Mottron and Belleville, 1993), characterized by a qualitative impairment in social interaction, marked by difficulties in the use of multiple nonverbal behaviours such as eye-to-eye gaze, facial expression, body postures, and gestures for the regulation of social interaction. Also, qualitative impairments in communication are shown by a delay, or even by a total lack of development with respect to spoken language. In some individuals with age- appropriate speech, marked impairment may be present in their lack of ability to initiate and/or sustain a conversation with others, as well as in their stereotyped and repetitive use of language, and in their idiosyncratic language (DSM-IV). Furthermore, individuals with autism often show restricted, repetitive, and stereotyped patterns of behaviour, interests and activities, such as encompassing preoccupation with one or more stereotyped and restricted patterns of interest. That is, abnormal either in intensity or in its apparently inflexible focus on adherence to specific, non-functional routines or rituals, stereotyped and repetitive motor mannerisms such as hand or finger flapping, twisting and/or complex whole- body movements, and a persistent preoccupation with parts of objects (DSM-IV).

2.5.3. Asperger's Syndrome

The third disorder described under the diagnostic category of Pervasive Developmental Disorders (PDD), which appears in the (DSM-IV), is Asperger Syndrome (AS). Aspergers's syndrome is named after the Austrian pediatrician Hans Asperger, who, in 1944, studied and described children lacking nonverbal communication skills and who demonstrated limited empathy with their peers and operated with physical clumsiness (Attwood 1997; Autism Society of America; Frith 1999). Asperger's Syndrome varies from other autism spectrum disorders because of the relative preservation of linguistic and cognitive development that individuals with this disorder display. Even though they are not considered criteria for a diagnosis of AS, physical clumsiness and atypical (peculiar, odd) use of language are often described (McPartland & Klin 2006; Baskin, Sperber et al., 2005). Researchers question whether AS is different from high- functioning autism (HFA), mainly because of its prevalence, which is not firmly established (Klin & Jones, 2006). In 2012, it was decided that the Asperger's diagnosis would be eliminated in the DSM-5 and replaced by a diagnosis of Autism Spectrum Disorder on a severity scale (DSM-5 Development, American Psychiatric Association).

2.6. What causes autism?

Several causes of autism have been suggested in literature. Many researchers and professionals point out that autism might be related to different factors such as "genetics" (Freitag, 2007; Folstein & Rosen- Sheidley, 2001; Sykes & Lamb, 2007; Happé & Ronald, 2008; Dufour-Rainfray, Vourch et al., 2011) as well as childhood "vaccines" (Persico and Bourgeron, 2006; Fombonne, Zakarian et al., 2006), and "environmental causes" (Bulletin of the World Health Organization, 2008). However, for many researchers, the relationship between "theory of causation" and autism spectrum disorders remains uncertain (American Medical Association, 2004; US Food and Drug Administration, 2012). The following section presents some of these important factors in more detail.

2.6.1. Genetics

The genetics of autism are "complex" (Freitag, 2007). According to the World Health Organization, the term "genetics" describes "*the study of heredity and of the mechanisms by which genetic factors are transmitted from one generation to the next. Dysfunctional genes, or gene mutations, can cause illness, and can be passed from parents to children. In addition, some people have a genetic, or inherited, predisposition to certain diseases, such as cancer, diabetes, cardiovascular disease, and mental disorders.*"

Studies suggest that different "genes" (Sykes & Lamb, 2007) might be associated with autism spectrum disorders and a number of "candidate genes" have been located (Persico & Bourgeron, 2006). For instance, some researchers claim that autism has a strong genetic background explained by rare "mutations" or by rare combinations of common genetic variants (Lord, et al., 2000; Beaudet, 2007). In fact, the most significant genetic finding related to autism is the recent identification of the gene responsible for Rett's syndrome (Amir et al., 1999). Autism spectrum disorders have also been found in a substantial minority of patients with full mutations of the Fragile X (FRAXA) gene FMR1 (Lord, Cook et al., 2000). Researchers claim that the sibling recurrence risk is approximately 4.5%, relative to a population incidence and estimated prevalence of approximately 0.1%–0.5%. Studies have demonstrated compelling evidence that autism spectrum disorders are inherited, having a greater than 50% concordance rate for monozygotic twins relative to a ~3% concordance for dizygotic twins (Lord C, et al., 2000). Recent research in molecular genetics is focusing on the identification of molecular genetic variation using candidate genes, including a family-based association and linkage finding between the serotonin transporter promoter gene insertion/deletion polymorphism and autism disorders. Other studies related to the genetics of autism reveal that chromosomal disorders may play a role. Specifically, a maternal duplication of 15q11-q13 is frequently found (0%– 3%) to be involved. These findings demonstrate that similar genetic anomalies are related to two other developmental disorders associated with mental retardation. Thus, absent maternal gene expression or "mutation" of ubiquitin binding enzyme 3A (*UBE3A*) is responsible for Angelman syndrome and the absence of paternal chromosomal gene expression leads to Prader-Willi syndrome (Autism Society of America).

2.6.2. Environmental factors

Other hypotheses related to the causes of autism are based on "environmental causes", such as heavy metals, pesticides or childhood vaccines, including the triple vaccine for measles, mumps, and rubella (MMR) (Kawashima, et al., 2000; Wakefield, Anthony et al., 2000; World Health Organization, 2006; US Food and Drug Administration, 2012). Some cases of autism have been reported by parents whose children have demonstrated some ability to speak and engage in other social and communicative actions prior to the second year of life. Such cases occur in about one fifth of children diagnosed with an autism spectrum disorder. Due to the age of onset of the disorder in these cases, it has been speculated that autism may possibly be linked to vaccinations. The vaccine theory was based on research conducted by (Wakefield, Anthony et al., 2000) which has been highly criticized by the scientific community as being "fraudulent" (Godlee, Smith et al., 2011). As a result, several epidemiological studies were conducted in different countries with comprehensive health registers and have not found convincing scientific evidence to support a link between MMR vaccines and autism (Bulletin of the World Health Organization, 2008).

2.7. The prevalence of autism

In the last decade, research carried out in the United States and Canada concerning the prevalence of autism spectrum disorder (ASD) revealed an increasing trend in the occurrence of autism. According to the Center for Disease Control (CDC), a comparison of the incidence rates for 2008 in the United States suggests an increase in ASD prevalence of approximately 23% compared with the 2006 estimates and 78% compared with 2002. Importantly the increase from 2002 to 2008 was observed among Hispanic children, non-Hispanic black children, and children without co-occurring intellectual disability alike. In Canada the recent estimates (March 2014) by the Centre for Disease Control (CDC) and the Developmental Disabilities Monitoring (ADDM) suggest that 1 in every 68 children is born with an Autism Spectrum Disorder (ASD). There are many controversies surrounding ASD among researchers. The lack of scientific evidence regarding the causes of autism is mainly due to the fact that the underlying questions regarding diagnosis have not been answered and because scientific evidence addressing the rise in incidence is lacking. In May 2013, the American Psychiatric Association (APA) completed the fifth edition of theDiagnostic and Statistical Manual of Mental Disorders (DSM 5). This new version brings in a new diagnostic category called 'Autism Spectrum Disorder' that takes the place of the previous diagnoses of Autistic Disorder, Asperger's Disorder, and PDD-NOS (Pervasive Developmental Disorder-Not Otherwise Specified). The dramatic increase in ASD prevalence rates has resulted in more attention and overseeing of ASD. In this respect, Health Canada, in 2012 and along with the Autism Society of Canada, has highlighted the necessity of implementing such monitoring in terms of risk factors, etiology, and effective interventions which are essential to the treatment of autism.

2.8. Conclusion

The preceding sections have covered the Autistic Spectrum Disorders (ASDs) characterized by impairments in language and communication, social interaction, imaginative ability, and in repetitive and restricted patterns of behavior. Several causes of autism have been postulated, including "genetics", childhood "vaccines", and "environmental causes" among other factors. Different types of autism have been described, such as Pervasive Developmental Disorder (PDD-NOS), autism, and Asperger's syndrome. These conditions cover a wide spectrum, with many individual differences. The next part of this chapter will be related to metacognition and learning, for which different theories will be presented. The self-regulated learning theory is intended to enhance the autistic student's positive behavior in order to facilitate metacognition, motivation, and thus, the learning process.

CHAPTER III

METACOGNITION AND LEARNING

3.1. Introduction

Researchers explain that metacognition is "complex" requiring an understanding and a control of cognitive processes, that take into account planning, monitoring and evaluating activities (Jacobs & Paris, 1987). Different frameworks are proposed for the understanding of metacognition. In spite of this, covering such a large amount of research is beyond the scope of this research project. Therefore, for the purpose of this paper, the next part presents the self-regulated learning theory, showing the essential role that metacognition plays in self-regulation and learning (Baird & White, 1996; Nichols, Tippins et al., 1997). Accordingly, Section 3.3 presents a framework which brings to light different strategies to enhance self- regulation.

3.2. The role of the Self-Regulated Learning theory (SRL)

3.2.1. What is Self-Regulated Learning theory (SRL)?

To begin with, self-regulated learning refers to our ability to understand and control our learning environments. As observed in Figure 3.1, the self-regulated learning process consists in three main components: cognition, metacognition, and motivation (Schraw, Olafson et al., 2002).

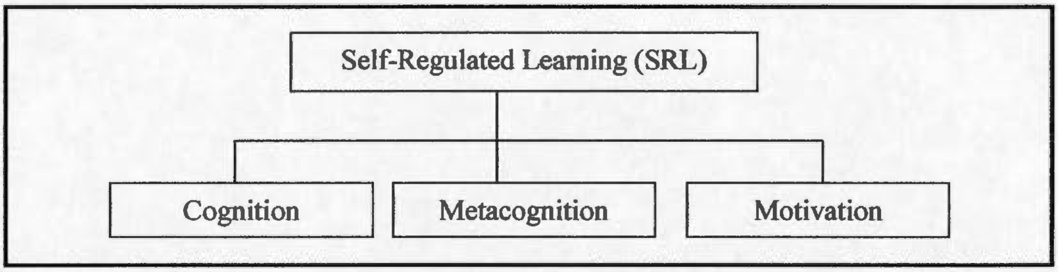

Figure 3.1 Components of self-regulated learning[3]

The researchers who developed the SRL suggest that although each component is necessary, they are, however, individually insufficient to achieve self-regulation. For example, studies reveal that students who possess cognitive skills are not necessarily motivated to use them. As a result, they do not achieve the same level of performance achieved by students who have cognitive skills and who feel motivated to use them (Zimmerman, 2000).

3.2.2. Cognition

The first component of self-regulated learning deals with cognition. As illustrated in Figure 3.1, cognition takes into account three types of learning skills, which are problem-solving, simple strategies, and critical thinking. Cognition concerns skills required for encoding, memorizing, and retrieving information. Several strategies, which were developed with the intention of enhancing cognitive learning strategies, are proposed to students and to teachers. Some examples of such strategies are: 1) The use of student-generated questions in order to draw the learner's attention (Chinn & Brown, 2002, Kahle & Boone, 2000). 2) The application of active learning strategies, such as the use of graphs and tables (House, 2002), and 3) The handling of close assessment tasks, such as the Koch–Eckstein's technique, which encourages deeper understanding (Koch, 2001).

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[3] Source: Schraw, Olafson et al., (2002)

Regarding problem-solving strategies, there exists a technique developed by (Rickey & Stacy, 2000), which is called the predict-observe-explain (POE) technique. Studies reveal that problem-solving can be further broken down into smaller individual tasks, which can be teachable and which can improve learning (Peterson & Treagust, 1998). The third cognitive strategy is concerned with critical thinking. This can be enhanced through instruction (Baird & White, 1996) by engaging in several skills, such as the person's ability to recognize the source of information, its credibility, reflect upon its relevance to his/her previous knowledge, and finally draw a conclusion based on his/her critical thinking (Linn, 2000).

3.2.3. Metacognition

With these concepts in mind, the question is: What place and role does metacognition play in learning? Metacognition takes into account the skills that enable learners to understand and monitor their cognitive processes. According to (Hartman & Sternberg, 1992), there are four general ways to increase metacognition in classroom settings. These include promoting general awareness of the importance of metacognition, improving knowledge regarding cognition, improving the regulation of cognition, and fostering an environment that promotes metacognitive awareness. These authors claim that there is a significant difference between two important components of metacognition such as cognition knowledge and cognition regulation. Cognition knowledge is related to what individuals know about their own cognition or about cognition in general. It consists in three different kinds of metacognitive awareness known as: metacognitive declarative, metacognitive procedural, and metacognitive conditional knowledge (Brown & Palincsar, 1989; Jacobs & Paris, 1987; Schraw and Moshman, 1995). Metacognitive declarative knowledge is concerned with the knowledge about oneself as a learner and about the different factors that may influence one's performance. Metacognitive procedural knowledge entails knowledge about "how" to do things, and it plays an important role in learning because students who have a high degree of metacognitive procedural knowledge tend to carry out their tasks more automatically. They are also more likely to use qualitatively different strategies for effective problem-solving (Pressley, Borkwski et al., 1989). Metacognitive conditional knowledge refers to knowing when and why to use metacognitive declarative and metacognitive procedural knowledge (Garner, 1990). It has strongly been suggested that metacognitive conditional knowledge is the key to learning, as it helps students allocate their resources selectively and to adjust to the changing situational demands of each learning activity (Reynolds, 1992). Cognition regulation provides a set of activities and helps students to be responsible for their own learning. Research reveals significant improvements in learning when regulatory skills and understanding of how to use these skills are included as part of classroom instruction (Brown & Palincsar 1989). In this regard, Sternberg (1985) explains that metacognition can be viewed as part of the concept of developing expertise for school success. He provides a list of expertise characteristics that are important in learning such as time allocation, representation development, strategy selections, difficulty prediction, and monitoring. These characteristics are components of metacognitive functioning and expertise development used among students. Also, abilities are typically seen as precursors to expertise (Chi, Glaser et al., 1988). For instance, it is believed that when employing a testing procedure, we are testing a form of expertise, regardless of the academic achievement or skill involved in solving a particular math problem.

3.2.4. Motivation

In the realm of education, motivation plays an important role in learning. One major issue faced by teachers is how to effectively motivate their students. However, we must first consider the question, What is motivation? Williams, Burden et al., (2001) define motivation as: "*A state of cognitive and emotional arousal, which leads to a conscious decision to act and which gives rise to a period of sustained intellectual and/or physical effort in order to attain a previously set goal (or goals).*"

According to Vicente and Pain (2003), inferring the motivational state of a student is a complex task. These authors claim that Intelligent Tutoring Systems (ITS) would take advantage of being able to adjust their tutoring task not only to the student's “cognitive state” but also to their “motivational state.” They propose that “motivational diagnosis” should be made when trying to assess a student's motivational state, rather than utilizing ‘motivational planning’ when concerned with planning instruction in order to motivate the student. In their study, they obtained many knowledge rules related to the detection of a motivational state of a student by a tutoring system. The motivational criteria set by these researchers contains nine criteria such as control, challenge, independence fantasy, confidence, sensory, interest, cognitive interest, effort, and satisfaction. In addition, motivation consists of self-efficacy and epistemological beliefs affecting the use and development of cognitive and metacognitive skills.

Self-efficacy plays an important role in self-regulated learning because it affects the degree to which students engage in and persevere at challenging tasks. In fact, studies have shown that, contrary to low efficacy students, those with higher self- efficacy tend to persevere on a task, even when faced with initial failures (Pajares, 1996). As a result, a higher degree of self-efficacy is positively associated with school achievement and self-esteem. Bandura (1997) explains that self-efficacy relates to the degree to which an individual is confident that he/she can perform a specific task and/or achieve a specific goal. Self-efficacy is affected by a number of variables, one being modeling. When learners intentionally acquire a learned behaviour from other individuals, i.e. teachers and students, they are said to model such behaviour. An example of modeling is when a teacher breaks down a difficult task into smaller activities and then has students show their ability in demonstrating each task separately in sequence. Bandura (1997) has highlighted the importance of modeling since it increases the expectations that a new strategy can be acquired and does so by providing a great deal of knowledge about the skill. Another strategy proposed to increase the students' self- efficacy uses teacher and non-expert (students) peer models. Peer models are usually most effective because they are often similar to the learner (Schunk, 1996). Providing as much informational feedback as possible in order to increase motivation, performance and self-efficacy has also been recommended, especially for students experiencing difficulty in performing a task.

Epistemological beliefs as shown in Table 3.1 concern the origin and nature of knowledge. In this sense, studies have revealed a relationship between epistemological beliefs and scientific problem solving (Neber & Schommer-Aikins, 2002). In the following section several strategies leading to self- regulated learning will be presented.

3.3. Strategies enhancing Self-Regulated Learning (SRL)

Table 3.1 presents a framework with different strategies proposed in literature to enhance self-regulation, thereby improving learning in science education (Schraw, Olafson et al., 2002). These proposed strategies are: (1) Curriculum change and the use of inquiry based learning, (2) The role of collaborative support, (3) Strategy and problem solving instruction, (4) The construction of mental models, (5) The role of personal beliefs, such as self-efficacy and epistemological world views, and (6) The use of technology to support learning.

3.3.1. Curriculum change and inquiry-based learning

Inquiry learning is a course of action in which students are engaged in learning by the use of a process-oriented approach to pose questions and construct solutions (Gunstone & Mitchell, 1998). Inquiry teaching plays an important role in learning since it encourages self-regulation in two ways. First, it stimulates the students' active engagement in the learning process by using cognitive learning and metacognitive strategies which monitor their understanding. Second, it acts as an aid to increase their motivation for being successful in science which is achieved by modeling active investigation strategies such as Predict–Observe–Explain (POE) (Kearney, 2002), or question-asking (Chinn & Brown, 2002).

Table 3.1

Strategies to enhance Self-Regulated Learning (SRL)[4]

Instructional strategies increase cognitive, metacognitive			
Strategies	**Cognitive**	**Metacognitive**	**Motivational**
Curriculum change and the use of inquiry based learning.	Promotes critical thinking through experimentation and reflection.	Improves explicit planning, monitoring, and evaluation.	Provides expert modeling.
Collaborative support.	Models strategies for novices.	Models self-reflection.	Provides social support from peers.
Strategies and problem-solving	Provides a variety of strategies	Helps students develop conditional knowledge	Increases self-efficacy to learn.
Mental models.	Provides explicit models to analyze.	Promotes explicit reflection and evaluation of the proposed models.	Promotes radical restructuring and conceptual change.
Personal beliefs, self-efficacy.	Increases engagement and persistence among students.	Promotes conceptual changes and reflection.	Promotes modeling epistemology characteristics of expert scientists.
The use of technology	Illustrates skills with feedback. Provides models and simulates data.	Helps students test, evaluate, and revise models.	Provides informational resources and collaborative support.

3.3.2. Collaborative Support

Collaborative support strategies are comprised of tutors or small collaborative work groups. On one hand, studies have revealed that peer tutors who are considered to possess comparable levels of ability to those of their students actually enhance the students' declarative and procedural knowledge, as well as their self-efficacy (Pajares, 1996). On the other hand, expert mentors (teachers) can help novice students to build up expertise and metacognitive understanding in a particular domain (Ramaswamy, Harris et al., 2001). Along these lines, the Thinking Aloud Together (TAT) program is an example of a cooperative learning group that was designed to promote metacognition and self-regulation

[4] Source: Schraw, Olafson et al., (2002)

in a small collaborative group setting (Hogan, 1999).

3.3.3. Strategies and problem-solving

Strategy instructions are also important to enhance self-regulation and thus improve learning. By helping students to focus their attention in a more selective way, strategy instructions enable students to better integrate information in a broad conceptual model for problem solving. Linn (2000) has taken the position by presenting three key general goals leading to success in science education. 1) making thinking visible. 2) helping students learn from each other, and 3) promoting lifelong scientific learning. To achieve these goals, Linn proposes the Knowledge Integration Environment (KIE) framework based on the idea that learners use support skills that allow them to integrate multiple sources of information into an unified framework of knowledge. Other scientific researchers have elaborated on this framework resulting in a set of strategies designed to improve content learning (Brooks & Crippen, 2001; Kahle & Boone, 2000), as well as metacognitive awareness (Beeth, 1998). For instance, the work of (Baird & White, 1996) presents four components, as part of their Project for Enhancing Effective Learning (PEEL), that emphasize increasing time and opportunities for learning, teacher guidance and student support.

3.3.4. Mental models

Another important strategy that enhances self-regulation is the use of mental models. According to Hogan & Thomas (2001), mental models are essential as they help thinking metacognitively about complex systems, mainly because learners often encounter obstacles reflecting complex phenomena without mental models. As a result, they find it difficult to examine and self-regulate their own learning. These authors have presented a number of differences between experts and novices when constructing mental models of a scientific phenomenon. They propose four components that deal with the model-construction process: construction, quantification, interpretation and revision models. Both authors argue that experts, who build mental models, emphasize the dynamic interrelationships within the model, whereas novices focus more particularly on isolated component variables. The discrepancies between experts and novices might be explained by experience and accessibility to skilled mentors, as well as by modeling epistemology and the experts' or novices' beliefs about the utility and credibility of models (Hogan & Thomas, 2001).

3.3.5. Self-efficacy and epistemological belief

As illustrated in Table 3.1, another important strategy for improving self- regulation, which plays a significant role for both students and teachers, deals with self- efficacy and epistemological beliefs and aims at encouraging students' and teachers' motivation (Elby & Hammer, 2001; Neber & Schommer-Aikins, 2002). According to Bandura (1997) self-efficacy refers to the degree to which individuals feel capable of accomplishing a particular task or goal. Students with a higher level of self-efficacy are more consistent, become more engaged in a difficult task, and when faced with setbacks, demonstrate greater persistence. Another strategy is modeling, which helps students increase their self-efficacy (Pajares, 1996), as well as their metacognitive skills (Kuhn, 2002). Strategy instruction also improves self-efficacy (Pressley, Goodchild et al., 1989), self-regulated learning (Butler & Winne, 1995), and metacognitive awareness (Schraw & Moshman, 1995). Epistemological beliefs refer to individuals' beliefs about the origin and nature of knowledge (Reiner & Gilbert, 2000). What stands out from the literature is that teachers' epistemological beliefs have an impact in their curricular and pedagogical decisions (Reybold, 2001; Olafson & Schraw; 2002). Teachers who support realistic beliefs are expected to rely on textbooks, and on standardized curriculum, and to use conventional texts, while minimizing field experiences, limiting the role of hypothesis testing and thought experiments (Elby & Hammer, 2001; Neber & Schommer-Aikins, 2000; Beeth, 1998; Reiner & Gilbert, 2000). Teachers who are portrayed as having sophisticated epistemological beliefs are more likely to promote inquiry and argument by using specific strategies, such as debate, by generating and by critiquing arguments, as well as by promoting group-based projects which facilitate the process of synthesizing ideas (Roth, McRobbie et al., 1997). Studies have also revealed that expert science teachers may promote sophisticated reasoning and argumentative skills through co-teaching (Roth & Tobin, 2002). As outlined in Table 3.1, a further important strategy that increases self-regulation deals with the use of technology. This important strategy will be presented in Chapter IV, Section 4.4.1.

3.4. The relationship between emotions and learning

The relationship between emotions and learning, as it pertains to the domain of specialized education, has been broadly recognized among researchers. The socio-cognitive and behavioral problems experienced by individuals with ASD are considered to stem from the difficulty in understanding others' mental states (Baron-Cohen, Leslie et al., 1985). In fact, the lack of joint attention displayed by individuals with ASD is regarded as a necessary "precursor" to a "developmental building block" (Tomasello, 1995). Studies have revealed that recognizing the possible behaviours that may indicate an autistic child's affective states, such as happiness, boredom, frustration, as well as cognitive states related to attention, curiosity, and understanding are essential for effective intervention for the child (Picard, 2009). As a result, "generalization" of gains is difficult to maintain for children in the spectrum (Green, Charman et al., 2010). Along these lines, (Rao, Beidel et al., 2008) explain that the "efficacy" of an intervention must be determined by means of more single- case and open trial designs within a specific learning task (Whalen & Schreibman, 2003). Other researchers consider emotions essential for "adapting to unpredictable environments" (Oatley & Johnson-Laird, 1987). Rolls (2000) points out that emotions might be triggered by different factors involved in "motivation", "communication" or "survival."

Damasio (2008), on the other hand, provides a theory called the "Somatic Marker Hypothesis" (SMH) by which emotional processes are able to guide (or bias) behavior mostly in decision-making. The idea is that "somatic states" play an important role in dealing with emotions. According to the authors, "emotions" are characterized as changes involving body and brain states in response to different physiological stimuli, such as muscle tone, heart rate, endocrine release, posture, and facial expression, among others. As a result, when a "somatic marker" associated with a positive outcome is perceived, the person might experience happiness and in this manner be motivated to engage in a particular behaviour. By contrast, when a "somatic marker" associated with a negative outcome is perceived, the person might experience sadness which triggers an internal alarm so as to advise the individual to avoid a course of action. Similarly, Chaffar & Frasson (2005) define "emotions" as: *"the consequence and display of a feeling."* In this context, emotion is a "visible" or "measurable" consequence of a feeling that is comprised of a set of emotional states which can trigger different reactions (heart rate, transpiration, skin conductivity, muscle tension, and blood pressure).

To better understand the relationship between emotions and learning, the author provides several definitions that are important to keep in mind.

> *A feeling is an internal perception of a situation (or sensation) which is compared with previous experiences. Feelings (and ability to feel) differ from one individual to another as the volume and variety of previous sensations is different. They need an evaluation of a given situation.*
>
> *An affect is a stimulation state or instinct able to change or provoke affective situations or experiences; affects are unconscious, without individual control. Successive affects will create different feelings according to the time. As a result, it is a physiological property of the body to generate intensities of affective situations. In other words, an individual can affect or be affected.*

3.4.1. Emotions and autism

Some individuals with learning disabilities (LD) such as Autism Spectrum Disorder (ASD) have difficulty processing their own and other's emotions. The theory of mind has been broadly studied in both individuals with and without ASD (Baron-Cohen, 2001). According to these researchers, possessing a theory of mind entails being able to infer a full range of mental states, such as: beliefs, desires, intentions, imagination, and emotions that cause action. Theory of mind is described as: *one being able to reflect on the contents of one's own and other's mind.* Frith (1999) refers to the theory of mind as the attribution of mental states such as desires, intentions and beliefs to others, or "mentalizing." Empathy has also been described by Gallese & Goldman (1998) as the ability to infer and share the emotional experience of another. In the same perspective, Baron-Cohen (2002) states that "empathizing" is the drive to identify another person's emotions and thoughts and to respond to these with an appropriate emotion. Gallese & Goldman (1998) have pointed out that it may be possible to predict and also "retrodict" an observed person's mental state by constructing the appropriate mental correlates of an act once it is "reconstituted" in the observer's own mirror neuron system.

One must wonder about the relationship between emotion and learning among children with autism. The process of teaching autistic individuals is challenging. During intervention, one important challenge is due to the difficulty of anticipating and recognizing negative behaviors, consequently calibrating the child's affective state to effective intervention and learning. These deficiencies vary from child to child as these individuals may have profound cognitive deficiencies while others may have IQ scores that are equal to or higher than the typical person (Diagnostic and Statistical Manual of Mental Disorder, 2000). This diversity of profiles causes multiple challenges in terms of methodologies and teaching programs directed towards autistic children. This is the reason why we believe that modeling affect is the proper approach for ISLA to teach mathematics to children with autism.

3.4.2. Why do autistic individuals profoundly lack theory of mindskills?

Through the use of functional neuronal imaging studies, several researchers are investigating the neural underpinnings of the theory of mind deficit associated with autism (Gallagher, Helen L., Francesca Happé, Nicola Brunswick, Paul C. Fletcher, Uta Frith, and Christopher D. Frith, 2000). Figure 3.2 illustrates the location of peak activities in medial prefrontal regions during tasks where subjects think about their own or other's mental states.

These studies suggest that the key neural regions for normal mindreading are the amygdala, orbito-frontal cortex, and medial frontal cortex. Baron-Cohen (1991) states that children with autism spectrum disorder often fail to develop the prerequisites of theory of mind, such as pretend play and a capacity to engage in shared attention with another individual.

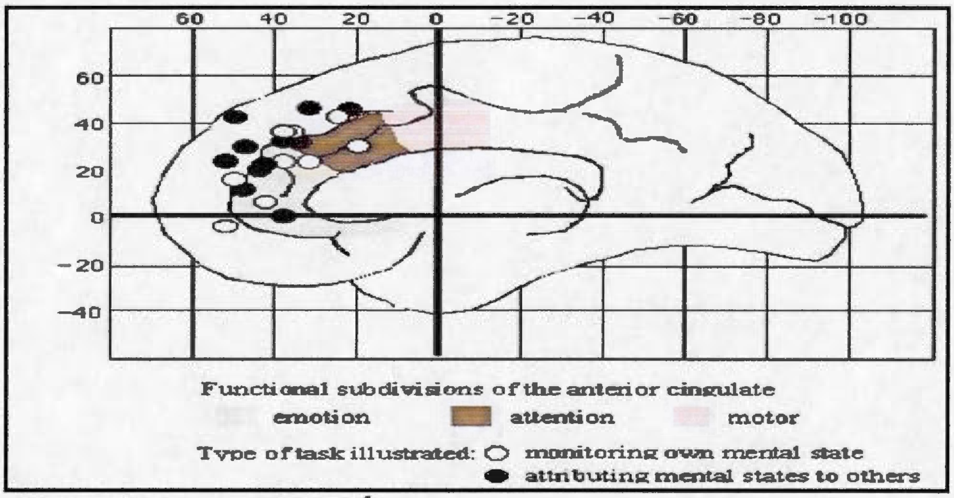


Figure 3.2 Theory of mind[5]

Hobson (1995) adds that the primary deficit stems from a lack of empathic and emotional engagement with others. The functional magnetic resonance imaging (fMRI) diagram illustrated in Figure 3.3 shows the areas in the brain that were activated to a greater extent when subjects were processing empathic stimuli than during theory of mind processing.

[5] Source: Gallagher, Helen L., Francesca Happé, Nicola Brunswick, Paul C. Fletcher, Uta Frith, and Christopher D. Frith. (2000).

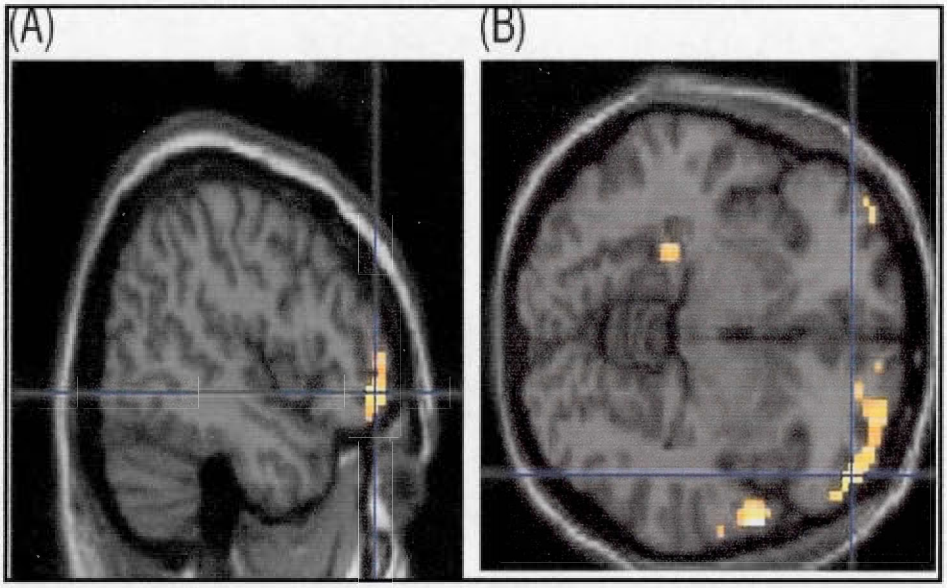


Figure 3.3 Empathy[6]

The areas included the right medial prefrontal cortex, left amygdala/parahippocampal gyrus and anterior cingulate, right posterior cingulate and middle occipital gyrus. Another important contribution to the understanding of the theory of mind deficit observed in children with autism comes from the study of Williams, Whitens et al., (2001). These authors argue that an imitative disturbance involves deficits in both copying actions and in inhibiting more stereotyped echolalia mimicking. They claimed that a candidate for the neural basis of this disturbance may be found in a discovered class of neurons in the frontal cortex called "mirror neurons" (MNs). These neurons play an important role when it comes to theory of mind as they show activity within the relation to both specific actions performed by one's self and matching actions performed by others, providing a potential bridge between minds.

What is the relationship between mirror neurons and theory of mind? The deficit of theory of mind in autism is the result of a poorly functioning system of Mirror Neurons (MNs). MNs are essential because they have the capacity to embody a "supramodal representation" of action, functioning as a bridge between higher visual processing areas

[6] Source: Gallagher, Helen L., Francesca Happé, Nicola Brunswick, Paul C. Fletcher, Uta Frith, and Christopher D. Frith. (2000).

and motor cortex. MNs represent the relationship between seeing and doing. The authors propose that MNs have been investigated with respect to hand actions, but it is likely that others will examine their involvement in different actions, such as facial expressions, speech, eye movements, and higher-level abstractions as well. Recent neuro-imaging studies have revealed that the mirror neuron region has been implicated in reading facial emotion in a normal population. In a study using a task that involved reading emotional expressions by looking at images of eyes, it was found that individuals with autism showed less involvement in areas normally activated during emotional interpretation, such as the left putative mirror-neuron region (BA 44/45), the superior temporal gyrus (BA 22) bilaterally, the right insula and the left amygdala (Williams, Whitens et al., 2001).

3.5. Conclusion

We covered the importance of the role that metacognition plays in learning, requiring an understanding and a control of cognitive processes that take into account: planning, monitoring and evaluating activities. Furthermore, the relationship between emotion and autism was discussed. The problem for individuals with Autism Spectrum Disorder (ASD) stems in part from the fact that they have difficulty processing their own and other's emotions. Self-regulated learning is essential as it refers to our ability to understand and control our learning environment which consists in three main components: cognition, metacognition, and motivation. Different strategies to enhance self-regulation and thereby improve learning in science education were presented. These important concepts lead us to Chapter IV dealing with affective intelligent tutoring systems (AITS), focusing on the student model and learning process, as well as several mechanisms of cognitive diagnosis related to autism. The question then is: How can an affective intelligent tutoring system (AITS) help an autistic child to develop to his/her fullest potential?

CHAPTER IV

INTELLIGENT TUTORING SYSTEMS (ITS) AND AFFECTIVE INTELLIGENT TUTORING SYSTEMS (AITS)

4.1. Introduction

Present day changes in Intelligent Learning Environments (ILE) have collectively responded to a variety of educational needs. These rapid advancements have made it possible for teachers and students to search, evaluate, and acquire knowledge. This chapter is divided into five sections. The first part presents instructional design and its importance in the context of an ILE. The second section refers to the intelligent learning environment as a combination of Intelligent Tutoring Systems (ITS) and Affective Intelligent Tutoring Systems (AITS), focusing on the student model and learning process. The third part focuses on Cognitive Diagnosis (CD) and adaptation within the framework of the affective intelligent tutoring systems, as well as several mechanisms pertaining to cognitive diagnosis. Following this, Section Four addresses specialized education and cognitive diagnosis with respect to autism. Finally, the conclusion is presented.

4.2. The importance of instructional design in Intelligent Learning Environments (ILE)

Different concerns regarding the pedagogical, psychological, and cognitive aspects of instructional design have been reported by different authors. Gruninger and Lee (2002) consider domain knowledge and pedagogical modeling to be essential. When it comes to intelligent assistance in an ILE, two main technologies are currently being used: intelligent tutoring and adaptive hypermedia (Brusilovsky & Peylo, 2003). In a context that includes intelligent assistance, Tchetagni, Nkambou et al., (2006) highlight the importance of the pedagogical aspect of cognitive diagnosis of learners' mistakes in order to provide relevant and helpful feedback to the learner. Liu et al., (2006) point out that "an interaction monitoring function and a learning outcome assessment method" are crucial they are working on the use of ontologies for dynamic web page authoring and for modeling adaptive instruction in terms of cognitive diagnosis. They propose a Tutorial Agent System (TAS) that adopts the ontological representation in order to design a student model related to the classification and detection of error types in the learning of primary mathematics.

4.3. What is an Intelligent Learning Environment(ILE)?

According to Dillenbourg, Schneider et al., (2002) the term "intelligent learning environment" (ILE) refers to a category of educational software in which the learner is "put" into a problem-solving situation. A learning environment is quite different from traditional courseware based on a sequence of questions, answers and feedback. The best known example of a learning environment is a flight simulator where the learner does not answer questions about how to pilot an aircraft, but instead learns how to behave like a "real" pilot in a rich flying context. The authors explain that an "intelligent learning environment" should include the previous aspects in terms of a problem-solving situation and one or more agents that assist the learner in his/her task to monitor his/her learning.

Brusilovsky & Peylo (2003) have a different point of view. They define ILEs as combinations of intelligent tutoring systems that respond to individual students' actions and needs through the use of a student model. This learning environment allows student-driven learning, for instance, the use of an open learner model where students can view and customize their student model and learning process.

In this respect, Wenger (1987) highlights three types of knowledge considered important in intelligent tutoring systems: 1) Knowledge pertaining to the domain, 2) Knowledge about tutoring, and 3) Knowledge about the student and student model. By extension, these types of knowledge are also essential to an effective ILE. These important concepts lead us to the next part of this paper, which discusses Intelligent Tutoring Systems (ITS) in more detail.

4.4. What is an Intelligent Tutoring System (ITS)?

An intelligent tutoring system (ITS) is a computer system designed with the objective of providing instant and customized instruction or feedback to learners. This is done without intervention from a human teacher, and with the intention of enabling learning in a meaningful and effective way by using a variety of computing technologies (Psotka, Kerst et al., 1994). Different examples of ITSs are being used in different domains, one being education (i.e. Algebra Tutor PAT, Auto Tutor, Smart Tutor, Active Math, among others). Another example is that of corporate training and industry, which use SHERLOCK, CardiacTutor, and CODES, all of which have demonstrated their capabilities and limitations. Several standardized components have been proposed in literature to deal with intelligent tutoring systems. These standards are based on a general consensus between researchers (Nkambou, 2010; Nwana, 1990), among others. The four essential components outlined are as follows:

1) The domain model contains the concepts, rules, and problem-solving strategies of the domain to be learned. This can accomplish several goals. It allows for a source of expert knowledge, a standard for evaluating the student's performance or for detecting errors, etc. (Nkambou, 2010). The student model is considered to be the core component of ITS as it provides special attention to students' cognitive and affective states and their evolution as the learning process advances.

2) The tutoring model is responsible for accepting information from the domain and student models, for making choices about tutoring strategies and actions that are best suited to the students' needs.

3) The user interface component integrates three types of information required to carry out a dialogue: "knowledge about patterns of interpretation (to understand a speaker) and action (to generate utterances) within dialogues; as well as, the domain knowledge needed for communicating content; and knowledge needed for communicating intent." (Padayachee, 2002).

Despite the increasing popularity of ITSs, many researchers believe that the capabilities of ITSs could be significantly enhanced if they were able to adapt to emotions, like effective human tutors can (Alexander & Sarrafzadeh, 2004; Picard, 1997). The following section discusses affective intelligent tutoring systems (AITS), along with how they function.

4.4.1. Supporting SRL using AITS technology

Many science researchers have claimed that technology supports self-regulated learning and metacognition in several ways. This can be done with the use of intelligent tutoring systems to assess the students' cognitive and metacognitive behaviours (Koedinger, K. R., et al. (2009). According to Azevedo (2009) "co-adapted learning" is a complex process involving interactions between neural, cognitive, motivational, affective and social processes. The problem stems from the fact that if computers are to interact naturally with humans, they must also be able to recognize affect and express social competencies. The author emphasizes the need to examine the role of motivational processes such as task value, self-efficacy and interest, as critical processes underlying students' self-regulated learning (SRL). He also stresses the idea of having learners choose motivational processes whose aim is to enhance the meta-cognitive awareness of the processes used. The questions then are: How do students regulate their own learning in regards to complex science topics when in a learning environment that uses a learning aid such as MetaTutor? Which processes, associated with self- and co- regulation, do students and pedagogical agents use with a Computer- Based Learning Environment (CBLE) such as MetaTutor, during collaborative learning? MetaTutor is a hypermedia learning environment designed to detect, model, trace, and foster students' self-regulated learning about human body systems (Azevedo, R., & Hadwin, A.F. (2005). It is based on a cognitive model of self-regulated learning (SRL), with non- linear, multi-agent, intelligent, open-ended learning environment involving the use of different processes, such as planning, knowledge activation, metacognitive monitoring and control, as well as strategy use and reflection. In this regard, MetaTutor uses these processes in an attempt to prompt and foster learning by asking relevant questions, in the form of short quizzes, and by reorienting the student towards other strategies to foster his/her learning.

According to the author, poor self-regulated learners fail to question themselves about their understanding and thus they lose the chance of using efficient strategies to improve their learning. Azevedo (2009) points out that Pedagogical Agents (PA) have the potential of providing students of all ages with information that will help them become strategic, motivated, and independent learners. As a matter of fact, MetaTutor is composed of four different pedagogical agents, each one with a role designed to detect different specific SRL processes. For example, the different phases to using MetaTutor for the purpose of training students on SRL processes and for instructing them about the human body system consisted of the following processes: First, the pedagogical agent models key SRL processes. Next, the pedagogical agent discriminates between tasks. It allows learners to choose between good and poor use of processes through the use of a detection task where learners are able to watch video clips of human agents engaging in similar learning tasks. Lastly, we have the actual learning environment used to learn about the biological system. In his research Azevedo demonstrated the effectiveness of pedagogical agents. Specifically, he highlights their usefulness in self-regulated learning and shows that through prompting feedback they facilitate learning about the human circulatory system. Sixty-nine undergraduate students participated in the study which was comprised of a 2-hour session. Students were tested under one of three conditions. The first condition was the Prompt and Feedback (PF) condition. The second was the Prompt Only (PO) condition. The third was the No Prompt (NP) condition. The PF condition received timely prompts from several pedagogical agents, deploying various SRL processes and getting immediate direct feedback. The results of the study indicated that students placed under the PF condition had significantly higher learning efficiency scores than those in both the PO and NP conditions. In addition, log file data provide support for the PA's effectiveness in facilitating metacognitive monitoring and regulation during the learning task, as revealed by data belonging to students placed in the PF condition. The author claims that since learners are frequently overconfident in their judgments, receiving prompts from the agent in MetaTutor enabled them to make more accurate judgments and provides insight into their performances. Learners become less over or under-confident and consequently more metacognitively calibrated. In addition to the use of technology, the development and application of cognitive strategies through the use of semantic networking software, such as *Inspiration*™, helps students understand important relationships between concepts (structural knowledge), as well as to model their thinking in a way that may be updated as the student's level of understanding evolves (Jonassen, Carr et al., 1998). Technology can be used to promote metacognitive activities such as planning and monitoring (Puntambekar, 1995). For this purpose, they have created a computer assisted instructional system called Metacognition in Studying from Texts (MIST) in order to train students to reflect upon their readings and thus monitor their understanding.

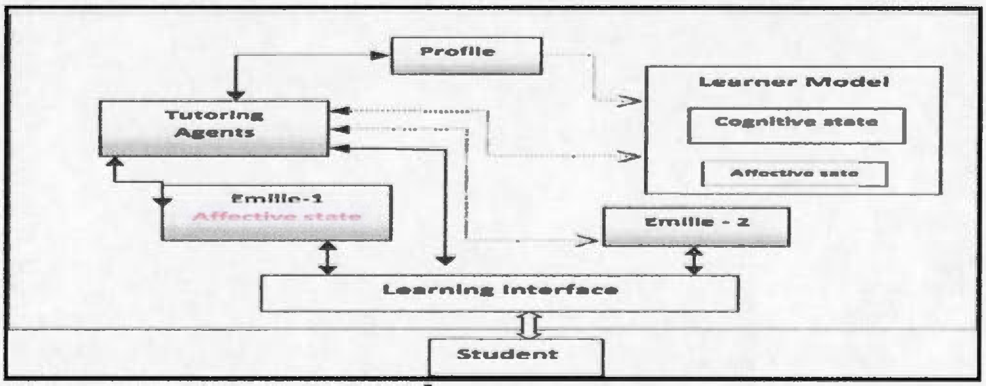


Figure 4.1 Architecture of AITS[7]

[7] Source: Nkambou, (2006)

4.5. Affective Intelligent Tutoring Systems (AITS)

Researchers in the ITS field claim that the success of affective agents exists because of a multidisciplinary approach to affect, which is based on neuroscience, psychology and pedagogy. According to some, such an approach has a positive impact on the learner's intuition, as well as on his/her self-esteem, as it relates to problem- solving tasks (Chalfoun & Frasson, 2009). Research in the field of AITS has created a link between emotion and learning. It has been argued that cognition, motivation and emotional affect are three components of learning (Sidney, Craig et al., 2005). Gagné (1985) holds the view that learning involves three particular cognitive processes: attention, memorization, and the ability to reason. With respect to each of these processes the learner's cognitive ability depends on his/her emotional state. Therefore, to be attentive requires the ability to focus and learning can take place only if the student listens. For instance, depending on the learner's cognitive state, a necessary condition for successful learning is to gain the attention of the student (Gagné, 1985). The idea is that negative emotions reduce or block thought processes, slow down the decision making process, and memory capacity (Idzihowski & Baddeley, 1987). Positive emotions, on the other hand, provide better conditions for problem-solving and improve innovation. The use of active listening, empathy, sympathy, and venting may be strategies aimed at reducing negative affect (Klein, Moon et al., 2002). Moreover, Rodrigo, Baker et al., (2008) investigated the incidence of positive and negative affective states and usage behaviors among individuals using ITS (Aplusix) and a computer problem-solving game (The Incredible Machine). Individuals played with a computer game and then used a scale to rate the level of frustration he/she experienced with the system. The results of the study indicated that support agents tend to offer affective feedback that mirrors the level of frustration that users reported. Therefore, some of the user's negative feelings are reduced.

A human tutor is an emotional practitioner in the sense that he/she can influence the emotions of those who are learning, with the objective of improving the efficiency of learning (Hargreaves, 2001). Emotional intelligence refers to the ability to recognize, interpret, and influence someone's emotions (Goleman, 2010). Some researchers believe that when the effect of feeling on thinking is known it can be used to improve one's cognitive abilities (Salovey, Rothman et al., 2000). For instance, Faivre, Nkambou et al., (2003) propose that an AITS is an ITS which consists of functional capabilities that are able to assess the learners' emotions and is able to evoke emotional responses in the learner. In order to improve performance, the author explains that AITS needs to achieve the following conditions: 1) Know the current emotional state of the learner. 2) Determine the impact of an action on a learner's emotional state. 3) Identify the most advantageous mental state of a learner that will result in an enhancement of his/her performance. Figure 4.1 represents an architectural description of AITS as proposed by Nkambou (2010), in an attempt to extend both the learner and tutor models by the addition of emotional aspects. This multi-agent architectural design of AITS contributes to learning process adaptation. The learner's model represents both the cognitive state including knowledge, skills, and performance history, along with the affective state which deals with mood, emotions, and the psychological profile. We can also see that a specific agent manages the cognitive state: the profiler. This agent updates the gained knowledge, skills, and performances of the learner and maintains the cognitive model's integrity. The profiler also helps to detect incorrectly learned or missing skills or knowledge and enables adaptation with the help of tutoring agents. Having explained the above, the next part of this paper focuses on cognitive diagnosis and its relationship with AITS.

4.6. Cognitive Diagnosis

The purpose of the cognitive diagnosis (CD) component within AITS is to accurately determine why the student made an error in a problem solving activity. This is useful as it helps to identify where to focus the subsequent learning activities (Tchetagni, Nkambou et al., 2006). The CD process interprets the learners' mistakes on the basis of two main factors: the hypotheses of the system in regard to the learners' current knowledge and the pedagogical context in which the learner is diagnosed. The authors further explain that establishing hypotheses about the learner's cognitive state is at the core of a CD due to the fact that these hypotheses direct the pedagogical orientations of the system. One important question is: How can the phenomenon of reflection be enabled while hypotheses about the learner are established in the CD process? Regarding this question, (Tchetagni, Nkambou et al., 2006) claim that instructional research would benefit from a more systematic method to pedagogy rather than the "operational aspect" of CD (Anderson, Corbett et al., 1995; Conati, Gertner et al., 2002; Katz, Lesgold et al., 1998), which entails the application of artificial intelligence (AI) techniques by allowing the system to accurately infer the learners' current level of knowledge, instead of the "pedagogical aspect" of the CD (Dimitrova, Self et al., 2000). According to (Tchetagni, Nkambou et al., 2006), the pedagogical aspect of the CD is important because it focuses on: 1) How to foster a remedial state upon the systems' hypotheses about the learners' cognitive states while performing the CD. 2) How to continually adjust the systems' hypotheses regarding the learners' cognitive states in order to obtain more accurate representations of the learners' needs. These authors present a framework that supports the implementation of the authoring tool: CD-SPECIES which is intended to support instructional design by specifying the features of the components for cognitive diagnosis.

4.6.1. The components of cognitive diagnosis

The literature describes cognitive diagnosis as: "*the process of inferring a person's cognitive state from his or her performance.*" (Ohlsson, 1986). It is a central activity in any system that aims to build a dynamic model of the user. Wenger, (1987) refers to explicit encoding of "knowledge" rather than "encoding" of decisions. He claims that ITS uses a varied set of knowledge bases and inference routines in order to "compose instructional interactions dynamically" making decisions by reference to the knowledge with which they have been provided. He claims that the "intelligence" in ITSs exists in cognitive diagnoses. It is the ability to analyze learners' solution histories dynamically, using principles rather than preprogrammed responses to decide what to do next and how to change instructions to suit different learners. Wenger, (1987) suggests three different perspectives pertaining to cognitive diagnosis (CD), that is, the epistemic, behavioural and individual perspectives, depending on the diagnosis of the learner's cognitive state. The author goes on to say that the epistemic diagnosis deals with the student's knowledge of the field of study, as well as their strategic and metacognitive skills. A behavioural diagnosis refers to the learner's behavior in terms of reasoning that takes place during a problem-solving activity. An individual diagnosis concerns issues such as the learner's personality, preferences, learning attitudes, and beliefs. (Mislevy, 1994) describes the CD process as "the execution of the same operation as in medical diagnoses." From this point of view, he defines the procedural component of a CD as the phase of observation, consisting of collecting data that are relevant to the kind of inferences that the CD process intends to make. In order to be useful, a CD process should establish relevant distinctions in order to retain such observations. The interpretation phase consists in rationalizing observations. The CD process should construct a problem-solving story or a coherent sequence of events that explain the observations in the simplest form, in which the interpretation of an observation could be seen as an evaluation of the learner's input. Lastly, the inference phase consists in formulating hypotheses pertaining to the learner, which explains the interpretation of the observation. In the following section, several mechanisms of the adaptation of cognitive diagnosis will be covered.

4.6.2. Mechanisms to cognitive diagnosis

In this section, the objective is to present several mechanisms pertaining to cognitive diagnosis and adaptation. As previously described, cognitive diagnosis is "the process of inferring a person's cognitive state from his or her performance." (Ohlsson, 1986). Within this view, several frameworks have been proposed in literature. VanLehn, (2006) suggests a "behavioral" description, as opposed to a software structure of cognitive diagnosis and adaptation. He describes intelligent tutoring as: "*a set of tasks divided into two loops: an outer loop over tasks, and an inner loop over steps*." The main duty of the outer loop is to decide which task the student should do next that will help the student learn. The author explains that the outer loop of a generic tutoring system is all about selecting tasks for the student to perform. With this mechanism, the intention is to help the instructional designer deal with two major problems: 1) Providing a set of instructional tasks. 2) Designing an algorithm that decides which task to assign next. While the outer loop pertains to tasks, the inner loop concerns the steps within a task. A step is a user interface action that is part of completing a task, for instance, solving a problem. The outer loop executes once per task, while the inner loop executes once per step. In his study, four basic methods have been used for selecting tasks for the student. First, the student selects the task from a menu that includes all tasks. For example, the design in Andes is appropriate because it displays a hierarchical menu of tasks as a "homework helper" for students in a normal physics class. Second, the tutor assigns tasks in a predetermined sequence. The main advantage is that students must finish a task before moving to the next which increases the chance that the students will have mastered the prerequisites of a task before starting it. For example, AutoTutor and many other tutoring systems have used this method. In addition to providing some kind of mechanism for selecting tasks, mastery learning requires that the tutoring system has some way to assess the student's level of knowledge (Bloom, 1984). The student learns a unit until he/she has mastered the unit's knowledge. Sherlock tutor uses this method. Lastly, the most complex method is based on a pedagogy called macro-adaptation (Anderson, Corbett et al., 1995), by virtue of which the tutor tracks traits, including both unchanging traits such as learning styles, and changing traits such as correct and incorrect knowledge components.

The Algebra Cognitive Tutor uses this method for each task that the tutoring system can assign and it knows which knowledge components are exercised by the task. For each knowledge component, the tutor maintains an estimate of the student's degree of mastery of the knowledge within that component. In this cognitive diagnosis framework, "support learning services" are classified within five categories. The questions of interest are: When should minimal feedback be given? How should error- specific feedback be given? When is it appropriate to give hints? What is the best possible way to give hints? The five categories proposed by VanLehn are summarized as follows: 1) Minimal feedback on a step, in most cases, this means indicating only whether the step is correct or incorrect. 2) Error-specific feedback on an incorrect step. This information is intended to help the student understand why a particular error is wrong and how to avoid making it again. 3) Hints on the next step, 4) Assessment of knowledge, and 5) Review of the solution. In terms of minimal feedback, Andes colours a correct step green and an incorrect step red, and the Algebra Cognitive Tutor also changes the appearance of steps in order to flag incorrect ones. Other tutors may use a pop up message such as "Forgot to put units on a number", whereas Steve shakes his head "yes" or "no."

The important question is: When should feedback be given? Aleven et al., (2000, June) present a model of a "Help-Seeking Tutor Agent" on student's seeking behavior. Different Tutoring systems may vary in their policies on when feedback is given. Some systems give immediate feedback. These include Andes, Algebra Cognitive Tutor, Steve and AutoTutor after each step taken by the student. An example of a system which gives delayed feedback is Sherlock, which will give immediate feedback only if the step violates a safety regulation. Systems that give feedback include The SQL-Tutor, which gives feedback only when the student clicks on the submit button and the learner can continue working on their solution after receiving such feedback. This does not count as delayed feedback.

Another important mechanism in cognitive diagnosis is proposed by (Tchetagni, Nkambou et al., 2006). The authors propose a framework that supports the implementation of an authoring tool called CDSPECIES. This methodology, pertaining to the specification of the CD process, is similar to the IMS learning design methodology intended to help the instructional designers formulate a specification about their CD knowledge. It is similar in that it presents a skeleton of the features of the knowledge according to the pedagogical context in which it will evolve in order to ensure two qualities of the design process. These qualities are the designers' explicit articulation of the CD components in the ILE and the comprehensiveness of the knowledge base used for the specification. Consequently, CDSPECIES helps the instructional designer to become aware of the CD. Two important issues are addressed. First, the cognitive diagnosis process should promote reflection, which may in turn enhance the accuracy of the hypotheses of the diagnosis. Reflection is important because it results in learners contemplating their understanding of the cognitive skills required in a learning situation. Second, when the pedagogical context is devoid of the physical presence of human tutors, reflection also allows for a more reliable representation of the learner's needs. In addition, the pedagogical context in which the learner is diagnosed must be taken into consideration. The context affects what is observed and therefore diagnosed during the learning experience. One feature of CD- SPECIES is that it allows for an evolution towards a more exhaustive framework for CD, since, as a computer tool, it can be continuously updated adding new components and features to the CD.

Figure 4.2 Why2-Atlas-Auto Tutor[8]

According to (VanLehn, Graesser et al., 2007) engaging in a one-on-one dialogue with a tutor is more effective than listening to a lecture or reading a text. The authors of this study tested the interaction hypothesis in seven experiments under the following constraints: 1) All students covered the same content during instruction. 2) The task domain was qualitative physics. 3)The instruction was in natural language as opposed to mathematical or other formal languages. 4) The instruction conformed to a well- established 5-step

[8] Source: VanLehn, Graesser et al., (2007)

framework of human tutoring. In their experiment, they compared two kinds of human tutoring (spoken and computer mediated) with two kinds of natural-language-based computer tutoring (Why2-Atlas and Why2- AutoTutor). They included three control conditions which involved studying texts. As observed in Figure 4.2, the window in the lower right quadrant accommodated the text typed by the student during the current turn.

The student's turn was processed with a speech act classifier (Olney, Louwerse et al., 2003) and a statistical natural language processing (NLP) technique called latent semantic analysis (Foltz, Gilliam et al., 2000, Graesser, Wiemer-Hastings et al., 2000. Laundauer, Foltz et al., 1998). In the upper left window, an animated conversational agent had a text-to-speech engine that spoke during the tutor's turns. It uses facial expressions with emotions when providing feedback to the student's contributions. The agent also uses occasional hand gestures to encourage the student to type in information. The recent dialogue history was displayed in a scrollable window in the lower left of the display. The tutor's most recent turn was added immediately after the tutor had finished speaking it. Regardless of what was entered in the final dialogue, the tutor ended the session by presenting it. When the student had studied it, the tutor moved on to the next physics problem.

Concerning cognitive diagnosis, one can see that both tutoring systems implement a four-phase mechanism as follows: 1) The tutor presents a problem. 2) The student enters an initial essay within their first dialog turn. 3) The tutor identifies flaws and attempts to correct all of them, and 4) The tutor presents the ideal essay. The dialogue management approach can be loosely categorized as a finite state model. It uses a reactive planner that allows states to be skipped if the goal of a state was already achieved. Also, it backtracks and attempts additional tries if a dialogue management plan fails (Freedman, Rosé et al., 2000).

As for the tutor responses, they are specified in a hand-authored, push-down network (Jordan, Rosé et al., 2001). State "nodes" in the network indicate that the system should either question the student or push or pop to other networks. The dialogue management of the third phase is somewhat different in the different tutoring systems, but the content of the expectations and misconceptions are exactly the same. Whereas Why2-Atlas launches a KCD for a missing expectation, Why2-AutoTutor presents a series of hints and prompts until the student articulates what is expected. Both tutor systems assert the expectation when they assess that their elicitation techniques fail. When the student expresses misconceptions, Why2-AutoTutor directly corrects the misconception in a single turn, whereas Why2-Atlas launches a remedial KCD. However, Why2-AutoTutor, unlike Why2-Atlas, ends phase 3 with the three dialogue moves listed previously.The results of these experiments revealed whether students' preparation matched the content of the instruction. When student novices, who had not taken college physics, studied content that was written for intermediate students who had taken college physics, the tutorial dialogue was reliably more beneficial than was the less interactive instruction. Furthermore, large effect sizes were found, which is indicative of a meaningful effect. On the other hand, when novices studied material written for novices or intermediates studied material written for intermediates, the tutorial dialogue was not reliably more effective than the text-based control conditions.

Another important mechanism related to cognitive diagnosis and adaptation is proposed by (Aleven, 2010) who brings to light the importance of the models' "flexibility" and its cognitive "fidelity." As such, the cognitive tutors use a rule-based cognitive model that captures the knowledge involved in the step-by-step guidance as students learn a complex problem-solving strategy. Within this mechanism, cognitive tutors use their rule-based model in order to provide tutoring by means of an algorithm called model tracing (Corbett, Anderson et al., 1995). Aleven (2010) examined a simple rule-based model developed for fraction addition designed with the cognitive tutor authoring tools, as well as the rule-based model used in the geometry cognitive tutor. The objective of solving a fraction addition problem can be broken down into three sub-goals: 1) Converting the fractions so that they share a common denominator. 2) Adding the converted fractions. 3) Reducing the resulting fraction to the lowest possible denominator.

Now let's look at the model. The main components of a production rule model are its working memory which contains a set of data structures designed for the given task domain such as "facts," "chunks" and production rules, and the fraction addition model implemented in Jess (Aleven, 2010). In terms of cognitive diagnosis, the purpose of model tracing is to assess student action and to interpret those actions in terms of underlying knowledge components. Student action is deemed correct only if it is among the multiple actions that the model can take next. If the student action is not among the potential next steps, it is deemed incorrect. When the action is considered incorrect, the tutor displays an error message, for example, "it looks like you are adding the denominators, but you need a common multiple." The model- tracing algorithm must explore all solution paths that the model can execute. The cognitive fidelity of a model used in a model-tracing tutor system may affect the efficiency or effectiveness of student learning due to the tutor. The author claims that greater cognitive fidelity may lead to a more accurate student model and to a better response to the needs of the student in terms of task selection decisions. As a result, lack of cognitive fidelity means that a model's rules do not correspond to actual student knowledge components. In the fraction addition model, different strategies for finding the common denominator are used rather than learning a single strategy. By contrast, lack of flexibility results when a model is not correct or complete. This problem stems from a lack of cognitive task analysis as it pertains to the student's behaviour.,

Different techniques are presented to increase cognitive task analysis. These include the "Difficulty Factors Analysis" (Baker, 2007), the learning curve (Newell & Rosen-Bloom, 1981), and the "Learning Factors Analysis" (Tzeng, Chiang et al., 2007), among others.

4.7. AITS Applications: Cognitive Diagnoses and adaptation

In addition to mechanisms that deal with cognitive diagnosis and adaptation, affective intelligent tutoring systems (AITS) have strong life-like presence, including animated pedagogical agents that can capture students' imaginations and play a critical role in keeping students deeply engaged in a learning activity (Lester, Converse et al., 1997). One of the main goals of AITS is to be able to recognize and address the emotional state of the learner and consequently react through the presence of the pedagogical agent. In the next section, we will explore how AITS can detect and appropriately respond to an emotional state of a learner.

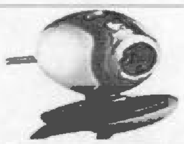
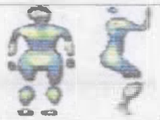
Sensor	Name	Descriptions
	Postures analysis seat	Detects if the learner is moving back or front to the screen.
	Conductance Bracelet	Measures skin conductivity which in turn has been known to correlate with arousal.
	Facial Expression Sensor	Predicts states such as acknowledgment, interest, reflexion, incertitude
	Pressure Mouse	Measures learner global pressure using mouse manipulation.
	Blood pressure measurement system	Measures blood pressure distribution on the back and under the learner.
	Eye detection	Detects coordinates of eyes and mouth in order to predict facial expression

Figure 4.3 Emotional sensors[9]

4.7.1. Approaches to Emotion Recognition

So far, we have seen that there is no magic recipe for labeling a person's emotional state or for responding to it. Several researchers claim that cognition, motivation and emotion are the three components of learning (D'Mello, Picard et al., 2007). According to Picard, Papert et al., (2004), one goal of affective tutors is to recognize affect or identify the affective state of people from a variety of physical cues that are produced in response to affective changes in the individual. Woolf, (2010) proposed an approach in recognizing emotion that deals with three different inputs: sensor data, student self-reports, and human observation of students. Their sensor platform is composed of four physiological sensors (mental state camera, skin conductance bracelet, pressure sensitive mouse, and pressure

[9] Source: Arroyo, Cooper et al., (2009)

sensitive chair) which have been tested with more than 1,000 students in middle high school and college classes. According to the authors, once a student's emotion has been recognized, the next step is to identify how to respond in order to improve student motivation and learning. As it pertains to the diagnosis, it is important to determine why the emotion occurred in the first place. In this sense, pedagogical agents act out their emotions and talk with the student, expressing full sentences comprised of cognitive, metacognitive and emotional feedback. As observed in Figure 4.3, (Arroyo, Cooper et al., 2009) have identified different sensors that can be used to detect emotions during a learning session. As a result, sensors are associated with specialized software able to assess an emotion or a set of emotions. Figure 4.4 presents other physiological sensors that have a direct correlation with emotions (Heraz, A., et al., 2007; Chalfoun & Frasson, 2009). The following sensors can measure emotion according to two dimensions: valence (positive or negative emotion), and arousal (intensity of emotion). The GSR sensor (Galvanic Skin Response) also allows the recording of skin conductivity, measuring the rate of skin transpiration.

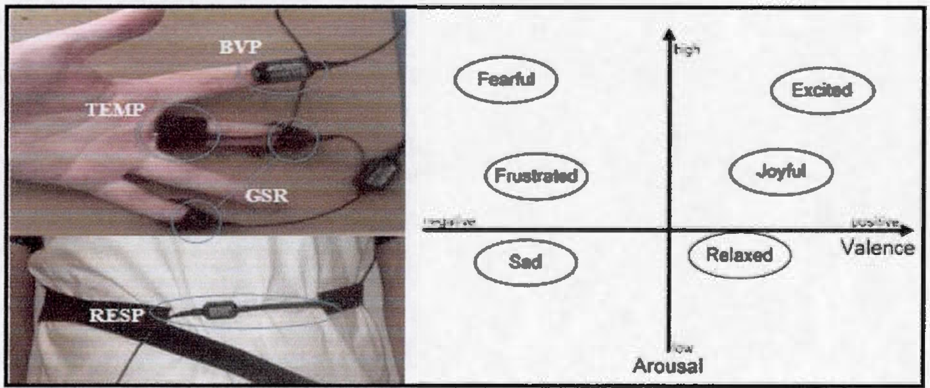


Figure 4.4 Physiological devices used for emotion detection[10]

By contrast, the RESP sensor (respiration) allows the recording of variations in respiration. GSR and RESP are positively correlated with arousal. The BVP sensor (Blood

[10] Source: Heraz, A., et al. , (2007); Chalfoun & Frasson,(2009)

Volume Pressure) records blood flow variations, from which Heart Rate (HR) data can be extracted. TEMP sensors allow the recording of temperature variations. BHV, HR, and TEMP are positively correlated with valence. Another important device used to detect emotions is the Electroencephalogram (EEG). EEG cables are connected to the ears and their sensors are able to assess brain activity.

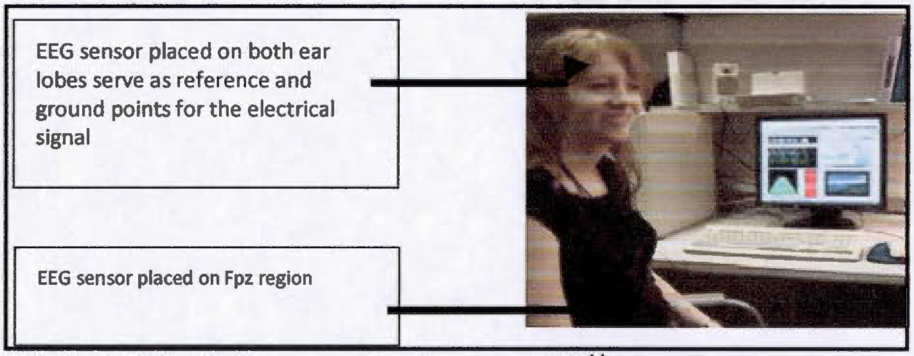


Figure 4.5 A learner wearing Pendant EEG[11]

When millions of neurons are activated, each contributes a small electrical current that can collectively generate a signal that is strong enough to be detected by an electroencephalogram (EEG) (Cantor, 1999; Heraz & Frasson, 2009). These devices can be used to detect and measure emotional reactions. Figure 4.5 represents a learner wearing a pendant EEG that is able to wirelessly transmit brainwave activity.

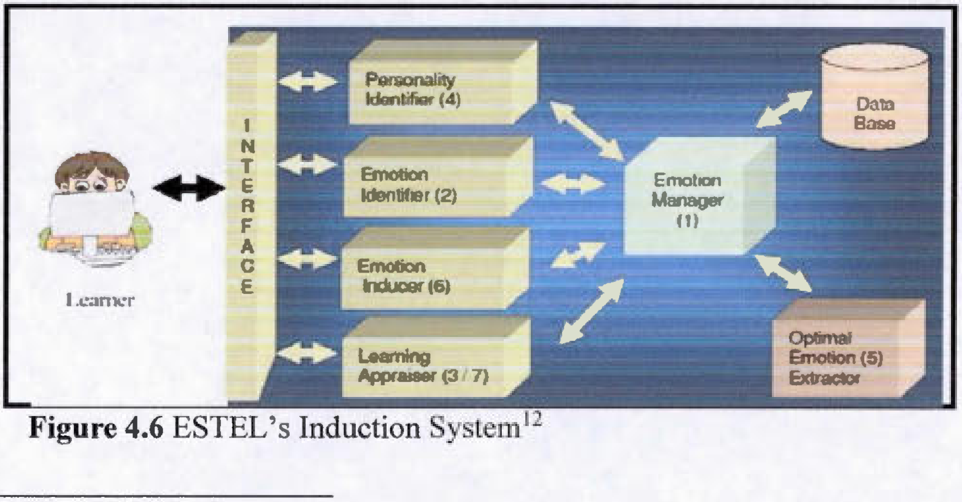


Figure 4.6 ESTEL's Induction System[12]

[11] Source: Cantor, (1999); Heraz & Frasson, (2009)
[12] Source: Chaffar & Frasson (2006)

Figure 4.7 illustrates the different frequency bands and their associated mental states. Research has indicated that an EEG is a valid source of information to detect emotion (Heraz, et al., 2007; Heraz et al. 2008). In fact, results show that the student's affect (anger, boredom, confusion, contempt, curious, disgust, eureka, and frustration) can be accurately detected from brainwaves 82% of the time.

Bandwidth Name	Frequency Range	Mental states (generalcharacteristics)
Delta	1-4 Hz	Sleep, repair, complex problem solving
Theta	4-8 Hz	Creativity, insight, deep states
Alpha	8-12 Hz	Alertness and peacefulness, readiness, meditation
Beta	13-21 Hz	Thinking, focusing, sustained attention
SMR	12-15 Hz	Mental alertness, physical relaxation
High beta	20-32 Hz	Intensity, hyper alertness, anxiety
Gamma	38-42 Hz	Cognitive processing, learning

Figure 4.7 Brainwaves Categories[13]

Other important technique comes from the field of psychology. An approach used for inducing emotional states with the goal of finding a relationship between emotions and thought tasks is the Velten procedure. This procedure consists of randomly assigning participants to read a graded set of self-referential statements: "I am physically feeling very good today." Guided imagery (Ahsen, 1989), which consists of asking participants to imagine themselves in a series of described situations, can also be used. Several researchers have used empathy to implement systems that are able to control and influence the learner's emotions. This is the case for the "affective companion" that adapts to the learner's emotions by adjusting the difficulty of an exercise (Isen, 2000). The affective tutor, on the other hand, is itself affectively adaptive to users' emotions (Estrada, Isen et al., 1994). Partala & Surakka (2004) studied the effects of affective interventions using synthetic

[13] Source: Heraz,et al., (2007); Heraz et al. (2008)

speech with emotional content by focusing on human-computer interaction. In addition to affect recognition, other studies come from the development of hybrid techniques which combine two or more procedures. Mayer, Allen et al., (1995) used the guided imagery procedure with a music procedure to induce four types of emotions; joy, anger, fear, and sadness. On the other hand, Chaffar and Frasson (2006) proposed a specific module (Figure 4.6) to induce an optimal emotional state which represents a positive state of mind that maximizes the learner's performance. The design of the module reveals that managing emotional conditions requires a complete cycle that includes the following:

1) Identification of the emotional state of the learner.

2) Identification of the adequate emotional state to improve the performance.

3) Induction of the new emotion and verification of learning improvement.

These modules are also components of emotional Intelligent Tutoring Systems (ITS). The next part of this paper will provide more detail on state of the art affective intelligent tutoring systems (AITS).

4.7.2. AITS Applications

As illustrated in Figure 4.8, one example of AITS is the Wayang tutor, presented by (Woolf, Arroyo et al., 2010). The Wayang tutor is intended for middle school and high school level mathematical learning. In its use, one can see Jake and Jane, two virtual agents that play the role of affective learning companions in an attempt to emulate empathy and help keep high school children more engaged in the lesson of the problem statement with four or five solutions.

Figure 4.8 Wayang Tutor[14]

Students select an answer and the tutor provides immediate visual feedback by coloring the answer green or red, indicating a correct or incorrect response, respectively (Woolf, Arroyo et al., 2010).

Prior to selecting an answer, a student may ask for a hint, which Wayang displays in progression from general suggestions to the correct answer. Within each topic section, Wayang adjusts the difficulty of problems provided, depending on past student performance. The intervention made by the learner's companion is tailored to a given student's needs, according to two models of affect and effort, which are embedded in the tutor. In the Wayang tutor system, the attribution theory proposes that students' motivation to learn is directly rooted in their beliefs about why they succeed or fail at certain tasks (Weiner, 1972). An affect model, on the other hand, assesses a student's emotional state. The models were further expanded with Wayang to classify four ranges of emotional self-concept, including frustration, interest, confidence, and excitement, all having an accuracy value over 78%. The results of this study show that, in the case of emotional outcomes (i.e.

[14] Source: Woolf, Arroyo et al., (2010)

confidence and frustration), there is a gender difference such that the effects are stronger for females than for males. The results also indicate that it was only the high achieving males that did not benefit from affective learning companions. This affect recognition evaluation made several important contributions to the field of sensor recognition related to student affect in intelligent tutors. Summaries of this physiological activity, and in particular data streams from facial detection software can help tutors predict more than 78% of the variance of students' emotional states, which is much better than when these sensors are not used. Cognitive psychologists have recognized that narratives play a relevant role in the way we store and make sense of episodic experience, often described as the phenomenon of narrative construction of reality.

In the pursuit to adapt and detect learners' emotions in Intelligent Tutoring Systems, (Nkambou, 2006) presents a multi-agent design of AITS that includes two emotional agents: Emilie-1 and Emilie-2. According to the author, Emilie-1 is built on the OCC model of emotions (Collins, Ortony et al., 1988). In this case, an agent core is in charge of managing the tutor's emotion state and determines which emotion will be expressed by analyzing the learning trace and considering the student's current performance.

The emotion analysis may reveal whether the student feels "satisfaction", "confidence", "surprise", "confusion", or "frustration." The author explains that these states are more prominent in an educational context and relevant pedagogical actions can be taken in order to influence those emotions. Emilie-2, on the other hand, is responsible for the detection of the learner's emotion, which establishes the learner's emotional state by capturing emotions that the student might express during learning activities. Inferences regarding the possible causes of those emotions are made. Emilie- 2 is composed of three conceptual layers. The first one deals with the student's perception and it captures, as well as extracts, facial expressions using image acquisition and face tracking. With this information, Emilie-2 then performs data categorization (classification). The second layer concerns cognition as well as analyzing and diagnosing the perceived learner's emotional state. The third layer, referred to as the action layer, makes decisions regarding which remedial pedagogical actions will be carried out in response to the actual emotional state. The problem with the perception layer was that face detection using the Eigenface method was limited and less accurate. The author explains that the multi-agent design of AITS contributes to learning process adaptation. To begin with the learner's model represents both cognitive states such as knowledge, skills, and performance history, as well as the model's affective state that deals with mood, emotions, and psychological profile. Importantly, there exists a specific agent that manages the cognitive state, the profiler. This agent updates the gained knowledge, skills, and performances of the learner, and maintains the integrity of the cognitive model. It also helps to diagnose the knowledge or skills incorrectly learned, or missing, and enables remediation with the help of tutoring agents.

One important contribution from this study is the development of a new version using a feature-based approach for face detection. According to the author, this approach allows for the search of different facial features (eyes, nose, and mouth) and extracts information about their spatial relationships, which is then used to compute distance variations (given a reference neutral expression). As a result, a vector of those differences is given as input to the neural net.

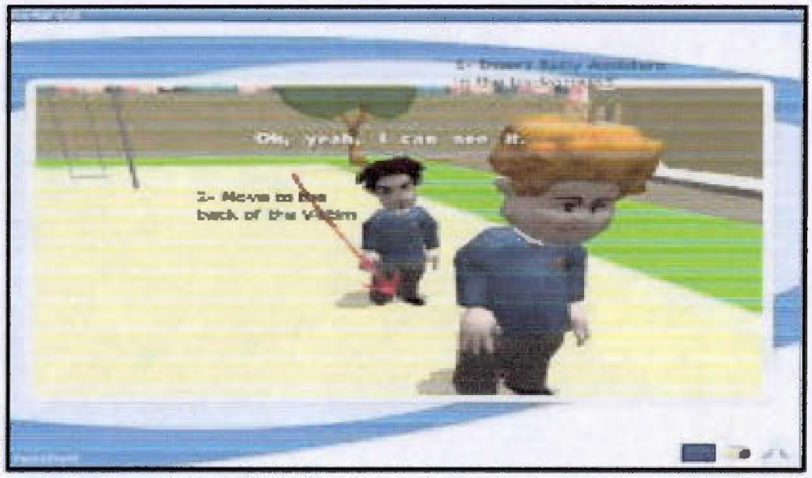


Figure 4.9 MOCAS[15]

[15] Source: Blanchard & Frasson, (2004)

As illustrated in Figure 4.9, MOCAS is another example of AITS that employs self-determination theory to produce pedagogical agents whose behaviors are closely aligned with the learner's motivational and cultural needs (Blanchard & Frasson, 2004). MOCAS's autonomy-supportive design and rule-based methodology lead to the adaptation of teaching, given the cultural backgrounds of its learners.

Narrative intelligent learning systems can promote different kinds of activities for learners. According to Frasson & Chaulfoun, (2010), a narrative intelligent learning environment (NLE), which is based on a narrative approach, can promote cognitive diagnosis by engaging in active exploration of the learning tasks. In this perspective, NLEs can promote reflection by engaging the learner in the consequent analysis of what happened during the learning session.

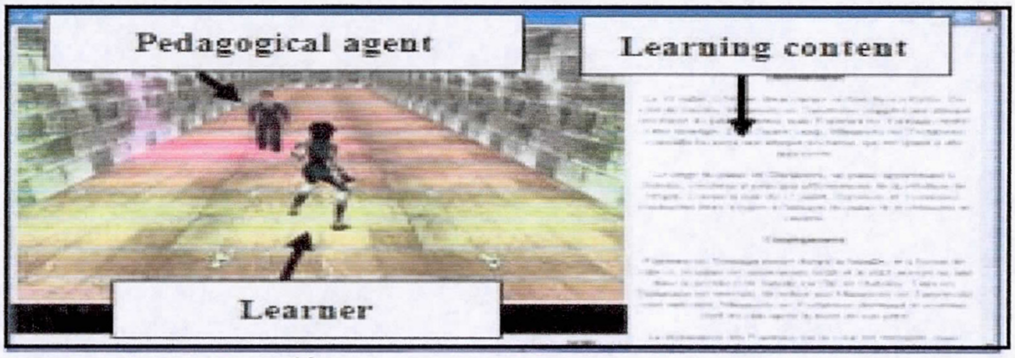


Figure 4.10 FearNot![16]

Reflection is important because it results in learners contemplating their own understanding of the cognitive skills required by a learning situation (Tchetagni, Nkambou et al., 2006). As a result, the use of a narrative approach makes it possible to attain an application that may help learners by illustrating phenomena and procedures, and by motivating them to stay engaged and immersed in learning tasks. The following section of this paper presents examples of narrative learning environments that utilize different pedagogical strategies

[16] Source: Aylett, Louchart et al., (2005)

and affect in the context of narration. Crystal Island developed by (Rowe, McQuiggan et al., 2007) is one narrative-centered learning system used for teaching microbiology and genetics. The animated agents in Crystal Island are built on empathy. They can express emotions in order to support intrinsic motivation in high school students, making it possible for students to overcome frustration and feelings of hopelessness. Another example of an interactive narrative learning environment is FearNot! (Figure 4.10) developed for education against bullying behavior in schools (Aylett, Louchart et al., 2005). The autonomous agents in FearNot! implement emotional expressions and personality dynamics, two important characteristics of synthetic characters necessary to attain a desirable level of empathy and believability, which are required in order to help deal with virtual bullies.

In addition to narrative learning systems, EMMA makes a contribution to the discussion of what types of automation should be included in interactive narrative environments. Part of that discussion includes what types of affect should be detected as well as how they should be detected. The generation of emotionally believable animation in response to detected affective states contributes to the simple and innovative user interface in edrama, leading to high-level user engagement and enjoyment (Zhang, Gillies et al., 2009). Can we adopt these mechanisms of cognitive diagnosis in the domain of specialized education?

4.8. Learning and autism

As previously mentioned, according to the Diagnostic and Statistical Manual of Mental Disorders (DSM-5), compiled by the American Psychological Association (APA), autism is: "*A neurological disorder affecting the way the brain processes information which can affect all aspects of the development of a person. The Autistic Spectrum Disorders (ASDs) are characterized by impairments in social interaction, communication, and the presence of restricted repetitive, and/or stereotyped patterns of behavior.*" The term "spectrum" refers to a continuum of severity or developmental impairment.

Individuals with autism display deficits in understanding mental states (Baron-Cohen, Tager-Flusberg et al., 1994). According to these researchers, possessing a theory of mind allows one to be able to infer a full range of mental states, such as beliefs, desires, intentions, imagination and emotions, all of which result in behavioural action. In fact, there is an IT application called "Mind Reading." The Interactive Guide to Emotions was developed by psychologist Simon Baron-Cohen. This application covers the entire spectrum of human emotions in an attempt to teach emotions and social cues to autistic individuals.

Figure 4.11 Mind Reading: The Interactive Guide to Emotions[17]

The application is divided into three main cores. The first core is the emotions library, the learning center, and the games zone. As illustrated in Figure 4.11, in the emotions library, 412 emotions are arranged in 24 groups representing various ages, cultures and both sexes. The material is graded into 6 levels of complexity, and various forms of help are available. In the learning center, the emotions groups are similar to the emotion library, although the structure is more oriented towards exploration through the use of videos,

[17] Source: Simon Baron-Cohen and the Mind-Reading Team at the Autism Research Centre, University of Cambridge. London: Human Emotions, (2002)

stories and vocal expressions. There are quizzes for finding faces with specific emotions, for matching emotional statements and faces, and for matching statements with people in a picture. The games zone includes matching games, hand-eye coordination games, real world face games and the opportunity to control a variety of emotions.

One must wonder about the relationship between cognitive diagnosis and autism? In my experience as a mother of three autistic children, as a specialized educator in autism, and as a doctoral student, the process of teaching autistic individuals is difficult and challenging. This is, in part, due to the fact that some individuals with ASD can have profound cognitive deficiencies while others may have IQ scores that are equal to or higher than the typical person. There are no magical therapies for the treatment of autism school teachers, therapists, specialists, and parents deal with these challenges on a daily basis.

Das, Naglieri et al., (1994) have developed a psychometric testing battery called the "Cognitive Assessment System" used in the understanding of the assessment of (diagnosis), and in the intervention of different educational problems like mental retardation, reading disabilities, autism, and attention deficit disorder, among others.

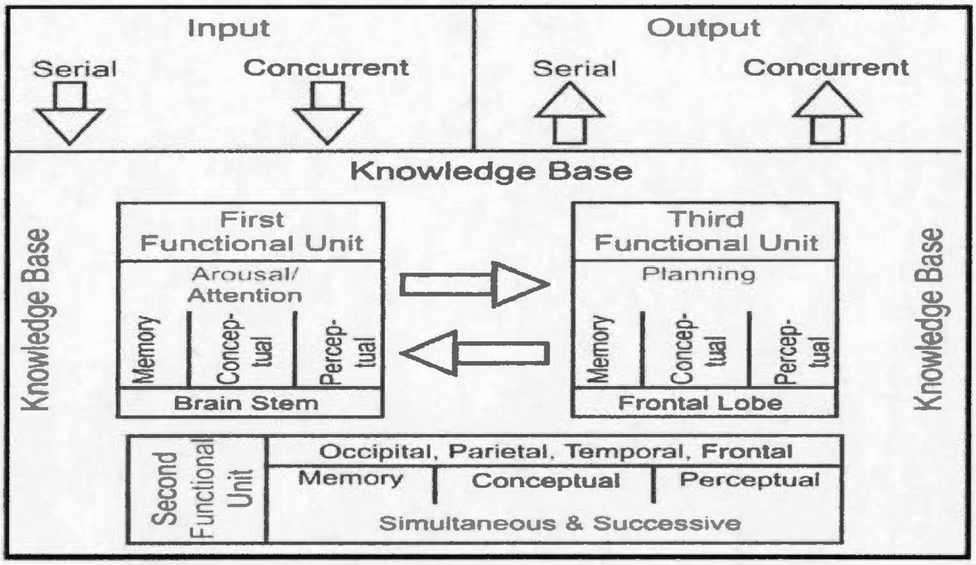


Figure 4.12 PASS Model[18]

As illustrated in Figure 4.12, the cognitive assessment system is based on the Planning, Attention-Arousal, Simultaneous and Successive (PASS) theory of intelligence, first proposed by Das, Kirby, and Jarman, in 1975[19]. According to this theory, cognition is organized in three systems and is made up of four processes. The first system is the "Planning" system, which engages in executive functions responsible for controlling and organizing behavior, selecting and constructing strategies, and monitoring performance. The second is the "Attention-Arousal" system, which entails maintaining arousal levels and alertness, and ensuring focus to relevant stimuli. The third system is the "Informational processing" system, which uses "Simultaneous" and "Successive" processing systems to encode, transform, and retain information. The next part of this paper is related to specialized education.

4.9. Specialized education

In the field of specialized education related to autism, most teaching and learning

[18] Source: Das, Naglieri & Kirby, (1994)
[19] Source: Das, Kirby, and Jarman, (1975)

approaches have a tendency to integrate a variety of educational and psychoeducational programs from the disciplines of behaviorism and psychology (National Research Council, 2001). The objective of these approaches is to tackle three main aspects of intervention among children with autism. The first aspect of intervention deals with communication and social interaction, the second aspect with developmental and educational strategies. The last one makes use of behavioral techniques in order to improve learning and behavior.

4.9.1. Educational strategies in autism

Research in autism has proven that early intervention is fundamental to any child in the spectrum (National Research Council 2001, Davis, Smith et al., 2002). One is said to have undergone early intervention when he/she has started therapy to address common deficits found in individuals with autism before the age of three. These deficiencies vary from child to child. Some forms of early intervention include physical and social therapy, Applied Behavioral Analysis (ABA), and speech- therapy, among others. For instance, the Applied Behavioral Analysis (ABA) (Dunlap, Kern-Dunlap et al., 1991) and Verbal Behavior (Barbera & Rasmussen 2007) approaches are drawn on the research and theories of Skinner (1957) related to operant conditioning and training programs that are focused on observable behaviors. In these approaches, tasks are broken down into subtasks, and each subtask is treated as a separate learning goal. Training is designed to reward correct performance and remediate incorrect performance. Generalization or mastery is assumed to be possible for every learner, given enough repetition and feedback. According to Lovaas (1987), the Early Intensive Behavioral Interventions (EIBI) model relies on the systematic teaching of "measurable behavioral units" entailing repetitive practice and structured activities presented from the simplest to the most complex. He was among the first proponents to demonstrate the effectiveness of EIBI for children with autism. In his study concerning the effectiveness of EIBI, he revealed that preschool children, engaged in one-to-one discrete trial learning sessions for forty hours a week for a period of at least 2 years. They exhibited major gains that were considered equal to increases in IQ scores of thirty points. In addition, 47% of children were described as reaching "normal intellectual and educational functioning." In spite of the Early Intensive Behavioral Interventions (EIBI) model's effectiveness, some criticisms have been made regarding the inclusion of "clinical applications" in terms of the recommended number of hours (Howlin, Magiati et al., 2009). Other researchers have applied modified versions of the EIBI program to different modern early intervention programs for individuals on the spectrum, including intensive behavioural intervention (Leaf & McEachin, 1999).

In 2003, the Ministry of Health and Social Services of Quebec introduced the program *"L'intervention Comportementale Intensive (ICI)"* as a *"geste porteur d'avenir"* to provide services to children on the spectrum up to the age of six years old, in the form of 20 hours per week of individualized intervention.

In terms of social-communication, (Bondy & Frost, 1994) have developed the Picture Exchange Communication System (PECS), which is a pictorial system that makes use of basic behavioral principles and techniques such as shaping and differential reinforcement to teach children functional communication using pictures as the communicative referent.

Several programs proposed for both nonverbal and verbal autistic children focus on early interactions among parents and recently diagnosed children in order to increase nonverbal and verbal communication training approaches (Aldred, Green et al., 2004), such as Pre-Linguistic Milieu Therapy (Yoder & Stone, 2006), More Than Words (Sussman, 1999), and Early Bird (Shields, 2001). Other developmental and educational programs, such as the Daily Life Therapy (Quill, Gurry et al., 1989), the Denver Model (Rogers, Hayden et al., 2006), and the Douglas Developmental Disabilities Center program (Handleman, Harris et al., 2006) combine aspects of developmental, educational, and behavioral approaches.

4.10. Conclusion

In this chapter, we have covered intelligent tutoring systems (ITS) and affective intelligent tutoring systems (AITS), focusing on the student model and learning process. Researchers claim that "intelligence" in ITSs exists in cognitive diagnoses. Many techniques and approaches were presented to study, detect and induce emotions with sensors, smart interfaces, as well as cognitive diagnosis (CD) within the framework of the affective intelligent tutoring systems (AITS) and specialized education related to autism. Chapter V is devoted to the architecture of the Integrated Specialized Learning Application (ISLA) which is the purpose of this research project to help autistic individuals to develop mathematical competencies and skills in addition.

CHAPTER V

THE ISLA PEDAGOGICAL AGENT

5.1. Section I: Integrated Specialized Learning Application (ISLA) architecture

5.1.1 Introduction

As human beings we are constantly socializing within our environments. Successful social interaction is dependent on our ability to detect cognitive and emotional processes in others. These concepts lead us to Chapter V, which is devoted to the specific architecture of the Integrated Specialized Learning Application (ISLA). This chapter is divided into four sections. The first section presents the architecture of the system and its importance in the domain of specialized education. The second section refers to the domain model of ISLA. Following this, the accompaniment model is covered highlighting its contribution to the field of specialized education. Finally, the conclusion is presented. Let's start with the architecture of ISLA.

5.1.2 System overview and Pedagogical methodology

5.1.2.1 ISLA Architecture

As illustrated in Figure 5.1, ISLA is an affective intelligent tutoring system capable of detecting the emotional state of an autistic child in a mathematical learning situation when engaged in an addition task and subsequently responding to this affective state by means of the use of a virtual pedagogical agent called Jessie. This is displayed in the user's interface and related to the accompaniment model. The interface will provide a three-dimensional view that allows personalizing the interaction of the three core models of ISLA. This is from the domain model point of view (by providing tools to manipulate domain objects), the accompaniment model point of view through Jessie (companion agent), and the learner model point of view using an "open-learner" modeling approach (Bull & Kay, 2010).

The open-learning model will promote "reflection" and "planning" in order to help the ASD student to "mirror" his/her own learning. The accompaniment model of ISLA is drawn from the self-regulated learning theory highlighting the essential role that metacognition plays in self-regulation and learning (Schraw, 1998).

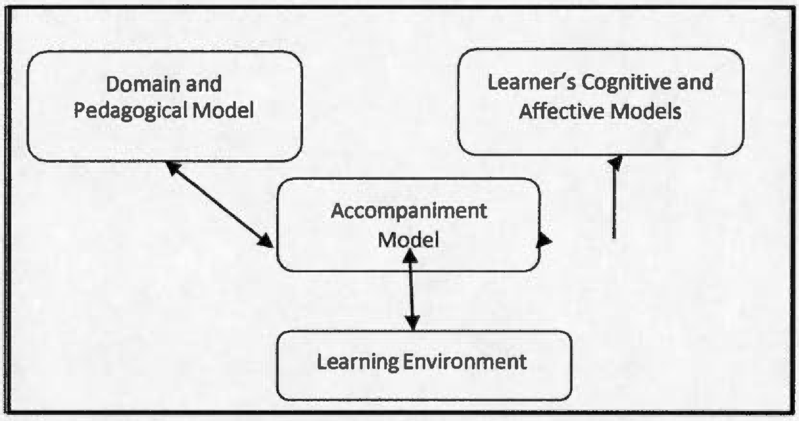


Figure 5.1 The Architecture of ISLA

ISLA is unique and its contribution entails the model of accompaniment for helping autistic children manage their emotions. This is done by analyzing the learning trace and the student's current performance. ISLA is an adaptive application that evolves along with the learner's needs. Through the incorporation of aspects of the accompaniment model, ISLA both supports and integrates the domain and learner models. For example, ISLA makes use of a personalized intervention plan, along with educational learning activities and teaching techniques employed by different actors to best meet the individual's learning needs. Next, each model of the application will be covered in detail.

5.1.2.2 Competency approach to Specialized Education

To begin with, the concept of learning design was introduced in the literature of technology for education in the late 1990s and early 2000s, promoting the idea that "designers and instructors need to choose for themselves the best mixture of behavior and constructive learning experiences for their online courses" (Gravemeijer, Cobb et al., 2000). Learning design might be defined as: *"the description of the teaching- learning process that takes place in a unit of learning (e.g., a course, a lesson or any other designed learning event)."* (Koper, 2006).

Other issues regarding pedagogical, psychological, and cognitive aspects have been addressed among researchers in education and are important with respect to this research project. Merrill, Drake et al., (1994) suggests a theory of instruction entitled "Component Display Theory," affirming that types of abilities can be divided into categories to which different teaching strategies can be associated. Gagné (1985) explains five important categories of 'human performance' focused on learning outcomes such as "intellectual skills, verbal information, cognitive strategies, motor skills, and attitudes." Along these lines, Romiszowski (1981) presents a taxonomy of knowledge, bearing on various facts, procedures, concepts, and principles. There exists a field of ontology which offers a basic formalized conceptual structure founded on shareable and reusable knowledge regarding learning theories (Gruninger & Lee, 2002).

According to Richey, Fields et al., (2001) a competency is defined as: *"an integrated set of skills, knowledge, and attitudes that enables one to effectively perform the activities of a given occupation or function to the standards expected."*

The method for engineering learning systems, or the "Méthode d'Ingénierie de Systèmes d'Apprentissage" (MISA) is intended to support the analysis, the design, and the delivery planning of a learning system by integrating the concepts, processes, and principles of instructional design, software engineering, and cognitive engineering (Paquette, De La Teja et al., 2005). Within this framework, the generic concept of "competence" is a statement of principle, governing a relation between a target public (actor), a skill, and knowledge. Thus, a competence is a relation between three domains, described as follows:

1) The domain of knowledge, described by means of a model of concepts, procedures, principles, and specific facts, all of which describe the exercise of a role or of a task.
2) The domain of the abilities (skills), describing the processes which could be applied to a domain of knowledge in order to perceive them, memorize them, evaluate them, assimilate them, analyze, and/or synthesize them.
3) The domain of public target, relating to the description of the actors, their properties, functions, and tasks, and especially their competencies. It is a matter of associating the basic competencies with an actor or with those sought by means of training for the exercise of a role or for the performance of a task.

When different methodologies for the development of knowledge-based systems are proposed in literature, the question that must be asked is: Why use the MISA methodology in the field of specialized education? I believe that the importance of MISA within the framework of specialized education is that it brings to light not only the essential role for the acquisition of "competencies" but also the design of the instructional scenarios. It allows for the re-use and adaptation of teaching approaches from the point of view of learning objectives vis-à-vis the Individualized Intervention Plan (IIP) which is the central point of ISLA when dealing with the accompaniment model.

As previously discussed, individuals with ASDs usually display particular communication and social deficits. These characteristics cover a wide spectrum, with individual differences in terms of age of onset, levels of functioning, challenges with respect to "social interactions", and "severity" ranging from mild to severe (Association 2000; Lord, et al., 2000). The affective impairments of individuals within the spectrum have been recognized as having an important impact on intervention (Seip, 1994). As a result, the "affective states" of the autistic child that best enable to meet the student's special needs in terms of "pedagogy" have been considered in this study, along with the learner model. ISLA entails a pedagogical engineering approach. We carried out a preliminary analysis of the learning application ISLA using the gauges resulting from MISA, as follows:

1) The competences are outlined in ED214[20]
2) The training objectives can be found in ED102[21]
3) The target population is presented in ED104[22]
4) The actual context is described in ED106[23]

The next section presents the domain model and accompaniment model of ISLA using MISA methodology.

5.1.3 The instructional design of ISLA

This part of the research presents the pedagogical engineering of the learning system related to teaching mathematics to children presenting autism. With this in mind, the question is: Do we all possess the cognitive capacities with regard to the levels of knowledge, as well as to the competencies and abilities that allow us to adapt and respond adequately to our environment? The clinical, behavioral, and asymmetric cognitive profiles of ASD are multiple and complex, with many individual differences (Happe & Frith, 1996). Individuals with autism can display normal levels of intelligence, above average IQs (Intellectual Quotients), or mental retardation, yet all meet diagnostic criteria for an autism spectrum disorder (Happe and Frith, 1996). As such services that support the integration and the participation of these individuals in society is crucial. This diversity of profiles causes multiple challenges in terms of methodologies and teaching programs directed towards autistic children. These important concepts bring us to the domain model as presented in Figure 5.2.

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[20] See Appendix A: ED214
[21] See Appendix B: ED102
[22] See Appendix C: ED104
[23] See Appendix D: ED106

5.1.3.1 The Domain Model of ISLA

The domain model of ISLA deals with the tutor expert plus the design and implementation of agent-based architecture of a Personalized Education System. The domain model of ISLA concerns the learning system related in teaching addition to children with autism. Competencies are at the heart of the domain model of ISLA. According to (Richey, Fields et al., 2001) a competency is defined as: *"An integrated set of skills, knowledge, and attitudes that enables one to effectively perform the activities of a given occupation or function to the standards expected."*

In this study we have considered the competencies which are to *analyze, utilize, correct, adapt, manage, explicit,* and *modify* in the acquisition of several skills associated with knowledge in mathematics from different domains such as the cognitive and the affective domains among children with autism. ISLA is able to help the learner to develop these competencies at different levels: beginner, intermediate, advanced, and mastery. For example, at an intermediate level, if the learner made an error related to carrying and writing 1's and 10's, then he/she is expected to be able to analyze, utilize, and correct his/her learning trace without prompting. MISA methodology allowed the construction of a domain model. Table 5.1 summarizes the necessary competencies for the acquisition of several skills associated with knowledge from different domains such as the cognitive and the emotional domains among children presenting autism.

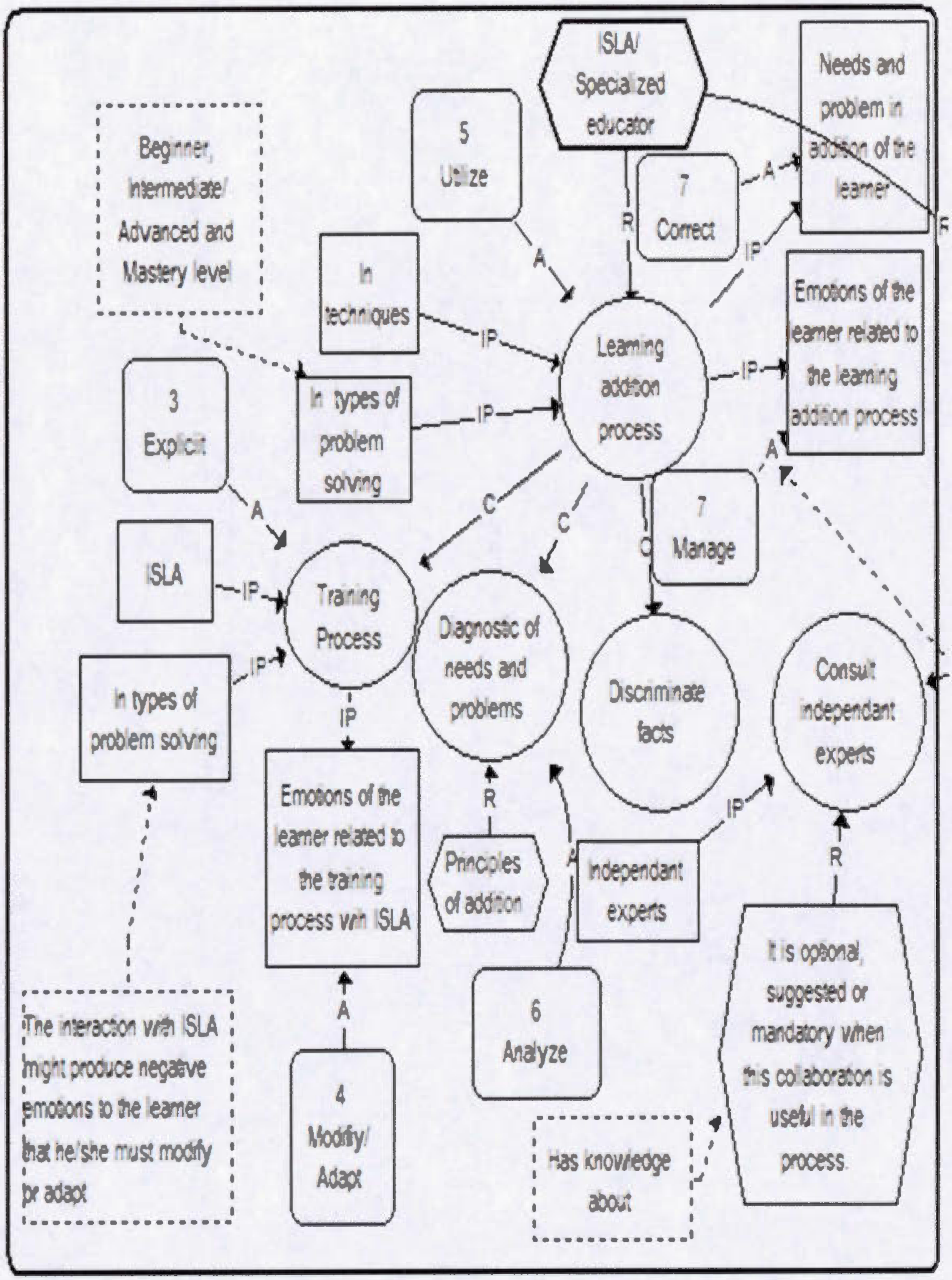

Figure 5.2 The Domain Model of ISLA

As shown in Figure 5.2, the domain model illustrates the six competencies that are at the heart of ISLA.

The various activities are represented by procedures, the sources of information by concepts, and the actors (ISLA and the specialized educator) by principles. It is ISLA and the specialized educator who govern the *process of learning addition* for children presenting autism involving the competency *Utilize* within the cognitive competency domain, the associated level of skill being *5*. The learner should be able to solve *Utilize* simple addition problems with or without prompting. The inputs relevant to the *Process of learning addition* are related to *Techniques* and *Type of problem-solving* which are exercises or pedagogical scenarios that are presented to the learner with the intention of developing these skills at an intermediate level.

Table 5.1

The competencies of ISLA

Competency	Competency Domain	Skills Associated	Actual Skills
The learner should be able to analyze, represent and to solve problems involving addition with or without prompting.	Cognitive	6 Analyze	Variable
The learner should be able to utilize and solve simple addition with or without prompting.	Cognitive	5 Utilize	Variable
The learner should be able to correct simple additions with or without prompting.	Cognitive	7 Correct	Variable
The learner should be able to manage his/her emotions in the process of learning addition with or without prompting.	Affective	7 Manage	Variable
The learner is expected to explicit and illustrate his/her skills in a context of training with the affective intelligent tutoring system (ISLA) with or without prompting.	Cognitive	3 Explicit	Variable
The learner should be able to modify or adapt his/her emotions in a context of training with the affective intelligent tutoring system (ISLA) with or without prompting.	Affective	4 Modify	Variable

As illustrated in Figure 5.2, the outputs from this process concern the *Needs and problems of addition* that the learner might have encountered, dealing with the competency *Correct* within the cognitive competency domain, and the associated level of skill being *7*. At this point, the learner should be able to correct simple additions with or without prompting. The second output illustrates the *emotions* about the *process of learning addition* that the learner might have experienced which falls under the competency *Manage* within the *affective* competency domain, the associated level of skill being *7*. The idea behind this important competency is that the learner should be able to manage his/her emotions in the *process of learning addition* with or without prompting.

The *process of learning addition* is composed of three sub-processes. The first sub-process is the *training process with ISLA* which entails the competency *Explicit* within the *cognitive* competency domain, the associated level of skill being *3*. With this competency, the learner is expected to clarify and illustrate his/her abilities in a context of training with the affective intelligent tutoring system (ISLA) with or without prompting. The inputs applicable to the *process of training* are related to the interaction between the learner and ISLA and to the *type of problem-solving* which encompasses exercises or pedagogical scenarios that are presented to the learner with the intention of developing these skills at a beginner level. As observed in Figure 5.2, the output *learner's emotions related to ISLA* deals with the competency *Manage*. With this competency, the learner should be able to *Modify* or *Adapt* his/her emotions in a context of training with ISLA with or without prompting. The second sub-process is the *diagnostic of the needs and problems* which is controlled by the *principles of addition* and implies the third competency *Analyze* within the domain of *cognitive* competency, the level of the skill associated being *6*. The third sub-process is *discriminate the facts* and has to do with the third competency *Analyze* within the domain of *cognitive* competency, the level of the skill associated being *6*. At this point the learner should be able to analyze, represent, and to solve problems involving addition with or without prompting. As described in Figure 5.1.3, the next part portrays the accompaniment model of ISLA.

5.1.3.2 The accompaniment Model of ISLA

In this study, I introduced the concept of *model of accompaniment* which does not exist in AITS literature. What exactly does the concept of *accompaniment* entail? In the context of music, the concept of *accompaniment* is described as: the composed music, arrangement, or improvised performance that is played to "back up" the soloist in a "supportive manner." As outlined in Figure 5.1.3, in the context of ISLA, the model of accompaniment integrates the domain and pedagogical model with the learner's cognitive and affective models. It makes use of an individualized intervention plan (IIP), along with educational learning activities and teaching techniques employed by different actors to best meet the individual's learning needs. Figure 5.3 presents the model of accompaniment. The input *learner model* involves *The process of accompaniment* for children presenting autism which is controlled by ISLA and the specialized educator. The input *Manage* concerns the competency *Manage* within the *affective* competency domain and the level of the skill associated being 7. The learner should be able to manage his/her emotions with or without prompting.

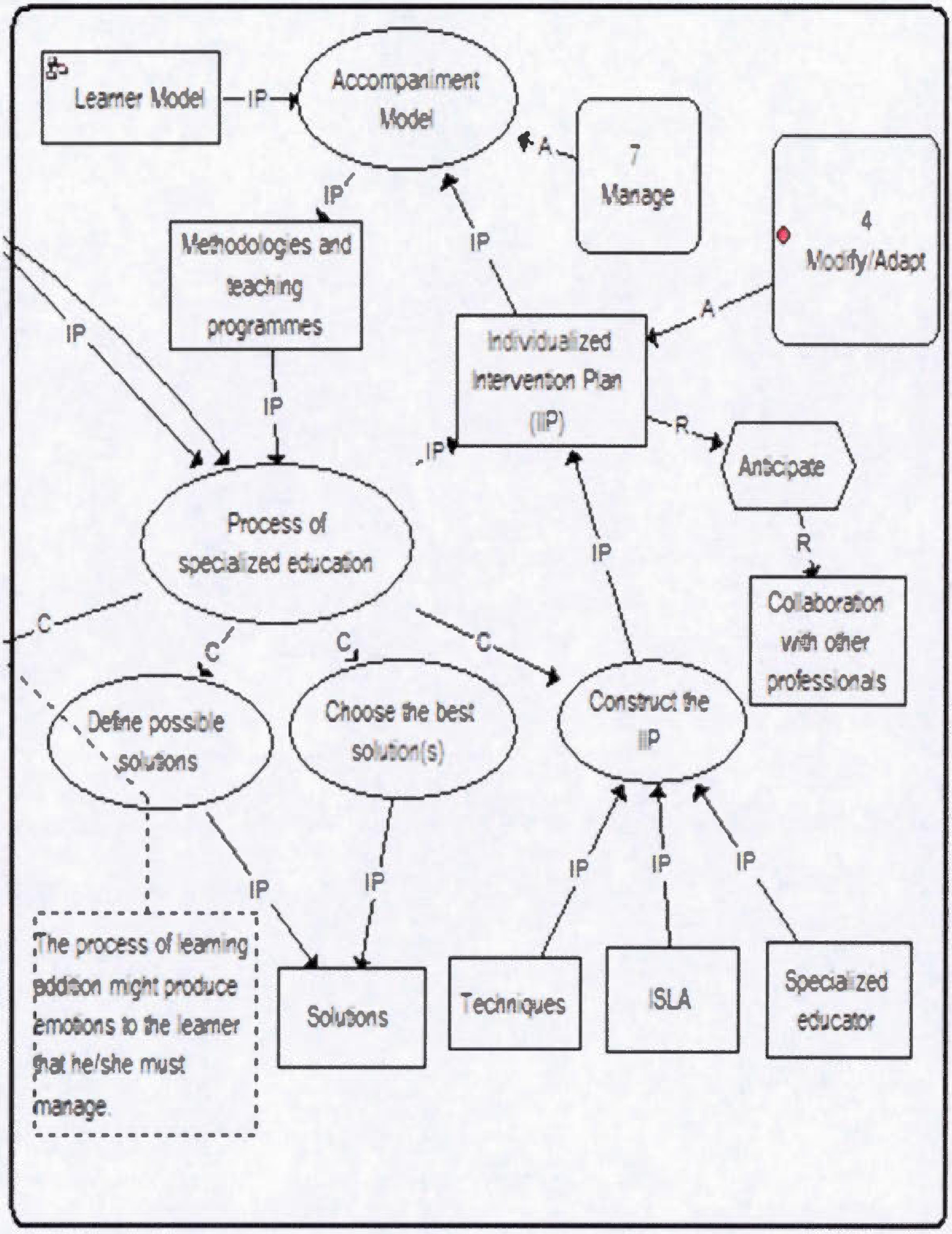

Figure 5.3 The Accompaniment Model of ISLA

The Individualized Intervention Plan (IIP) is the framework for the model. Its integration into ISLA is essential because it provides guidance and key elements about the curriculum, the pedagogy, and the behavior required from the autistic person, among others. The IIP provides information about previous interventions, including their range of effectiveness and possible reasons for failure. The IIP outlines a clear description of the current intervention strategies and data collection procedures, as well as a cognitive profile in terms of strengths and weaknesses that the autistic child may display. Studies have revealed that recognizing the possible behaviours that may indicate an autistic child's affective states such as happiness, boredom, frustration, as well as cognitive states related to attention, curiosity, and understanding, are essential for effective intervention with the child (Picard, 2009). As observed in Figure 5.3, the output from the process of accompaniment is associated with *methodologies and teaching programs* which turns into the output for the *process of specialized education plan.* The process of specialized education is composed of three sub-processes: *consult experts*, *define possible solutions*, and *choose the best solution* in order to *construct the IIP*. As observed in Figure 5.3, the outputs of the *Individualized Intervention Plan* deal with the competency *Modify/Adapt* within the *affective* competency domain, the level of the skill associated being *4*. With this competency, the learner should be able to *Modify or Adapt* his/her emotions in the *Process of learning addition* with or without prompting. As shown in figure 5.3, the teaching of autistic individuals entails a multidisciplinary collaboration that involves experts from different domains such as specialized educators and professionals (for example, psychologist, speech therapist, among others) whose expertise play an important role in terms of the *process of specialized education plan* that best fits the individual's needs. The learner model of ISLA is presented in Chapter IV, along with the pedagogical model, the experimental protocol and the methodology used to validate this research project.

5.1.4. Conclusion

In this chapter, we have introduced the architecture of ISLA related to the domain of specialized education. ISLA is an affective intelligent tutoring system that evolves along with the learner's needs. Through the incorporation of aspects of the accompaniment model, ISLA supports and integrates the domain and learner models with the intention of providing individualized instruction in real-time as "effective" as one-on-one human instruction (Verdu, Regueras et al., 2008). How do we detect the affective state of an autistic child in a mathematical learning situation and consequently responding to it by using ISLA?

5.2. Section II: The Pedagogical Model of ISLA

5.2.1. Introduction

Several researchers have been examining the potential of computer technology to improve the quality of life for children presenting autism. In an attempt to tackle the issue of social communication impairments faced by children with ASD, these researchers have made use of virtual reality technologies (Bernard-Opitz, Sriram et al., 2001; Mitchell, Parsons et al., 2007). This chapter is dedicated to the pedagogical model of ISLA divided into three sections. The first part presents the learner model of ISLA which entails the affective and the cognitive state of the autistic learner. The second section concerns the pedagogical model. Finally, the conclusion is presented. Let's start with the learner model.

5.2.2. The Learner Model of ISLA

In the learner model, the *clinical profile of the learner* is personalized to the student and involves two important processes. The first process deals with the *affective process of the learner*, and the second one relates to the *cognitive process of the learner*. As illustrated in Figure 5.4, both processes are controlled by ISLA and the specialized educator. The accompaniment model of the Integrated Specialized Learning Application (ISLA) is drawn from the self-regulated learning (SRL) theory (Baird & White 1996, Nichols, Tippins et al., 1997). SRL refers to our "ability" to understand and control our learning environment and it consists of three main components: cognition, metacognition, and motivation (Schraw, Olafson et al., 2002). As pertains to the teaching of autistic children, the affective impairments of individuals within the spectrum have been recognized as having an important impact on intervention (Seip, 1994). Table 5.2 outlines the self- regulated learning strategies that are employed in this research project in order to overcome these challenges when teaching first grade addition to children presenting autism by the means of ISLA.

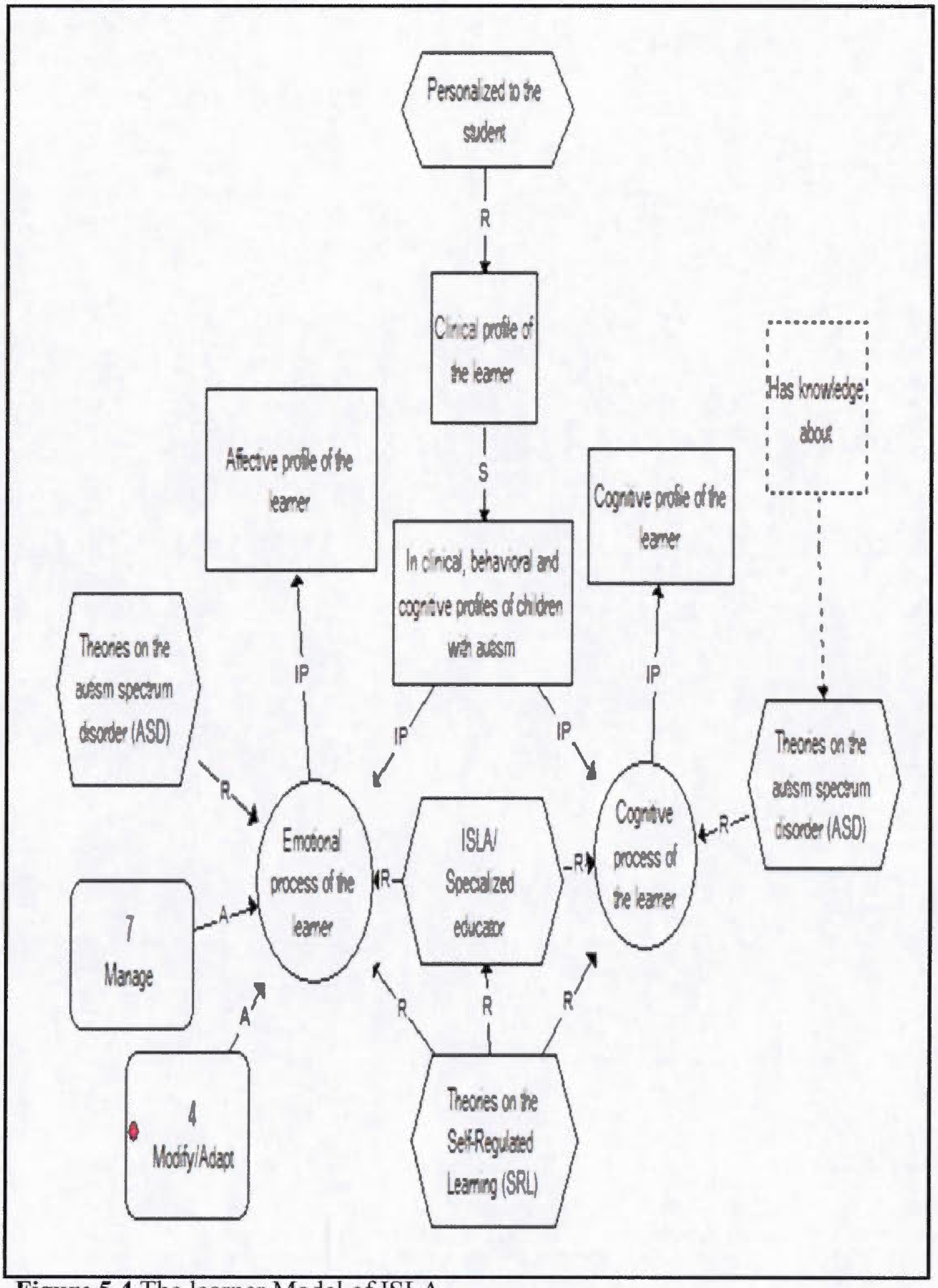

Figure 5.4 The learner Model of ISLA

Table 5.2

SRL strategies used in ISLA

Self-Regulated Learning strategies used in ISLA		
Cognition	**Metacognition**	**Motivation**
Cognition concerns skills required for encoding, memorizing and retrieving information.	Metacognition takes into account the skills that enable learner to understand and monitor their cognitive processes.	Motivation is a "state of cognitive and emotional arousal, which leads to a conscious decision to act, and which gives rise to a period of sustained intellectual and/or physical effort in order to attain a previously set goal." Williams & Burden, (2001)
Strategies:	**Strategies:**	**Strategies:**
- The use of student generated questions in order to draw the learner's attention (Chinn & Brown, 2002; Kahle & Boone, 2000). - The application of active learning strategies, like graphs and tables (House, 2002). - Problem-solving can be further broken down into Smaller individual tasks, which can be teachable and which can improve learning.	- Metacognitive conditional knowledge is the key to learning knowledge, as it helps students allocate their resources selectively and adjust to the changing situational demands of each learning activity (Reynolds, 1992). - Cognition regulation provides a set of activities, helping students to be responsible for their own learning (Palincsar & Brown, 1989).	- Motivational diagnosis (Vicente & Pain, 2002). - A higher degree of self- efficacy is positively associated with school achievement and self-esteem (Pajares, 1996). - Peer models are usually most effective because they are often similar to the learner (Schunk, 1996).

This part of the research relates to the pedagogical model of ISLA dealing with the design and the conception of a mathematical learning situation highlighting the important role of competence in the course of teaching addition to children presenting autism. According to the *Ministère de l'Éducation, du Loisirs et du Sport (MELS)* competencies are essential in the field of education. The MELS defines the concept of "competency" as: "*Un savoir-agir* *fondé sur la mobilisation et l'utilisation efficaces d'un ensemble de ressources.*"

In this research project, the idea behind *competencies* is to help and support the autistic student to develop mathematical abilities and skills in order to encourage generalization or mastery, which are assumed to be possible for every learner, given enough repetition and feedback. Mastering learning (Bloom, 1984) requires that the tutoring system has some way of assessing the students' level of knowledge.

Table 5.3

The learning process of mathematics[24]

Phase 1: Free play makes it possible for the ASD student to explore by manipulating objects.
Phase 2: Teaching addition mathematical properties of addition by playing games according to certain restrictions.
Phase 3: Teaching 'isomorphous' games for better understanding the mathematical concept whose properties are similar to the ones presented in phase 2.
Phase 4: Teaching representation where the child uses graphs, drawings or even natural language to describe what he/she did.
Phase 5: Teaching description of the properties, where the child makes use of a more abstract representation while using an invented mathematical language.
Phase 6: Teaching formal demonstration, where the child manages to support his reasoning by using a formula.

In the pedagogical model the student learns a unit (phase) until he/she has mastered the unit's knowledge. We have considered the work of (Bruner, 1966) who explains three important types of representations when learning mathematics: concrete, image and symbolic.

When representing a mathematical concept as concrete, the student manipulates objects. In image mode, the student represents, through the use of designs, the action that corresponds to the object. In symbolic mode, the student makes use of mathematical

[24] Source: Dienes and Walusinski, 1966; Dienes, (1970)

symbols. In this study the foundation of the mathematical application is based on the work of Dienes and Walusinski, (1966); Dienes, (1970) who presents a framework for the comprehension and learning process of mathematics, which is grouped into six phases. These phases, shown in Table 5.3 are at the heart of the pedagogical model. As one can see in Figure 5.5, the *Individualized Intervention Plan* resource plays an essential role by identifying measurable and observable objectives, but also the strengths and the weaknesses of the autistic child. It also provides key elements of orientation during the development of the objectives, in addition to strategies of training necessary for the child, plus the length of the intervention.

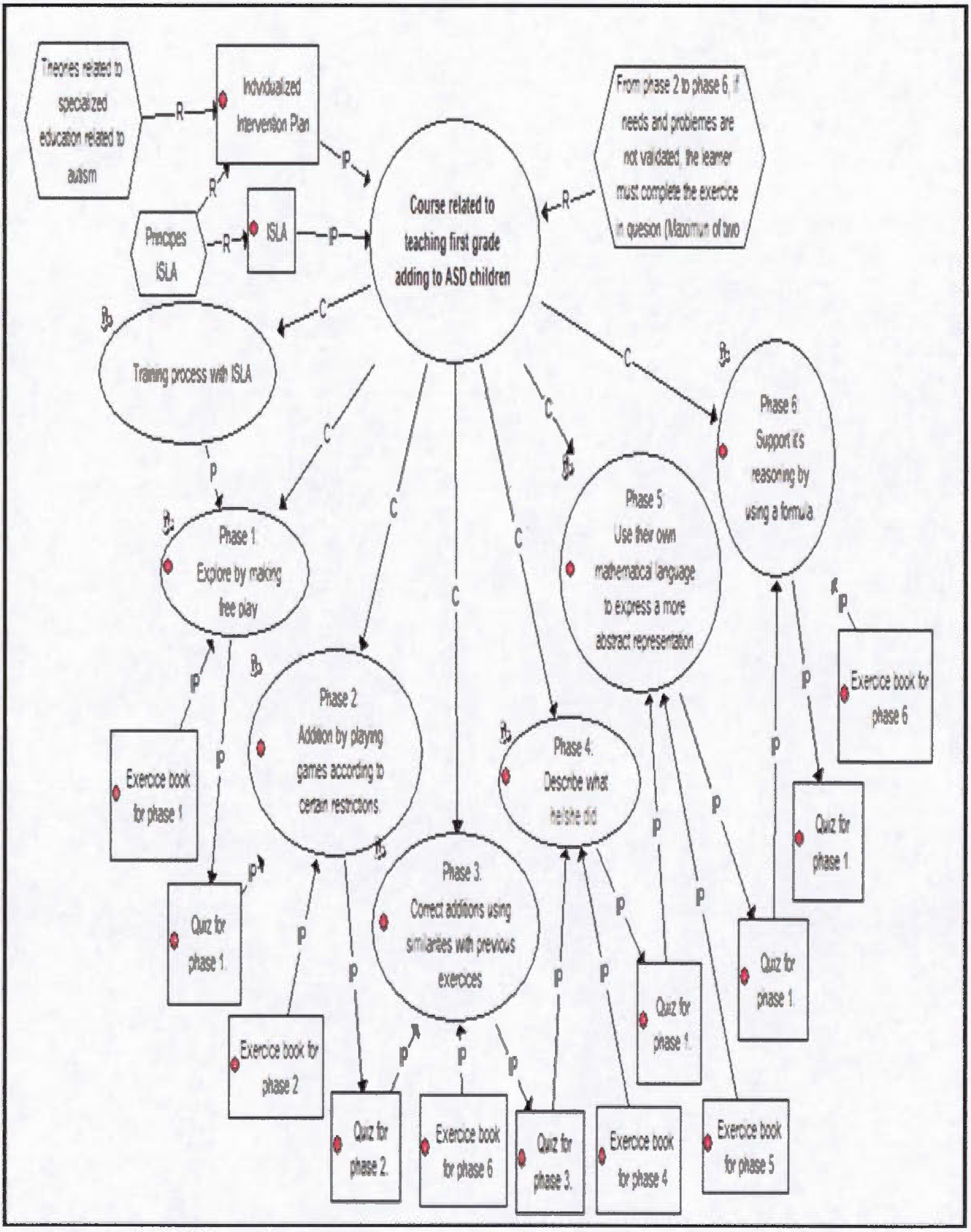

Figure 5.5 The Pedagogical Model of ISLA

Figure 5.6 ISLA (Error #1)

This model also includes the training process, which uses ISLA. The pedagogical model of ISLA entails a "behavioral" approach to cognitive diagnoses (VanLehn, 2006) in which tasks are assigned in a predetermined sequence. The main advantage is that the learner must finish a task before moving to the next, increasing the chance that the ASD student will have mastered the prerequisites of a task before starting the next. From phase one to phase six, if the resource *needs and problems* is not validated, the learner must complete the exercise in question (maximum of two trials without prompting). It is important to measure and validate the acquisition of objectives. From phase one to phase six, in order to move forward to the next phase, the learner must pass the quiz with a passing mark of at least 75 %. Error Analysis is performed to determine whether this objective is met (Tindal & Marston, 1990). Figure 5.4 illustrates an error with carrying and writing 1's and 10's.

Table 5.4

Error Analysis List[25]

Error	Description
Error # 1	Difficulty with 1s and 10s in carrying and writing.
Error # 2	Difficulty with understanding regrouping.
Error # 3	Difficulty in discriminating H(Hundreds), D(Tens),
Error # 4	Difficulty with carrying 10s and 100s.

For example, when the student performs a quiz, ISLA/specialized educator corrects the student's exercises and categorizes the errors. In this research, identifying the error is crucial in order for the pedagogical agent to be able to provide the appropriate feedback to the ASD learner. The list of errors will be incorporated into the domain model and are related to the model tracing in the next part. The list of errors is highlighted in Table 5.4. The objectives for the use of error analysis are as follows: First, it helps to identify the patterns of errors or mistakes that ASD students make in their exercise. Second, it provides information as to why students make the errors, and finally, it presents targeted instruction to help the student to correct the errors (Tindal & Marston, 1990).

5.2.2.1. The cognitive state

For the purpose of this study, the sample is constrained to high functioning children in order to use a standardized training method. In literature, autistic individuals displaying a normal or high IQ are considered as having high functioning autism, which is characterized by lower functioning in social and language skills, in contrast to visuospatial skills. In this case (Mottron & Belleville, 1993) reveals exceptional abilities when dealing with localized visual details in several studies conducted on individuals with high functioning autism.

Within the domain of specialized education "generalization" of gains for children in

[25] Source: Tindal & Marston, (1990)

the spectrum is difficult to maintain. Green, Charman et al., (2010) and Rao, Beidel et al., (2008) claim that the "efficacy" of an intervention must be determined by means of more single-case and open trial designs within a specific learning task (Whalen & Schreibman, 2003). In this research, the pedagogical aspect of the cognitive diagnosis within ASD students has been taken into consideration. According to Tchetagni, Nkambou et al., (2006), the pedagogical aspect of cognitive diagnosis is important because it focuses on: 1) How to foster a remedial state upon the system's hypothesis about the learners' cognitive states while performing the CD, and 2) How to continually adjust the systems' hypothesis regarding the learners' cognitive state in order to obtain more accurate representation of the learners' needs. The technique used in ISLA to model the cognitive state of the learner is based on prior probability criteria that the concept of adding is known by the learner. In addition, the learner is capable of discriminating numbers up to 100. Thus, the specialized educator performs a baseline measure of performance through a quiz[26] consisting of thirty additions grouped in four different levels of competencies for each participant. The criteria baseline is provided in the first part of the experiment and is described in Chapter VI, along with the preliminary results.

5.2.2.2. The affective state

The Ortony, Clore et al., (1988) model of emotion is widely used in artificial intelligence literature. This framework considers emotions as "valenced" reactions to the external or internal stimuli based on the manner in which the situation is interpreted. Three specific types of stimuli are defined by this model that determines the strength of a given emotion depending on the events, agents' actions, and objects situated in the environment of the agent exhibiting the emotion. This framework categorized 22 emotions into three main classes. The first class of emotions corresponds to objects such as liking (love) and disliking (hate). The second class of emotions are consequences of events such as being pleased or displeased (e.g. joy, distress), prospect-based (e.g. hope, relief, fear), fortunes-

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[26] See Appendix E: The Quiz

of- others (e.g. happy, resentment, gloating, pity). Finally, we have attribution compounds which include pride, admiration, shame, and reproach. The emotion's intensity relies on the internal and external stimuli the agent receives from the environment.

In ISLA, the computational model which detects the affective state of the autistic child relies on the framework of emotions proposed by (Davidson, Ekman et al., 1990) where happiness is positively-valenced, surprise, sadness, and neutral are non- valenced, whereas frustration and fear are negatively-valenced emotions. This affect recognition evaluation framework has been broadly validated among "typical" students with intelligent tutors (Rani, Liu et al., 2006). The purpose of their study was to determine the proportional embodiment of the valence (positive or negative) of discrete emotional states during a learning experience with MetaTutor, a multi-agent learning environment for human biology. The results of this study demonstrated that the tutorial strategy deployed by the pedagogical agent had a significant effect on the negative emotions (anger) embodied by the learner. By making use of meaningful and explanative feedback while tutoring a human user in a computer-based learning environment, it is possible to significantly reduce the user's negative emotions. The Davidson, Ekman et al., (1990) set of emotions was further expanded by Wayang, who classified four ranges of emotional self- concept including frustration, interest, confidence, and anxiety, with over 78% accuracy. The results of this study show that in the case of the emotional outcomes (confidence and frustration), the effects are stronger for females than for males. The results also indicated that it was only high achieving males who clearly did not benefit from affective learning companions.

By contrast, research on the correlation of affect recognition through the use of sensor indicators and the affective states of individuals presenting autism is poor (Shalom, Mostofsky et al., 2006). In this study, the affective model of the learner is based on state-of-the-art FaceReader technology sensors. As children on the spectrum display communicative (nonverbal and verbal) deficits (DSM-IV), it makes it difficult for observational methodologies. The affective profile selected in this study includes the affects of: interest, frustration, anxiety, happiness, anger, disengagement, engagement, and guidance because they are considered relevant in autism intervention practices (Dautenhahn & Werry, 2004).

5.2.3. The Pedagogical agent of ISLA

We have designed and implemented the pedagogical model of ISLA in terms of the learning process of mathematics in the field of specialized education highlighting the important role of *competencies* in the course of teaching addition to children with autism.

Figure 5.7a Correct answer **Figure 5.7b** Incorrect answer

The idea behind competencies is to help and support the autistic student in developing mathematical skills. Mastering learning requires that the tutoring system has some way of assessing the students' level of knowledge (Bloom, 1984). We have considered the work of (Bruner, 1966) who explains three important types of representations when learning mathematics: concrete, image and symbolic. The pedagogical model of ISLA entails a "behavioral" approach to cognitive diagnoses in which tasks are assigned in a predetermined sequence. The learner must finish a task before moving on to the next phase, thus increasing the chance that the ASD student will have mastered the prerequisites of a task. The error analysis is presented in Table II. Different types of feedback are suggested to the student by the pedagogical agent Jessie.

As observed in Figure 5.7a, color-based flag feedback is used to indicate the correctness of the answer. Second, a buggy message which is a specific text message related to the error made by the student can be provided. Third, a chain of hints is used if the student needs help. A "hint" can be given if it is needed. In Figure 5.7b, the idea is that when the learner provides the right answer, the pedagogical agent will reward him/her with social encouragement: *Good job*, *Champion*, *You did it,* etc. If the learner gets frustrated by the activity and reacts negatively towards the task, ISLA is able to anticipate and detect the learner's emotional state ahead of time, and thus shifts his/her attention to a ludic activity to diminish negative behavior. Once the learner's negative behavior has shifted to positive behavior, ISLA is able with *hints* to respond by means of pedagogical scenarios to the motivational needs to the student. To keep track of the cognitive state of the student, a window of the errors is made, along with any corrective action taken by the learner. This approach provides the appropriate feedback to answer the following questions: How many and what kind of errors does the student make? How often does the learner succeed with or without prompting?

5.2.4. The Affect Detection Cycle in ISLA

This part of the paper leads us to the state-of-the-art specialized software technology measurement and processing sensors that are used in this research project for the purpose of affective state recognition such as FaceReader technology systems.

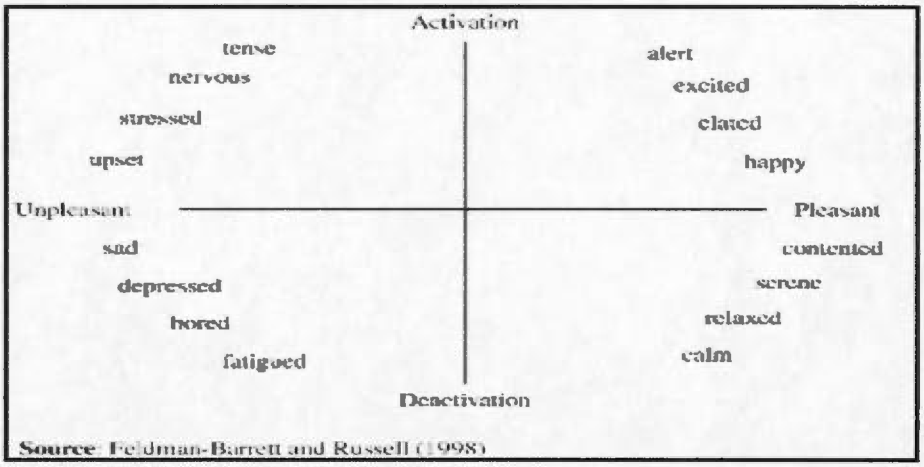

Figure 5.8 Circumplex model[27]

To begin with, Figure 5.8 explains the circumplex model of affect (Feldman Barrett & Russell, 1998) which proposes that "affective states" rely on the behavior of two important independent neurophysiological systems. The first one is related to valence (a pleasure-displeasure continuum), and the second to activation (arousal) or alertness. Affective states are a function of these two systems. The circumplex model is two dimensional, with activation and valence defined as orthogonal (perpendicular) axes. As a result, the activation axis, displayed vertically, ranges from deactivation (zero arousal) to activation (high arousal).

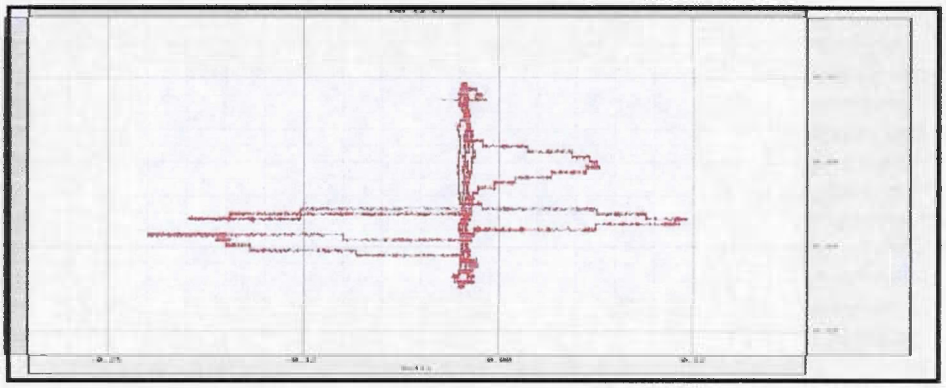

Figure 5.9 Affect-Valence Integrated[28]

[27] Source: Feldman Barrett & Russell, (1998)
[28] Source: Feldman Barrett & Russell, (1998)

For example, Figure 5.9 illustrates the valence axis, displayed horizontally, and ranges from negative to positive. Both arousal and valence levels can be estimated by sensing aspects of affective states through the use of X/Y Plotting for Real-time affective state estimate. As illustrated in Figure 5.10, in this current research, the affective recognition cycle consists of four cycles and is triggered when the participant presenting autism interacts with the affective intelligent tutoring system (ISLA). His/her emotional states are measured and processed in real-time through the use of FaceReader state-of-the-art technology illustrated in phase 2.

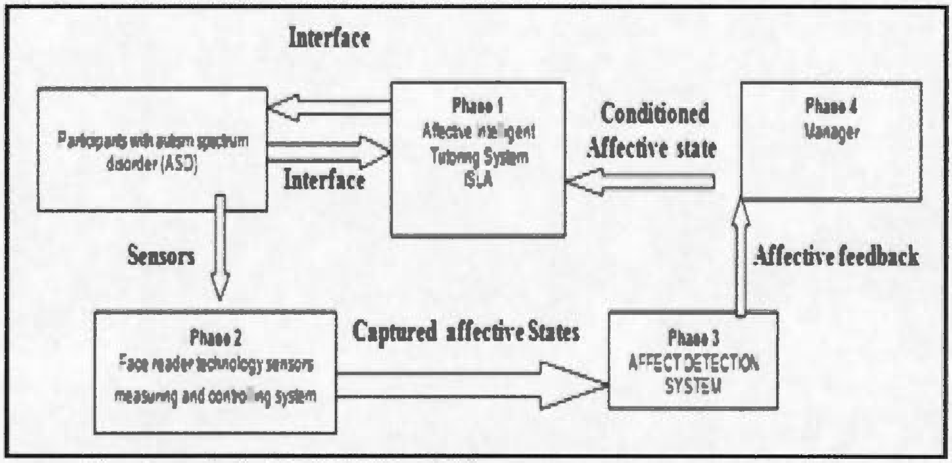

Figure 5.10 Affect Detection Cycle in ISLA

The captured affective states are measured and processed which in turn sends back the information as an input to the affect detection system (phase 3). In phase 4, the *manager* associated with specialized software is able to gather and analyze a set of emotional signals from the autistic learner. It then returns it as a *conditioned affective state*, which becomes the input for ISLA to respond accordingly to it in order to help the ASD learner to calibrate his/her affective states in mathematical learning.

In this research, FaceReader facial expression recognition technology was used to detect the affective state of the autistic student. This technology automatically analyzes seven basic facial expressions such as happy, surprised, disgust, angry, scared, sad, as well as neutral. FaceReader classifies a face in three consecutive steps. First, an accurate position of a face is found using a method called the Active Template Method (ATM). Second, it uses a model-based method called the Active Appearance Model (AAM). The AAM controls individual facial variations in addition to variations related to pose/orientation, lighting and facial expression. It also calculates gaze direction, head orientation, and person characteristics.

Table 5.5

FaceReader emotional expression classification[29]

	happy	angry	Sad	surprised	scared	disgust	neutral	recall
happy	138	0	1	0	0	0	1	0.99
angry	1	116	2	1	3	11	0	0.87
sad	3	4	109	19	2	1	1	0.78
surprised	0	1	6	128	0	0	0	0.95
scared	0	8	5	2	115	5	3	0.83
disgust	1	5	3	0	3	126	0	0.91
neutral	0	11	2	1	1	0	125	0.89
precision	0.97	0.80	0.85	0.85	0.93	0.88	0.96	0.89

Table 1. Confusion table for emotional expression classification.

Finally, in the FaceReader architecture is the actual classification of the expression or facial features. Table 5.5 presents the precision % for each of these facial expressions (Den Uyl & Van Kuilenburg, 2005). Data acquired with FaceReader was then imported into Observer XT, a software analysis system for collection, analysis, and presentation of observational data for each participant. One advantage of Observer XT is that it provides a solution for joint analysis, synchronization and integration of FaceReader data including screen captures, and eye tracking data video with manually coded events for each participant during the mathematical learning. The results and observations will be

[29] Source: Den Uyl and Van Kuilenburg, (2005)

discussed in Chapter VI, when presenting the prototype of this study.

5.2.5. Conclusion

In this chapter, the learner model of ISLA has been presented outlining the affective and cognitive state of the autistic learner. In the pedagogical model, the design and the conception of a mathematical learning situation has been described emphasizing the important role of *competencies* in the course of teaching addition to children presenting autism.

5.3. Section III: The conception of the Integrated Specialized Learning Application (ISLA)

5.3.1. Introduction

As previously stated, the affective impairments of an individual within the spectrum have been recognized as having an important impact on intervention (Seip, 1994). As a result, the "affective state" of the autistic child in terms of "pedagogy" that best meets the special needs of the student, has been reflected in this project research, along with the learner model. This section presents the conception and development of ISLA in the course related to teaching addition to children on the spectrum of autism. This chapter is divided into four sections. In the first section, we present the conception of ISLA dealing with the learning event network, highlighting the competencies that are at the heart of this study, along with the mediatic and diffusion model, giving rise to the pedagogical design of scenarios for the activities described in the ISLA pedagogical model. The second part entails the development model of the Integrated Specialized Learning Application, highlighting the rules of the model which will be used in the realization and in the implementation of the system. Finally, the conclusion is presented. Let's start with the conception of ISLA.

5.3.2. The Conception of the Integrated Specialized LearningApplication

5.3.2.1. The Pedagogical design of ISLA

ISLA entails a pedagogical engineering approach. Therefore, the analysis of the learning system is carried out, using the gauges, resulting from the MISA methodology, as follows: First, the training objectives were analyzed. Secondly, the target population was considered. Thirdly, the actual context, and finally, the competencies table were reviewed.

Indeed, Paquette (2005) defines a pedagogical scenario as : "*Une organisation des* *activités d'apprentissage*. " It is a "model" intended to capture at the same time, a method, a strategy and tactics of learning and teaching, as a process of work on the treatment of knowledge vis-à-vis the acquisition of skills. The objective of ISLA is to teach addition to students on the spectrum of autism.

5.3.2.2. The Learning Events Network (Global)

At this stage, the goal is to present the global learning events network (REA) playing an essential role, not only at the level of the pedagogical strategy, but also in terms of the roles granted to the learner, the specialized educator, and ISLA. As observed in Figure 5.11, the learning system course is composed of three important learning units. The time frame to complete the learning units is scheduled for 12 weeks. Thus the first learning unit concerns the training process schedule for one to two weeks, using the *Homepage* resource, implicating the cognitive competency *3 Explicit* and the emotional competency *Modify/Adapt*. This learning unit is related to the second one, *REA initial and pedagogical scenario* through the written evaluation and the *trial-error* process. The purpose of the second learning unit is to achieve the accompaniment model that best meets the ASD student by means of the pedagogical scenario, involving different resources such as the webography, ISLA, and the individualized intervention plan (IIP) among others. This unit is governed by *Methodologies and teaching programs* and the *Collaboration with other professionals*. In addition, the second learning unit involves the affective competency *4 Modify/Adapt* and *7 Manage* which lead to the third learning unit, i.e. *The addition learning process* with the objective of teaching addition. As indicated in Figure 5.11, this important unit comprises three cognitive competencies including *5 Utilize*, and *6 Analyze*, as well as the third competency *7 Correct*, bearing on the *Written evaluation* and the rules for *Trial-error* requesting the resource *Solutions* and the *Validated Individualized Intervention Plan* dealing with the learning events network (Detailed- REA) described in Figure 5.12 with the production of the evaluations in the form of *quiz* from phase 1 to phase 6 to make sure that the learner has achieved the skills and objectives prescribed in his/her individualized intervention plan (IIP).

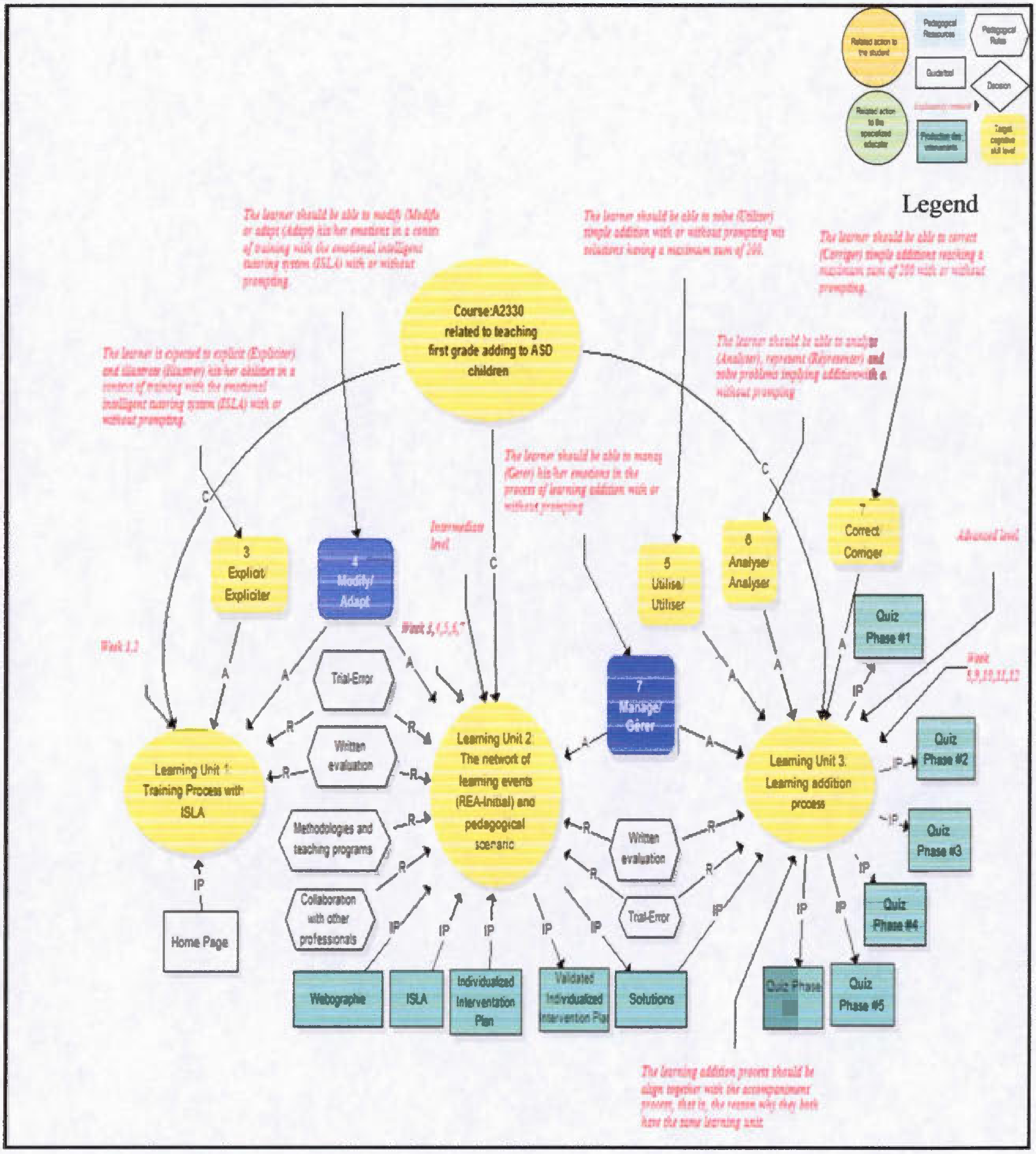

Figure 5.11 The Network of Learning Events (Global)

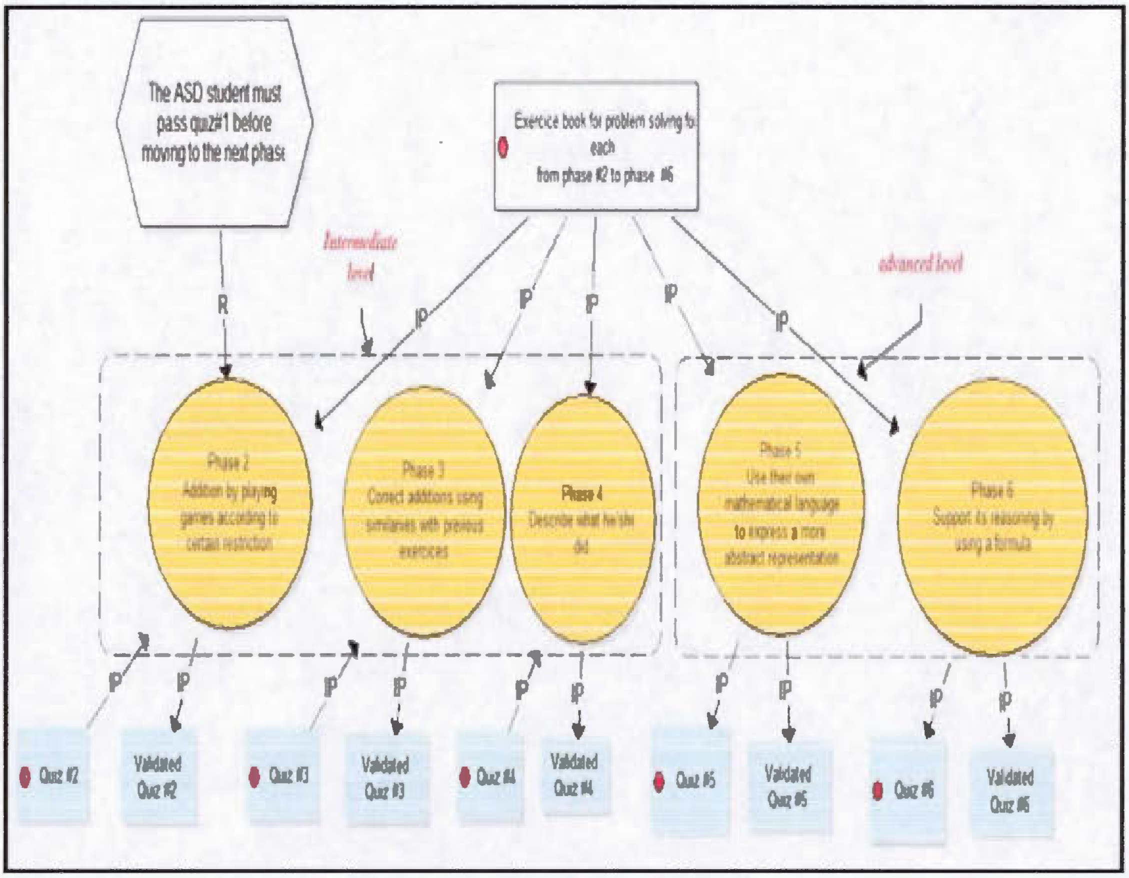

Figure 5.12 The learning events network (Detailed-LEN)

5.3.3. The Pedagogical Scenario of ISLA

As can be seen in Figure 5.13, the goal of the pedagogical scenario is to familiarize the learner with the training process of ISLA, in order to evaluate the ASD student's competencies with the support of the specialized educator and of the resources such as didactic material, ISLA, the webography, and the exercise book for problem-solving, among others. In this respect, the technique used in ISLA to model the cognitive state of the learner is based on a prior probability, stated as follows: (1) the concept X1 = Concept of adding by 80% is owned, and (2) the concept X2 = the learner is capable of discriminating numbers. The specialized educator will obtain a baseline measure of performance for each participant that will be used in the first learning unit.

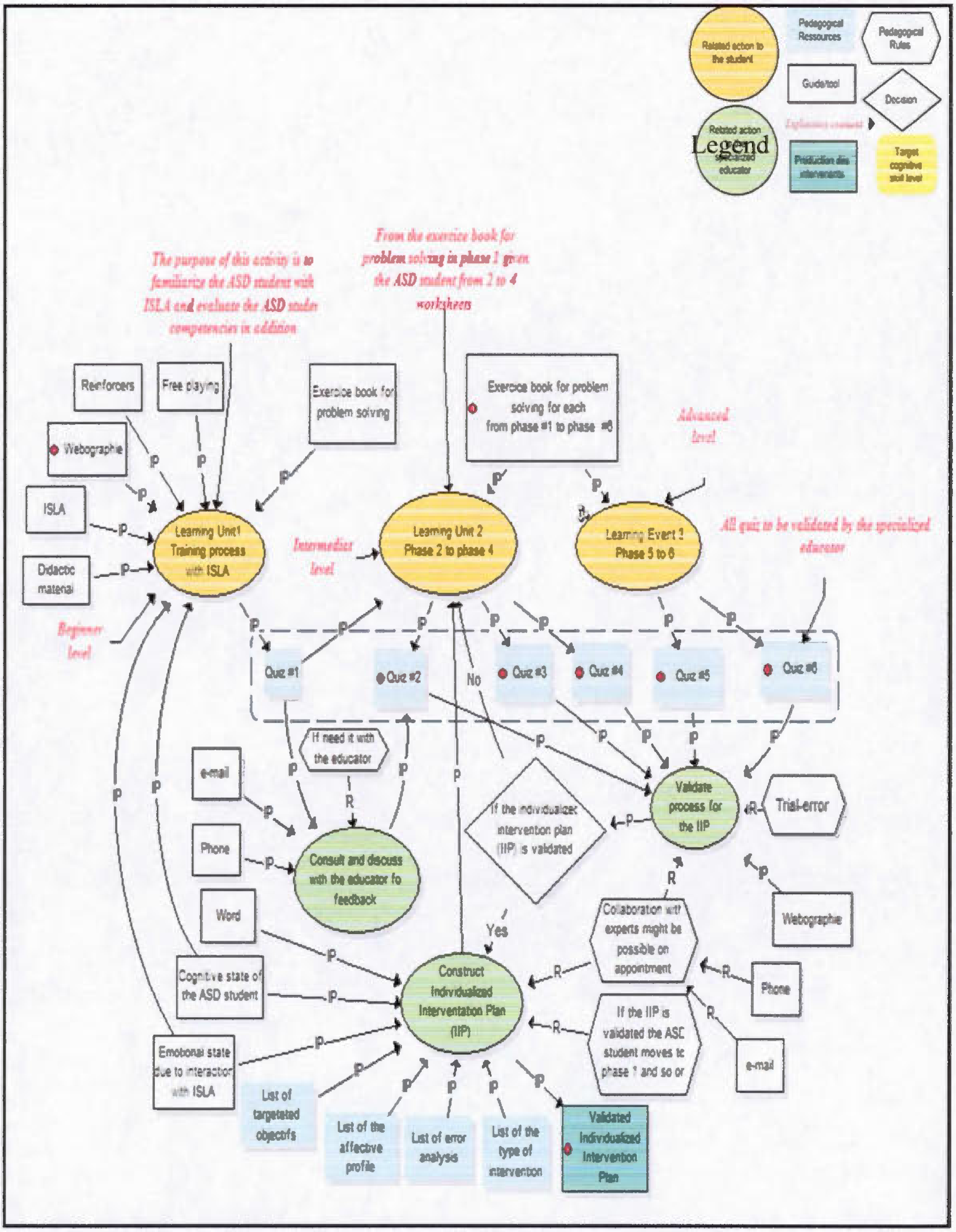

Figure 5.13 The pedagogical scenario of ISLA

This measure will serve as an assumption that the learner understands the concept of addition (adding up numbers). The student will need to succeed the evaluation by means of the *Quiz* in order to progress to the following learning unit. Consequently, the resource *Quiz #1* becomes the input for the second learning unit and plays a key role in the construction of the individualized intervention plan (IIP), by identifying not only the measurable and observable objectives, but also the strengths and weaknesses of the ASD learner. As shown in Figure 3, the construction of the IIP is a ***trial and error*** process, governed and validated by the collaboration of several experts in the field of autism.

5.3.4. The Mediatic Model of ISLA

This part of the report examines the various instruments and guides for making the necessary information available to the different actors in the exercise in their function of the course of teaching addition to children on the autism spectrum disorder. To this end, Figure 5.14 shows the mediatic model of the course, whose access is governed by the specialized educator. The users, as the educator and/or the student, must identify themselves on the course's homepage. Thus and so, on the basis of the target public, several links of transition are used to allow access to different contents. For example, using a transition link, the specialized educator accesses the page to download the exercises related to teaching addition from phase 1 (beginner) to phase six (mastery) by following the instructions given in a hyperlink. As illustrated in Figure 5.14, each phase of the content of the course is independently stated, such as phase 1, phase 2, and so on, up to phase 6, using the links of transition.

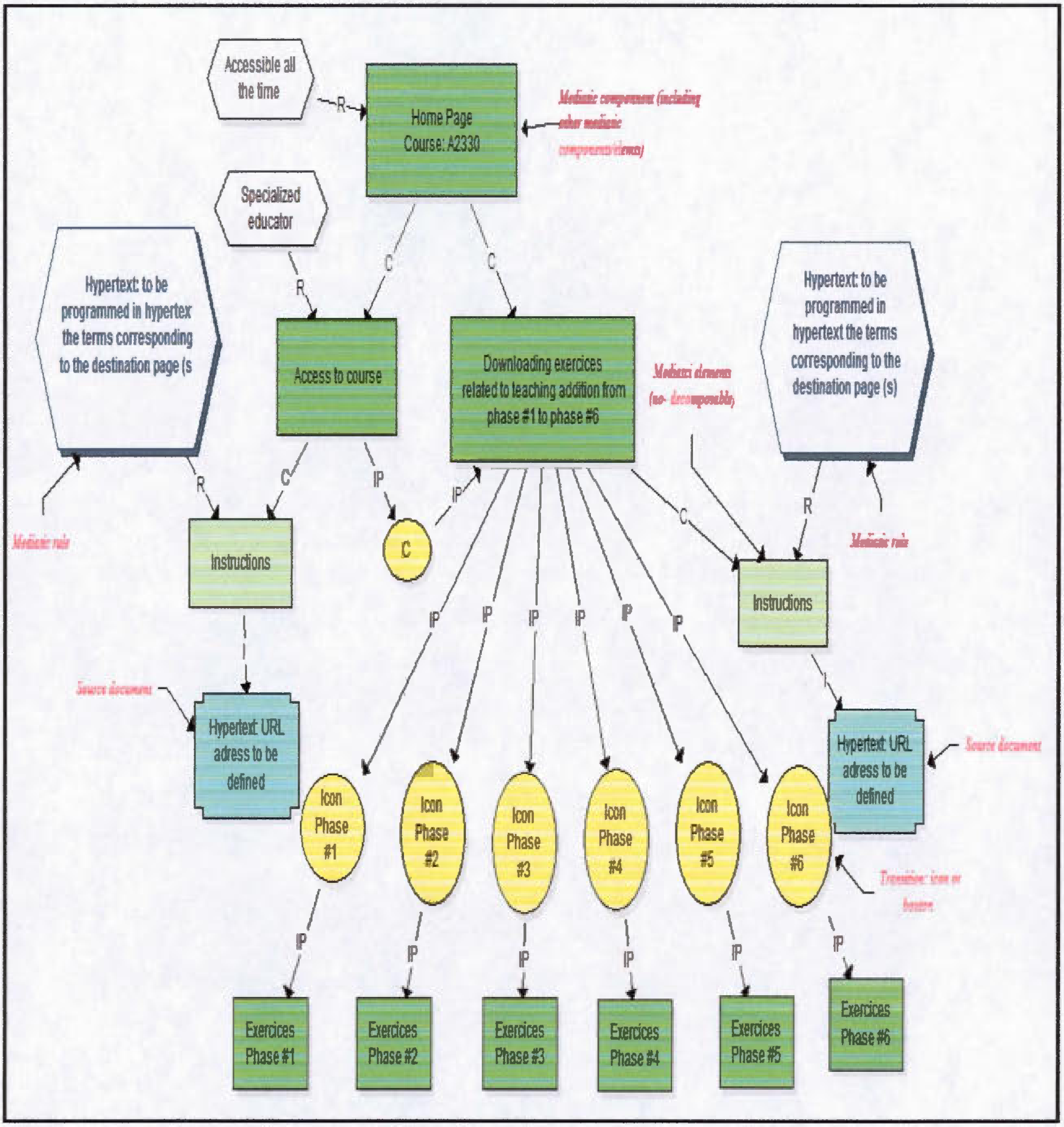

Figure 5.14 The Mediatic Model of ISLA

5.3.5. The Diffusion Model of ISLA

This phase presents the human resources required for the operation of the learning system. As can be seen in Figure 5.15, the diffusion model also provides the tools and means of communication, taking into account the educational scenarios and learning objects. As a first step, the use of the learning system is governed by the specialized educator who must have access to use the resources available through the specialized learning application. This task uses the following resources: *Technical Support*, *Pedagogical support,* as well as *Support from specialists* labeled S. In order to request technical or pedagogical support or any other support from specialists and technicians, this can be done by means of communication such as telephone, e-mail, and Web links labeled *C,* as illustrated. This model thus promotes interaction among the specialized educator and the technician labeled *A.* Hence, the ISLA model of diffusion is composed of four activities that are: *To provide technical support, To provide pedagogical support, To use pedagogical material* and *To use ISLA resources.*

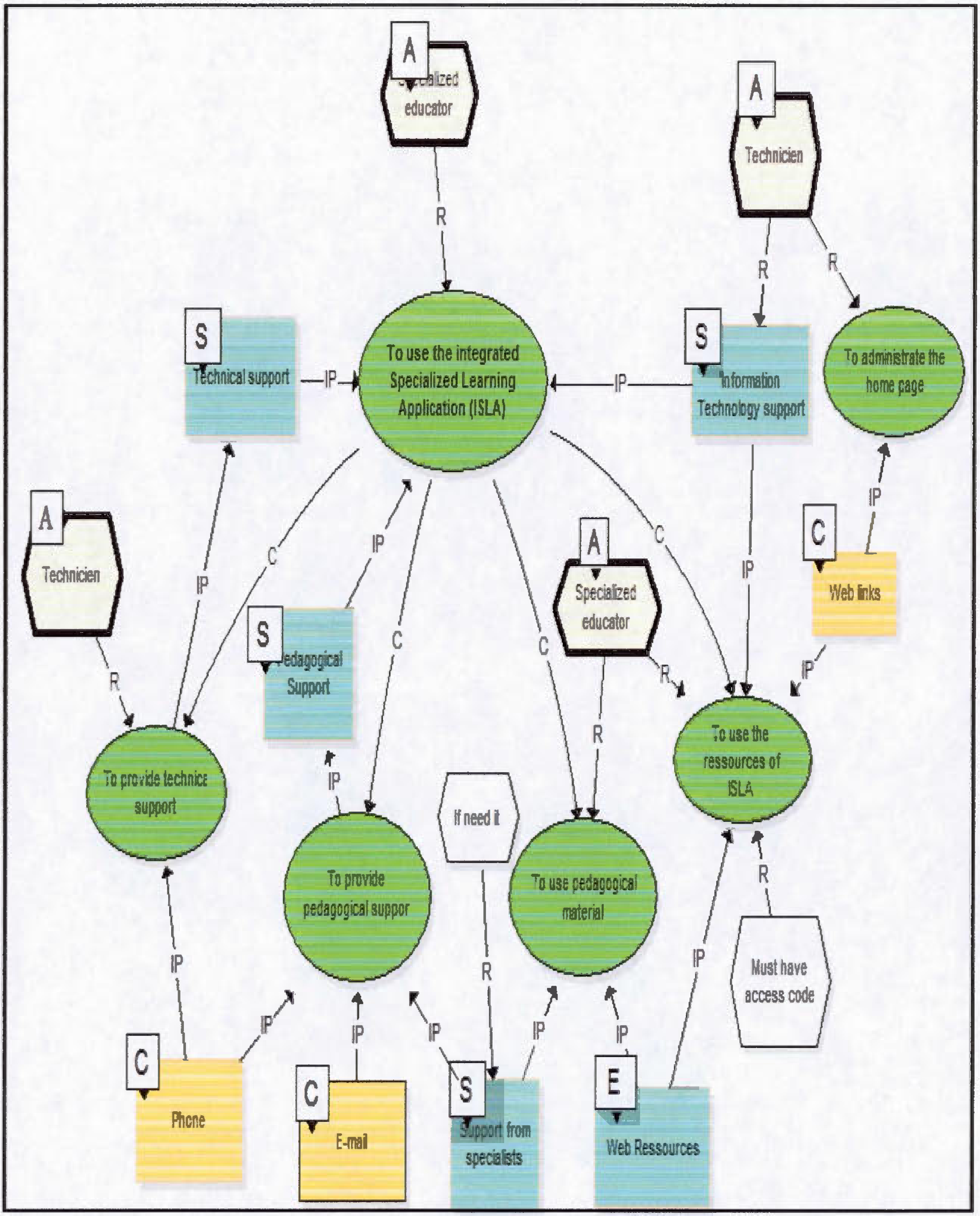

Figure 5.15 The Diffusion Model of ISLA

5.3.6. The development of the Integrated Specialized LearningApplication

ISLA is an affective intelligent tutoring system, capable of detecting the emotional state ofan autistic child in a mathematical learning situation, for example, when engaged in an addition task, and subsequently responding to this affective state, by means of using a virtual pedagogical agent Jessie, which is displayed in the user's interface and related to the accompaniment model. As observed in Figure 5.16, the conception of ISLA is composed of two main processes, i.e. the *Edit mode* and the *Navigate mode* each one providing different options to the user who might be the student or the specialized educator. Consequently, in order to open the application, the *Access code andpassword* are required from the user in both processes. Once access is granted in *Navigate mode,* the user will be able to *Consult* an existent student profile as well as to *Consult* or *Actualize* an existent individualized intervention plan.

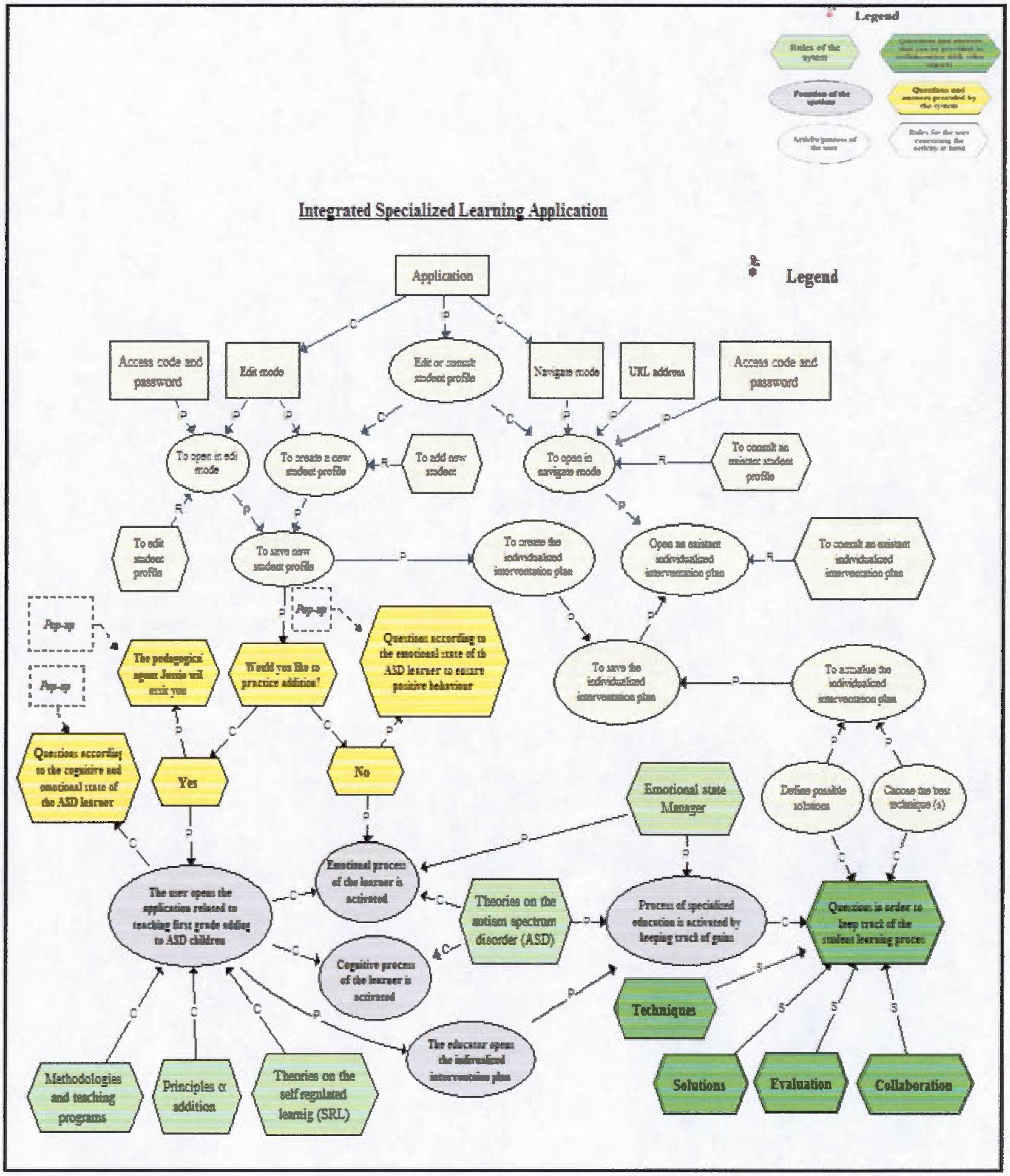

Figure 5.16 The development model of ISLA

On the other hand, in *Edit mode*, the user will be capable to *Edit* or *Create*, and *Save* a new student profile which triggers the creation of the individualized intervention plan. As one can see in Figure 5.16, the system will prompt the learner with a *pop-up* question: *Would you like to practice addition?* If the answer is *Yes*, the pedagogical agent Jessie will assist the ASD student as the user opens the application related to teaching addition, thus activating two important processes: The affective and cognitive state of the learner bearing on *Methodologies and teaching programs, Principles of addition*, as well as *Theories on the self-regulated learning (SRL)*, initiating the specialized education process by prompting questions in order to keep track of the learning process in terms of *Techniques, Solutions, Evaluation,* and *Collaboration,* actualizing, as a result, the individualized intervention plan. By contrast, if the answer is *No,* the system will prompt the learner with *pop-up* questions to ensure positive behaviour. In this regard, and based on the set of emotions described in (Ekman & Friesen, 2003), the emotional profile selected in this study includes the affects of interest, frustration, happiness, anger, engagement, disengagement, anxiety, and guidance because they are considered relevant in autism intervention practices (Dautenhahn and Werry, 2004).

As shown in Figure 5.16, the emotional state of the learner is regulated by the *Emotional state manager* system. According to current research, positive emotions are linked with positive feedback provided by the learner companion Jessie, which provides real-time immediate visual feedback by coloring the answer in green or in red, respectively for a correct or incorrect answer, as well as by providing social rewards such as *Good job* in an attempt to help the autistic child to calibrate his/her emotions which will diminish his/her frustration and promote his/her motivation in order to accomplish the mathematical task. To do so, Figure 5.17 shows the approach of the model tracing that will be used for the inference of the causes of errors made by learner. Three types of feedback are then suggested to the learner, such as flag feedback indicating the correctness of the response, by using a color (e.g., green for correct or red for wrong). Secondly, a buggy message is a specific text message related to the error made by the student. Thirdly, the chain of hints is used if the student needs help.

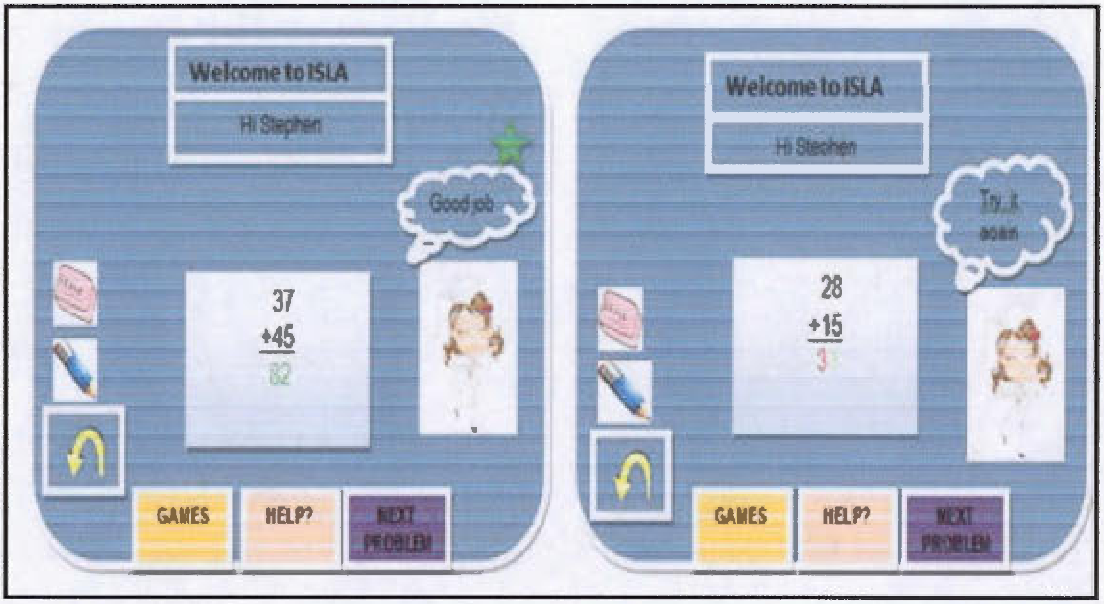

Figure 5.17 Model tracing approach

Indeed, he/she can thus request a *Hint* to receive the first among a series of hints suggesting things for the student to think about. In case the learner gets frustrated by the activity and reacts negatively towards the mathematical task, ISLA should be able to anticipate and detect the emotional state of the learner, ahead of time through the sensors, and thus deviate the learner's attention by prompting him/her with a game or an activity in order to help him/her diminish his/her negative behavior. Once the learner's negative behavior (frustration) has shifted to positive behavior (interest), ISLA should be able to provide the student with *hints* by means of the pedagogical scenario, so as to incite the student's motivation in solving the mathematical task. The next part of this study concerns the decision tree, relevant to ISLA development.

5.3.6.1. The Decision Tree of ISLA

Studies have revealed that Intelligent Tutoring Systems (ITSs) have the capacity of inexpensively providing individualized instruction, which is as "effective" as one-on-one human instruction (Verdu, Regueras et al., 2008).

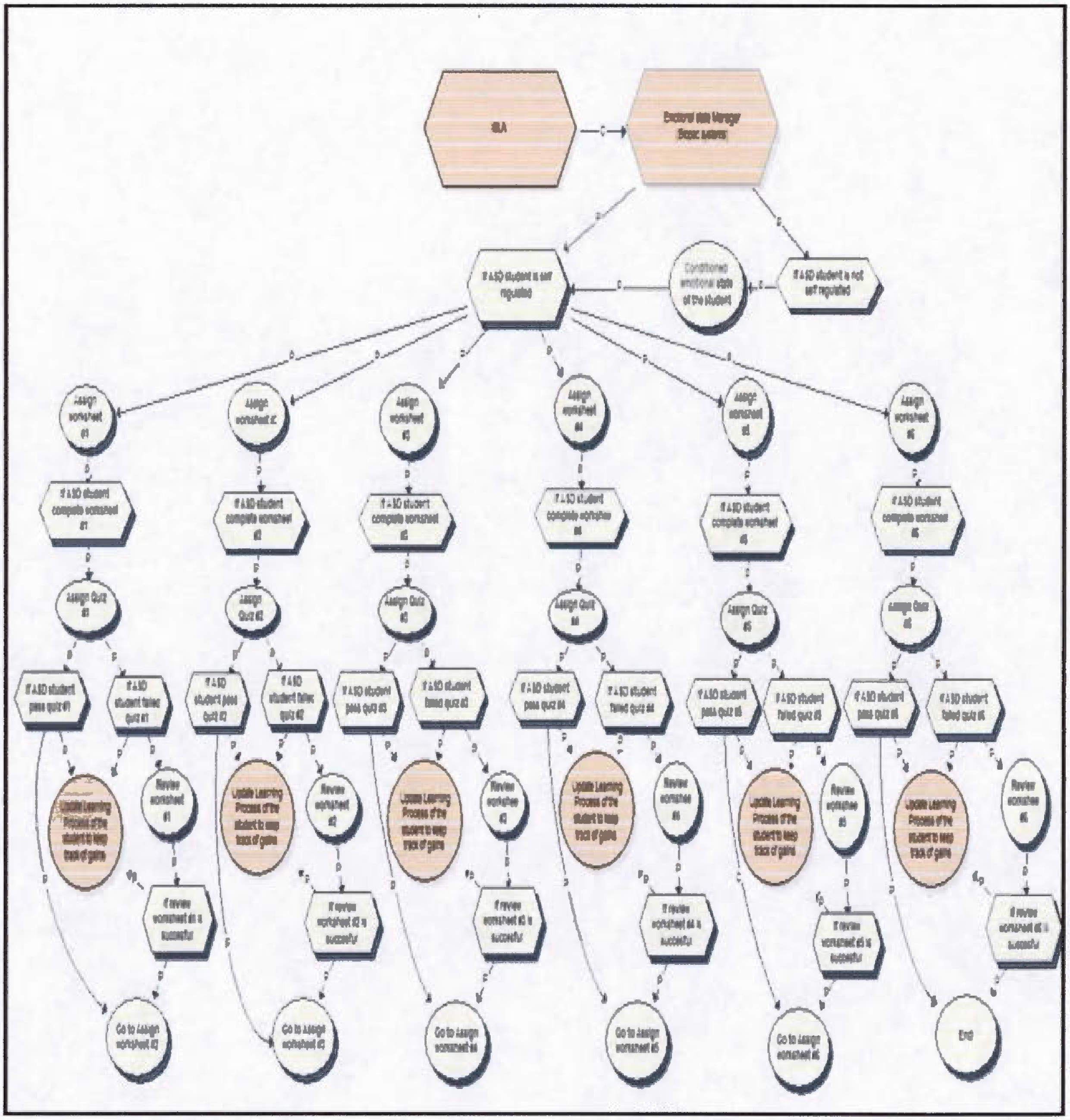

Figure 5.18 The Decision Tree

As previously discussed, ISLA is related and is unique in the field. Its contribution entails the model of accompaniment to help autistic children manage their emotions, by analyzing the learning trace, while considering the student's current performance with the intention of increasing his/her positive behavior so as to facilitate his/her motivation and, thereby, his/her learning process as well. Figure 5.18 describes the integrated specialized learning application, which is composed of the *Emotional State manager* system process dealing with the affective recognition cycle of ISLA. In this current research, the affective recognition cycle consists of four cycles and is triggered when the participant presenting autism interacts with the affective intelligent tutoring system (ISLA). His/her emotional states are measured and processed in real-time through the use of the FaceReader state-of-the-art technology sensors covered in Chapter V.

As outlined in Figure 5.18, if the student is self-regulated, then he/she will be assigned *Worksheet #1* according to his/her level of competency. Consequently, if the student successfully completes *Worksheet #1*, he/she will then be directed to *Quiz #1*. Further to this, if the student succeeds *Quiz #1*, the system will then update the student's profile in order to keep track of his/her gains. Consequently, if the student wants to continue to the following assignment, then the system will allow him/her to do so. By contrast, if the student fails *Quiz #1*, then the learner must review *Worksheet #1* and work on the errors that he/she has made. If he/she is successful, then the system will update the student's profile in order to keep track of his/her gains and, consequently, if the student wants to continue to the following assignment, then the system will then allow him/her to do so. As observed in Figure 5.18, this loop will continue from phase 2 to phase 6 implicating *Quiz#6*. At this stage, the student is expected to know addition. The next section will be dealing with general and specific rules applicable to ISLA.

5.3.6.2. General and specific rules of ISLA

As indicated in Figure 5.19, this section presents the guidelines in terms of rules that are at the heart of ISLA development. The process of teaching addition to children on the spectrum of autism relies on rules dealing with the *Theories on the self-regulated learning*, with the *Theories on autism spectrum disorder*, as well as with rules to *First grade addition*, each of them being presented in the following part. For example, as one can see, Figure

5.20 outlines the first set of rules that are applicable to addition, including that addition is *Represented by the plus sign (+)* by virtue of which the ASD student should be able to determine that addition is represented by the + sign. Secondly, we have the *Addition of 1* whereby the ASD student should be able to determine that repeated addition of 1 is the same as counting.

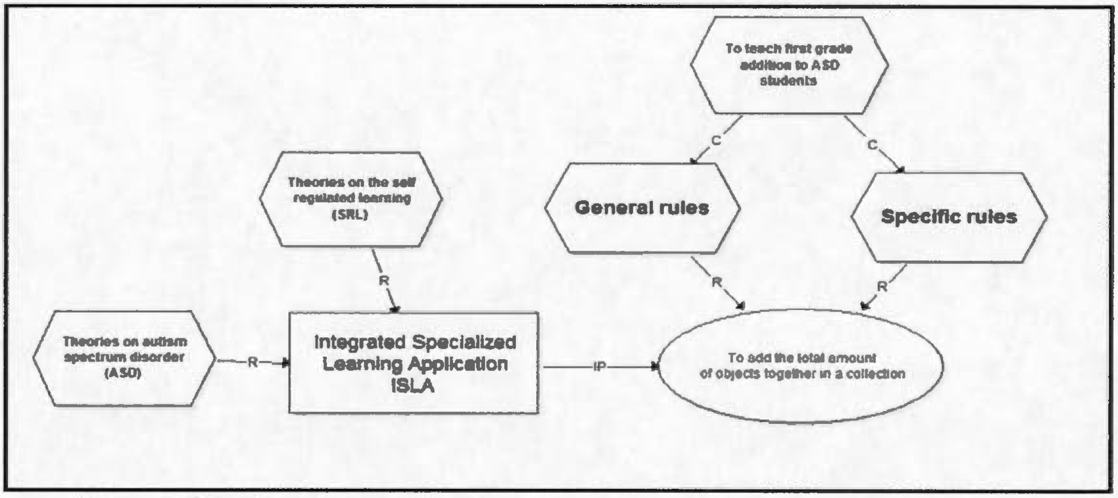

Figure 5.19 The rules model

Thirdly, we have the *Addition of 0* rule whereby the ASD student should be able to determine that addition of 0 does not change the sum, and which requests the resource *Discriminate numbers up to 100*. Another rule is the *Commutative and Associative properties* implicating *Regrouping, Discriminate numbers up to 100* and *Commutative property* resources.

Another important rule, related to this study, deals with the *Theories on the self-regulated learning,* as well as the *Theories on autism spectrum disorder* with the intention of calibrating the emotional state of the learner as presented in Figure 5.21, requiring the clinical profile, methodologies and techniques for specialized education related to autism.

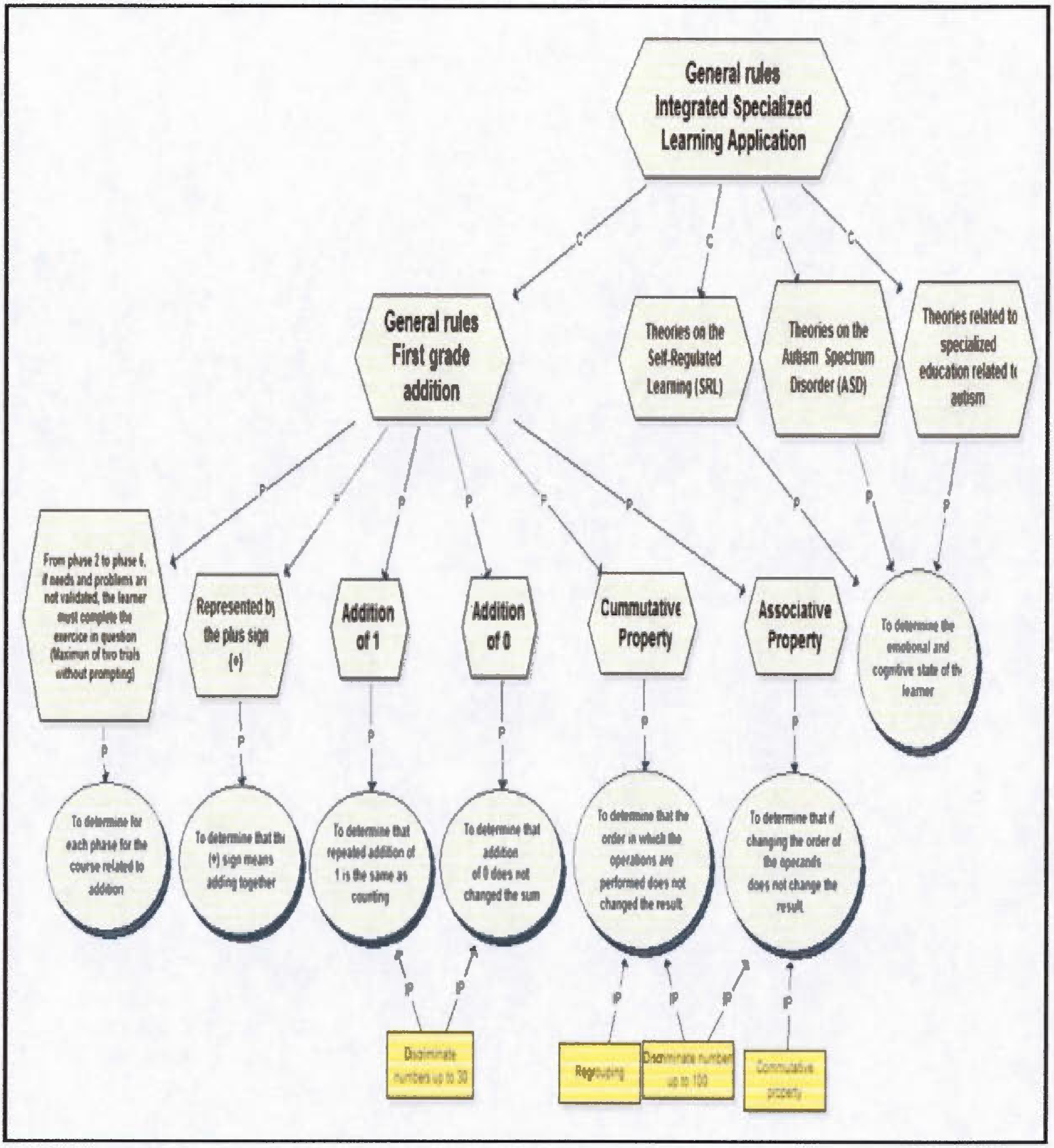

Figure 5.20 General rules ISLA

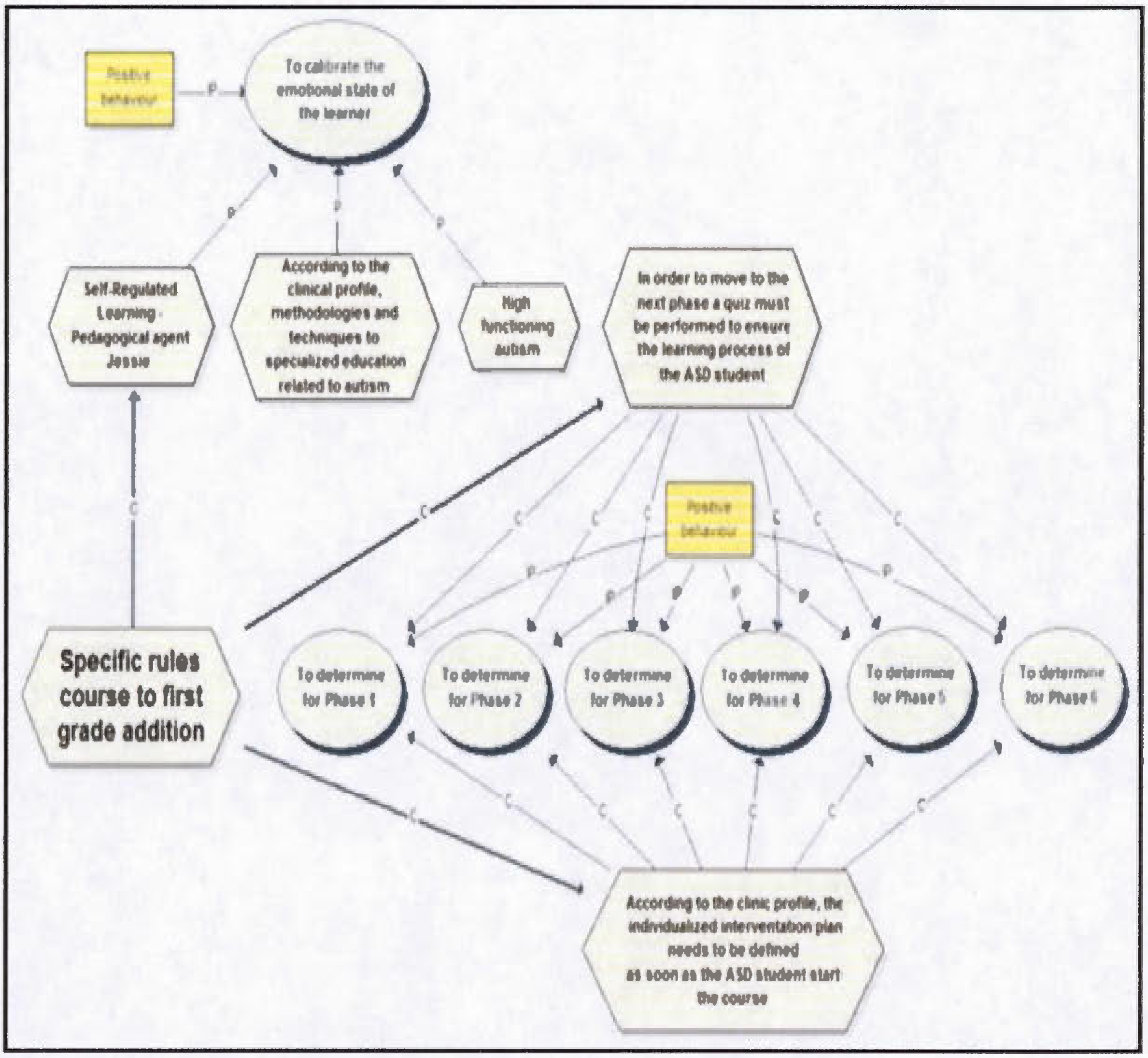

Figure 5.21 Specific rules ISLA

Within the domain of specialized education, "generalization" of gains is difficult to maintain (Green, Charman et al., 2010) for children in the spectrum. Rao, Beidel et al., (2008) suggest that the "efficacy" of an intervention must be determined by means of more single-case and open trial designs with respect to a specific learning task (Whalen and Schreibman, 2003). As observed in Figure 5.21, the sample is constrained to high functioning children, in order to use a standardized training method. In literature, autistic individuals displaying a normal or high IQ, are considered as having high functioning autism, which is characterized by lower functioning in social and language skills, in contrast to visuospatial skills. As a result, cognitive diagnosis plays an important role in the accompaniment model dealing with the individualized intervention plan (IIP), which best meets the needs of the ASD learner. In this regard, the purpose of the cognitive diagnosis (CD) component within AITS is to accurately determine why the student makes an error in a problem-solving activity. This is important as it helps identify where to focus the subsequent learning activity (Tchetagni, Nkambou et al., 2006). Therefore, as previously stated, the goal of model tracing is to assess the student's actions and to interpret those actions in terms of underlying knowledge components (Aleven, 2010). In this research, in order to keep track of the child's cognitive state, a window will keep track of his/her errors, along with any other correct action taken by the learner. The list of errors examined in this research is presented in Table 5.4.

Table 5.4

Error Analysis List[30]

Error	Description
#1	Difficulty with 1s and 10s in carrying and writing.
#2	Difficulty with understanding regrouping.
#3	Difficulty in discriminating H (100), D (Decimals), U (Units).
#4	Difficulty with carrying 10s and 100s.

This approach suggests following the sequence of action taken by the learner, in order to provide appropriate feedback and rewards. The idea is that "instruction" must be modeled vis-à-vis the cognitive model of the competences that the ASD learner is supposed to learn.

[30] Source: Tindal, & Marston, (1990)

5.3.7. Conclusion

In this chapter, the conception and development of the AITS ISLA have been presented, outlining the emotional and cognitive state of the autistic learner. As concerns, the pedagogical model, the design and the conception of a mathematical learning situation has been described, emphasizing the important role of "competencies" in the course of teaching addition to children presenting autism. The following part concerns the implementation of ISLA.

CHAPTER VI

IMPLEMENTATION, VALIDATION AND RESULTS

6.1. Introduction

This chapter describes the implementation, validation and results of my research project. This section first presents the methodology used for the validation of ISLA. The preliminary results of our first experiment (Wizard of Oz) are then covered. Subsequently, the main experiment with a control group and with a test group, using the prototype we have developed, is presented. Finally, the statistical analysis of the results is discussed, followed by someconclusions.

6.2. The Methodology

Some individuals with ASD can have profound cognitive deficiencies and behavior issues. Consequently, the group of participants recruited in this research were high functioning autistic children without mental retardation in order for it to be possible to use a standardized training method during the intervention. The participants in this study came from private clinics, specializing in autism, as well as from centers for adaptation and specialized education related to autism, all located in Montreal, Canada. The research population consisted of fifteen participants diagnosed with high functioning autism spectrum disorders (ASDs), i.e. boys and girls aged from 6 to 12 years old, with the consent of their parents and under the supervision of a specialized educator. During a period of one hour, in a one-on-one structured intervention in mathematical learning, two important questions were considered:

1) *What is the affective state and performance of the ASD student in a learning situation, such as addition,* **without** the use of a pedagogical agent *such as ISLA?*

2) *What is the affective state and performance of the ASD student in a learning situation, such as addition,* **with** the use of a pedagogical agent *such as ISLA?*

The experimental process is made up of two parts. The first part entails a training period in order to familiarize the ASD student with ISLA. The second part deals with validating the integrated specialized learning application and the use of its pedagogical agent Jessie so that it provides effective help to the learner during a mathematical activity, such as adding, based on his/her affective state established by the system.

6.3. The preliminary experiment

Before giving some more details on the main experiments, I would like to mention that a preliminary study was previously carried out. That study consisted in a Wizard of Oz experiment, played by the specialized educator, simulating the behavior of an affective intelligent tutoring system ISLA and with its pedagogical agent Jessie in an arithmetic learning activity. The pedagogical agent Jessie was capable of managing the student's affective state, with the purpose of anticipating negative behavior.

Table 6.1

Participants' profile

Participant Code	Diagnosis	Age	Gender
#1	Autism disorder	12	Male
#2	Autism disorder	10	Male
#3	Asperger Syndrome	8	Female

Table 6.2

Reward System

Reward Code	Reward Type	Reward Examples
S	Social	Bravo, good job, excellent
E	Edible	Snacks
L	Ludic activity	Games

This helps the autistic student to calibrate his/her emotions and consequently, complete the mathematical task at hand. Though we aimed to have fifteen students for the project, only three were involved in this preliminary study. All three were successful in fulfilling the criteria. Their profiles are presented in Table 6.1 above. Prior to the one-on-one intervention, a questionnaire made up of five questions was provided to the parents in order to predict their child's affective state during the mathematical activity.

In this regard, two questions, relating to the affective state dealing with positive or negative behavior the student might experience during the mathematical activity. The affects of interest, frustration, anxiety, disengagement, encouragement, anger, happiness, and guidance could be displayed. The list of rewards is presented in Table 6.2 above. The one-on-one intervention lasted for one hour.

6.3.1 Preliminary experiment: Without the use of a pedagogical agent

In the first part of the experiment, the following question was addressed: *What is the affective state and performance of the ASD student in a learning situation such as addition without the use of a pedagogical agent such as ISLA?*

The specialized educator performed a baseline measure of performance for each participant. Therefore, in the first experiment, a quiz was individually presented to each student, consisting of thirty additions which he/she had to solve without the use of a pedagogical agent, such as Jessie, played by the specialized educator.

Table 6.3

Error Analysis List[31]

Error	Description
#1	Difficulty with 1s and 10s in carrying and writing.
#2	Difficulty with understanding regrouping.
#3	Difficulty in discriminating H (100), D (Decimals), U (Units).
#4	Difficulty with carrying 10s and 100s.

A list of errors that the student might encounter when performing the mathematical activity is presented in Table 6.3. The additions in the quiz were grouped into four different levels of competencies, from beginner to mastery (of skills), presented in Table 6.4. The quiz lasted fifteen minutes and a score between 91% and 100% excluded the participant from the study.

Table 6.4

Score criteria baseline

Level of competency	Score Quiz	Criteria
1) Beginner	$\leq$50%	Recruited
2) Intermediate	>50 and $\leq$60%	Recruited
3) Advanced	>60 and $\leq$ 85%	Recruited
4) Mastery	> 85 and $\leq$100%	Excluded

6.3.1.1. Results and discussions

The results of this preliminary study about the affective state and performance of the ASD student in a learning situation, such as addition **without** the use of a pedagogical agent,

31 Source: Tindal, & Marston (1990)

are presented in Table 6.5.

Table 6.5

Affective profile ASD participant without the use of a pedagogical agent

Participant	Affective Profile	Difficulty	Accomplishment Scale	Score Quiz
#1	Neutral	1= Not difficult	5	100%
#2	2, 3	4= Very difficult	1	50%
#3	3	3=Difficult	2	45%

As illustrated above, one can see that the affect profile for participant #1 was *Neutral* and that his level of difficulty was *1*. Consequently, he successfully performed with 100% success on the quiz given to him. The activity lasted 5 minutes. This is probably due to the fact that he already knew addition. The score of 100% in the quiz at a mastery level excluded this participant from the study. In contrast, participant #2 performed poorly in the quiz with a *1* measure of accomplishment and a difficulty level of *4*, experiencing the effects of frustration and anxiety. He played with his hair and complained by saying "I hate maths; this is too hard for me." The activity lasted 15 minutes and he scored only 50% at a beginner level of competency. He was selected to participate in the second experiment of this study. In addition to the results, participant #3 also performed poorly in the quiz with a *2* measure of accomplishment and a difficulty level of *3*, experiencing the affect of anxiety. Even though her level of accomplishment was *2*, that is higher than that of participant #2, she did not complete the quiz. She seemed very distracted and anxious. At different moments, she flapped her hands and asked for "help". The specialized educator had to interrupt her evaluation because of the negative behavior of the student. She scored 45% on the quiz at a beginner level and was selected to participate in the second experiment of this study. The compiled scores indicated that, except for student #1, the other two students, #2 and #3, did not pass the quiz. As illustrated in Table 6.5 above, the results of this preliminary experiment allowed us to determine that the affective state and performance of the ASD student in a mathematical situation, without the use of a pedagogical agent providing support and encouraging motivation, was negative for participants #2 and #3.

6.3.2 Preliminary experiment: With the use of a pedagogical agent

In the second experiment of this study, the following question was addressed: *What is the affective state and performance of the ASD student in a learning situation, such as addition with the use of a pedagogical agent such as ISLA?*

Table 6.6

Error analysis list with the use of a pedagogical agent

Error	Description	Participants
#1	Difficulty with 1s and 10s in carrying and writing.	2,3
#2	Difficulty with understanding regrouping.	3
#3	Difficulty in discriminating H (100), D (Decimals), U (Units).	2, 3
#4	Difficulty with carrying 10s and 100s.	2,3

A second quiz was individually presented to each student, consisting of fifteen additions reflecting his/her level of competency. The student was asked to perform the task with the use of a pedagogical agent Jessie, played by the specialized educator providing support, who was hiding in another room. It is essential to measure and keep track of the student's performance and learning to validate the acquisition of the objectives. The list of errors performed by each participant is presented in Table 6.6. Therefore, having assessed the baseline for each student, the specialized educator was thus able to gather his/her competency level. Table 6.7 presents the list of rewards for participants #2 and #3. Moreover, a schedule was also implemented by using pictograms to help the student follow the activity.

Table 6.7

Participants' rewards

Participant	Rewards
#2	Snacks, games, social
#3	Social, snacks

6.3.2.1. Results and Discussions

The results of this preliminary study are presented in Table 6.8. One can see that participant #2 performed better in the second quiz, with a *2* measure of accomplishment and a difficulty level of *3*, displaying the affects of interest, frustration and happiness. He stood up and complained saying "I don't remember." The activity lasted 20 minutes and he scored 65% on the quiz. In addition to the results, participant #3 also performed better in the second quiz. Although, she seemed anxious, playing with her fingers, she asked for "help" and was able to complete the task with a 3 measure of accomplishment, experiencing the affects of interest, anxiety, and happiness. The activity lasted 25 minutes and she scored 60% on the quiz. Both children required extra time to complete the task.

Table 6.8

Affective profile ASD participants with the use of a pedagogical agent

Participant	Affective Profile	Difficulty	Accomplishment Scale	Score Quiz
#2	1, 2, 4	3=Difficult	2	65%
#3	1,3,4	3=Difficult	3	60%

Table 6.9

Participants' scores

Participant	Score without the use of a pedagogical agent	Score with the use of a pedagogical agent
#1	100%	Excluded
#2	50%	65%
#3	45%	60%

In this preliminary experiment, each individual participant was prompted by Jessie during the intervention. She helped each child to calibrate his/her emotions, by providing, a real-time immediate visual feedback to diminish his/her frustration, to promote motivation and enable the accomplishment of the mathematical task. For example, as observed in Figure 5.2a, when participant #2 gave a correct answer, the pedagogical agent, Jessie, prompted him with a social reward, such as *Good job!* By contrast, when he gave an incorrect answer (Figure 5.2b), Jessie prompted him with hints, by means of pedagogical scenarios suggesting Error #1, dealing with difficulty, in carrying and writing 1s and 10s. Jessie invited the learner to try again in order to complete the task. Table 6.9 illustrates the scores of each participant during the two experiments (i.e. without and with the use of a pedagogical agent). The results show that the affective state and performance of the ASD student in a mathematical situation, such as addition with the use of a pedagogical agent, had a positive impact on the performance of both participants #2 and #3. By comparing the two scores of 50% (*without* the use of pedagogical agent) and 65% (*with* the use of pedagogical agent), we can see that participant #2 benefited from real-time feedback, provided by the pedagogical agent Jessie. As for participant #3, she scored 45% success in the first experiment (without the use of pedagogical agent), whereas in the second experiment (withthe use of the agent), she was able to complete the task with a 60% score. The next part concerned the ISLA prototype, dealing with a larger group of twelve participants with high functioning autism, in which a control group of six students interacted without the pedagogical agent, Jessie, while the test group, composed of the other six participants, interacted with Jessie.

6.4. The implementation of the Integrated Specialized Learning Application

6.4.1. The mathematical application used in ISLA prototype

For the main part of this experiment, we have developed an interactive game, called *The Chalkboard Game* in mathematical learning to perform the baseline quiz in addition for the two groups interacting with ISLA. Two versions were created to measure the performance and affective state of each ASD participant.

Figure 6.1 ISLA interface

The first version of the interactive game was intended for the six students without the pedagogical agent Jessie. The other version was used to test the group of the other six participants with the pedagogical agent Jessie. In the first version, with the pedagogical agent, several animated screens were used to prepare the ASD student to interact with the system. The participant was asked to enter his/her name and to click on the START GAME button, as shown in Figure 6.1. In the second screen of the application (Figure 6.2), Jessie appears, waving her hand and saying: *Hi, my name is Jessie. CLICK HERE to get started.* In Figure 6.3, Jessie invites the learner to play the game. In the following screen, Jessie asks:

Are you ready and the quiz starts when the ASD student clicks on the START GAME button.

Figure 6.2 Jessie interface

In the two versions of the mathematical application, and as displayed in the green gem box, the interactive quiz consisted of thirty questions, in which the ASD learner will gain points for every good answer.

Figure 6.3 Jessie interface

Figure 6.4 The Chalkboard Game interface

Competencies are at the heart of ISLA. This is the reason why the quiz was grouped into four different levels of competencies. The question was: How do we measure the academic performance of an autistic child in a mathematical learning situation? Within the quiz, the first beginner competency level counted for five questions. In the second intermediate level, seven questions were considered, while the third advanced level included ten questions. Finally, the mastery level contained eight questions, in which three of them dealt with problem-solving as pertains to addition. The quiz was validated by professionals in the field of specialized education related to autism. The raw scores were compiled with Jessie and without Jessie by correcting what the child achieved during the quiz. The measure of performance baseline quiz score was considered according to the level of competency as described in Table 6.10.

Table 6.10

Level of competency criteria

Level of	Score Quiz	Number of questions
1) Beginner	$\leq$50%	5
2) Intermediate	>50 and $\leq$60%	7
3) Advanced	>60 and $\leq$85%	10
4) Mastery	>85 and $\leq$100%	8
		30 questions

6.4.2. Technologies used in ISLA to affect recognition

6.4.2.1. FaceReader

As previously described in Chapter V, FaceReader[32] facial expression technology developed by Noldus Information Technology was used in this study to detect the affective state of the autistic student. Compared to physiological affect detection sensors, an important reason for considering FaceReader was the advantage that it is an unobtrusive

[32] Source : http://www.noldus.com

technology. As shown in Figure 6.5, FaceReader's core output is a classification of the intensities of individual facial expressions displayed by the participant. As a result, each expression has a value between "0" and "1", indicating its intensity. Thus "0" means that the expression is not absent, "1" means that it is fully present. Facial expressions can be triggered by a mixture of emotions and some expressions occur simultaneously with a high intensity[33]. Consequently, the sum of the intensity values for the seven expressions, at a particular point in time, is normally not equal to "1". In FaceReader, the affective state of the subject is estimated. That is, the state values are an estimation of the affective state of the subject, based on amplitude, duration and continuity shown in the latest emotional responses. For instance, each time the affective state of the learner changes, a record is then written in the state log file. The detailed log provides all the emotional classifier outputs per time point. In this study, the detailed log for all participants, for both groups, is presented in Appendix F.

Figure 6.5 Face Reader core output[34]

[33] Source: Noldus Information Technology
[34] Source: Noldus Information Technology

The valence of the ASD participant is essential in this research as it indicates whether the affective state of the ASD participant was positive or negative. For instance, in FaceReader *happy* is the only positive emotion, whereas *sad*, *angry*, *scared* and *disgusted* are considered to be negative emotions, *surprised* can be either positive or negative. The valence is calculated as the *happy* intensity, minus the intensity of the negative emotion with the highest intensity. In this research, the valence detailed log values for each participant for the control and test group are reported in Appendix F.

6.4.2.2. Observer® XT

Observer® XT software was used in this research. This technology was developed by Noldus Information Technology[35]. Dr. Lucas Noldus is the founder of Noldus Information Technology. He developed the first version of what later became The Observer observational software for the measurement and analysis of behavior.

As shown in Figure 6.6. This technology was used for collecting and analyzing observational data. We were able to combine FaceReader data, with manually scored events, with data from other systems, such as eye tracking, when the ASD participant was interacting with ISLA while performing the quiz. Figure 6.7 presents the observational data marking grid and the codes used in Observer XT. The marking grid was grouped into three categories: The first category was errors in addition such as writing, regrouping, discriminating, and carrying. The second category was support dealing with guidance, encouragement, and feedback (provided by Jessie). The third category was the diagnosis related to the affective states (frustrated, interested, sad, anxious, calm, proud, angry, afraid and disengaged), which the learner might have experienced. The data logs of Observer XT for all participants, in both groups, are presented in Appendix F.

[35] Source : http://www.noldus.com

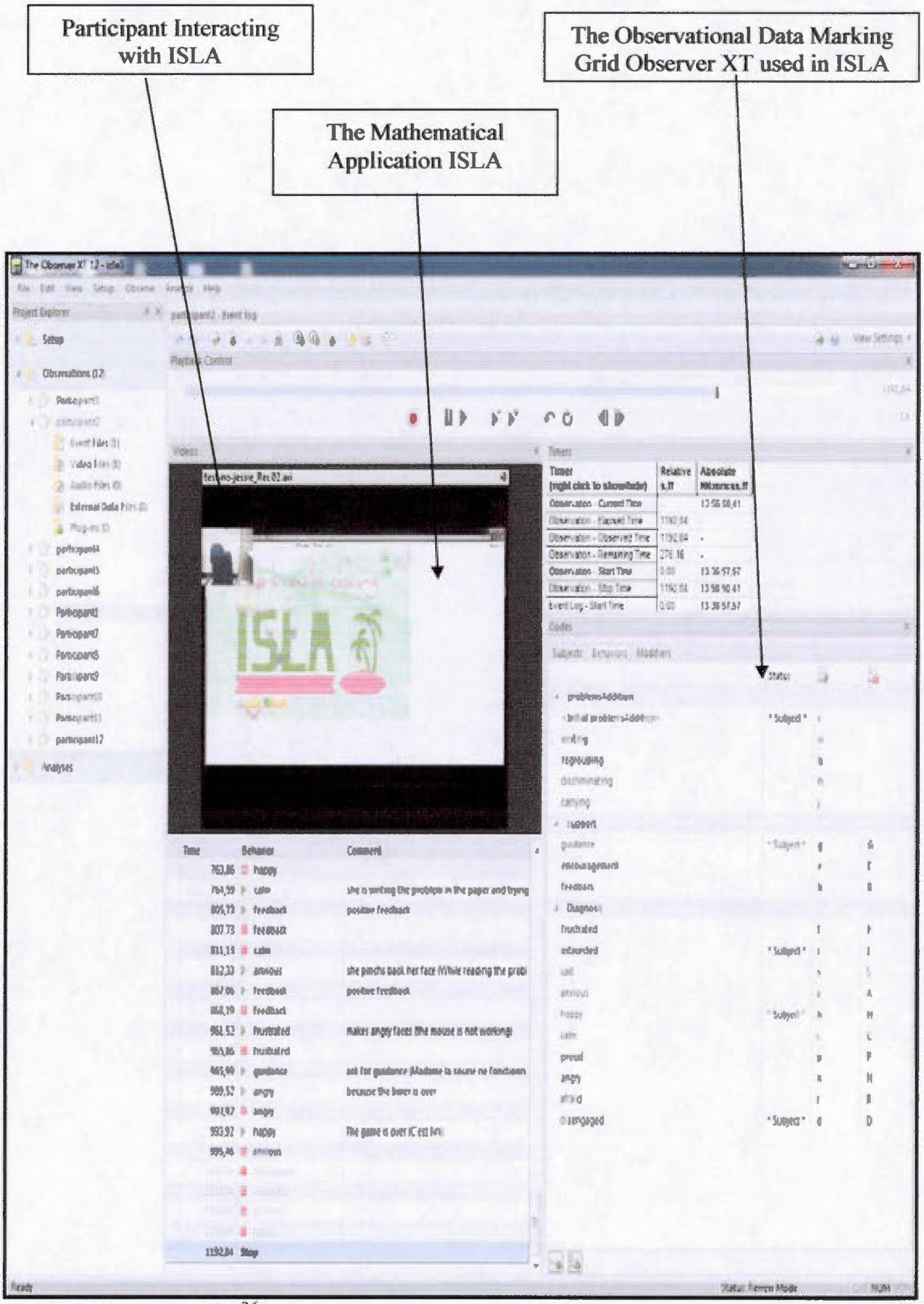

Figure 6.6 Observer® XT[36]

[36] Source: Noldus Information Technologies

The Observational Data Marking Grid Observer XT in ISLA	
Problems in Addition	**Code**
Writing	W
Regrouping	R
Discriminating	D
Carrying	C
Support	
Feedback	F
Encouragement	E
Guidance	G
Diagnosis	
Disengaged	d
Frustrated	p
Interested	I
Anxious	A
Happy	H
Calm	C
Angry	a

Figure 6.7 The observational data marking grid Observer XT used in ISLA

6.4.2.3. Tobii TX300

Another important technology employed was Tobii TX300 for Eye Tracking sensors. This technology is integrated within a display monitor and camera to efficiently obtain valid, unobtrusive and highly accurate eye tracking research results. For the purpose of this study, the main objective of Eye Tracking was to help us determine if the participant was focused or disengaged by keeping track of his/her gaze fixation during the mathematical activity (see Figure 6.8.). Thus, Eye Tracker sensors can be described in terms of gaze accuracy and gaze precision. Gaze accuracy describes the angular average distance, from the actual gaze point to the one measured by the Eye Tracker. Gaze precision describes the spatial variation between the successive samples collected when the subject fixates at a specific point on stimuli. Data was immediately collected, after calibration, in a controlled laboratory environment with constant illumination, with 9 stimuli points at gaze angles of $\leq 18°$. The configuration of the Tobii monitor was set-up within the range of 50 and 70 cm, where 60 cm was the recommended distance.

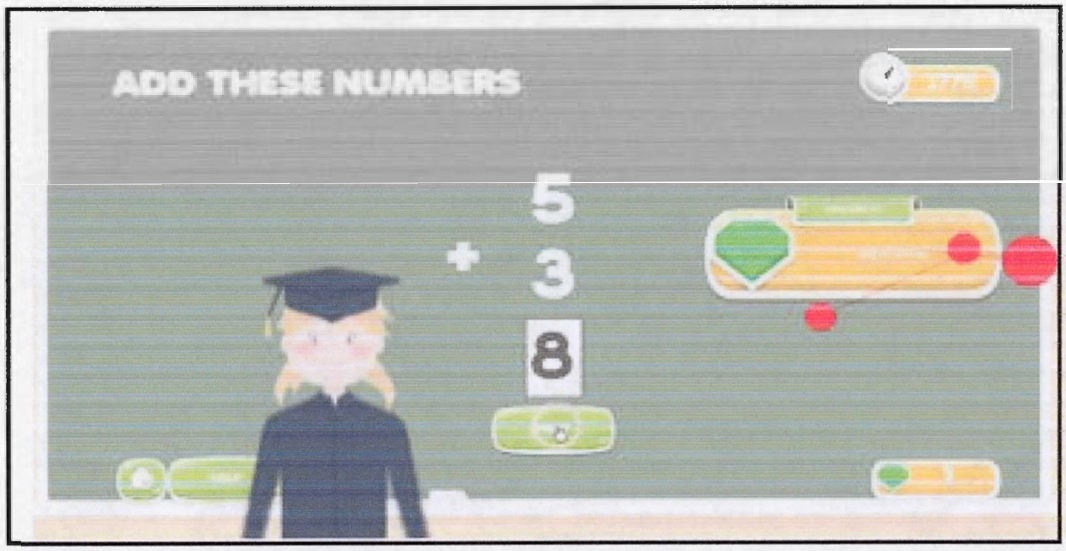

Figure 6.8 Participant performing the quiz using Tobii TX300

The eye calibration process, conducted with the autistic participants, was challenging to perform, due to compliance issues and head movement. For instance, most children moved their head around, while others played with the eye tracker monitor. As children with ASD may display visual and auditory hypersensitivities, some adaptations were anticipated to ensure that these sensitivities did not interfere with the experiment session and the integrity of eye calibration accuracy gaze data and precision required in this research. First, we used a chair without wheels and an ERGO-Pedic cushion to help the child sit still, as well as earmuffs to soften loud noises. The other techniques employed dealt with pictograms and modeling eye calibration performed by the specialized educator to comfort and better prepare the ASD participant. As illustrated in Figure 6.9 below, the white dots are the participant's recorded eye positions, by using Tobii TX300 before starting calibration.

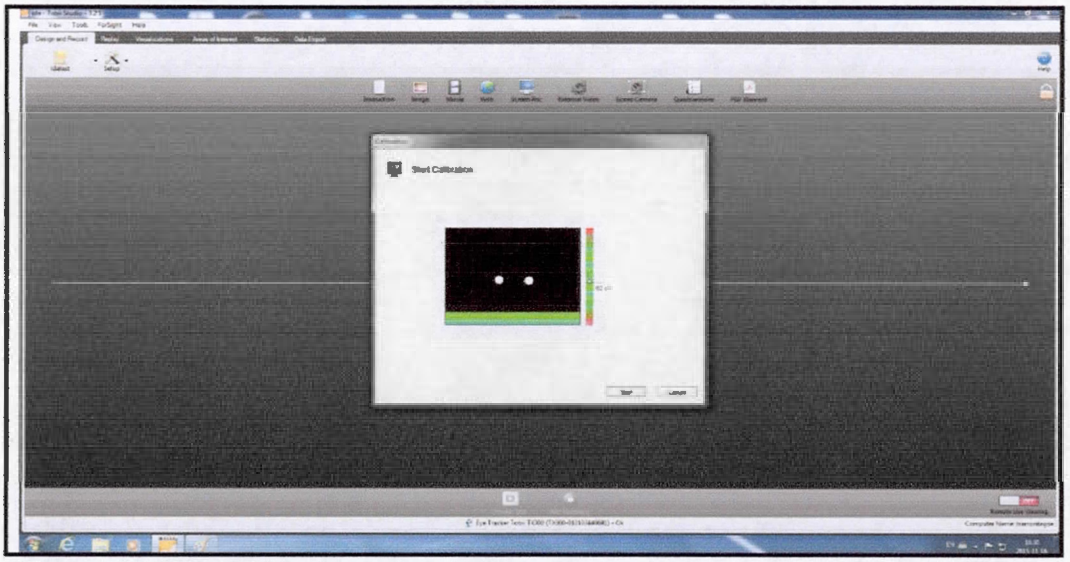

Figure 6.9 Eye Calibration using Tobii TX300

As described in the study protocol[37], and prior to the intervention with ISLA, eye calibration was individually performed by each participant for the main experiments.

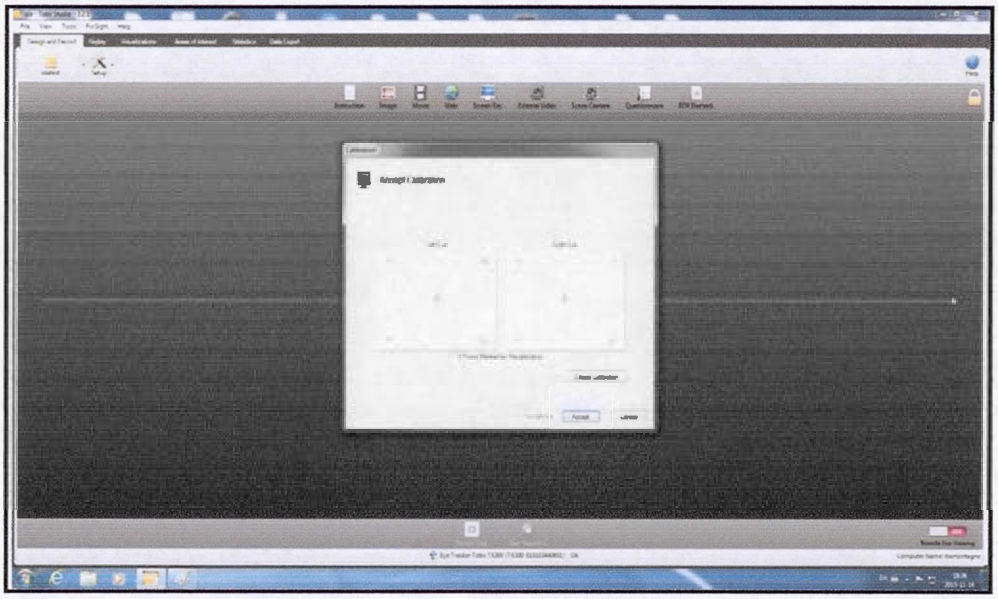

Figure 6.10a Eye Calibration using Tobii TX300 (Accept)

[37] See Appendix K: The study protocol

As the affective state of the participant was an important issue during the calibration procedure, we therefore decided that eye calibration needed to be carried out, as if the autistic participant was playing a game, with rewards, to facilitate compliance and positive behaviour. First, the participant who was sitting in front of the eye tracker monitor was asked by the specialized educator to sit properly. Then he/she was asked to look at the screen, without moving his/her head around, and to follow the red calibration points. Subsequently, if the calibration was performed by the participant, within the high precision quadrant, as illustrated in Figure 6.10a below, then an "accept" message was prompted by the Eye Tracker system. On the other hand, if the calibration was not properly performed, then a "recalibration" message was displayed, indicating the marked points for recalibration. Figure 6.10b illustrates an example of the eye tracker calibration. One can see the green dots showing the calibration locations, whereas the black dots indicated the participant's recorded eye positions, when he/she was looking at the green dots.

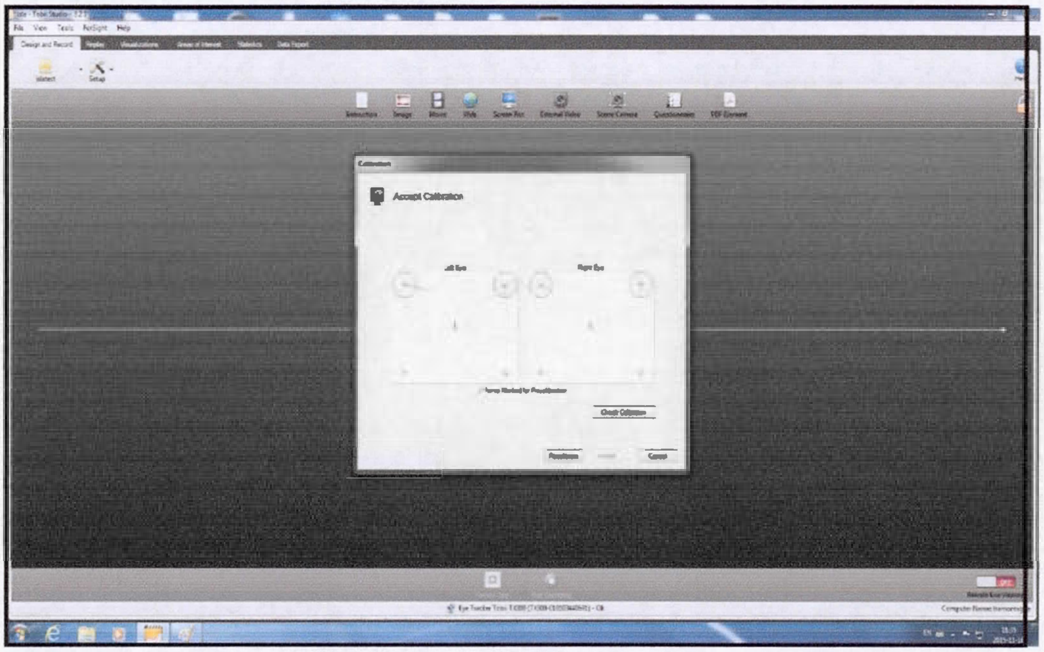

Figure 6.10b Eye Calibration using Tobii TX300 (Recalibrate)

6.4.2.4. TeamViewer technology

In addition, TeamViewer[38] a computer software application for remote control, was used for file transfer and desktop sharing. This helped us monitor the autistic student, while he/she was interacting with ISLA and performing the mathematical task. It is important to note that, for both experiments **with** and **without** Jessie, the technologies mentioned above were synchronized and running parallel at the same time as the participant was conducting the mathematical activity as described in the study and intervention protocols discussed in the following section.

6.5. The laboratory environment used in ISLA

6.5.1. The study protocol

A study protocol was created for each of the main experiments which are respectively presented in Appendix K. The main experiments were held in the computer science laboratory at the University of Montreal. The laboratory environment was properly set up in order to minimize stimuli from the outside, which might interfere with the participant's attention and compliance. Even though we wanted to use different rooms to perform the Wizard of Oz for the main experiments, this was difficult to implement because of the different technologies which were used and which all needed to be connected, synchronized and working simultaneously. For synchronization purpose, the interactive quiz consisting of thirty questions in addition using the mathematical application ISLA was programmed to be launched within seconds after eye calibration using Tobii TX300 technology. Following this, data was immediately collected, and recorded using FaceReader and Observer XT technologies. The supervision of the autistic child when performing the interactive quiz was another concern for the researcher. For example, if the autistic student needed an intervention other than the one provided by Jessie, such as

[38] Source: TeamViewer technologies

"Please sit down", the specialized educator would step in. If the ASD student needed to withdraw from the intervention, the specialized educator could then immediately intervene by monitoring the student's screen and by keeping track of the child's performance, without having his/her feelings observed through the use of TeamViewer technology.

In order to conduct the Wizard of Oz for the main experiments, emphasis was given so that the researcher/specialized educator could not be seen by the ASD participant while performing the mathematical quiz. For this purpose, the laboratory was divided into two sections, with one section of the room adapted only for the ASD participant to perform the mathematical activity, as shown in Figure 6.11.

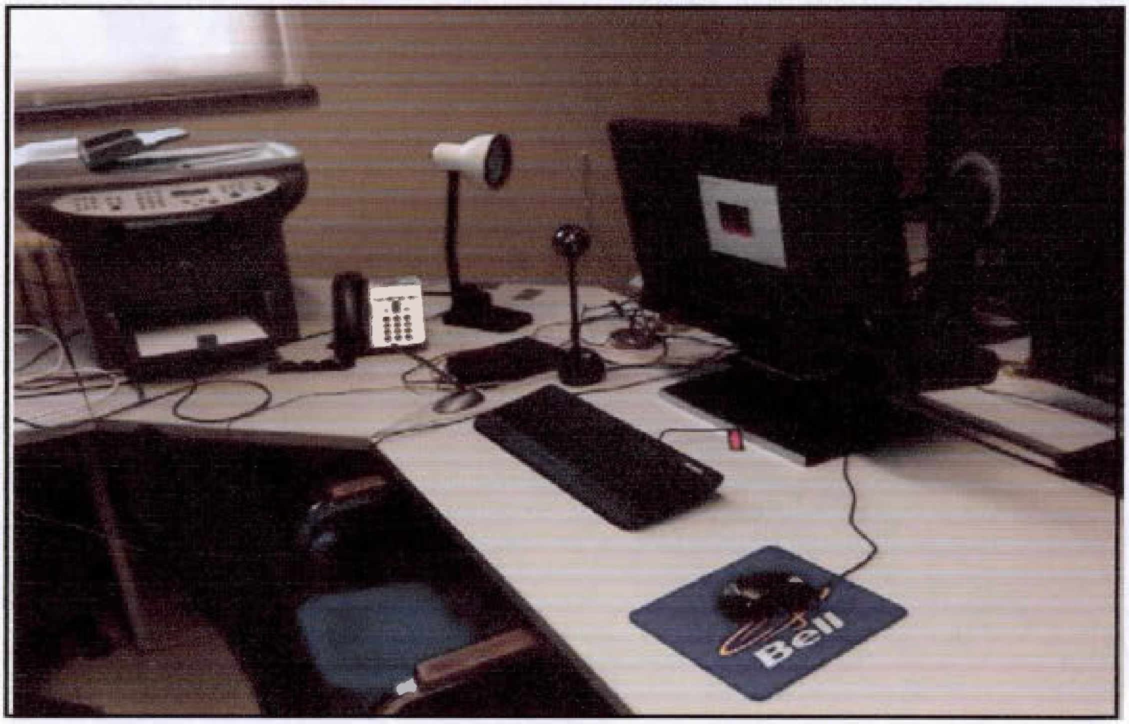

Figure 6.11 Laboratory set-up (ASD participant's side)

The other section of the room was intended for the specialized educator/researcher as well as for the IT specialist, making sure that all technologies were working as scheduled. By placing a partition, using the participant's eye tracking monitor and the researcher host computers between the two sections, we managed to have the participant isolated and out of view, so as to avoid distractions. With the use of Team Viewer, we could share the participant's monitor and have control, in real- time, of his/her behaviour and performance, while completing the interactive quiz, as illustrated in Figure 6.12.

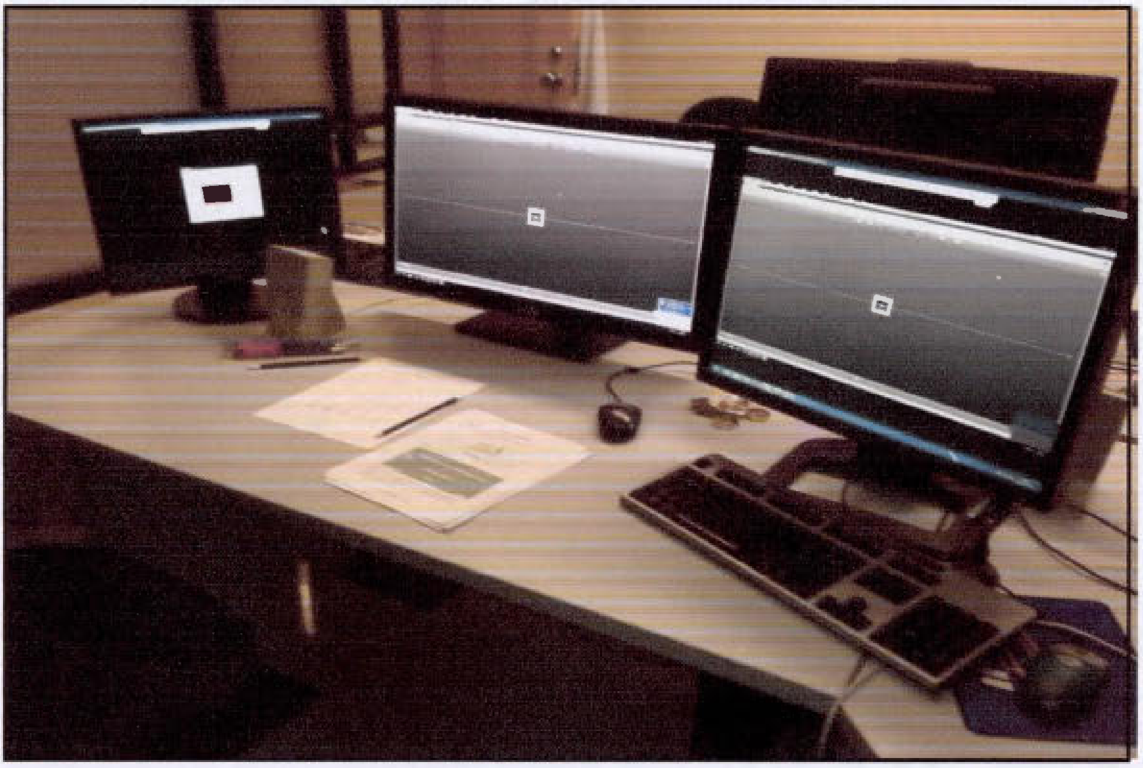

Figure 6.12 Laboratory set-up (Researcher team side)

6.5.2. The intervention protocol

An intervention protocol was considered for each of the main experiments (**without** and **with** Jessie), as presented in Appendix H. Prior to the one-on-one intervention, it was important to meet with the parents in order to answer any of the questions they might have. During that interview, we talked about the purpose of this study and its methodology. The intervention protocol, providing the guidelines on how the intervention was conducted, was also explained to the parents. The interactive mathematical quiz and the technologies used in the experiments were discussed as well. Moreover, along with the parents' consent[39], parents were provided with a parental assessment questionnaire in mathematics in specialized education (PAQ-SE)[40] to help us predict the child's affective state. In the mathematical questionnaire, two questions were related to the affective state, dealing with positive or negative behaviors the student might experience during the mathematical activity. Another question was related to the reward system. In this respect, it is important to know how to reward the student at the end of the intervention for his/her achievement. The list of rewards is presented in Table 6.2. The predicted score obtained from the parents that the student might have during the quiz, as well as the errors that he/she might encounter when performing the mathematical activity were recorded. The list of errors in this experimental study is presented in Table 6.3. At the end of the interview, the parents' consent forms, the authorization form for taking a video recording of the child, and the parental assessment questionnaire in mathematics in specialized education were to be duly completed and signed, in accordance with this research's ethics certificate[41]. These important elements were taken into consideration in order to perform the intervention.

6.6. The prototype

As discussed previously, the results of the preliminary experiment revealed that the performance of the ASD student, in a mathematical situation such as addition, **with** the use of a pedagogical agent providing real-time support, had a positive impact on these participants' performances. The next part of this study presents the prototype and its main experiments, dealing with a larger group of twelve participants with high functioning autism, in which a control group of six students interacted **without** the pedagogical agent, Jessie, while the test group formed by the other six participants interacted **with** Jessie.

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[39] See Appendix J: The parents' consent forms

[40] See Appendix H: The Parental Assessment Questionnaire in mathematics in specialized education (PAQ-SE)

[41] See Appendix L: The Ethics certificate

Two important hypotheses were considered:

1) *The affective state of the ASD student in a mathematical situation, **without** the use of a pedagogical agent to provide support and encourage motivation, would have a negative impact on his/her performance.*

2) *The affective state of the ASD student in a mathematical situation, **with** the use of a pedagogical agent to provide support and encourage motivation, would have a positive impact on his/her performance.*

6.7. The main experiments

As previously described, the preliminary experiment consisted of a Wizard of Oz, played by the specialized educator, simulating the behavior of an affective intelligent tutoring system, that is ISLA and its pedagogical agent Jessie, in an arithmetic learning activity.

Before proceeding further, it is important to mention that the Wizard of Oz, used in the main experiments, was different from that of the preliminary experiment, because it was played by Jessie and by the specialized educator, with each one of them playing different roles. For example, during the mathematical activity with the group test, Jessie helped by providing real-time support and feedback to help the ASD student to calibrate his/her emotions. Another important role of Jessie was to have the student motivated and on task, by using positive reinforcement. In fact, Jessie could provide feedback within 1 or 2 seconds, by means of hints, social rewards, and pedagogical scenarios. Despite its capabilities, the pedagogical agent Jessie has limitations. For example, when the participant displayed distress, frustration (cries, screams, kicks, etc.) while performing the activity at hand, it was the role of the specialized educator to immediately stop the intervention and to calm the child down. The parents, who were present but waiting in another room, were also immediately informed.

Let's remember that each child in the spectrum of autism is unique, with different individual learning challenges. Therefore, the feedback reaction time from Jessie was also important during the intervention. For instance, if the ASD student was going *idle*, (i.e. not answering for more than 3-4 seconds), the specialized educator had to immediately intervene by simulating Jessie's behaviour. She would ask the student *Do you need help*? and/or suggesting *Add these numbers!* Another intervention from the specialized educator was to say to the learner: *Please sit down and/*or *Listen carefully!*

6.7.1. Control experiment group: Without the use of a pedagogical agent Jessie

In the first part of the experiment, the following hypothesis was addressed

> *1) The affective state of the ASD student in a mathematical situation,* ***without*** *the use of a pedagogical agent to provide support and encourage motivation, would have a negative impact on his/her performance.*

Before proceeding with the quiz, a demonstration was conducted for each autistic participant on how to interact with ISLA, by using pictograms. The one-on-one intervention was one hour and it is described in the intervention protocol without Jessie[42]. The participants' profiles have been successful in fulfilling the criteria and their profiles are presented in Table 6.11. The age of the children ranged from 7 years old for participant #6, 8 years old for participant #4, 9 years old for participant #2 and participant #3, 11 years old for participant #5, and 12 years old for participant #1. Within the group, one participant was a girl, and five participants were boys. Most parents were concerned about the performance and behaviour of their child during the mathematical activity. For example, for participant #4, they were not sure about his competency level and told us: "*it's very difficult to do math with him.*" They were also concerned about his oppositional behaviour. Parents were generally enthusiastic in participating in this research. They wanted to know

[42] See Appendix I: The intervention protocol without Jessie

their children's competency level and scores.

Table 6.11

Participants' profile: Group without Jessie

Participant Code	Diagnosis	Age	Gender
#1	Autism disorder	12	Male
#2	Autism disorder	9	Female
#3	Autism disorder	9	Male
#4	Autism disorder	8	Male
#5	Autism disorder	11	Male
#6	Autism disorder	7	Male

After the quiz performance, I met with the parents, providing some recommendations regarding the difficulties that each child might have experienced, according to his/her competency level, in order to help him/her improve his/her mathematical skills in addition. They appreciated the feedback and the fact that the mathematical activity was presented as an interactive game, rather than through a printed test. The program of intervention dealing with the baseline measure of performance was carried out individually for each student by means of an interactive quiz consisting of thirty additions and using the ISLA mathematical application. Figure 6.13 presents an example of the quiz at a beginner competency level. One can see that, in the quiz, the additions were presented to the student on the basis of one addition at a time. The duration of the quiz, without the help of the pedagogical agent Jessie, lasted fifteen minutes and the rewards to the child were provided at the end of the intervention.

In the next section, the results are presented along with the data analysis with FaceReader and Observer XT technologies, dealing with the group that interacted **without** Jessie.

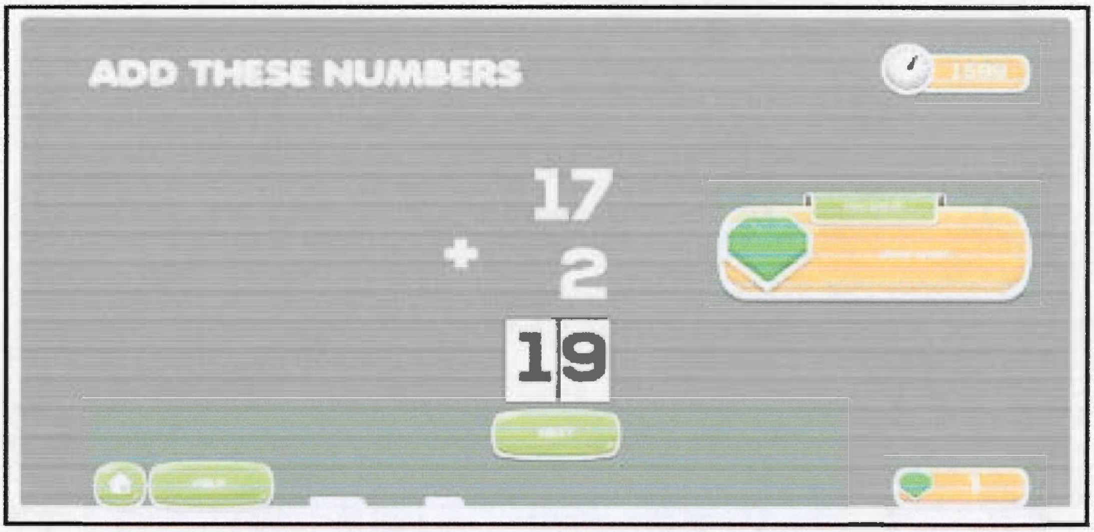

Figure 6.13 Interactive quiz, beginner level

6.8. Data analysis: FaceReader and Observer XT

6.8.1. Results: Group without Jessie

The results of the first group, regarding the affective state and performance of the ASD student in a mathematics learning without the use of a pedagogical agent, are presented in Table 6.13. By comparing the level of difficulty among participants, one can see that it was a ***heterogeneous*** group, in terms of age and of competency level. In fact, we observed that the level of difficulty varied from *Not difficult* for participant #5, *Difficult* for participants #1 and #2, to *Very difficult* for participants #3 and #4. Moreover, as observed in Table 6.13, there is a difference when comparing the parents' predicted score and the one obtained by the child when performing the quiz. For most parents, predicting their children's scores in mathematics was challenging. For instance, for participant #6, his parent mentioned that: "working on mathematics depended on his mood." For participant #4, his parent explained: "il n'aime pas les maths." The only correct prediction concerned participant #5 whose parents' predicted score was 100% equal to the score performed by the student at the quiz.

Table 6.12

Performances scores–Group without Jessie

Participant	Parent predicted score	Level of competency	Score Quiz in %	Difficulty	Accomplishment Scale
#1	70%	Intermediate	56%	3= Difficult	3
#2	70%	Intermediate	63%	3= Difficult	3
#3	60%	Beginner	26%	4=Very difficult	2
#4	40%	Beginner	7%	4=Very difficult	1
#5	100%	Master	100%	1=Not difficult	5=Excellent
#6	50%	Beginner	23%	4=Very difficult	2

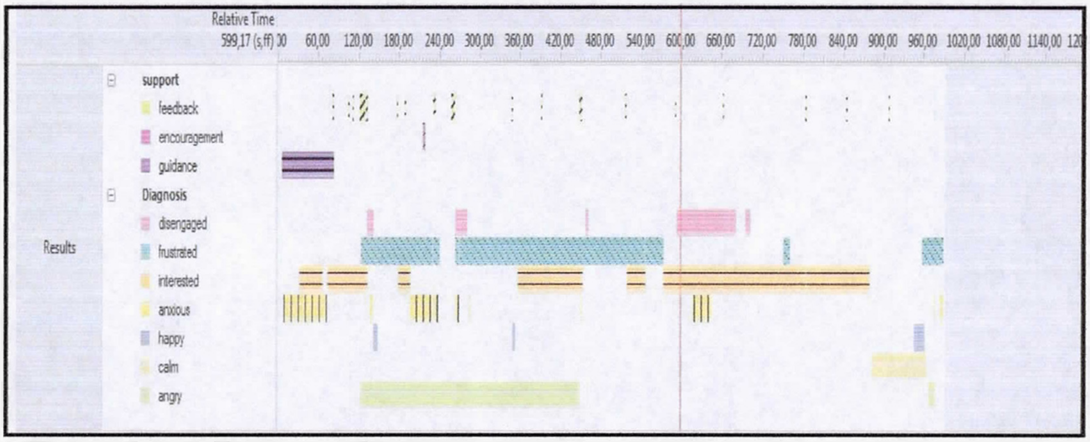

Figure 6.14 Affective profile (Observer XT) - Participant #1

As illustrated in Table 6.12, participant #1 obtained a score of 56% on the quiz, at an intermediate competency level with a *3* measure of accomplishment and a difficulty level of 3, experiencing the effects of frustration, anger, anxiety, and disengagement displayed in Figure 6.14. Thus, one can see that participant #1 was interested, displaying a positive valence during the guidance section on how to interact with the ISLA application. As he advanced in the quiz, it became more difficult for the student (as shown in Figure 6.15). At that time, he was then complaining, saying: *That's it, I'm out of here. I don't like this game.* His affective profile showed a negative valence, as observed in Figure 6.15.

The activity lasted 15 minutes. He could not however complete the quiz reflecting his competency level.

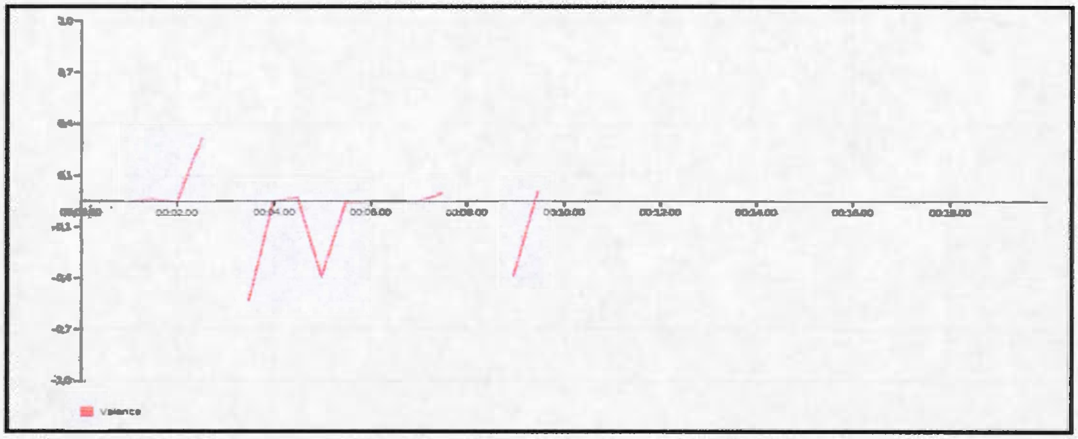

Figure 6.15 Valence profile (Face Reader) - Participant #1

In addition, participant #4 also performed poorly in the quiz. He obtained a score of 7% at a beginner competency level, with a *1* measure of accomplishment and a difficulty level of *4*, experiencing the affects of anxiety and disengagement, as displayed in Figure 6.16.

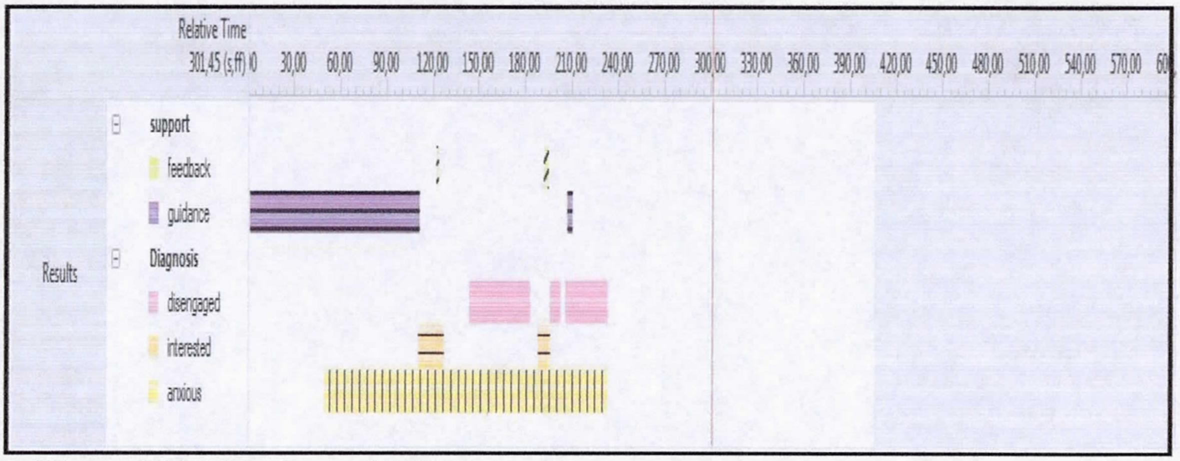

Figure 6.16 Affective profile (Observer XT) - Participant #4

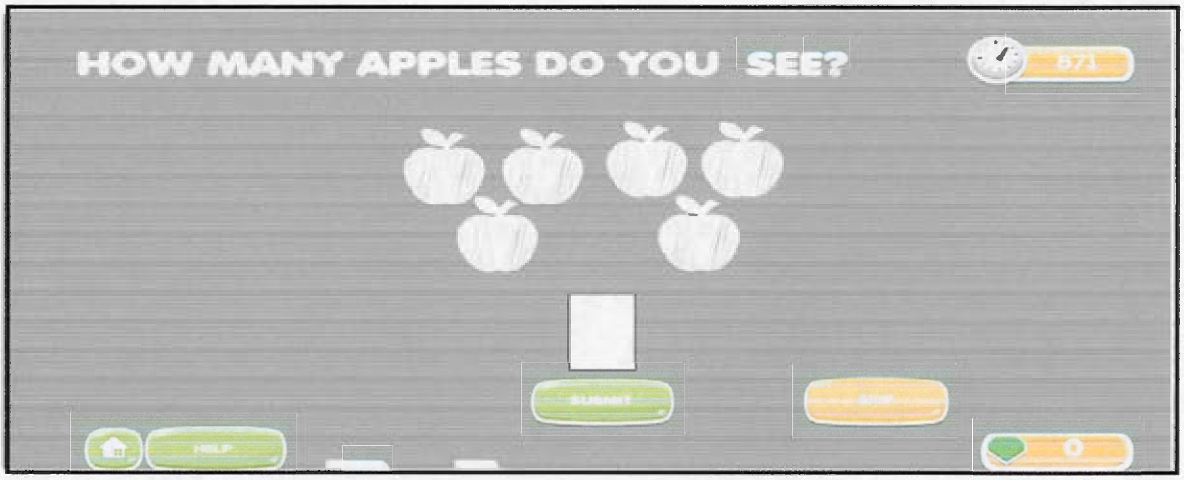

Figure 6.17 Interactive quiz (question for a beginner level)

Participant #4 liked 'The Chalkboard Game' and was interested in counting the apples at a beginner competency level, as observed in Figure 6.17. His valence was neutral during the guidance section. After that activity, he was disengaged. He kept playing with the mouse, skipping the questions. As illustrated in Figure 6.18, he seemed anxious and could not sit still. So, the specialized educator had to stop the intervention because of his behaviour. The session lasted only 2 minutes. He did not complete the quiz reflecting his competency level.

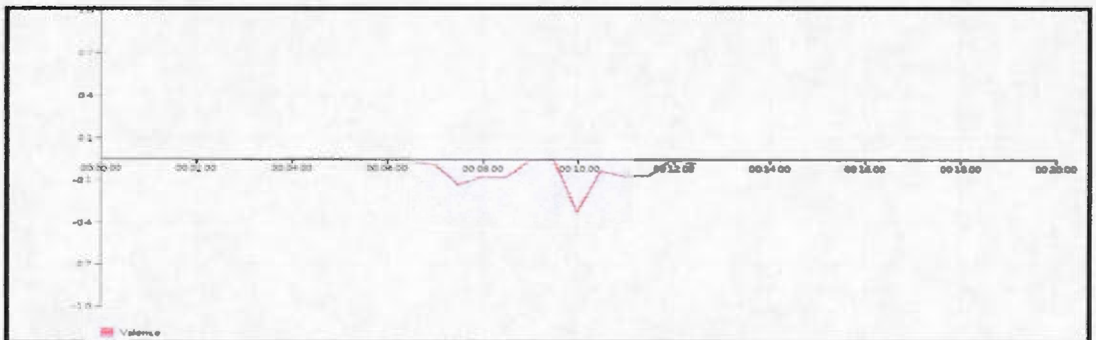

Figure 6.18 Valence profile (FaceReader) - Participant #4

Regarding participant #5, he obtained a score of 100%, at a mastery competency level, with a *5* measure of accomplishment and a difficulty level of *1*. Although his level of accomplishment was *5*, i.e. greater than that of all participants, he seemed very anxious throughout the quiz, as shown in Figure 6.19.

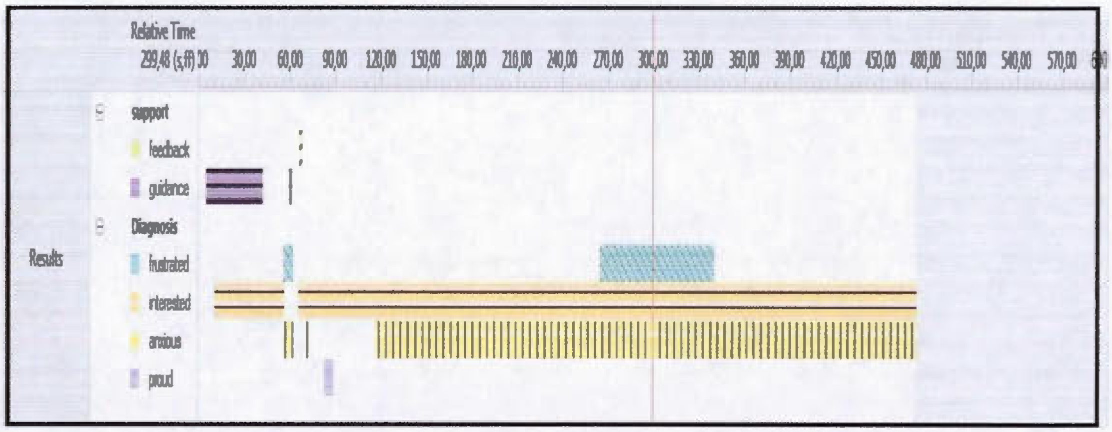

Figure 6.19 Affective profile (Observer XT) - Participant #5

During the solving-problem section, participant #5 displayed a negative valence, as observed in Figure 6.20. He hesitated, wondering: "Do I have to add or subtract?" Figure 6.21 portrays an example of a problem-solving question which was presented to the ASD student. He completed the quiz reflecting his level of competency in 7 minutes and 35 seconds.

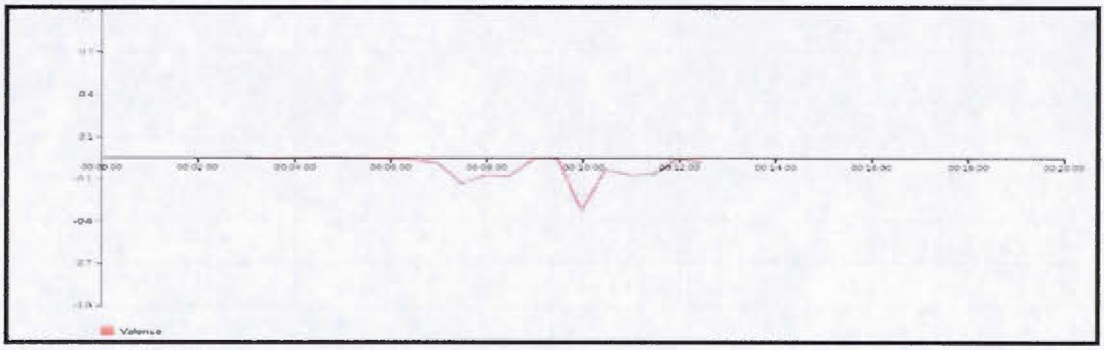

Figure 6.20 Valence profile (FaceReader) - Participant #5

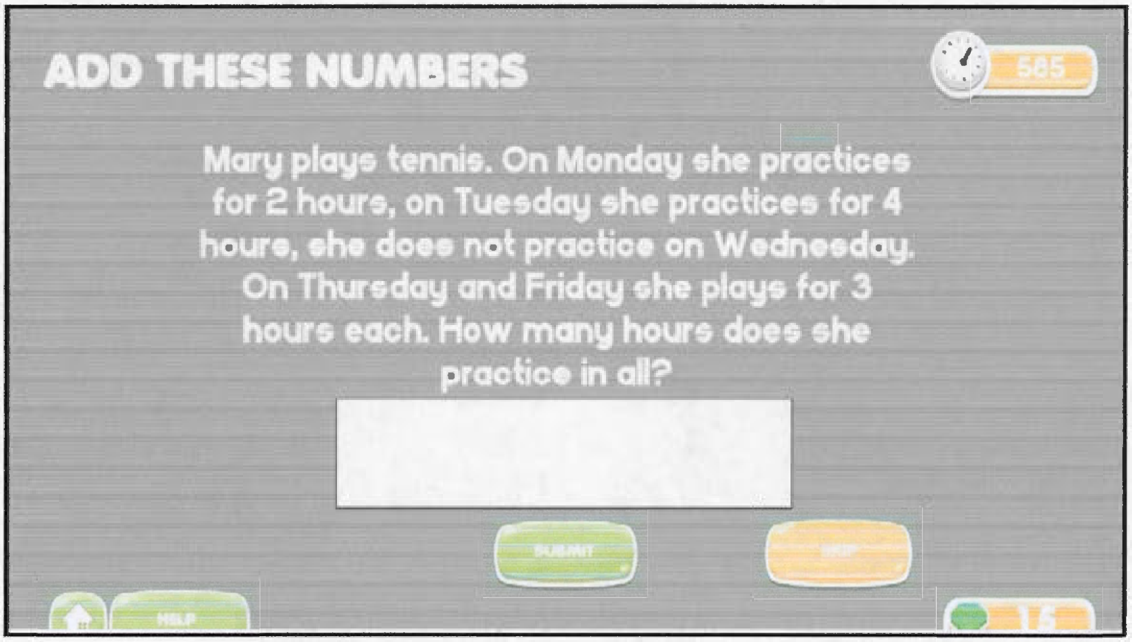

Figure 6.21 Interactive quiz (question of advanced level)

The scores compiled in Table 6.12, indicated that **the majority of participants, with the exception of participant #5, did not succeed on the quiz without** the use of a pedagogical agent providing support and encouraging motivation during the mathematical activity.

6.9 Test experiment group: With the use of a pedagogical agent Jessie

In the second experiment of this study, the following hypotheses were addressed:

*The affective state of the ASD student in a mathematical situation, **with** the use of a pedagogical agent to provide support and encourage motivation, would have a positive impact on his/her performance.*

The duration of the one-on-one intervention was one hour. It is described in the intervention protocol with Jessie[43]. The participants' profiles for the test group with Jessie, is presented in Table 6.13. As observed, the age of the children ranged from 6 years old for participant #8, 7 years old for participant #9, 8 years old for participant #10, 9 years old for participant #7, 10 years old for participant #11, and 12 years old for participant #12. Within the test group, two participants were girls and four participants were boys. The duration of the quiz lasted 30 minutes, with the help of the pedagogical agent, Jessie.

Table 6.13

Participants' profile–Group with Jessie

Participant Code	Diagnosis	Age	Gender
#7	Autism disorder	9	Female
#8	Autism disorder	6	Male
#9	Autism disorder	7	Male
#10	Autism disorder	8	Male
#11	Asperger Syndrome	10	Female
#12	Autism disorder	12	Male

[43] See Appendix I: The intervention protocol with Jessie

The following part entails the results and data analysis with FaceReader and Observer XT technologies related to the test group.

6.9.1. Results: Group with Jessie

The results of the second group, concerning the affective state and performance of the ASD student in a learning situation such as addition **with** the use of a pedagogical agent, are presented in Table 6.14.

Table 6.14

Performances scores–Group with Jessie

Parent predicted Score	Score Quiz in % (According to level of competency)	Level of Competency	Difficulty	Accomplishment Scale
60%	86%	Advanced	3=Difficult	3
40%	60%	Beginner	4=Very difficult	2
40%	83%	Intermediate	3=Difficult	3
60%	91%	Intermediate	3=Difficult	3
50%	86%	Advanced	3=Difficult	3
65%	90%	Advanced	3=Difficult	3

During the intervention provided to each participant, the autistic child was prompted by Jessie and by the specialized educator, with the intention of helping the learner to become self-regulated while performing the mathematical task. This was done by providing a real-time immediate visual feedback, provided by Jessie, in order to diminish frustration and promote motivation, so as to enable the accomplishment of the mathematical task and make it reflect the competency level of the ASD learner.

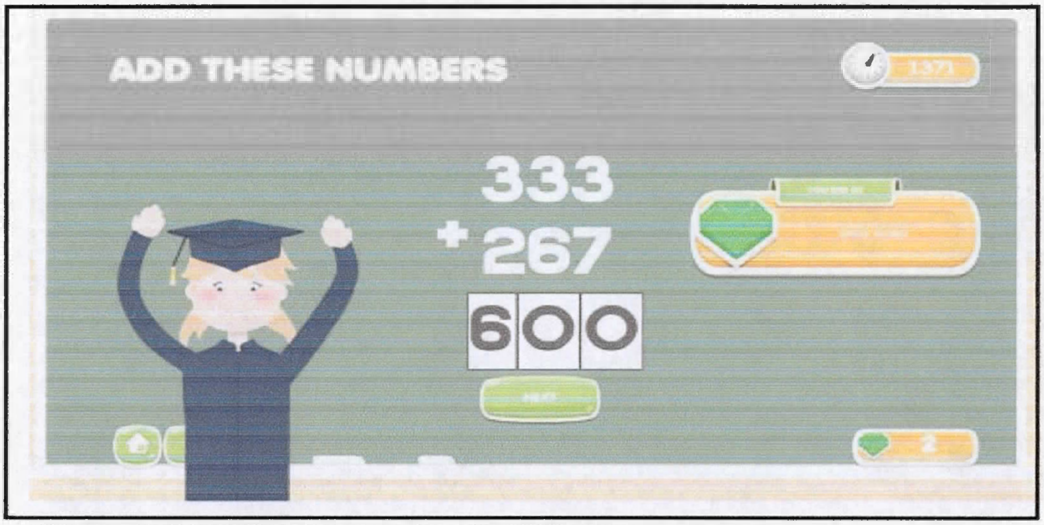

Figure 6.22 Feedback color flag, **Good** answer.

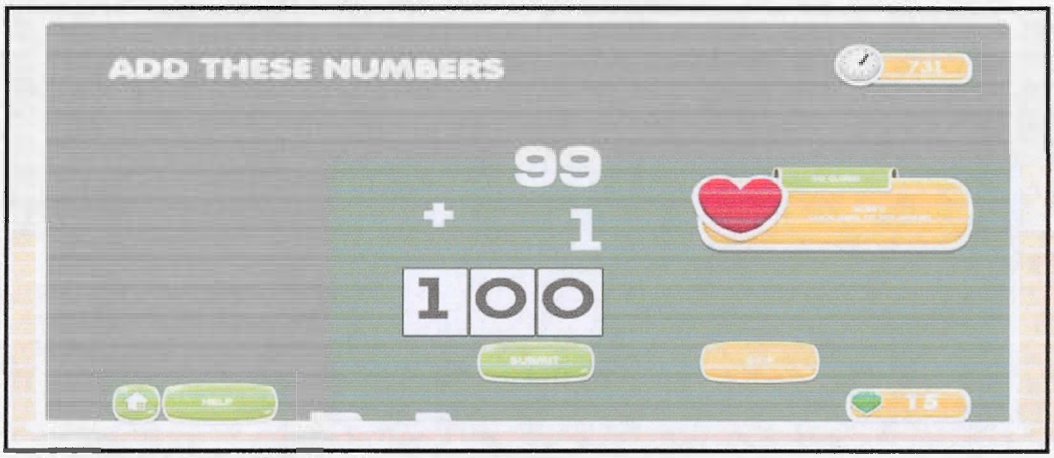

Figure 6.23 Feedback color flag, **Wrong** answer.

When a right answer was provided, a positive reinforcement was then used by Jessie, with social rewards, in order to encourage and motivate the student, such as *Yes, you did it!* or *Good Job!* (Figure 6.22). By contrast, when a wrong answer was given, Jessie then said: *That was close nice try* and invited the ASD learner with prompting to try again (Figure 6.23). Furthermore, if the student needed help, hints were provided by means of pedagogical scenarios to help the student mirror his/her own learning (Figure 6.24).

Although we have been trying hard to obtain, a *homogenous* group, in terms of age and competency level, it was difficult to do so. For example, as outlined in Table 6.14, participant #8 obtained a score of 60% at a beginner level, with a *2* measure of accomplishment and a difficulty level of *4*, displaying the affects of interest, frustration and pride, as observed in Figure 6.24. He experienced difficulties in discriminating, in regrouping and in writing numbers.

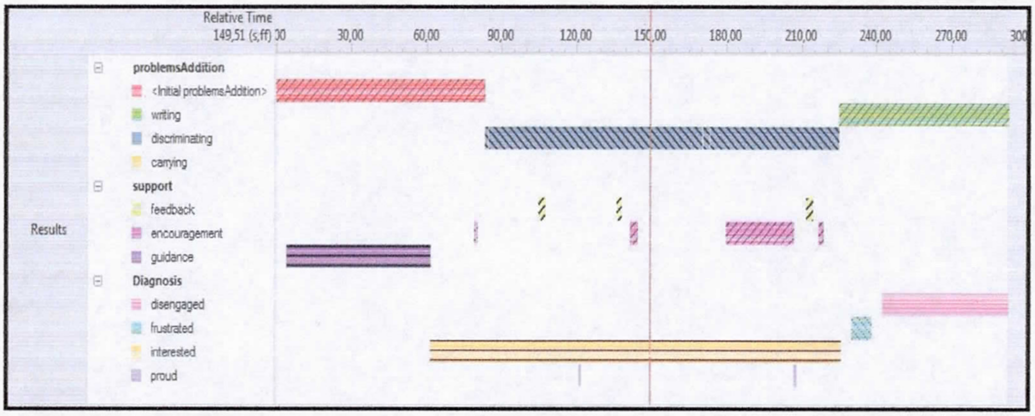

Figure 6.24 Affective profile (Observer XT) - Participant #8

For instance, when asked to add *7+5*, he wrote *7*, as the quiz tended to be more difficult for him, his valence became negative, showing his frustration. He kept saying: ***I don't know,*** covering his ears with his hands. Jessie encouraged him to perform the problems, according to his competency level. Despite his difficulties, he asked Jessie for ***help***, receiving reinforcement ***Try again!*** Finally, he found the right answer, having Jessie reply ***All right, you did it!*** The student then felt proud of himself, showing a positive valence, as illustrated in Figure 6.25. He completed the quiz reflecting his level of competency.

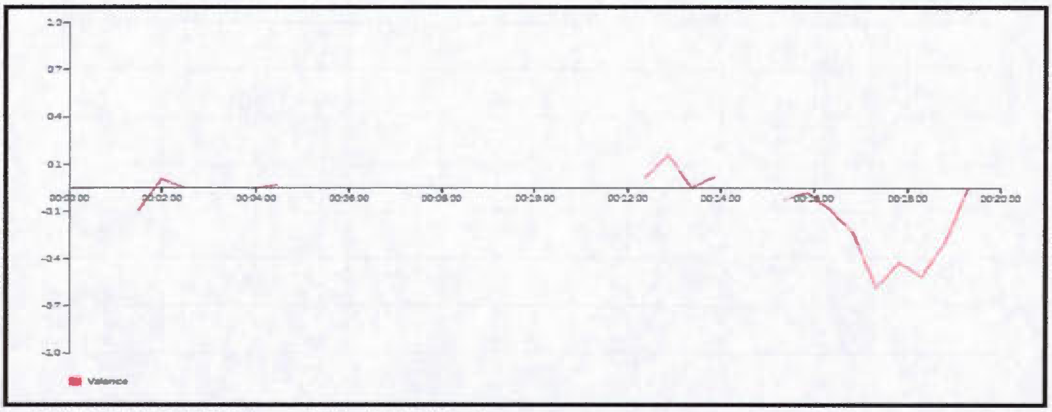

Figure 6.25 Valence profile (FaceReader) - Participant #8

With regards to participant #10, he lacked verbal skills. He performed 85% on the quiz. He was rated at an intermediate level, according to his competency level, with a *3* measure of accomplishment and a difficulty level of *3*, experiencing the affects of interest and anxiety as shown in Figure 6.26.

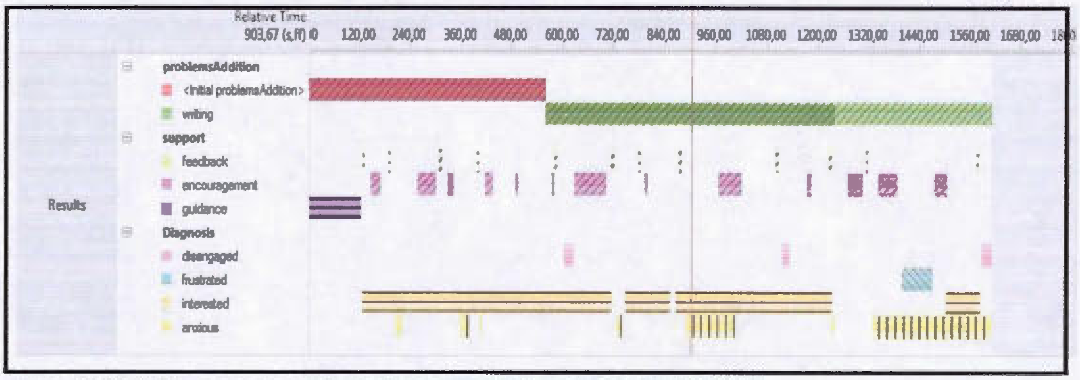

Figure 6.26 Affective profile (Observer XT) - Participant #10

He had some difficulties in writing numbers. He received support from Jessie but, because of his lack of verbal skills, Jessie simulated by the specialized educator, had to adapt the intervention, asking *Do you need help?*. The student nodded a *yes* with his head. If he didn't need help, he would shake *no* with his head. Moreover, he was allowed to use a pen and paper to add. As displayed in Figure 6.27, his valence was most of the time neutral. At times, he was smelling the pad and playing with his hands. As the quiz progressed, he grew tired, making the specialized educator stop the intervention. He was able to complete the quiz matching his level of competency.

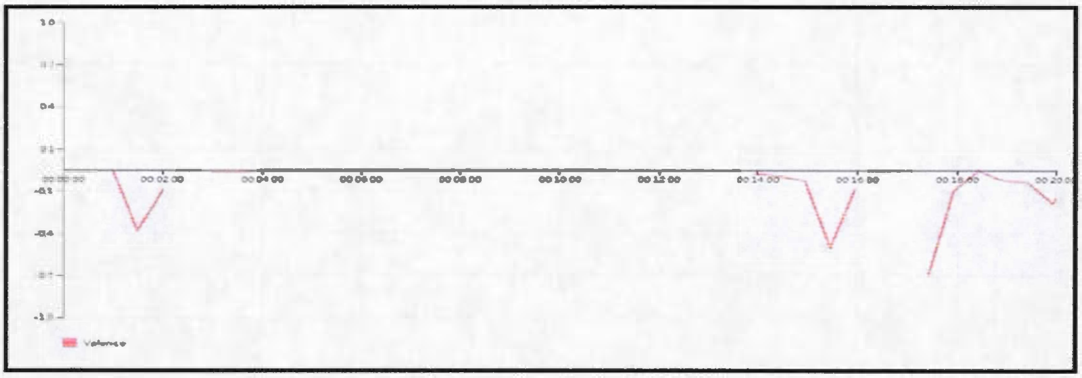

Figure 6.27 Valence profile (Face Reader) - Participant #10

Participant #7 performed at 70% in the quiz at an advanced level, according to her competency level, with a *3* measure of accomplishment and a difficulty level of *3*, experiencing the affects of interest, anxiety as well as intervals of disengagement, as observed in Figure 6.28. Her valence was most of the time neutral as illustrated in Figure 6.29.

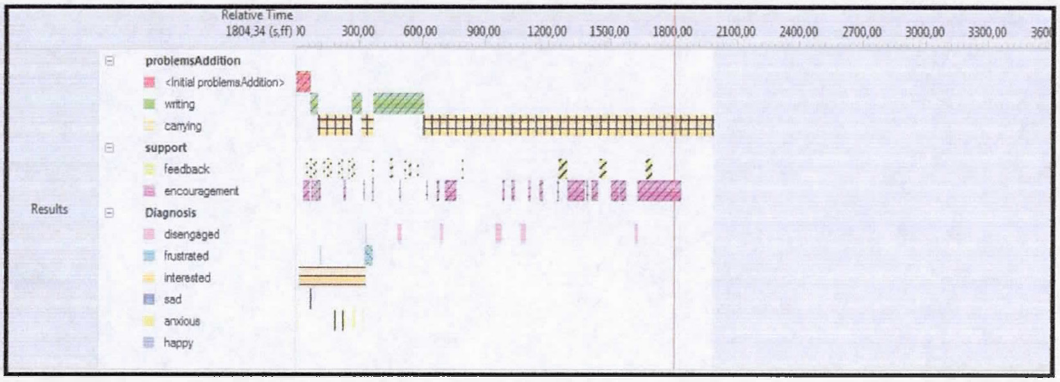

Figure 6.28 Affective profile (Observer XT) - Participant #7

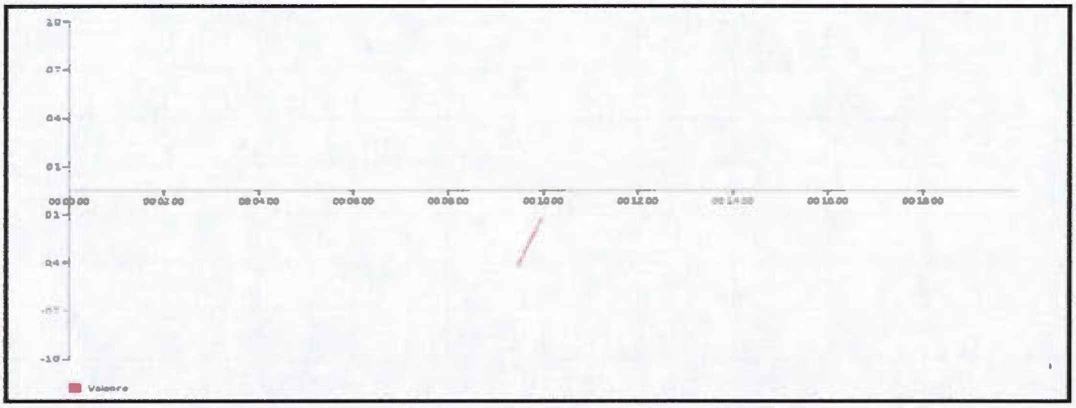

Figure 6.29 Valence profile (Face Reader) - Participant #7

She had some difficulties in writing and in carrying numbers (Ones, Tens, and Hundreds). She received a lot of feedback (encouragements) from Jessie to keep her on task. For instance, when asked to add *464 + 46*, she was disengaged, playing with her fingers. While waiting for an answer, Jessie asked: *Do you have an answer?* She entered the answer, but she made a mistake in carrying with *Tens*. Within seconds, Jessie prompted the child by saying: *Try it again!* Then, the ASD student tried again, but entered the incorrect answer. Jessie said *Almost, try again!* Then, the student replied to Jessie: "I don't know this one, I need help."

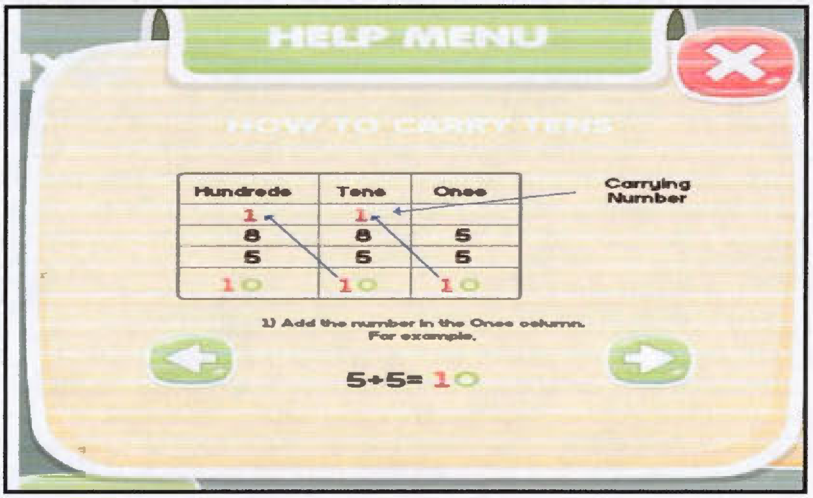

Figure 6.30 Scenario 'How to carry tens'

Jessie presented the pedagogical scenario on *How to carry tens*, as observed in Figure 6.30. This helped the learner to correct and to provide the right answer. Jessie replied and said: *That one was tough, but you did it!* Watching Jessie and the autistic child interacting and working together showed some kind of complicity between Jessie and the ASD learner. The learner performed the quiz according to her competency level. The intervention lasted 30 minutes.

The scores compiled in Table 6.14 above revealed that **the majority of participants benefited from the personalization and support provided by the pedagogical agent, Jessie**, which aimed at helping the autistic student become self-regulated by calibrating his/her emotions and encouraging motivation during the mathematical activity. In the next section, the statistical analysis is presented.

6.10. Statistical analysis

This part of my research aims to provide the statistical analysis and the results of the main experiments for the validation of the prototype of the integrated specialized learning application (ISLA). To begin with, the question being addressed in this study is:

How do we develop a virtual companion capable of establishing the affective state of an autistic child in a mathematical situation such as addition so as to effectively respond to it?

Two general hypotheses were initially considered:

1) *The affective state of the ASD student in a mathematical situation,* ***without*** *the use of a pedagogical agent to provide support and encourage motivation, would have a negative impact on his/her performance.*

2) *The affective state of the ASD student in a mathematical situation,* ***with*** *the use of a pedagogical agent to provide support and encourage motivation, would have a positive impact on his/her performance.*

For the purpose of statistical analysis, the two general hypotheses presented above were broken down into two important questions. In the first question, the relationship between support and performance dealing with the score of each participant for both groups with and without Jessie during the mathematical activity was investigated. The first hypotheses is presented below.

E1: The use of a pedagogical agent to provide support and encourage motivation would have a positive impact on the performance of the autistic student in mathematical learning.

In the second question, the analysis dealt with the comparison of the affective states per group for every affective state of each participant of the groups with and without Jessie while performing the quiz. The second hypothesis is as follows:

E2: The use of a pedagogical agent to provide support and encourage motivation would have a positive impact on the affective state of the autistic student in mathematical learning.

6.11. Methods

Descriptive statistics summarize all study variables of interest. For categorical variables, we reported counts and percentages whereas for continuous variables we reported medians and inter- quartile range (IQR), because the values did not follow an approximate normal distribution. We compared scores between the group with and without Jessie. Due to small sample size and the difficulty to verify the assumption that the scores in the population follow an approximate normal distribution, we performed the exact version of Wilcoxon Rank Sum (WRS) test for independent samples, a non-parametric equivalent of the t-test. The null hypothesis for this test is that the distributions of values of scores for the two groups do not differ from one group to another. All statistical tests of hypothesis were two-sided and performed at the pre-specified level of significance of 5%. The *p*-values reported are not adjusted for multiple testing. We used SAS, version 9.3 (SAS Institute Inc., Cary, NC, USA) for all statistical analyses.

As previously stated, we have conducted two statistical analyses dealing with a group of twelve participants with high functioning autism. A control group of six students performed the interactive mathematical quiz **without** the help of the pedagogical agent Jessie. The experimental group consisted of six other participants, which performed the interactive mathematical quiz while interacting with the pedagogical agent Jessie.

6.12. Results

Participation of each child in each group was allocated randomly. In the group without Jessie, the age of the children ranged from 7 years old to 12 years old. Within this group, one participant was a girl, and five participants were boys. The participants' profile for the group without Jessie is presented in Table 6.11. In the group with Jessie, the age of the children ranged from 6 years to 12 years old. In this group, two participants were girls and four participants were boys. The participants' profile for the group with Jessie is illustrated in Table 6.13.

6.12.1. Comparison of performance scores (N=12)

In the following part, we present the results related to the relationship between support and performance dealing with the score of each participant for both groups with and without Jessie during the mathematical activity. Since competencies are at the heart of the pedagogical model of the integrated specialized learning application, raw scores were corrected to determine the ASD participant's level of success according to his/her level of competency in addition. The levels of competency criteria are presented in Table 6.10. Table 6.15 shows the medians and inter-quartile range (IQR) of the raw scores as well as the competency scores. Figure 6.31 shows the boxplots with the distribution of raw scores and the competency scores for each ASD participant.

As illustrated in Figure 6.31, the dots represent the scores[44] obtained for each participant during the interactive quiz. In the group without Jessie, the ASD participants did not receive encouragement from the pedagogical agent Jessie.

Except for a participant whose score was 100%, no participant was able to complete the quiz according to his/her level of competency. One can see that the raw scores fluctuated from 7% as being the lowest score to 100% as being the maximum score. In this group, the median for the raw scores was 41.7 (IQR 23.3-63.3).

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[44] The performance scores – Group without Jessie is presented in Table 6.12

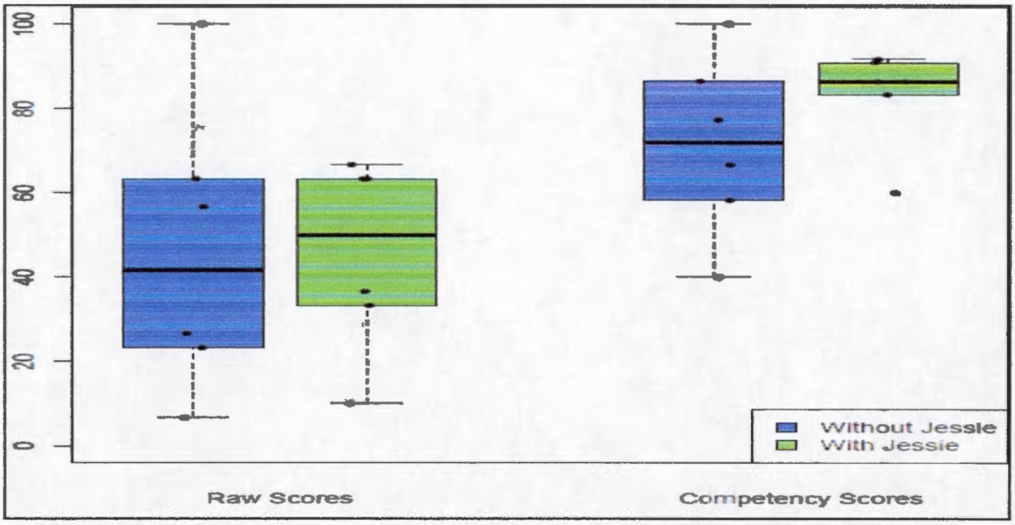

Figure 6.31 Box plots of performance scores with data points (N=12)

On the other hand, in the group with Jessie, where participants benefited from the support of Jessie, all six children were able to complete the quiz according to their level of competency. The raw scores differed from 10% as being the lowest score to 67% as being the maximum score. As observed in Table 6.16, the results indicated a median of 50.0 (IQR 33.3-63.3).

Table 6.15

Scores performance: With and Without Jessie (N=12)

					Wilcoxon Rank Sum Test	
	Version	**N**	**Median**	**IQR**	**S**	***p*-value**
Raw Scores	With	6	50.0	33.3-63.3	42.0	0.70
	Without	6	41.7	23.3-63.3		
Competency Scores	With	6	86.4	83.3-90.9	46.0	0.31
	Without	6	72.0	58.3-86.4		

For the competency scores, in the group without Jessie, one can see that the scores fluctuated from 40% to 100%. In this group, the median for the competency scores was 72.0 (IQR 58.3-86.4). In the group with Jessie, the competency scores ranged from 60% to

92%. As observed in Table 6.15, the results indicated a median of 86.4 (IQR 83.3-90.9). These results, however, were not statistically significant. Table 6.15 also shows the results of the statistical tests comparing the groups. The exact WSR test on raw scores shows no difference in the distribution of scores between the groups (S=42.0, p=0.7). Similarly, the exact WSR test shows no difference in the distributions of competency scores between the groups (S=46.0, p=0.31).

6.12.2. Comparison of performance scores (N=11)

In the next part, we present the results where participant #5 from the group without Jessie's support was excluded because his score was 100% at a mastery level indicating that he knew addition, making the score of this subject a possible outlier. As observed in Figure 6.32, one can see that the raw scores fluctuated from 7% as the lowest score to 63% as the maximum score. In this group, the median for the raw scores was 26.7 (IQR 23.3-56.7).

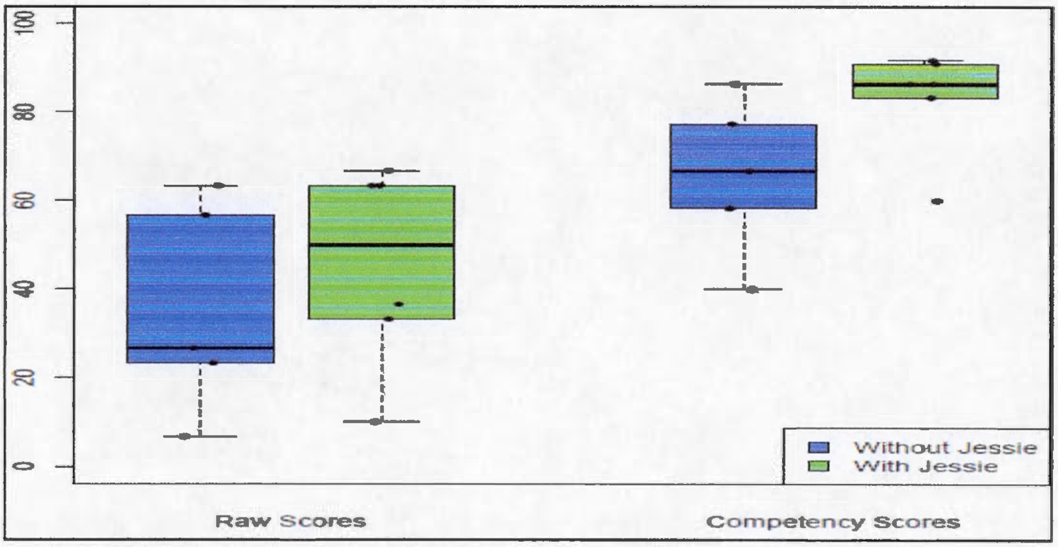

Figure 6.32 Box plots of performance scores with data points (N=11)

In the group with Jessie, the raw scores ranged from 10% to 67%. As observed in Table 6.16, the results indicated a median of 50.0 (IQR 33.3-63.3).

In terms of competency scores, in the group without Jessie, one can see that the competency scores varied from 40% to 86%. In this group, the median for the competency scores was 66.7 (IQR 58.3-77.3). In the group with Jessie, the competency scores ranged from 60% to 92%. As observed in Table 6.16, the results indicated a median of 86.4 (IQR 83.3-90.9).

Table 6.16

Scores performance: With and Without Jessie (N=11)

					Wilcoxon Rank Sum Test	
	Version	**N**	**Median**	**IQR**	**S**	***p*-value**
Raw Scores	With	6	50.0	33.3-63.3		
	Without	5	26.7	23.3-56.6	24.00	0.33
Competencies Scores	With	6	86.3	83.3-90.9		
	Without	5	66.6	58.3-77.2	20.00	0.08

The exact WSR test on raw scores reveals no difference in the distribution of scores between the groups (S=24.0, p=0.33). Similarly, the exact WSR test displays no difference in the distributions of competency scores between the groups (S=20.0, p=0.08).

We noted that when the possible outlier was removed from the group without Jessie, the competency scores revealed a moderate statistical difference between the groups in a two-sided statistical test (p=0.08). Besides, a one-sided WSR test on competency scores revealed a significant difference between the groups (WRS test, S=20.0, p=0.04), with a distribution with higher values for the group with Jessie.

6.12.3. Comparison of affective states (N=12)

Figure 6.33 shows the box plots of affective states with data points obtained for each participant while performing the mathematical interactive quiz.

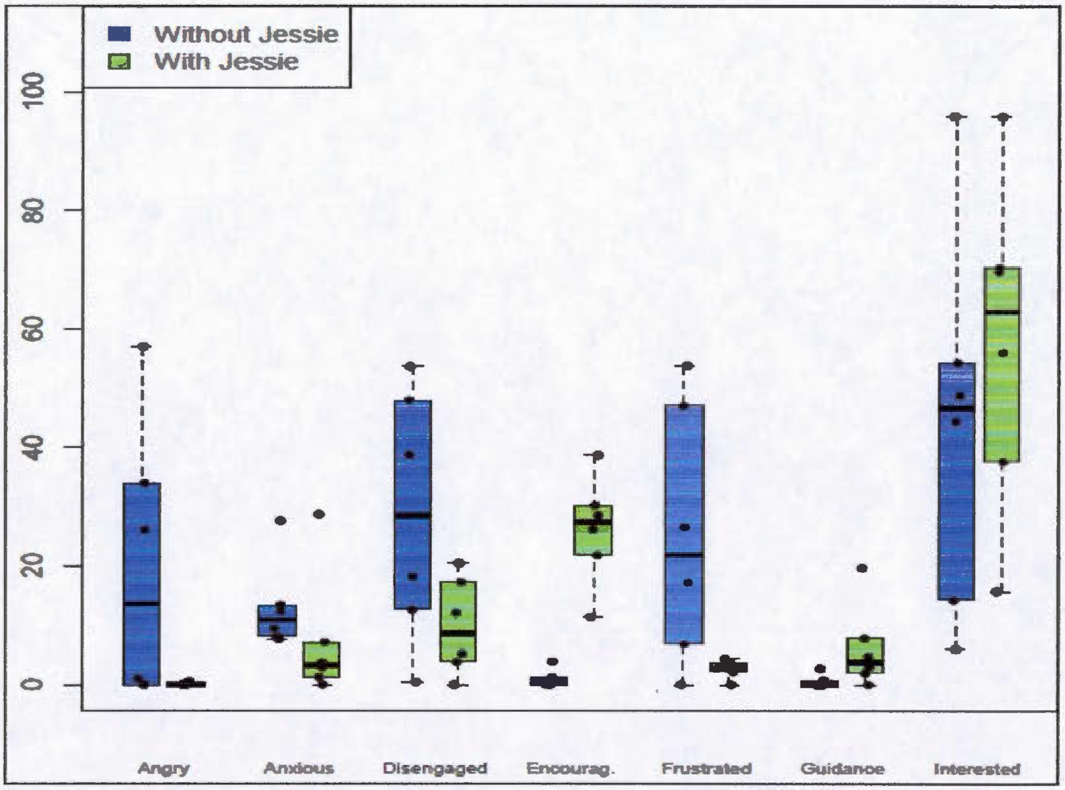

Figure 6.33 Box plots of affective states with data points (N=12)

Table 6.17 shows the median and inter-quartile range (IQR) of the affective states per group based on average differences for every affective state of each participant for both groups with and without Jessie during the mathematical activity.

The results indicated that the participants who benefited from the help of the pedagogical agent Jessie were more encouraged with a median of 27.3 (IQR 21.8-30.2), and more interested, with a median of 62.9 (IQR 37.6-70.4). They displayed less negative behaviour such as disengagement, with a median of 8.6 (IQR 3.8-17.2).

Table 6.17

Affective states: With and Without Jessie (N=12)
Inter-Quartile Range (IQR)

Affective State	Version	N	Median	IQR
Disengagement	Without Jessie	6	28.4	12.6-47.9
	With Jessie	6	8.6	3.8-17.2
Feedback	Without Jessie	6	3.9	1.1-4.5
	With Jessie	6	3.2	2.7-9.2
Encouragement	Without Jessie	6	0.2	0-1.2
	With Jessie	6	27.3	21.8-30.2
Frustration	Without Jessie	6	21.9	6.8-47.0
	With Jessie	6	2.8	2.2-3.7
Interest	Without Jessie	6	46.6	14.2-54.2
	With Jessie	6	62.9	37.6-70.4
Anxiety	Without Jessie	6	10.9	8.1-13.4
	With Jessie	6	3.3	1.3-7.2
Guidance	Without Jessie	6	0	0-0.7
	With Jessie	6	3.8	2.0-7.8
Joy	Without Jessie	6	0	0-4.7
	With Jessie	6	0	0-0.3
Calmness	Without Jessie	6	0	0-0.7
	With Jessie	6	0	0
Anger	Without Jessie	6	13.5	0-33.9
	With Jessie	6	0	0-0.3

Table 6.18

Affective states: With and Without Jessie (N=12)

Test-Statistics

Affective State	Test-Statistic	P-value
Disengagement	29.0	0.13
Feedback	41.0	0.81
Encouragement	57.0	0.002
Frustration	19.5	0.05
Interest	45.0	0.39
Anxiety	27.0	0.06
Guidance	51.5	0.04
Joy	39.0	1.00
Calmness	33.0	0.45
Anger	29.0	0.09

They displayed less frustration, with a median of 2.8 (IQR 2.2-3.7) whereas without Jessie the level of frustration was greater, with a median of 21.9 (IQR 6.8-47.0). They were less anxious with a median of 3.3 (IQR 1.3- 7.2) compared to a median of 10.9 (IQR 8.1-13.4) without Jessie, and less angry in comparison to 13.5 (IQR 0-33.9) without Jessie.

Table 6.18 displays the results of the statistical test to compare the affective states between the groups without Jessie and with Jessie. The affective profile selected in this study includes the affects of: disengagement, encouragement, frustration, interest, anxiety, happiness, guidance, and anger because they are considered relevant in autism intervention practices (Dautenhahn &Werry, 2004). Table 6.18 reveals that the guidance of Jessie to help the autistic child to calibrate his/her emotions during the mathematical activity entailed a significant difference for the affects of encouragement between the groups (WRS test, S=57.0, p=0.002), frustration (WRS test, S=19.5, p=0.05), and guidance (WRS test, S=51.5, p=0.04). A one-sided WSR test on the affect of anxiety revealed a significant difference between the groups (WRS test, S=27.0, p=0.03), with a distribution with higher values for the group with Jessie. Similarly, for the affect of anger, a one- sided WSR test revealed a significant difference between the groups (WRS test, S=29.0, p=0.05).

6.12.4. Comparison of affective states (N=11)

This part of the analysis excludes participant #5 who scored 100% at the quiz, as previously explained. Figure 6.34 shows the box plots of affective states with data points obtained for each participant during the interactive quiz between groups.

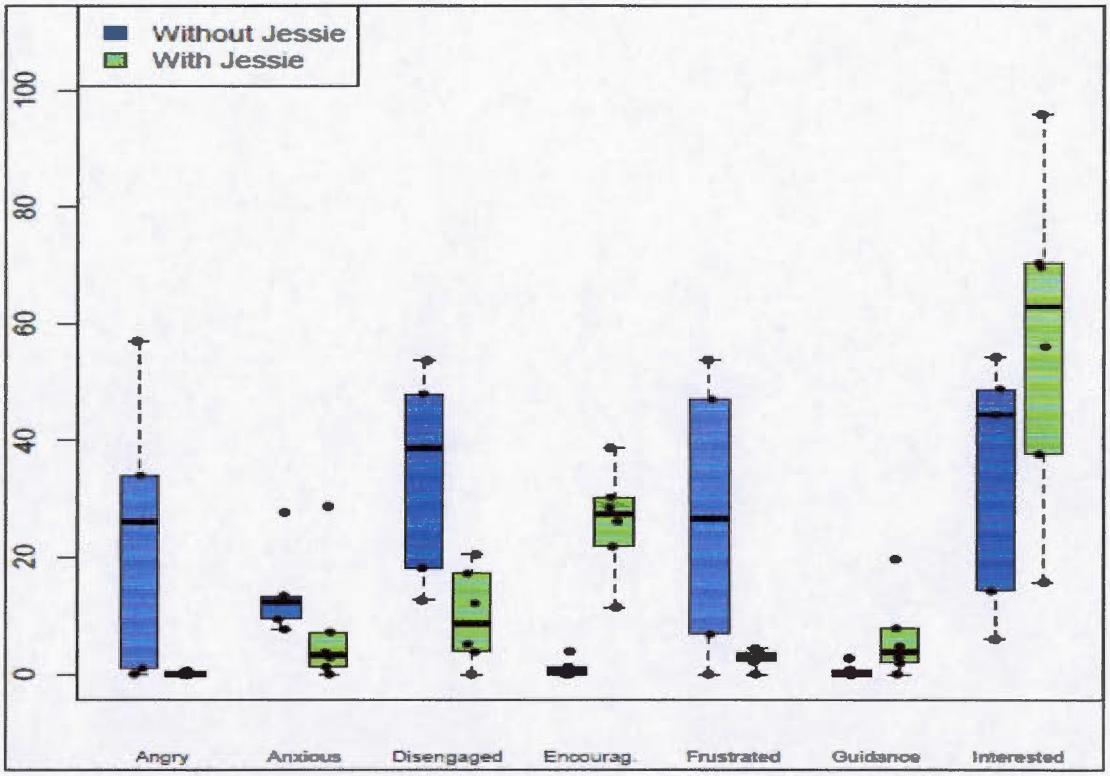

Figure 6.34 Box plots of affective states with data points (N=11)

Table 6.19 shows the medians and inter-quartile range (IQR) of the affective states per group based on average differences for every affective state of each participant for both groups with and without Jessie during the mathematical activity. We believed that the affective states of participant #5 would be different from the remaining participants. As presented below, by excluding this participant, the statistical results indicated that participants who benefited from the help of the pedagogical agent Jessie were more encouraged, with a median of 27.3 (IQR 21.8-30.2), and more Interested, with a median f 62.9 (IQR 37.6-70.4).

Table 6.19

Affective states: With and Without Jessie (N=11)

Inter-Quartile Range (IQR)

Affective State	Version	N	Median	IQR[45]
Disengagement	Without Jessie	5	38.7	18.1-47.9
	With Jessie	6	8.6	3.8-17.2
Feedback	Without Jessie	5	4.1	3.7-4.5
	With Jessie	6	3.2	2.6-9.2
Encouragement	Without Jessie	5	0.3	0-1.2
	With Jessie	6	27.3	21.8-30.2
Frustration	Without Jessie	5	26.6	6.8-46.9
	With Jessie	5	2.8	2.2-3.7
Interest	Without Jessie	5	44.4	14.2-48.8
	With Jessie	6	62.9	37.6-70.4
Anxiety	Without Jessie	5	12.3	9.4-13.4
	With Jessie	6	3.3	1.3-7.2
Guidance	Without Jessie	5	0.1	0-0.7
	With Jessie	6	3.8	2.0-7.8
Joy	Without Jessie	5	0	0-4.7
	With Jessie	6	0	0-0.3
Calmness	Without Jessie	5	0	0-0
	With Jessie	6	0	0-0
Anger	Without Jessie	5	26.0	1.0-33.9
	With Jessie	6	0	0-0.3

They displayed less negative behaviour such as disengagement, with a median of 8.6 (IQR 3.8-17.2). They were less frustrated, with a median of 2.8 (IQR 2.2-3.7), whereas without Jessie, the level of frustration was greater, with a median of 26.6 (IQR 6.8-46.9). The participants were less anxious, with a median of 3.3 (IQR 1.3-7.2), compared to 12.3 (IQR 9.4-13.4) without Jessie, and less angry in comparison to 26.0 (IQR 1.0-33.9) without

[45] IQR=Inter-Quartile Range = 25% percentile – 75% percentile

Jessie.

Table 6.20 reveals that the support of Jessie to help the autistic child to calibrate his/her emotions during the mathematical activity had a significant difference for the affects of disengagement (WRS test, S=42.0, p=0.03), encouragement (WRS test, S=15.0, p= 0.004), and anger with (WRS test, S=51.0, p=0.04). A one-sided WSR test on the affect of frustration revealed a significant difference between the groups (WRS test, S=19.5, p=0.05), with a distribution with higher values for the group with Jessie. Similarly, for anxiety, a one-sided WSR test would show a significant difference between the groups (WRS test, S=40.0, p=0.04). Also, for guidance, a one- sided WSR test would show a significant difference between the groups (WRS test, S=20.0, p=0.04).

Table 6.20

Affective states: With and Without Jessie (N=11)

Test-Statistics

Affective State	Test-Statistic	P-value
Disengagement	42.0	0.03
Feedback	31.0	0.93
Encouragement	15.0	0.004
Frustration	19.5	0.10
Interest	21.0	0.13
Anxiety	40.0	0.08
Guidance	20.0	0.08
Joy	31.5	0.84
Calmness	33.0	0.45
Anger	41.0	0.04

6.13. Analysis of affect detection technologies

6.13.1. Comparison of affective states using observations with FaceReader

The next section illustrates the differences in affective states from data gathered using FaceReader. This technology automatically analyzes seven basic facial expressions such as happy, surprised, disgusted, angry, scared, sad, as well as neutral. As shown in Figure 6.35, the students who benefited from the help of the pedagogical agent Jessie displayed more positive affective states relevant in this research, such as happiness.

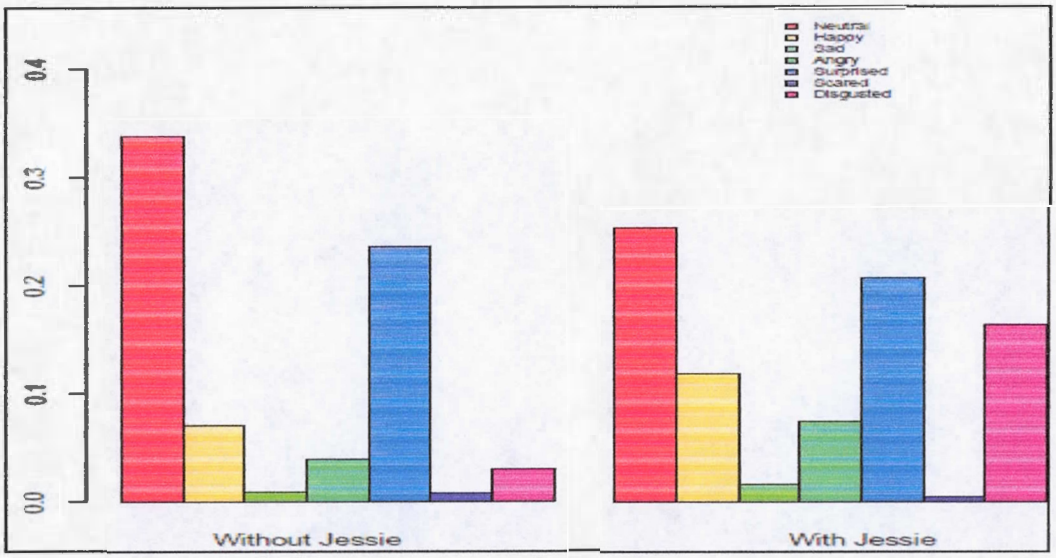

Figure 6.35 Differences between groups using Face Reader

Table 6.21 presents the results of the statistical test to compare the groups in terms of affective states obtained with FaceReader. Neutral and disgusted affective states show differences between the groups where the group without Jessie is higher. As reported in Table 6.21, the exact WSR test displays no difference in the distributions of affective states between the groups. Perhaps, the differences in affective states with FaceReader may be due to the child not looking at the screen (moving his/her head around) or when he/she was disengaged while performing the activity at hand.

As previously explained, in FaceReader the state values are computed as an estimation of the affective state of the subject, based on amplitude, duration, and continuity. As a result, each time that the affective state of the learner changes, a record is then written in the state log file to show the latest emotional response.

Table 6.21

Affective states using FaceReader: With and Without Jessie

Affective State	Test-Statistic N=12	Test-Statistic N=11	P-value N=12	P-value N=11
Neutral	31.0	37.0	0.24	0.25
Happiness	41.0	29.0	0.81	0.93
Sad	43.0	26.0	0.58	0.54
Anger	46.0	25.0	0.30	0.42
Surprise	32.0	35.0	0.30	0.43
Scare	37.0	29.0	0.81	0.93
Disgust	51.0	20.0	0.09	0.08

6.13.2. Differences between groups using observations with ObserverXT

The next step consisted in measuring the differences in affective states from data gathered using Observer XT. Table 6.21 presents the results of the statistical test in order to compare the groups in terms of affective states obtained with Observer XT.

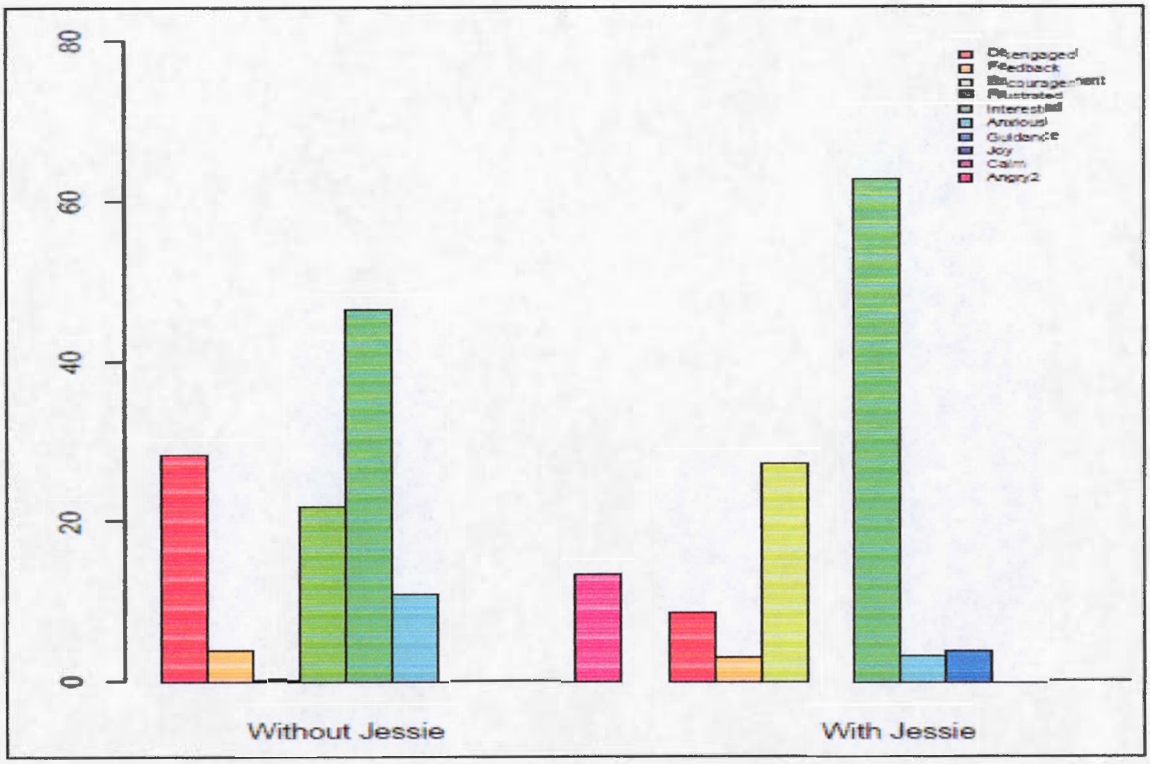

Figure 6.36 Differences between groups using Observer XT

As shown in Figure 6.36, the presence of the pedagogical agent Jessie significantly eased the affective states, consequently increasing the children's performance in the understanding and practice of their knowledge in mathematical learning. The students that benefited from the help of the pedagogical agent Jessie were more encouraged and displayed less negative affective states such as anxiety, anger, frustration, and disengagement. They were more encouraged and motivated to perform the mathematical activity.

6.14. Conclusion

In this research, we have conducted a study using a prototype of ISLA consisting of two main experiments that implemented Jessie as a pedagogical agent. The Wizard of Oz experiments involved twelve participants with high functioning autism among which, one control group of six students interacted without the pedagogical agent Jessie under the supervision of a specialized educator, while the test group of six participants interacted with the pedagogical agent Jessie under the supervision of a specialized educator.

The statistical analysis[46] was based on two important questions. In the first question, we measured the relationship between support and performance dealing with the score of each participant for both groups with and without Jessie during the mathematical activity. In the second question, we measured the affective state per group based on average differences for every affective state of each participant for both groups with and without Jessie.

In order to validate the first question mentioned above, the statistical analyses were performed for N=12 participants and for N=11 participants for both groups with and without Jessie. For the group with N=12 participants, the results were not statistically significant on raw scores and competency score between the groups. However, for the group with N=11, we observed that when the possible outlier was removed from the group without Jessie, the competency scores revealed a moderate statistical difference between the groups in a two-sided statistical test (p=0.08). In fact, a one-sided WSR test on competency scores revealed a significant difference between the groups (p=0.04), with a distribution of higher values for the group with Jessie.

In the second question, the analysis dealt with the affective state per group for every affective state of each participant in both groups with and without Jessie. For the group with N=12 participants, our findings showed that the support of Jessie helped the autistic child to calibrate his/her emotions during the mathematical activity, entailing a significant difference for the affects of encouragement (p =0.002), frustration (p =0.05), and guidance (p=0.04). Furthermore, a one-sided WSR test revealed a significant difference regarding the affect of anxiety (p=0.03), and the affect of anger (p=0.05). For the group with N=11 participants, when one participant was excluded from the analysis because the score of this subject was a possible outlier. The findings revealed that the support of Jessie to help the autistic child to calibrate his/her emotions during the mathematical activity entailed a

[46] See Appendix M

significant difference for the affects of disengagement (p=0.03), encouragement (p=0.04), and anger (p=0.04). Also, a one-sided WSR test revealed a significant difference between the groups for the affect of frustration (p=0.05), for anxiety (p=0.04), and guidance (p=0.04).

The findings in this study indicate that the majority of participants in the group without Jessie did not complete the quiz, with the exception of the participant who scored 100% on the quiz. The majority of participants did not succeed on the quiz according to his/her level of competency **without** the use of a pedagogical agent to provide support and encourage motivation during the mathematical activity.

The results of this research reveal that **the majority of participants benefited from the personalization and support provided by the pedagogical agent Jessie**, which aimed at helping the autistic student become self-regulated by calibrating his/her emotions and encouraging motivation during the mathematical activity. In this group, all children were able to succeed on the quiz according to his/her level of competency.

In the next chapter, we will be presenting the conclusion, the contributions in terms of cognitive sciences and technology, as well as, the limitations and lessons learned during this research.

CHAPTER VII

CONCLUSION

Autism is a neurological disorder affecting the way the brain processes information which can affect all aspects of the development of a person. The Autistic Spectrum Disorders (ASDs) are characterized by impairments in language and communication, in social interaction, in imaginative ability as well as by repetitive, and restricted patterns of behavior.

In this research, we proposed an affective intelligent tutoring system in the field of specialized education to overcome the lack of individualized intervention in mathematical learning. The affective intelligent tutoring system (ISLA) is an adaptive application evolving along with the learner's needs. In the educational system, the lack of one-on-one intervention as it pertains to the domain of specialized education related to autism poses a "complex multi-factor" problem. Emotions and learning have been broadly recognized as challenging among individuals diagnosed with autism.

7.1. The contributions

7.1.1. Technology Contribution

From a technological point of view, this research contributes to the advancement of intelligent tutoring systems in different ways.

I propose an affective intelligent tutoring system ISLA in the field of specialized education to overcome the lack of individualized intervention such as in the education of individuals with an autism spectrum disorder (ASD).

ISLA is unique in the field of AITS. I introduced the concept of ***model of accompaniment*** to help the autistic learner to manage his/her emotions by analyzing the learning trace and considering the student's cognitive profile to help the ASD learner to calibrate his/her emotions and complete the activity at hand.

The design of ISLA entails a pedagogical engineering approach in the domain of specialized education. Competencies are at the heart of the domain model of ISLA. In this study, we have considered various competencies for the acquisition of several skills associated with knowledge in mathematics from different domains such as the cognitive and the affective domains among children with autism.

Through the incorporation of aspects of the accompaniment model, ISLA supports and integrates the domain and learner models with the intention of delivering individualized instruction in real-time as "effective" as one-on-one human instruction in specialized education. The architecture of ISLA provides a three-dimensional view that allows to personalize the interaction of the three core models of ISLA. That is, by combining a domain model point of view (by providing tools to manipulate domain objects), an accompaniment model point of view through Jessie (companion agent), and a learner model point of view using an open-learner modeling approach, the architecture of ISLA enables to promote "reflection" and "planning" in order to help the ASD student to "mirror" his/her own learning.

7.1.2. Cognitive Contribution

From a cognitive point of view, the socio-cognitive and behavioral problems experienced by individuals with ASD stem from the difficulty in understanding others' mental states (Baron-Cohen, Leslie et al., 1985, Frith & Frith 1999). The lack of joint attention displayed by individuals with ASD is regarded as a necessary "precursor" to a "developmental building block" (Tomasello, 1995). Thus generalization of gains is difficult to maintain for children in the spectrum (Green, Charman et al., 2010).

The pedagogical model of ISLA entails a "behavioral" approach to cognitive diagnoses in which tasks are assigned in a predetermined sequence. The learner must finish a task before progressing to the next phase, increasing the chance that the ASD student has mastered the prerequisites of the task. The learner model of ISLA deals with the "clinical profile of the learner" personalized to the student and involves two important processes. The first process deals with the "affective process of the learner," and the second one deals with the "cognitive process of the learner."

As it pertains to the teaching of autistic children, the affective impairments of individuals within the spectrum have been recognized as having an important impact on intervention (Seip, 1994). To promote motivation, social rewards, promptings, and different types of feedback are suggested to the student by the pedagogical agent Jessie such as color-based flag feedback indicating the correctness of the answer, and text messaging related to the error made by the student. Furthermore, if the ASD student needs help, hints are provided by Jessie inviting the ASD learner with prompting to try again to complete the task at hand.

Pedagogical scenarios are also used by ISLA. The purpose of the pedagogical scenario is to familiarize the learner with the training process by helping the student mirror his/her own learning course according to his/her level of competency in addition.

In ISLA, we introduced the personalized intervention plan, along with educational learning activities and teaching techniques to best meet the student's learning needs.

In ISLA, we introduced, The Parental Assessment Questionnaire in mathematics in specialized education (PAQ-SE)

ISLA is able to help the learner develop competencies in addition at different levels: beginner, intermediate, advanced, and mastery. For example, at an intermediate level, if the learner made an error related to carrying and writing 1's and 10's, then he/she is expected to be able to analyze, utilize, and correct his/her learning trace without prompting. The list of errors is incorporated into the domain model and is related to the model tracing of the system. The objectives regarding the use of error analysis in ISLA is important because it helps to identify the patterns of mistakes that ASD students make in their exercises. Second, it provides information as to why the student made the errors, and finally, it presents targeted instruction to help the student to correct and understand the errors.

7.2. Limitations, lessons learned, and future research

7.2.1. Limitations

Our initial goal was to have twenty children. However, due to time constraints and some administrative difficulties dealing with the certificate of ethics, and the parents' consent forms, twelve children with high functioning autism participated in this research. One control group made up of six students interacted without the pedagogical agent Jessie, while the test group of six participants interacted with the pedagogical agent Jessie.

Some individuals with ASD can have profound cognitive deficiencies and behavior issues. Consequently, the second limitation of this study was that the participants recruited were high functioning autistic children without mental retardation in order for it to be possible to use a standardized training method during the intervention.

In addition to this limitation, the groups were heterogeneous for the two experiments with and without Jessie in terms of age which varied from 6 years to 12 years old. Also, the level of competency had a limitation, especially in the group without Jessie where one participant scored 100% on the quiz. Perhaps with a larger group of participants, and more time to experiment, we would have the opportunity to perform the baseline and to group the children according to their level of competence and age.

7.2.2. Lessons learned

It is important to thank the parents for their insightful comments and for believing in this research.

For most parents, predicting their autistic children's score in mathematics proved to be challenging. According to these parents, the challenges in mathematical learning were related to their children's behavioural issues, lack of focus, lack of concentration, anxiety, and frustration. For instance, one parent said: "To work on mathematics, it depends on his mood." Another parent replied "Il n'aime pas les maths." Despite these challenges, it is important to mention that all parents believed that their children could do better with the appropriate tools. They wanted to know their child's level of competency and score. At the end of the intervention, I met with the parents and based on my observations, I provided them with recommendations on how to improve their children's mathematical skills in addition, along with the errors made and affects expressed while performing the quiz.

Parents were enthusiastic in participating in this research because it was innovative. They appreciated my feedback and the fact that the mathematical activity was presented as an interactive game rather than through a printed test. Also, the feedback from them was positive and encouraging.

Children liked the game and the presence of Jessie was mostly appreciated. Some children waved their hand and smiled when Jessie appeared. At the end of the individualized intervention, and in the presence of the parents, children were rewarded for their success and their effort in playing the *Chalkboard Game* in mathematical learning. Difficulties with carrying 1s', 10s', and 100s' were observed for intermediate and advanced ASD students. I observed that beginner students had difficulties with discriminating and writing numbers. All children had difficulty with problem-solving in addition. Even the participant in the first group, without Jessie, who performed with a score of 100%, hesitated during the problem-solving part of the quiz.

As previously stated, self-regulated learning (SRL) is at the heart of the integrated specialized learning application ISLA. SRL refers to our ability to understand and control our learning environment and consists of three main components: cognition, metacognition, and motivation. These important SRL processes were targeted in this research through the use of the pedagogical agent Jessie by prompting and by providing feedback in order to calibrate the affective state of the autistic student. Two important patterns were found in this research. We believe that emphasis should be given to Jessie's reaction time to provide scaffolding feedback to the student, by anticipating negative behaviours such as disengagement, anxiety, and anger. For instance, in order to encourage and motivate the student, social rewards were used by Jessie within seconds by saying *Yes* *you did it, Awsome, Great job* when the right answer was provided. When the wrong answer was provided, Jessie would say *That was close*, or, *Try again*. This was done to hold the attention of the subjects.

7.3. Future research

Future research will be dealing with a full implementation of ISLA by reproducing what has been done according to the prototype experiments. A larger group of participants with high functioning autism will be interacting with the pedagogical agent Jessie, and the behavior of the pedagogical agent Jessie will be programmed so as to provide real-time support to help calibrate the affective state of the ASD learner. Children will be grouped according to different criteria such as age and competency level. They will be interacting with ISLA until the mastery level is achieved.

One important question stood out from this research as I investigated the relationship between support and performance in terms of raw scores and level of competency of each participant for both groups with and without Jessie during the mathematical activity. How do we measure the academic performance of an autistic child in a mathematical learning situation? Should it be measured according to his/her level of competency? Should it be measured as pertaining to a "neurotypical" child without special needs? This question will be for future research.

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APPENDIX A
ED214

The competencies of ISLA

ED 214

Public Cible : ASD Learner

Énoncé de la compétence visée	Competency Domain	Skills associated	Actual skills
The learner should be able to analyse, represent and to solve problems implying addition with or without prompting.	Cognitif	6 Analyse	variable
The learner should be able to utilize and solve simple addition with or without prompting.	Cognitif	5 Utilize	variable
The learner should be able to correct simple additions with or without prompting.	Cognitif	7 Correct	variable
The learner should be able to manage his/her motions in the process of learning addition with or without prompting.	Affective	7 Manage	variable
The learner is expected to explicit and illustrate his/her skills in a context of training with the affective intelligent tutoring system (ISLA) with or without prompting.	Cognitif	3 Explicit	Variable
The learner should be able to modify or adapt his/her emotions in a context of training with the affective intelligent tutoring system (ISLA) with or without prompting.	Affective	4 Modify	Variable

Annexe 1 : Barème pour le niveau de compétence

Taxonomie des habiletés (*Verbes d'action de référence dans la formulation d'une compétence*)

N	Habileté	Description	Exemples Domaine cognitif (c), affectif (a), social (s)
01	**Porter attention**	À ce niveau, l'apprenant est sensibilisé à l'utilité des connaissances concernées et il y porte une attention.	**c- S'intéresser au problème du client** **a- Être touché par la qualité d'un discours** **s- Percevoir une situation tendue dans une négociation**
02	**Intégrer**, identifier, repérer, noter, mémoriser, se rappeler	À ce niveau, l'apprenant a la capacité de mémoriser, d'identifier, de repérer, de noter les informations ou les éléments d'une situation.	**c- Retenir en mémoire des faits** **a- Reconnaître son état de stress** **s- Prendre note d'une façon de travailler en groupe**
03	**Instancier**, **préciser**, illustrer, discriminer, expliciter	À ce niveau, l'apprenant a la capacité de préciser (expliciter), d'illustrer par des exemples les informations ou les situations. Il peut aussi les différencier (discriminer) les unes par rapport aux autres.	**c- Préciser une procédure en donnant un exemple** **a- Distinguer une blague d'une attaque verbale** **s- Décrire au participant son rôle dans le groupe de travail**
04	**Traduire, transposer**	À ce niveau, l'apprenant est capable de reproduire, sous une même forme ou une autre forme, des informations ou des comportements face à des problèmes ou situations de même nature	**c- Mettre par écrit les idées présentées oralement** **a- Ajuster son comportement à partir d'une situation semblable** **s- Animer un groupe dans une situation semblable à une autre déjà vécu**
05	**Utiliser**, simuler	À ce niveau, l'apprenant utilise ou simule fidèlement les connaissances conceptuelles, procédurales ou stratégiques en cause.	**c- Utiliser une procédure connue** **a- Calmer son angoisse par une technique connue** **s- Simuler une technique connue de gestion de crise**
06	**Analyser**, déduire, classifier, prédire, diagnostiquer	À ce niveau, l'apprenant produit à partir de sa capacité d'analyse et de déduction. Il peut classifier, prédire des situations, faire des diagnostics et fournir des explications cohérentes.	**c- Déduire les objectifs, les données et les contraintes d'un type de problème** **a- Prédire ses états émotifs face à un problème** **s- Analyser la dynamique d'une négociation**
07	**Réparer**, adapter, corriger, modifier	À ce niveau, l'apprenant démontre dans de nouvelles situations qu'elle peut adapter les connaissances avec un minimum d'aide. Il peut être créatif dans sa façon de corriger un problème ou modifier des façons de faire.	**c- Corriger certaines lacunes d'une procédure. Trouver un terrain d'entente.** **a- Modifier sa réaction émotive dans une situation tendue pour réduire son stress** **s- Améliorer le climat d'une médiation difficile**
08	**Synthétiser**, induire, planifier, modéliser	À ce niveau, l'apprenant produit à partir de sa capacité de synthèse. Il peut planifier des processus, induire des conclusions ou communiquer adéquatement à partir modèle.	**c- Construire un plan de solution** **a- Développer une nouvelle attitude en entrevue** **s- Trouver une façon de faire progresser un groupe**
09	**Évaluer**	À ce niveau, l'apprenant a la capacité d'évaluer les situations, de porter des jugements selon son expertise. Il peut aussi déterminer de la pertinence ou non de son expertise en fonction des besoins du client	**c- Évaluer le bien-fondé d'une argumentation** **a- Évaluer son niveau de stress dans une discussion tendu** **s- Déterminer l'efficacité de notre collaboration dans une situation de partage de juridiction**
10	Initier, influencer, s'adapter, contrôler, gérer, auto-contrôler, **auto-gérer**	À ce niveau, l'apprenant démontre une manifestation sociale (initie, influence, gère). Il a la capacité d'expliquer les règles et heuristiques propres à son domaine ainsi que la capacité de réflexion sur son propre processus	**c- Orienter judicieusement un client. Enseigner sa démarche** **a- Contrôler ses attitudes émotives dans un groupe** **s- Prendre sur soi d'améliorer un climat social tendu**

Annexe 1 : Barème pour le niveau de compétence

Critères de performance										
A-Fréquence		*B-Couverture*		*C-Autonomie*		*D-Complexité*			*E-Contexte*	
À l'occasion	De façon constante	Partielle	Totale	Avec assistance	Sans aide	Faible	Moyenne	Forte	Familier	Nouveau

Le « critère de performance » consiste à définir si l'habileté (la compétence) peut s'appliquer à la connaissance dans une :

- façon guidée ou autonome
- façon complète ou partielle
- façon régulière ou irrégulière
- situations simples ou complexes
- situations familières ou nouvelles

Qui correspond aux niveaux suivants

Indicateur de performance pour une compétence (habileté)		**Le niveau débutant** (sensibilisation) **0.0 - 2,5**	**Le niveau intermédiaire** (familiarisation) **2.5 -- 5.0**	**Le niveau Avancé** (maîtrise) **5.0 - 7.5**	**Le niveau expert** (expertise) **7.5 - 10.0**
Description sommaire		Un apprenant peut exécuter une compétence seulement si guidé, partiellement et irrégulièrement, dans des situations simples et familières	Un apprenant peut exécuter une compétence dans une façon autonome, partielle et régulière, mais toujours dans des situations familières simples.	Un apprenant peut exécuter une compétence dans une façon autonome, régulière et complète, dans des situations plus complexes mais familières	Un apprenant peut exécuter une compétence dans un autonome, achever et la façon régulière, dans des situations complexes aussi bien que nouvelles.
Façon (Comment)	**de guidée à autonome**	Guidée	**Autonome**	Autonome	Autonome
	Irrégulière à régulière	Irrégulière	**régulière**	Régulière	Régulière
	De partielle à complète	Partielle	Partielle	**Complète**	Complète
Situation (quand, dans quelle condition)	**Simple à complexe**	Simple	Simple	**Complexe**	Complexe
	Familière à nouvelle	Familière	Familière	Familière	**Nouvelle**

Annexe 1 : Barème pour le niveau de compétence

Généralement (pas toujours) les **objectifs d'apprentissage** sont formulés sans précision sur le contexte ou la performance impliquée. Par exemple, "Connaître la mécanique automobile" peut être l'objectif du cours ou d'une leçon. Cette formulation est imprécise et peu opérationnalisable : "connaître" à quel point et dans quel contexte? Au point de l'appliquer, de l'analyser, de l'enseigner? D'où l'utilité de transposer (ou reformuler) les objectifs d'apprentissage en terme de compétence visée utilisant un verbe d'action relatif à une taxonomie d'habileté (classée selon une complexité progressive dans les domaines cognitif, affectif ou psycho-moteur). De plus la formulation d'une compétence observable et mesurable implique d'ajouter les critères de performance attendus (contexte d'application de l'habileté concerné). Par exemple, l'objectif de "Connaître la mécanique automobile" pourrait se préciser par la compétence suivante: Appliquer les principes de la mécanique automobile, avec ou sans aide selon la complexité de la mécanique impliquée.

Cette façon de faire, plus précise, permet une **évaluation** observable et mesurable de la réussite ou non de la compétence.

Dans l'ensemble, les formations centrées sur le formateur conviennent d'avantage aux compétences impliquant des habiletés de bas niveaux dans l'échelle (de 1 à 10) des habiletés, proposée dans MISA. Plus on progresse dans l'échelle des habiletés, l'atteinte des compétences visées sera favorisée par une approche de plus en plus centrée sur l'apprenant.

Bien sur, il faut aussi tenir compte : du contexte d'application de la compétence ; des particularités des apprenants telles que l'autonomie et la motivation ; des besoins d'apprentissage, un écart important impliquant souvent une formation progressive dans l'échelle des habiletés ; du mode de diffusion prévu.

Par exemple, l'atteinte de la compétence "Appliquer les principes de la mécanique automobile, avec ou sans aide" implique une participation importante de l'apprenant, possiblement supervisée par le formateur. Si le contexte implique "sans aide", la présence du formateur devrait forcément être plus discrète. Si l'écart entre l'habileté actuelle et visée est important, il faudra prévoir des activités pédagogiques intermédiaires visant des habiletés de "reproduction" où la présence du formateur sera importante. Une faible autonomie ou motivation des apprenants implique une aide particularisée du formateur. De plus, si le mode de diffusion est à distance, cela implique que la formation sera forcément d'avantage centrée sur l'apprenant.

APPENDIX B
ED102

Objectifs de la formation (ÉD 102)

A- Objectifs généraux et priorités de formation	
Objectifs généraux	Enseigner l'opération mathématique impliquant l'addition allant jusqu'au 100 chez les personnes ayant en Trouble Envahissant de Développement (TED) à l'aide d'un système tutoriel intelligent affective (ISLA).
Priorités	- Favoriser l'analyse, et l'adaptation des techniques dans un contexte de l'enseignement spécialisé afin d'aider l'apprenant à trouver les meilleures solutions pour un type de problème mathématique. - Favoriser l'application des principes de l'addition dans une situation d'apprentissage de mathématiques chez les personnes ayant en Trouble Envahissant de Développement (TED). - Représenter et résoudre des problèmes impliquant l'addition dans une situation d'apprentissage de mathématiques chez les personnes ayant en Trouble Envahissant de Développement (TED)

B- Date de livraison du SA	08/15

C- Durée de vie du SA (*d'ici la première révision majeure*)	
Matériels	> 2 ans
Outils	1 à 2 ans
Moyens de communication	1 à 2 ans

D- Orientations générales du SA	
Ampleur du futur SA	
Cours intensifs	12 semaines (cours)
Secteur de formation	
Formation en milieu de travail	Niveau primaire de 1er cycle
Type d'action de formation	
Type d'intervention	---
Types de modèles des connaissances	Conceptuel, prescriptifs
Domaines de compétences visées	Cognitif, Émotionnelle
Certification avec un seul examen	Exclue
Certification avec contrôles cumulatifs	Possible
Collaboration des apprenants en présence	Exigée

Objectifs de la formation (ÉD 102)

Collaboration des apprenants par télématique	-----
Assistance d'un formateur	Assistance de l'intervenant
Assistance informatisée	Système Tutoriel Intelligent
Modes de diffusion	
Autoformation	Possible
Formation en classe	Possible
Formation synchrone à distance	Possible
Formation asynchrone à distance	Possible
Canal de communication	
Communication postale/téléphonie/ télécopie	Possible
Communication par radio/télévision	---
Communication télématique	---
Matériels	
Matériel multimédia (informatisé)	Matériel didactique sous forme de jeux pour favoriser l'apprentissage et la manipulation de chiffres allant jusqu'au le chiffre 100.
Matériel unimédia (informatisé)	Possible
Matériel audiovisuel (non informatisé)	Vidéo pour favoriser la formation avec ISLAA.
Matériel texte et/ou/image fixe	Matériel didactique pour favoriser l'apprentissage et la manipulation de chiffres allant jusqu'au le chiffre 100.
Matériel à composantes physiques	Matériel didactique sous forme des exercices pour favoriser la compréhension des centaines, dizaines et unités afin de favoriser la manipulation de chiffres allant jusqu'au le chiffre 100.

APPENDIX C
ED104

Publics cibles (ÉD 104)

Nom du public cible	Apprenant	
Définition	Enfant ayant des Troubles Envahissantes de Développement (TED) sans déficience cognitive visant l'apprentissage de "Mathématique – 1 premier cycle" dans le système d'éducation régulière.	
Nombre	1 à 1	
Lieux de formation	A l'école, en clinique	
Langues de formation requises	**Français:**	80%
	Anglais:	80%
	Autre:	0%
Disponibilité	**Temps plein:**	60% - au rythme de l'enfant
	Temps partiel:	40% - au rythme de l'enfant
	Irrégulier:	0%
Scolarité moyenne	**Dernière scolarité complétée:**	Primaire
Attitudes générales	**Le contenu du cours (intérêt):**	Positive
	L'apprentissage en général:	Positive
	Les technologies de l'information:	Positive
	Motivation:	Positive : En utilisant les théories de l'auto régulation (Self-Regulation Learning - SRL) chez l'enfant TED.
	La collaboration entre apprenants:	Positive
	Autonomie:	Neutre
Autres caractéristiques	**Les handicaps physiques:**	TED sans déficience cognitive
	La culture:	École primaire
	Le style d'apprentissage:	Avec l'aide du système tutoriel intelligent émotionnel ISLA et l'accompagnement de l'éducatrice spécialisée au besoin.
	Le stade de développement cognitif:	Enfant TED sans déficience cognitive ayant indépendamment de leur âge un développement au niveau mathématique correspondant à des élèves de la 1^{er} année primaire.

APPENDIX D
ED106

Contexte actuel (ÉD 106)

		Jessie	
Locaux		Fournit	
Mobilier		Fournit	
Fournitures		Fournit	
Site WEB		Plan du cours, ressources en ligne	Codes d'accès requis pour accéder aux ressources.

Financières

Ressources	Montant $	Description	Contraintes
Budget de conception	1,500	5 jours à 300$/j	
Budget de médiatisation	300	5 jours à 300$/j	
Budget de diffusion	1,500	5 jours à 300$/j	

Organisationnelles

Ressources	Description	Contraintes
Distribution du matériel	Parmi l'équipe multidisciplinaire	
Gestion des formateurs	Au besoin	
Rétroaction	Des différents experts du domaine.	- Partager une vision commune.
Certification	------	
Validation, révision, maintenance du SA	Des différents experts du domaine.	ISLA doit être validés par des experts dans le domaine de Trouble Envahissants de Développement (TED). La validation du système consiste en deux étapes. La première partie concerne une période de formation afin de familiariser l'étudiant TED avec le système tutoriel intelligent ISLA. La deuxième partie vise la validation et l'utilisation de l'agent pédagogique de l'application ISLA afin de fournir l'aide efficace à l'étudiant pendant le processus d'addition, en établissant l'état émotif de l'apprenant autiste.
Lieux de formation	École, clinique	

Contexte actuel (ÉD 106)

Autre		

C - Recommandations quant à l'opportunité du projet

Facteurs de risque

- ISLA est unique. La résistance au changement par l'utilisation des nouvelles technologies au domaine de l'éducation spécialisée.

Conditions de la réussite

- Formation efficace de l'éducatrice spécialisée.
- Formation efficace de l'apprenant.
- Concertation efficace entre l'éducatrice spécialisée et les experts multidisciplinaire.
- L'adaptation des experts à cette nouvelle approche.
- La validation du système lors de la réalisation et l'implémentation du système.

Recommandations

- Il faut favoriser la rétroaction positive face aux techniques d'apprentissage essai-erreur chez l'apprenant.
- Le travail en équipe.
- L'écoute et l'objectivité de l'éducatrice spécialisée.

APPENDIX E
The Quiz

Interactive Quiz

How much?

1)	2)	3)	4)
		5	7
		+ 3	+ 5
6	15	8	12

5)	6)	7)	8)	9)
17	38	51	75	327
+ 2	+ 9	+16	+ 19	+ 22
19	47	67	94	349

10)	11)	12)	13)	14)
588	267	588	958	234
+ 96	+ 122	+109	+ 172	+ 76
684	389	697	1130	310

15) 16) 17) 18) 19)

$$\begin{array}{r} 223 \\ +\ 92 \\ \hline 315 \end{array} \qquad \begin{array}{r} 99 \\ +\ 1 \\ \hline 100 \end{array} \qquad \begin{array}{r} 464 \\ +46 \\ \hline 510 \end{array} \qquad \begin{array}{r} 333 \\ +267 \\ \hline 600 \end{array} \qquad \begin{array}{r} 655 \\ +562 \\ \hline 1217 \end{array}$$

20)

Annie won 356 points in a race contest. Sebastian earned 278 points. How many points do they have together?
Answer: 634 points

21)

Allison earned 645 dollars during her first month of work. She earned 356 dollars during her second and third month of work. How much money did Allison earn during the three months?
Answer: 1357 $

22) 7 + 8 = 15

23) 13 + 27 = 40

24) 123 + 287 = 410

25) 58 +19 = 77

26) 52 + 188 = 240

27) $\begin{array}{r} 24 \\ +266 \\ \hline 290 \end{array}$

28) $\begin{array}{r} 5003 \\ +388 \\ \hline 5391 \end{array}$

29) $\begin{array}{r} 5062 \\ +309 \\ \hline 5371 \end{array}$

30)
Mary Plays tennis. On Monday she practices 2 hours, Tuesday she practices 4 hours, she does not practice on Wednesday. On

Thursday and Friday she plays for 3 hours each. How many hours does she practice in all?
Answer: 12 hours

APPENDIX F
The detailed log for all participants using Face Reader

Detailed log for all participant Using Face Reader

Groupe	Participan	Neutral	Happy	Sad	Angry	Surprised	Scared	Disgusted	Others	Raw	Competency
With	#1	0.24928	0.18094	0.060381	0.035777	0.140665	0.037428	0.178287	8.2	63.333	86.363636
With	#2	0.21444	0.10521	0.010025	0.007536	0.381727	0.002422	0.182701	2.2	10	60
With	#3	0.43167	0.13085	0.004352	0.041378	0.213738	0.005052	0.021905	8.6	33.333	83.333333
With	#4	0.2582	0.02261	0.006064	0.192315	0.220238	0.009079	0.226781	3.9	36.667	91.666667
With	#5	0.2472	0.00734	0.024944	0.300294	0.09442	0.003437	0.150186	4.3	63.333	86.363636
With	#6	0.27683	0.16103	0.022555	0.106564	0.199973	0.000418	0.099732	2.6	66.667	90.909091
Without	#7	0.23441	0.04923	0.095827	0.068242	0.325561	0.002689	0.097876	0.3	56.667	77.272727
Without	#8	0.34162	0.09678	0.011104	0.09723	0.20283	0.003016	0.155212	1.4	63.333	86.363636
Without	#9	0.81864	0.07259	0.000579	0.004267	0.176373	0.000141	0.001532	0.6	26.667	66.666667
Without	#10	0.35293	0.23938	0.008381	0.005056	0.245717	0.013588	0.009019	4.2	6.6667	40
Without	#11	0.26927	0.06862	0.022004	0.011157	0.332157	0.049596	0.032563	8.4	100	100
Without	#12	0.33575	0.05888	0.001585	0.134825	0.226586	0.029233	0.026815	7.1	23.333	58.333333

APPENDIX G
The detailed log for all participants using Observer

Detailed log for all participant Using Observer XT

Groupe	Participan	Disengag	Feedback	Encourage	Frustrated	Interested	Anxious	Guidance	Joy	Calm	Angry2	Valenc	Arousa
With	#1	5.11799	9.14761	30.2005	2.18341	15.778	2.85445	0	0.0434	0	0	-0.198	0.5027
With	#2	17.1758	2.64786	11.439	2.78435	56.0623	0	19.6531	0	0	0.5221	-0.137	0.501
With	#3	12.094	2.44375	38.6723	0	69.6362	1.26735	4.78051	0.3405	0	0.2691	0.0663	0.4178
With	#4	3.77619	3.00712	21.791	4.37888	70.3474	28.6931	7.79834	0	0	0	0.207	0.5297
With	#5	0	3.30625	26.114	3.7173	37.627	7.15223	1.96231	0	0	0	-0.039	0.4641
With	#6	20.4437	10.1866	28.5209	#NULL!	95.8414	3.74237	2.89937	0.522	0	0	-0.131	0.4868
Without	#7	12.6139	3.70168	0.295061	46.9445	54.2377	7.6783	2.71591	8.2684	0	33.912	-0.09	0.43
Without	#8	38.6885	4.11897	0	6.79483	48.7937	12.3306	0.736758	4.6624	0	0.9889	-0.092	0.5023
Without	#9	53.6536	4.51321	1.21432	53.775	14.2277	9.42108	0.091074	0	0.68	57.044	0.0607	0.456
Without	#10	18.1276	1.11366	0	0	6.02208	27.6451	0	0	0	0	-0.338	0.4841
Without	#11	0.455757	0	0	17.1753	95.9074	8.08336	0	0	1.32	0	-0.446	0.3424
Without	#12	47.9376	4.64864	3.88612	26.5606	44.4236	13.382	0	0	0	26.042	-0.053	0.4717

Raw	Competency
63.333	86.363636
10	60
33.333	83.333333
36.667	91.666667
63.333	86.363636
66.667	90.909091
56.667	77.272727
63.333	86.363636
26.667	66.666667
6.6667	40
100	100
23.333	58.333333

APPENDIX H
The Parental assessment questionnaire in mathematics in specialized education (PAQ-SE)

Integrated specialized learning application (ISLA) to teaching first grade addition to high functioning children presenting autism spectrum disorder (ASD)

Date: ______________________________

Nom de l'enfant: _________________________ Nom du parent: ___________________________

Diagnostic : _____________________________ Age : ______________ Sexe : F ☐ M ☐

Questionnaire compétences en mathématique

1) Selon vous, quel est le niveau de compétences en mathématique de votre enfant? Cochez votre réponse.

   Débutant ☐ Intermédiaire ☐ Avancé ☐ Master ☐

2) Selon vous, quelles sont les difficultés que votre enfant pourrait réaliser lors d'une évaluation en mathématique tel que l'addition? SVP Expliquez brièvement.

   ____

   ____

3) Selon vous, quels sont les erreurs que votre enfant pourrait effectuer lors des évaluations en mathématique tel que l'addition? SVP Expliquez brièvement.

   ____

   ____

4) Selon vous, quel serait le score que vous pensiez que votre enfant pourrait avoir lors du premier quiz sans l'aide de l'agent pédagogique ISLA? SVP cochez votre réponse.

   40% ☐ 50% ☐ 60% ☐ 70% ☐ 80% ☐ 90% ☐ 100% ☐

5) Selon vous, quelles sont les récompenses que votre enfant pourrait apprécier pour ces efforts en mathématique?

   Social ☐ Alimentaire ☐ Jeux ☐

   Autres : ____

6) Selon vous, quel est l'état affectif que votre enfant pourrait manifester lors des évaluations en mathématique tel que l'addition? SVP cochez votre réponse.

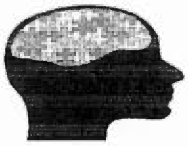
   Frustration ☐ Anxiété ☐ Intérêt ☐ Heureux ☐

   Autres : ____

Merci de votre participation

APPENDIX I
The intervention protocol with and without Jessie

Integrated specialized learning application (ISLA) to teaching first grade addition to high functioning children presenting autism spectrum disorder (ASD)



Intervention Protocol
(With the pedagogical agent Jessie)

Domain: Teaching addition

Objective: To measure the affective states of an autistic student such as frustration, happiness, anxiety, and motivation during a learning mathematical situation such as addition with the help of the virtual pedagogical agent Jessie. To provide real-time feedback to the student.

Program: A baseline measure of performance of each student is used through an interactive quiz using the application ISLA consisting of thirty additions. The additions in the quiz are presented one at a time to the student, and are grouped in four different levels of competencies: beginner, intermediate, advanced and master. The duration of the quiz is fifteen minutes.

Pre-requirements:
- The child should be able to use a keyboard.
- The child should be able to use a mouse.
- The child should be able to understand discriminative stimulus (DS) such as 3 word instructions from Jessie.
- The child should be able to read the help menu by the means of 'pop-ups', and 'hints' provided by Jessie.
- The child should be able to read problem solving.
- The child should be able to know how to solve additions by using a pencil and paper.

DS (instruction): 'Add these numbers'
When an addition exercise is prompted by ISLA, the student is expected to solve it accordingly to his/her level of competency in addition.

Material:
- Computer
- Keyboard
- Application of ISLA
- Mouse
- Paper
- Pencil
- Eraser

Incitation ('prompting'): For wrong answers, a help menu by means of 'pop-ups' and 'hints' are provided by Jessie:
- First trial: 'almost', 'nice try'
- Second trial: 'Try again'

- Third trial: 'Do you need help?' 'Click the help bottom'
- Use of pedagogical scenarios

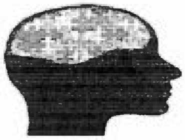
In the case that the student displays distress, frustration (cries, screams, kicks, etc.) while performing the activity at hand, the specialized educator stops the intervention immediately and calms the child down. The parents who are present are informed immediately.

Mistake corrections: Redo the exercise at hand with incitation by having Jessie provide the correct answer with real-time feedback. Jessie invites the student to try again.

Reinforcers:

- Verbal with Jessie (social continue, 'you did it', 'awesome', 'congratulations') for right answers.
- Verbal with Jessie (social continue, 'That one was tough' 'try again'.
- Cristal game points.
- Ludic activity such as game (tangible) at the end of the intervention.
- Edible (snacks if necessary) at the end of the intervention.

Integrated specialized learning application (ISLA) to teaching first grade addition to high functioning children presenting autism spectrum disorder (ASD)



Intervention Protocol
(Without the pedagogical agent Jessie)

Domain: Teaching addition

Objective: To measure the affective states of an autistic student such as frustration, happiness, anxiety, and motivation during a learning mathematical situation such as addition without the help of the virtual pedagogical agent Jessie. To provide real-time feedback to the student under the supervision of a specialized educator.

Program: A baseline measure of performance of each student is used through an interactive quiz using the application ISLA consisting of thirty additions. The additions in the quiz are presented one at a time to the student, and are grouped in four different levels of competencies: beginner, intermediate, advanced and master. The duration of the quiz is fifteen minutes

Pre-requirements:
- The child should be able to use a keyboard.
- The child should be able to use a mouse.
- The child should be able to understand discriminative stimulus (DS) such as 3 word instructions from Jessie.
- The child should be able to read the help menu by the means of 'pop-ups', and 'hints' provided by Jessie.
- The child should be able to read problem solving.
- The child should be able to know how to solve additions by using a pencil and paper.

DS (instruction): 'Add these numbers'
When an addition exercise is prompted by ISLA, the student is expected to solve it accordingly to his/her level of competency in addition.

Material:
- Computer
- Application of ISLA
- Keyboard
- Mouse
- Paper
- Pencil
- Eraser

Incitation ('prompting'): No prompting is provided by the pedagogical agent Jessie.

In the case that the student displays distress, frustration (cries, screams, kicks, etc.) while performing the activity at hand, the specialized educator stops the intervention immediately and calms the child down. The parents who are present are informed immediately.

Mistake corrections: Redo the exercise at hand if the child desires to continue the quiz.

Reinforcers:
- Social continue, 'you did it', 'awesome', 'congratulations' for right answers
- Cristal game points
- Ludic activity such as game (tangible) at the end of the intervention.
- Edible (snacks if necessary) at the end of the intervention.

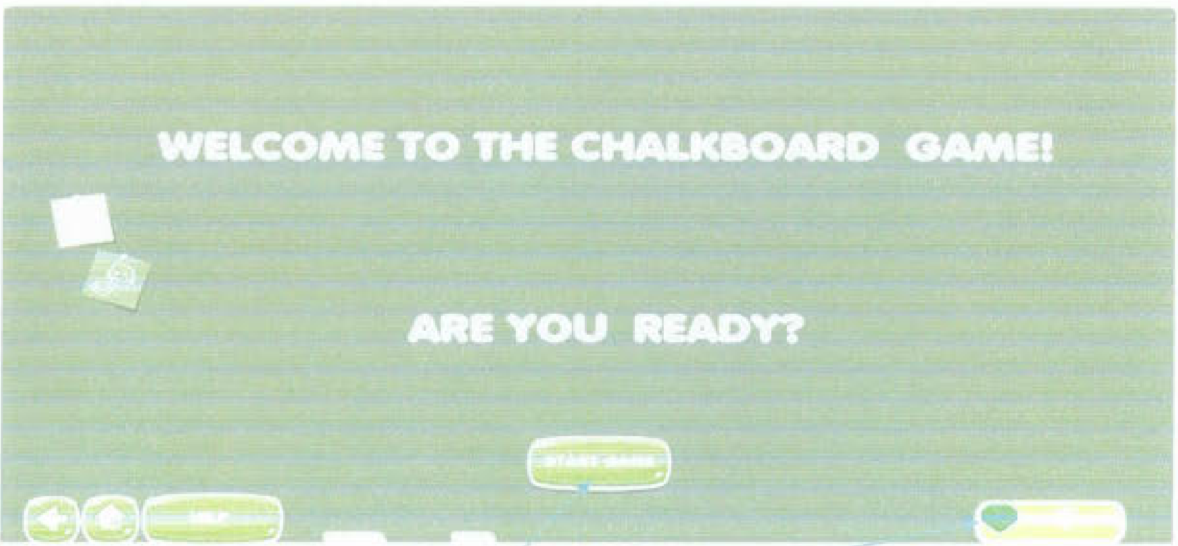
Schedule

1) Sit down

2) Write down the name of your favorite character in the white box

3) Click on the START GAME bottom

4) Welcome to the CHALKBOARD GAME



5) Explain: Notice the Green Diamond bottom on the right hand corner of the screen.

6) Explain: Try to answer the questions and you will win points for every good answer.

7) Explain: If you don't know the answer is fine.

8) Click on the START GAME bottom.

9) Explain: You ca use a pencil and paper.

10) Are you ready?

11) GO

Good luck

APPENDIX J
The parent's consent forms

Formulaire de consentement des enfants, complété par les parents

IDENTIFICATION
Responsable du projet : Aydée Liza Mondragon
Programme d'enseignement : Doctorat en Informatique Cognitive
Adresse courriel : aydeelizamondragon@gmail.com

Titre:
Application spécialisée intégrée pour l'apprentissage de l'addition chez les personnes ayant des troubles envahissants de développement de haut niveau.

Traduite de : *'Integrated specialized learning application (ISLA) to teaching addition to high functioning children presenting autism spectrum disorder (ASD)'.*

Recherche doctorale dirigée par :
M. Roger Nkambou et M. Pierre Poirier, Université de Québec à Montréal (UQÀM)

Description de la recherche et objectifs : Cette recherche contribue à l'avancement des systèmes tutoriels intelligents affectifs en proposant un modèle informatique pour surmonter le manque d'intervention individualisée dans le domaine de l'éducation spécialisée chez les personnes ayant des troubles envahissants de développement (TED). La question traitée est : pouvons-nous développer un compagnon virtuel capable d'établir l'état affectif d'un enfant autiste dans une situation d'apprentissage telle que l'addition et ainsi y répondre efficacement ? ISLA est une application adaptative dans le domaine de l'éducation spécialisée qui évolue avec les besoins de l'étudiant. ISLA est unique et sa contribution comporte le modèle d'accompagnement pour aider les enfants autistes à gérer leurs émotions en analysant la trace d'apprentissage de l'étudiant et de répondre en conséquence afin d'aider l'étudiant autiste à calibrer ses émotions dans une situation d'apprentissage de mathématique telle que l'addition.

Recrutement

L'échantillon de recherche est limité aux enfants ayant des troubles envahissants du développement de haut niveau pour nous permettre d'utiliser une méthode d'observation normalisée au sein d'une population d'enfants. Celle-ci est limitée à douze participants atteints du spectre de l'autisme, des garçons et des filles âgés de 6 à 12 ans, l'observation étant faite pendant une durée d'une heure, avec le consentement de leurs parents et sous la surveillance d'une éducatrice spécialisée, ceci dans le cadre d'une intervention structurée dans une situation d'apprentissage de mathématique, telle que l'addition. Aucune rémunération n'est consentie dans cette recherche.

Mesures évaluées : Deux interventions structurées et individualisées sont prévues pour chaque enfant d'une durée de 1 heure chacune. Deux évaluations par les moyens de quiz (2 quiz) seront présentés à l'enfant afin d'établir les compétences en mathématiques et l'état affectif de l'enfant vis-à-vis la situation d'apprentissage. Le premier quiz comprend 30 additions sans l'aide de l'agent pédagogique d'ISLA. Le deuxième quiz comprend 15 additions avec l'aide de l'agent pédagogique d'ISLA.

Endroit de la recherche
La recherche se déroulera au laboratoire d'informatique de l'Université de Montréal.

Durée de la recherche

La partie expérimentale qui concerne la participation active des enfants TED est prévue pour le mois de juin 2015 et sera complétée en juillet 2015. Pendant les interventions, les enfants seront aussi observés et filmés pendant une période de 15 minutes lors du premier quiz et de 15 à 25 minutes lors du deuxième quiz.

Bénéfice et risques pour les participants : Cette recherche contribue à l'avancement des systèmes tutoriels intelligents affectifs en proposant un modèle informatique pour surmonter le manque d'intervention individualisée dans le domaine de l'éducation spécialisée chez les personnes ayant des troubles envahissants de développement. Les résultats de quiz (1 et 2) seront fournis aux parents et aux participants leur permettant de connaître leur niveau de compétence, les difficultés en addition et son état affectif vis-à-vis la situation d'apprentissage.

Les étudiantes pourraient manifester des états affectifs négatifs (frustration, anxiété) lors de la situation d'apprentissage en mathématique. Si tel est le cas, je possède un DESS en éducation spécialisée en autisme avec dix ans d'expérience. S'il y a un problème, je vais donner le support à l'enfant et aux parents. De plus, l'enfant est libre d'y participer et demeure libre de se retirer en tout temps, sans que cela n'affecte la qualité des interventions.

Confidentialité et anonymat : Tous les renseignements concernant l'identification des participants autistes seront remplacés, par des codes numériques (ex. Participants #1,.....Participant#12). La clé de ces codes sera conservée par l'éducatrice spécialisée en chef dans un fichier numérique chiffré. Aucune information identificatrice ne sera liée à ces mesures. Les données seront conservées sur papier et dans des fichiers électroniques pour une période de cinq ans.

La diffusion des résultats de cette recherche sera envoyée par courriel électronique, par des lettres envoyées aux parents des enfants ainsi qu'aux partenaires et collaborateurs de cette recherche. Les résumés des résultats scientifiques seront publiés dans des revues ou des conférences scientifiques.

Approbation éthique : Cette recherche a été approuvée par le Comité d'éthique de la recherche avec des êtres humains de l'UQAM (CERPÉ). Si vous désirez obtenir des informations sur les responsabilités de l'équipe de recherche au plan de l'éthique ou formuler une plainte, vous pouvez faire votre demande auprès de Mme. Josée Savard. Elle peut être contactée au (514) 987 3000 poste 1646 ou par courriel : savard.josee@ uqam.ca.

Autorisation parentale :

J'ai lu et compris le contenu du présent formulaire. Je peux contacter Aydée Liza Mondragon en tout temps pour poser des questions au sujet de cette recherche par courriel électronique : aydeelizamondragon@gmail.com, ou bien par téléphone au : 438 937 4977. Je sais que mon enfant est libre d'y participer et que je demeure libre de le retirer en tout temps, par avis verbal, sans que cela n'affecte la qualité des interventions.

Nous, ______________________________________, acceptons que notre enfant participe à l'étude ci-haut décrite. Ce consentement est valide pour la période allant de juin à août 2015.

____

Nom de l'enfant

___________________________________ __________________________ ____________

Nom du parent Signature du parent Date

Nom de la chercheuse | Signature de la chercheuse | Date

Je consens à ce que les vidéos ne soient pas détruites et qu'elles soient conservées sous clés au Laboratoire d'informatique de l'Université de Montréal à des fins de recherche. Tous les renseignements relatifs à l'identification des participants autistes seront remplacés par des codes numériques. La clé de ces codes sera conservée dans un fichier numérique chiffré, et ne sera accessible que par les chercheurs liés à cette recherche. Les données de cette recherche seront conservées durant une période de cinq ans et seront détruites par la suite. Le visionnement vidéo ne sera pas utilisé pour des publications et sera seulement accessible qu'aux chercheurs.

Nom du parent | Signature du parent | Date

Numéro de téléphone où il est possible de vous contacter____________________

Integrated specialized learning application (ISLA) to teaching first grade addition to high functioning children presenting autism spectrum disorder (ASD)

ISLA

Date: ______________________________

Nom de l'enfant: ________________________ Nom du parent: __________________________

Diagnostic : ____________________________ Age : _____________ Sexe : F ☐ M ☐

<u>Autorisation pour enregistrement vidéo des participants</u>

Je consens à ce que mon enfant soit enregistrée dans le vidéo à des fins de recherche, à la condition qu'aucune présentation à l'extérieur du laboratoire ne soit visionnée par des personnes non soumises à un engagement de confidentialité ou sans que soit masqué le visage de mon enfant.

______________________	__________________________	______________
Nom du parent	Signature du parent	Date
______________________	__________________________	______________
Nom de la chercheuse	Signature de la chercheuse	Date

APPENDIX K
The study protocol
with and without Jessie

Integrated specialized learning application (ISLA) to teaching first grade addition to high functioning children presenting autism spectrum disorder (ASD)

Study Protocol - With Jessie

Step 1:

Interview with parent & participant /accueil parent et participant by Liza Mondragon ((~5-10 min.).

1. Ask the participant with the permission of the parent to choose an activity such as game (3DS) or colouring while Liza meets the parents /demander au participant de faire une activité de jeux (3DS) ou colorier pendant que Liza rencontre le parent.
2. Explain to the parents the technology (Face reader and Eye tracking) used in the experimentation
   /expliquer aux parents la technologie (Face reader and Eye tracking) utilisés dans l'expérimentation.
3. Consent form have the parents to read and sign the consent form / demander au parent de lire et signer le formulaire de consentement.
4. Ask the parent to complete the questionnaire/ demander au parent de remplir le questionnaire.
5. Thank the parent for participating in this study/remercier le parent de participer dans l'expérimentation.

Step 2:

Demo to participant of the application ISLA: Without Jessie/demo au participant (~5min).

Explain: Now that we have completed the interview, we will proceed with the demo of the application ISLA to the participant with version: Without Jessie by using pictograms and the schedule to be followed during the intervention. See Annex 3 / Après avoir complété l'étape 1, nous allons faire le demo au participant de l'application ISLA version: Sans Jessie en utilisant des pictogrammes et l'horaire pendant l'intervention. Voir annexe 3.

Step 3:

SET-UP (to be done before the participant arrives/ à faire avant que le participant arrive) (~5min).

1. Lunch Tobii Studio/lancer l'application Tobii Studio
2. Lunch Team Viewer/lancer Team Viewer
3. Load ISLA application version: Without Jessie (only when the child is ready to initiate the quiz/seulement lorsque l'enfant est prêt à débuter le quiz.
4. Use chair without wheels /utiliser une chaise sans roulettes.
5. Make sure to have the participant's head facing the monitor/ s'assurer d'avoir la tete de l'enfant en face de l'écran.

Step 4:

STUDY SET-UP AND CALIBRATION (~10-12 min)

For Eye tracking: Calibrate the eye-tracker for participants.

1. Sit down properly/ Assis-toi bien.
2. Look at the screen/regarde bien l'écran
3. Follow the red spots with your eyes/ suit les points rouges avec tes yeux.
4. Calibrate
5. Are you ready?/ Êtes-vous prêt?
6. 1, 2, 3 go

Intervention: Quiz 30 additions with the pedagogical agent Jessie

7. Start recording (write time of recording and participant #)
8. Start quiz (15-20 min)
9. Refer to Annex 4: Intervention protocol
10. During the quiz, write difficulties, level of competency and affective state of the participant / écrire les difficultés, niveau de compétences et l'état affective du participant.
11. Stop screen of ISLA when the participant ends the quiz.
12. Felicitate participant/Féliciter participant
13. Give reward to the participant/ donner recompense au participant
14. Bring the child with the parent/ accompagner l'enfant avec les parents.
15. Present level of competency and difficulties during the mathematical activity to the parent.
16. Thank the parent for participating in this study / remercier le parent pour la participation de son enfant.

Step 5:

Analysis Face Reader

1. Go to system c: utilisateurs\locarno\mes documents\Tobii studio projects
2. Choose ISLA
3. Choose Usercams
4. According to the date, choose the right video
5. We save the video with the format (participant #) in the USB key to analyse using Face Reader.
6. In the face reader application (password: cite2014)
7. Insert the USB key and load project ISLA 3
8. Add video analyse
9. Choose the participant (bleu bottom)
10. In the desktop under ISLA video
11. Choose the video
12. Start analysis (red bottom)
13. Save project

Step 6:
Analysis Observer XT

1. Choose project: Isla no Jessie
2. Do Replay
3. Then Export video

Integrated specialized learning application (ISLA) to teaching first grade addition to high functioning children presenting autism spectrum disorder (ASD)

Study Protocol - Without Jessie

Step 1:

Interview with parent & participant /accueil parent et participant by Liza Mondragon ((~5-10 min.).

1. Ask the participant with the permission of the parent to choose an activity such as game (3DS) or colouring while Liza meets the parents /demander au participant de faire une activité de jeux (3DS) ou colorier pendant que Liza rencontre le parent.
2. Explain to the parents the technology (Face reader and Eye tracking) used in the experimentation /expliquer aux parents la technologie (Face reader and Eye tracking) utilisés dans l'expérimentation.
3. Consent form have the parents to read and sign the consent form / demander au parent de lire et signer le formulaire de consentement.
4. Ask the parent to complete the questionnaire/ demander au parent de remplir le questionnaire.
5. Thank the parent for participating in this study/remercier le parent de participer dans l'expérimentation.

Step 2:

Demo to participant of the application ISLA: Without Jessie/demo au participant (~5min).

Explain: Now that we have completed the interview, we will proceed with the demo of the application ISLA to the participant with version: Without Jessie by using pictograms and the schedule to be followed during the intervention. See Annex 1. / Après avoir complété l'étape 1, nous allons faire le demo au participant de l'application ISLA version: Sans Jessie en utilisant des pictogrammes et l'horaire pendant l'intervention. Voir annexe 1.

Step 3:

SET-UP (to be done before the participant arrives/ à faire avant que le participant arrive) (~5min).

1. Lunch Tobii Studio/lancer l'application Tobii Studio
2. Lunch Team Viewer/lancer Team Viewer
3. Load ISLA application version: Without Jessie (only when the child is ready to initiate the quiz/seulement lorsque l'enfant est prêt à débuter le quiz.
4. Use chair without wheels /utiliser une chaise sans roulettes.
5. Make sure to have the participant's head facing the monitor/ s'assurer d'avoir la tete de l'enfant en face de l'écran.

Step 4:

STUDY SET-UP AND CALIBRATION (~10-12 min)

For Eye tracking: Calibrate the eye-tracker for participants.

1. Sit down properly/ Assis-toi bien.
2. Look at the screen/regarde bien l'écran

3. Follow the red spots with your eyes/ suit les points rouges avec tes yeux.
4. Calibrate
5. Are you ready?/ Êtes-vous prêt?
6. 1, 2, 3 go

Intervention: Quiz 30 additions without the pedagogical agent Jessie

7. Start recording (write time of recording and participant #)
8. Start quiz (15 minutes maximum)
9. During the quiz, write difficulties, level of competency and affective state of the participant / écrire les difficultés, niveau de compétences et l'état affective du participant.
9. Stop screen of ISLA when the participant ends the quiz.
10. Felicitate participant/Féliciter participant
11. Give reward/ donner recompense
12. Bring the child with the parent/ accompagner l'enfant avec les parents.
13. Present level of competency and difficulties during the mathematical activity to the parent.
10. Thank the parent for participating in this study / remercier le parent pour la participation de son enfant.

APPENDIX L
The ethics certificate

UQÀM | Faculté des sciences de l'éducation

UQÀM | Faculté des sciences

CÉRPÉ-3

 # DE CERTIFICAT : 2014-0136A

Conformité à l'éthique en matière de recherche impliquant la participation de sujets humains

Le Comité pour l'évaluation des projets étudiants impliquant de la recherche avec des êtres humains (CÉRPÉ) des facultés des sciences et des sciences de l'éducation de l'Université du Québec à Montréal a examiné le projet de recherche suivant :

Titre du projet : Application spécialisée intégrée pour l'apprentissage de l'addition chez les personnes ayant des troubles envahissants de développement de haut niveau.

Responsable du projet : Aydée Liza Mondragon
Programme: Doctorat en informatique cognitive

Superviseurs : Roger Nkambou
Pierre Poirier

Ce projet de recherche est jugé conforme aux pratiques habituelles et répond aux normes établies par le «*Cadre normatif pour l'éthique de la recherche avec des êtres humains de l'UQAM*». Le projet est jugé recevable au plan de l'éthique de la recherche sur des êtres humains. Notez que toutes modifications apportées au projet doivent être approuvées par le comité en complétant les formulaires à cet effet, disponible sur le site web de la Faculté.

Membres du Comité

NOM	TITRE	DÉPARTEMENT
Proulx, Jérôme	Président du Comité, professeur	Mathématiques, Faculté des sciences
Grenier, Johanne	Professeur	Kinanthropologie, Faculté des sciences
Bigras, Nathalie	Professeur	Didactique, Faculté des sciences de l'éducation
Fortier, Marie-Pierre	Professeur	Éducation et formation spécialisées, Faculté des sciences de l'éducation
Venant, Fabienne	Professeur	Mathématiques, Faculté des sciences
Proulx, Sylvia	membre de la collectivité externe	
Banik, Marc	Professeur versé en éthique	Management et technologie, École des sciences de la gestion

28 mai 2015

Date

Jérôme Proulx
Président du Comité

APPENDIX M
The statistical analysis

GROUPE (6, 6)

With and without Jessie

The SAS System

The UNIVARIATE Procedure
Variable: RawScores (RawScores)
Group = Avec

Moments

N	6	Sum Weights	6
Mean	45.5555555	Sum Observations	273.333333
Std Deviation	22.6732016	Variance	514.074073
Skewness	-0.6905959	Kurtosis	-0.8857934
Uncorrected SS	15022.2222	Corrected SS	2570.37036
Coeff Variation	49.7704427	Std Error Mean	9.25629581

Basic Statistical Measures

Location		Variability	
Mean	45.55556	Std Deviation	22.67320
Median	50.00000	Variance	514.07407
Mode	63.33333	Range	56.66667
		Interquartile Range	30.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	4.921575	Pr > |t|	0.0044
Sign	M	3	Pr >= |M|	0.0313
Signed Rank	S	10.5	Pr >= |S|	0.0313

Quantiles (Definition 5)

Quantile	Estimate
100% Max	66.6667
99%	66.6667
95%	66.6667
90%	66.6667
75% Q3	63.3333
50% Median	50.0000
25% Q1	33.3333
10%	10.0000
5%	10.0000
1%	10.0000
0% Min	10.0000

The SAS System

The UNIVARIATE Procedure
Variable: RawScores (RawScores)
Group = Avec

Extreme Observations

------Lowest-----		-----Highest-----	
Value	Obs	Value	Obs
10.0000	2	33.3333	3
33.3333	3	36.6667	4
36.6667	4	63.3333	1

63.3333	5	63.3333	5
63.3333	1	66.6667	6

The SAS System

The UNIVARIATE Procedure
Variable: RawScores (RawScores)
Group = Sans

Moments

N	6	Sum Weights	6
Mean	46.1111112	Sum Observations	276.666667
Std Deviation	33.9553082	Variance	1152.96296
Skewness	0.63019416	Kurtosis	-0.2645765
Uncorrected SS	18522.2222	Corrected SS	5764.81479
Coeff Variation	73.6380178	Std Error Mean	13.8621965

Basic Statistical Measures

Location		Variability	
Mean	46.11111	Std Deviation	33.95531
Median	41.66667	Variance	1153
Mode	.	Range	93.33333
		Interquartile Range	40.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	3.326393	Pr > |t|	0.0209
Sign	M	3	Pr >= |M|	0.0313
Signed Rank	S	10.5	Pr >= |S|	0.0313

Quantiles (Definition 5)

Quantile	Estimate
100% Max	100.00000
99%	100.00000
95%	100.00000
90%	100.00000
75% Q3	63.33333
50% Median	41.66667
25% Q1	23.33333
10%	6.66667
5%	6.66667
1%	6.66667
0% Min	6.66667

The SAS System

The UNIVARIATE Procedure
Variable: RawScores (RawScores)
Group = Sans

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
6.66667	10	23.3333	12

23.33333	12	26.6667	9
26.66667	9	56.6667	7
56.66667	7	63.3333	8
63.33333	8	100.0000	11

The SAS System

The UNIVARIATE Procedure
Variable: ScoreCompetences (ScoreCompetences)
Group = Avec

Moments

N	6	Sum Weights	6
Mean	83.1060605	Sum Observations	498.636363
Std Deviation	11.7416911	Variance	137.86731
Skewness	-2.0690358	Kurtosis	4.58994485
Uncorrected SS	42129.0403	Corrected SS	689.33655
Coeff Variation	14.1285618	Std Error Mean	4.79352532

Basic Statistical Measures

Location		Variability	
Mean	83.10606	Std Deviation	11.74169
Median	86.36364	Variance	137.86731
Mode	86.36364	Range	31.66667
		Interquartile Range	7.57576

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	17.33715	Pr > |t|	<.0001
Sign	M	3	Pr >= |M|	0.0313
Signed Rank	S	10.5	Pr >= |S|	0.0313

Quantiles (Definition 5)

Quantile	Estimate
100% Max	91.6667
99%	91.6667
95%	91.6667
90%	91.6667
75% Q3	90.9091
50% Median	86.3636
25% Q1	83.3333
10%	60.0000
5%	60.0000
1%	60.0000
0% Min	60.0000

The SAS System

The UNIVARIATE Procedure
Variable: ScoreCompetences (ScoreCompetences)
Group = Avec

Extreme Observations

------Lowest-----		-----Highest-----	
Value	Obs	Value	Obs
60.0000	2	83.3333	3
83.3333	3	86.3636	1
86.3636	5	86.3636	5

86.3636	1	90.9091	6
90.9091	6	91.6667	4

The SAS System

The UNIVARIATE Procedure
Variable: ScoreCompetences (ScoreCompetences)
Group = Sans

Moments

N	6	Sum Weights	6
Mean	71.4393938	Sum Observations	428.636363
Std Deviation	21.23889	Variance	451.090448
Skewness	-0.2071675	Kurtosis	-0.3221065
Uncorrected SS	32876.9742	Corrected SS	2255.45224
Coeff Variation	29.7299415	Std Error Mean	8.67074053

Basic Statistical Measures

Location		Variability	
Mean	71.43939	Std Deviation	21.23889
Median	71.96970	Variance	451.09045
Mode	.	Range	60.00000
		Interquartile Range	28.03030

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	8.239134	Pr > |t|	0.0004
Sign	M	3	Pr >= |M|	0.0313
Signed Rank	S	10.5	Pr >= |S|	0.0313

Quantiles (Definition 5)

Quantile	Estimate
100% Max	100.0000
99%	100.0000
95%	100.0000
90%	100.0000
75% Q3	86.3636
50% Median	71.9697
25% Q1	58.3333
10%	40.0000
5%	40.0000
1%	40.0000
0% Min	40.0000

The SAS System

The UNIVARIATE Procedure
Variable: ScoreCompetences (ScoreCompetences)
Group = Sans

Extreme Observations

------Lowest-----		------Highest-----	
Value	Obs	Value	Obs
40.0000	10	58.3333	12

58.3333	12	66.6667	9
66.6667	9	77.2727	7
77.2727	7	86.3636	8
86.3636	8	100.0000	11

The SAS System

The UNIVARIATE Procedure
Variable: Valence (Valence)
Group = Avec

Moments

N	6	Sum Weights	6
Mean	-0.0387192	Sum Observations	-0.232315
Std Deviation	0.15166514	Variance	0.02300232
Skewness	0.87591498	Kurtosis	-0.1919746
Uncorrected SS	0.12400662	Corrected SS	0.11501158
Coeff Variation	-391.7056	Std Error Mean	0.06191704

Basic Statistical Measures

Location		Variability	
Mean	-0.03872	Std Deviation	0.15167
Median	-0.08524	Variance	0.02300
Mode	.	Range	0.40532
		Interquartile Range	0.20297

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	-0.62534	Pr > |t|	0.5592
Sign	M	-1	Pr >= |M|	0.6875
Signed Rank	S	-2.5	Pr >= |S|	0.6875

Quantiles (Definition 5)

Quantile	Estimate
100% Max	0.206954
99%	0.206954
95%	0.206954
90%	0.206954
75% Q3	0.066278
50% Median	-0.085243
25% Q1	-0.136695
10%	-0.198366
5%	-0.198366
1%	-0.198366
0% Min	-0.198366

The SAS System

The UNIVARIATE Procedure
Variable: Valence (Valence)
Group = Avec

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
-0.198366	1	-0.136695	2
-0.136695	2	-0.131159	6
-0.131159	6	-0.039327	5

-0.039327	5	0.066278	3
0.066278	3	0.206954	4

The UNIVARIATE Procedure
Variable: Valence (Valence)
Group = Sans

Moments

N	6	Sum Weights	6
Mean	-0.159607	Sum Observations	-0.957642
Std Deviation	0.19141788	Variance	0.03664081
Skewness	-0.7095161	Kurtosis	-0.8972295
Uncorrected SS	0.33605039	Corrected SS	0.18320403
Coeff Variation	-119.93076	Std Error Mean	0.07814602

Basic Statistical Measures

Location		Variability	
Mean	-0.15961	Std Deviation	0.19142
Median	-0.09092	Variance	0.03664
Mode	.	Range	0.50666
		Interquartile Range	0.28526

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	-2.04242	Pr > |t|	0.0966
Sign	M	-2	Pr >= |M|	0.2188
Signed Rank	S	-8.5	Pr >= |S|	0.0938

Quantiles (Definition 5)

Quantile	Estimate
100% Max	0.0606850
99%	0.0606850
95%	0.0606850
90%	0.0606850
75% Q3	-0.0526260
50% Median	-0.0909185
25% Q1	-0.3378850
10%	-0.4459790
5%	-0.4459790
1%	-0.4459790
0% Min	-0.4459790

The UNIVARIATE Procedure
Variable: Valence (Valence)
Group = Sans

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
-0.445979	11	-0.337885	10

-0.337885	10	-0.092000	8
-0.092000	8	-0.089837	7
-0.089837	7	-0.052626	12
-0.052626	12	0.060685	9

The SAS System

The UNIVARIATE Procedure
Variable: Surprised (Surprised)
Group = Avec

Moments

N	6	Sum Weights	6
Mean	0.20846017	Sum Observations	1.250761
Std Deviation	0.09783797	Variance	0.00957227
Skewness	1.09174299	Kurtosis	2.08910124
Uncorrected SS	0.30859519	Corrected SS	0.04786134
Coeff Variation	46.9336538	Std Error Mean	0.03994219

Basic Statistical Measures

Location		Variability	
Mean	0.208460	Std Deviation	0.09784
Median	0.206856	Variance	0.00957
Mode	.	Range	0.28731
		Interquartile Range	0.07957

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	5.219048	Pr > |t|	0.0034
Sign	M	3	Pr >= |M|	0.0313
Signed Rank	S	10.5	Pr >= |S|	0.0313

Quantiles (Definition 5)

Quantile	Estimate
100% Max	0.381727
99%	0.381727
95%	0.381727
90%	0.381727
75% Q3	0.220238
50% Median	0.206856
25% Q1	0.140665
10%	0.094420
5%	0.094420
1%	0.094420
0% Min	0.094420

The SAS System

The UNIVARIATE Procedure
Variable: Surprised (Surprised)
Group = Avec

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
0.094420	5	0.140665	1
0.140665	1	0.199973	6
0.199973	6	0.213738	3

0.213738	3	0.220238	4
0.220238	4	0.381727	2

The SAS System

The UNIVARIATE Procedure
Variable: Surprised (Surprised)
Group = Sans

Moments

N	6	Sum Weights	6
Mean	0.25153733	Sum Observations	1.509224
Std Deviation	0.06427684	Variance	0.00413151
Skewness	0.42212309	Kurtosis	-1.7306052
Uncorrected SS	0.40028374	Corrected SS	0.02065756
Coeff Variation	25.5535982	Std Error Mean	0.02624091

Basic Statistical Measures

Location		Variability	
Mean	0.251537	Std Deviation	0.06428
Median	0.236152	Variance	0.00413
Mode	.	Range	0.15578
		Interquartile Range	0.12273

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	9.585694	Pr > |t|	0.0002
Sign	M	3	Pr >= |M|	0.0313
Signed Rank	S	10.5	Pr >= |S|	0.0313

Quantiles (Definition 5)

Quantile	Estimate
100% Max	0.332157
99%	0.332157
95%	0.332157
90%	0.332157
75% Q3	0.325561
50% Median	0.236152
25% Q1	0.202830
10%	0.176373
5%	0.176373
1%	0.176373
0% Min	0.176373

The SAS System

The UNIVARIATE Procedure
Variable: Surprised (Surprised)
Group = Sans

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
0.176373	9	0.202830	8

0.202830	8	0.226586	12
0.226586	12	0.245717	10
0.245717	10	0.325561	7
0.325561	7	0.332157	11

The SAS System

The UNIVARIATE Procedure
Variable: Scared (Scared)
Group = Avec

Moments

N	6	Sum Weights	6
Mean	0.00963933	Sum Observations	0.057836
Std Deviation	0.01392235	Variance	0.00019383
Skewness	2.21929995	Kurtosis	5.08120749
Uncorrected SS	0.00152666	Corrected SS	0.00096916
Coeff Variation	144.432727	Std Error Mean	0.00568378

Basic Statistical Measures

Location		Variability	
Mean	0.009639	Std Deviation	0.01392
Median	0.004245	Variance	0.0001938
Mode	.	Range	0.03701
		Interquartile Range	0.00666

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	1.695938	Pr > |t|	0.1507
Sign	M	3	Pr >= |M|	0.0313
Signed Rank	S	10.5	Pr >= |S|	0.0313

Quantiles (Definition 5)

Quantile	Estimate
100% Max	0.0374280
99%	0.0374280
95%	0.0374280
90%	0.0374280
75% Q3	0.0090790
50% Median	0.0042445
25% Q1	0.0024220
10%	0.0004180
5%	0.0004180
1%	0.0004180
0% Min	0.0004180

The SAS System

The UNIVARIATE Procedure
Variable: Scared (Scared)
Group = Avec

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
0.000418	6	0.002422	2
0.002422	2	0.003437	5
0.003437	5	0.005052	3

0.005052	3	0.009079	4
0.009079	4	0.037428	1

The SAS System

The UNIVARIATE Procedure
Variable: Scared (Scared)
Group = Sans

Moments

N	6	Sum Weights	6
Mean	0.01637717	Sum Observations	0.098263
Std Deviation	0.01952456	Variance	0.00038121
Skewness	1.19024464	Kurtosis	0.40479675
Uncorrected SS	0.00351531	Corrected SS	0.00190604
Coeff Variation	119.218191	Std Error Mean	0.00797087

Basic Statistical Measures

Location		Variability	
Mean	0.016377	Std Deviation	0.01952
Median	0.008302	Variance	0.0003812
Mode	.	Range	0.04946
		Interquartile Range	0.02654

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	2.054628	Pr > |t|	0.0951
Sign	M	3	Pr >= |M|	0.0313
Signed Rank	S	10.5	Pr >= |S|	0.0313

Quantiles (Definition 5)

Quantile	Estimate
100% Max	0.049596
99%	0.049596
95%	0.049596
90%	0.049596
75% Q3	0.029233
50% Median	0.008302
25% Q1	0.002689
10%	0.000141
5%	0.000141
1%	0.000141
0% Min	0.000141

The SAS System

The UNIVARIATE Procedure
Variable: Scared (Scared)
Group = Sans

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
0.000141	9	0.002689	7

0.002689	7	0.003016	8
0.003016	8	0.013588	10
0.013588	10	0.029233	12
0.029233	12	0.049596	11

The SAS System

The UNIVARIATE Procedure
Variable: Sad (Sad)
Group = Avec

Moments

N	6	Sum Weights	6
Mean	0.02138683	Sum Observations	0.128321
Std Deviation	0.0209219	Variance	0.00043773
Skewness	1.61599965	Kurtosis	2.76731226
Uncorrected SS	0.00493301	Corrected SS	0.00218863
Coeff Variation	97.826068	Std Error Mean	0.00854133

Basic Statistical Measures

Location		Variability	
Mean	0.021387	Std Deviation	0.02092
Median	0.016290	Variance	0.0004377
Mode	.	Range	0.05603
		Interquartile Range	0.01888

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	2.503923	Pr > |t|	0.0542
Sign	M	3	Pr >= |M|	0.0313
Signed Rank	S	10.5	Pr >= |S|	0.0313

Quantiles (Definition 5)

Quantile	Estimate
100% Max	0.060381
99%	0.060381
95%	0.060381
90%	0.060381
75% Q3	0.024944
50% Median	0.016290
25% Q1	0.006064
10%	0.004352
5%	0.004352
1%	0.004352
0% Min	0.004352

The SAS System

The UNIVARIATE Procedure
Variable: Sad (Sad)
Group = Avec

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
0.004352	3	0.006064	4
0.006064	4	0.010025	2
0.010025	2	0.022555	6

0.022555	6	0.024944	5
0.024944	5	0.060381	1

The SAS System

The UNIVARIATE Procedure
Variable: Sad (Sad)
Group = Sans

Moments

N	6	Sum Weights	6
Mean	0.02324667	Sum Observations	0.13948
Std Deviation	0.03638937	Variance	0.00132419
Skewness	2.213019	Kurtosis	5.04983047
Uncorrected SS	0.00986338	Corrected SS	0.00662093
Coeff Variation	156.535874	Std Error Mean	0.0148559

Basic Statistical Measures

Location		Variability	
Mean	0.023247	Std Deviation	0.03639
Median	0.009743	Variance	0.00132
Mode	.	Range	0.09525
		Interquartile Range	0.02042

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	1.56481	Pr > |t|	0.1784
Sign	M	3	Pr >= |M|	0.0313
Signed Rank	S	10.5	Pr >= |S|	0.0313

Quantiles (Definition 5)

Quantile	Estimate
100% Max	0.0958270
99%	0.0958270
95%	0.0958270
90%	0.0958270
75% Q3	0.0220040
50% Median	0.0097425
25% Q1	0.0015850
10%	0.0005790
5%	0.0005790
1%	0.0005790
0% Min	0.0005790

The SAS System

The UNIVARIATE Procedure
Variable: Sad (Sad)
Group = Sans

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
0.000579	9	0.001585	12

0.001585	12	0.008381	10
0.008381	10	0.011104	8
0.011104	8	0.022004	11
0.022004	11	0.095827	7

The SAS System

The UNIVARIATE Procedure
Variable: Neutral (Neutral)
Group = Avec

Moments

N	6	Sum Weights	6
Mean	0.279602	Sum Observations	1.677612
Std Deviation	0.0772092	Variance	0.00596126
Skewness	2.06494623	Kurtosis	4.68123531
Uncorrected SS	0.49886997	Corrected SS	0.0298063
Coeff Variation	27.6139654	Std Error Mean	0.03152052

Basic Statistical Measures

Location		Variability	
Mean	0.279602	Std Deviation	0.07721
Median	0.253742	Variance	0.00596
Mode	.	Range	0.21723
		Interquartile Range	0.02963

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	8.870474	Pr > |t|	0.0003
Sign	M	3	Pr >= |M|	0.0313
Signed Rank	S	10.5	Pr >= |S|	0.0313

Quantiles (Definition 5)

Quantile	Estimate
100% Max	0.431670
99%	0.431670
95%	0.431670
90%	0.431670
75% Q3	0.276825
50% Median	0.253742
25% Q1	0.247198
10%	0.214436
5%	0.214436
1%	0.214436
0% Min	0.214436

The SAS System

The UNIVARIATE Procedure
Variable: Neutral (Neutral)
Group = Avec

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
0.214436	2	0.247198	5
0.247198	5	0.249283	1
0.249283	1	0.258200	4

0.258200	4	0.276825	6
0.276825	6	0.431670	3

The SAS System

The UNIVARIATE Procedure
Variable: Neutral (Neutral)
Group = Sans

Moments

N	6	Sum Weights	6
Mean	0.39210417	Sum Observations	2.352625
Std Deviation	0.21407524	Variance	0.04582821
Skewness	2.1850465	Kurtosis	5.06975501
Uncorrected SS	1.15161511	Corrected SS	0.22914105
Coeff Variation	54.5965235	Std Error Mean	0.08739585

Basic Statistical Measures

Location		Variability	
Mean	0.392104	Std Deviation	0.21408
Median	0.338687	Variance	0.04583
Mode	.	Range	0.58422
		Interquartile Range	0.08366

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	4.486531	Pr > |t|	0.0065
Sign	M	3	Pr >= |M|	0.0313
Signed Rank	S	10.5	Pr >= |S|	0.0313

Quantiles (Definition 5)

Quantile	Estimate
100% Max	0.818635
99%	0.818635
95%	0.818635
90%	0.818635
75% Q3	0.352930
50% Median	0.338687
25% Q1	0.269274
10%	0.234413
5%	0.234413
1%	0.234413
0% Min	0.234413

The SAS System

The UNIVARIATE Procedure
Variable: Neutral (Neutral)
Group = Sans

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
0.234413	7	0.269274	11

0.269274	11	0.335751	12
0.335751	12	0.341622	8
0.341622	8	0.352930	10
0.352930	10	0.818635	9

The SAS System

The UNIVARIATE Procedure
Variable: Others (Others)
Group = Avec

Moments

N	6	Sum Weights	6
Mean	4.96666667	Sum Observations	29.8
Std Deviation	2.77464712	Variance	7.69866667
Skewness	0.64355662	Kurtosis	-1.8208419
Uncorrected SS	186.5	Corrected SS	38.4933333
Coeff Variation	55.8653783	Std Error Mean	1.13274495

Basic Statistical Measures

Location		Variability	
Mean	4.966667	Std Deviation	2.77465
Median	4.100000	Variance	7.69867
Mode	.	Range	6.40000
		Interquartile Range	5.60000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	4.384629	Pr > |t|	0.0071
Sign	M	3	Pr >= |M|	0.0313
Signed Rank	S	10.5	Pr >= |S|	0.0313

Quantiles (Definition 5)

Quantile	Estimate
100% Max	8.6
99%	8.6
95%	8.6
90%	8.6
75% Q3	8.2
50% Median	4.1
25% Q1	2.6
10%	2.2
5%	2.2
1%	2.2
0% Min	2.2

The SAS System

The UNIVARIATE Procedure
Variable: Others (Others)
Group = Avec

Extreme Observations

----Lowest----		----Highest---	
Value	Obs	Value	Obs
2.2	2	2.6	6
2.6	6	3.9	4
3.9	4	4.3	5

4.3	5	8.2	1
8.2	1	8.6	3

The SAS System

The UNIVARIATE Procedure
Variable: Others (Others)
Group = Sans

Moments

N	6	Sum Weights	6
Mean	3.66666667	Sum Observations	22
Std Deviation	3.4742865	Variance	12.0706667
Skewness	0.4866273	Kurtosis	-2.0014964
Uncorrected SS	141.02	Corrected SS	60.3533333
Coeff Variation	94.7532681	Std Error Mean	1.41837152

Basic Statistical Measures

Location		Variability	
Mean	3.666667	Std Deviation	3.47429
Median	2.800000	Variance	12.07067
Mode	.	Range	8.10000
		Interquartile Range	6.50000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	2.585124	Pr > |t|	0.0491
Sign	M	3	Pr >= |M|	0.0313
Signed Rank	S	10.5	Pr >= |S|	0.0313

Quantiles (Definition 5)

Quantile	Estimate
100% Max	8.4
99%	8.4
95%	8.4
90%	8.4
75% Q3	7.1
50% Median	2.8
25% Q1	0.6
10%	0.3
5%	0.3
1%	0.3
0% Min	0.3

The SAS System

The UNIVARIATE Procedure
Variable: Others (Others)
Group = Sans

Extreme Observations

----Lowest----		----Highest---	
Value	Obs	Value	Obs
0.3	7	0.6	9

0.6	9	1.4	8
1.4	8	4.2	10
4.2	10	7.1	12
7.1	12	8.4	11

The SAS System

The UNIVARIATE Procedure
Variable: Joy (Joy)
Group = Avec

Moments

N	6	Sum Weights	6
Mean	0.15099067	Sum Observations	0.905944
Std Deviation	0.22519231	Variance	0.05071158
Skewness	1.21670144	Kurtosis	-0.2790894
Uncorrected SS	0.39034698	Corrected SS	0.25355789
Coeff Variation	149.143202	Std Error Mean	0.09193438

Basic Statistical Measures

Location		Variability	
Mean	0.150991	Std Deviation	0.22519
Median	0.021701	Variance	0.05071
Mode	0.000000	Range	0.52203
		Interquartile Range	0.34052

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	1.642374	Pr > |t|	0.1614
Sign	M	1.5	Pr >= |M|	0.2500
Signed Rank	S	3	Pr >= |S|	0.2500

Quantiles (Definition 5)

Quantile	Estimate
100% Max	0.5220270
99%	0.5220270
95%	0.5220270
90%	0.5220270
75% Q3	0.3405160
50% Median	0.0217005
25% Q1	0.0000000
10%	0.0000000
5%	0.0000000
1%	0.0000000
0% Min	0.0000000

The SAS System

The UNIVARIATE Procedure
Variable: Joy (Joy)
Group = Avec

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
0.000000	5	0.000000	4
0.000000	4	0.000000	5
0.000000	2	0.043401	1

0.043401	1	0.340516	3
0.340516	3	0.522027	6

The SAS System

The UNIVARIATE Procedure
Variable: Joy (Joy)
Group = Sans

Moments

N	6	Sum Weights	6
Mean	2.15513	Sum Observations	12.93078
Std Deviation	3.52808532	Variance	12.4473861
Skewness	1.39489171	Kurtosis	0.62859918
Uncorrected SS	90.1044422	Corrected SS	62.2369303
Coeff Variation	163.706381	Std Error Mean	1.4403348

Basic Statistical Measures

Location		Variability	
Mean	2.155130	Std Deviation	3.52809
Median	0.000000	Variance	12.44739
Mode	0.000000	Range	8.26843
		Interquartile Range	4.66235

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	1.49627	Pr > |t|	0.1948
Sign	M	1	Pr >= |M|	0.5000
Signed Rank	S	1.5	Pr >= |S|	0.5000

Quantiles (Definition 5)

Quantile	Estimate
100% Max	8.26843
99%	8.26843
95%	8.26843
90%	8.26843
75% Q3	4.66235
50% Median	0.00000
25% Q1	0.00000
10%	0.00000
5%	0.00000
1%	0.00000
0% Min	0.00000

The SAS System

The UNIVARIATE Procedure
Variable: Joy (Joy)
Group = Sans

Extreme Observations

------Lowest-----		-----Highest-----	
Value	Obs	Value	Obs
0.00000	12	0.00000	10

0.00000	11	0.00000	11
0.00000	10	0.00000	12
0.00000	9	4.66235	8
4.66235	8	8.26843	7

The SAS System

The UNIVARIATE Procedure
Variable: Interested (Interested)
Group = Avec

Moments

N	6	Sum Weights	6
Mean	57.5487167	Sum Observations	345.2923
Std Deviation	28.0004291	Variance	784.024029
Skewness	-0.2839522	Kurtosis	-0.1004605
Uncorrected SS	23791.2489	Corrected SS	3920.12015
Coeff Variation	48.6551755	Std Error Mean	11.4311273

Basic Statistical Measures

Location		Variability	
Mean	57.54872	Std Deviation	28.00043
Median	62.84925	Variance	784.02403
Mode	.	Range	80.06340
		Interquartile Range	32.72040

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	5.034387	Pr > |t|	0.0040
Sign	M	3	Pr >= |M|	0.0313
Signed Rank	S	10.5	Pr >= |S|	0.0313

Quantiles (Definition 5)

Quantile	Estimate
100% Max	95.8414
99%	95.8414
95%	95.8414
90%	95.8414
75% Q3	70.3474
50% Median	62.8493
25% Q1	37.6270
10%	15.7780
5%	15.7780
1%	15.7780
0% Min	15.7780

The SAS System

The UNIVARIATE Procedure
Variable: Interested (Interested)
Group = Avec

Extreme Observations

------Lowest-----		-----Highest-----	
Value	Obs	Value	Obs
15.7780	1	37.6270	5
37.6270	5	56.0623	2
56.0623	2	69.6362	3

69.6362	3	70.3474	4
70.3474	4	95.8414	6

The SAS System

The UNIVARIATE Procedure
Variable: Interested (Interested)
Group = Sans

Moments

N	6	Sum Weights	6
Mean	43.9353633	Sum Observations	263.61218
Std Deviation	32.0968374	Variance	1030.20697
Skewness	0.55228885	Kurtosis	0.44628523
Uncorrected SS	16732.9318	Corrected SS	5151.03486
Coeff Variation	73.0546762	Std Error Mean	13.103479

Basic Statistical Measures

Location		Variability	
Mean	43.93536	Std Deviation	32.09684
Median	46.60865	Variance	1030
Mode	.	Range	89.88532
		Interquartile Range	40.01000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	3.352954	Pr > |t|	0.0203
Sign	M	3	Pr >= |M|	0.0313
Signed Rank	S	10.5	Pr >= |S|	0.0313

Quantiles (Definition 5)

Quantile	Estimate
100% Max	95.90740
99%	95.90740
95%	95.90740
90%	95.90740
75% Q3	54.23770
50% Median	46.60865
25% Q1	14.22770
10%	6.02208
5%	6.02208
1%	6.02208
0% Min	6.02208

The SAS System

The UNIVARIATE Procedure
Variable: Interested (Interested)
Group = Sans

Extreme Observations

------Lowest------		-----Highest-----	
Value	Obs	Value	Obs
6.02208	10	14.2277	9

14.22770	9	44.4236	12
44.42360	12	48.7937	8
48.79370	8	54.2377	7
54.23770	7	95.9074	11

The SAS System

The UNIVARIATE Procedure
Variable: Happy (Happy)
Group = Avec

Moments

N	6	Sum Weights	6
Mean	0.10132983	Sum Observations	0.607979
Std Deviation	0.07185974	Variance	0.00516382
Skewness	-0.4648785	Kurtosis	-1.7852311
Uncorrected SS	0.08742552	Corrected SS	0.02581911
Coeff Variation	70.9166641	Std Error Mean	0.02933661

Basic Statistical Measures

Location		Variability	
Mean	0.101330	Std Deviation	0.07186
Median	0.118030	Variance	0.00516
Mode	.	Range	0.17361
		Interquartile Range	0.13841

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	3.45404	Pr > |t|	0.0182
Sign	M	3	Pr >= |M|	0.0313
Signed Rank	S	10.5	Pr >= |S|	0.0313

Quantiles (Definition 5)

Quantile	Estimate
100% Max	0.180943
99%	0.180943
95%	0.180943
90%	0.180943
75% Q3	0.161026
50% Median	0.118030
25% Q1	0.022614
10%	0.007337
5%	0.007337
1%	0.007337
0% Min	0.007337

The SAS System

The UNIVARIATE Procedure
Variable: Happy (Happy)
Group = Avec

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
0.007337	5	0.022614	4
0.022614	4	0.105211	2
0.105211	2	0.130848	3

0.130848	3	0.161026	6
0.161026	6	0.180943	1

The SAS System

The UNIVARIATE Procedure
Variable: Happy (Happy)
Group = Sans

Moments

N	6	Sum Weights	6
Mean	0.0975815	Sum Observations	0.585489
Std Deviation	0.07128301	Variance	0.00508127
Skewness	2.1868333	Kurtosis	4.94967757
Uncorrected SS	0.08253923	Corrected SS	0.02540634
Coeff Variation	73.0497142	Std Error Mean	0.02910117

Basic Statistical Measures

Location		Variability	
Mean	0.097582	Std Deviation	0.07128
Median	0.070605	Variance	0.00508
Mode	.	Range	0.19015
		Interquartile Range	0.03790

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	3.353182	Pr > |t|	0.0203
Sign	M	3	Pr >= |M|	0.0313
Signed Rank	S	10.5	Pr >= |S|	0.0313

Quantiles (Definition 5)

Quantile	Estimate
100% Max	0.239381
99%	0.239381
95%	0.239381
90%	0.239381
75% Q3	0.096783
50% Median	0.070605
25% Q1	0.058883
10%	0.049232
5%	0.049232
1%	0.049232
0% Min	0.049232

The SAS System

The UNIVARIATE Procedure
Variable: Happy (Happy)
Group = Sans

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
0.049232	7	0.058883	12

0.058883	12	0.068619	11
0.068619	11	0.072591	9
0.072591	9	0.096783	8
0.096783	8	0.239381	10

The SAS System

The UNIVARIATE Procedure
Variable: frustrated
Group = Avec

Moments

N	5	Sum Weights	5
Mean	2.612788	Sum Observations	13.06394
Std Deviation	1.68667482	Variance	2.84487196
Skewness	-0.9599347	Kurtosis	0.93565057
Uncorrected SS	45.5127935	Corrected SS	11.3794878
Coeff Variation	64.5545993	Std Error Mean	0.75430391

Basic Statistical Measures

Location		Variability	
Mean	2.612788	Std Deviation	1.68667
Median	2.784350	Variance	2.84487
Mode	.	Range	4.37888
		Interquartile Range	1.53389

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	3.46384	Pr > |t|	0.0257
Sign	M	2	Pr >= |M|	0.1250
Signed Rank	S	5	Pr >= |S|	0.1250

Quantiles (Definition 5)

Quantile	Estimate
100% Max	4.37888
99%	4.37888
95%	4.37888
90%	4.37888
75% Q3	3.71730
50% Median	2.78435
25% Q1	2.18341
10%	0.00000
5%	0.00000
1%	0.00000
0% Min	0.00000

The SAS System

The UNIVARIATE Procedure
Variable: frustrated
Group = Avec

Extreme Observations

------Lowest-----		-----Highest-----	
Value	Obs	Value	Obs
0.00000	3	0.00000	3
2.18341	1	2.18341	1
2.78435	2	2.78435	2

3.71730	5	3.71730	5
4.37888	4	4.37888	4

Missing Values

Missing Value	Count	-----Percent Of----- All Obs	Missing Obs
.	1	16.67	100.00

The SAS System

The UNIVARIATE Procedure
Variable: frustrated
Group = Sans

Moments

N	6	Sum Weights	6
Mean	25.2083717	Sum Observations	151.25023
Std Deviation	21.5842109	Variance	465.878162
Skewness	0.32230248	Kurtosis	-1.6957325
Uncorrected SS	6142.16282	Corrected SS	2329.39081
Coeff Variation	85.6231859	Std Error Mean	8.81171722

Basic Statistical Measures

Location		Variability	
Mean	25.20837	Std Deviation	21.58421
Median	21.86795	Variance	465.87816
Mode	.	Range	53.77500
		Interquartile Range	40.14967

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	2.860779	Pr > |t|	0.0354
Sign	M	2.5	Pr >= |M|	0.0625
Signed Rank	S	7.5	Pr >= |S|	0.0625

Quantiles (Definition 5)

Quantile	Estimate
100% Max	53.77500
99%	53.77500
95%	53.77500
90%	53.77500
75% Q3	46.94450
50% Median	21.86795
25% Q1	6.79483
10%	0.00000
5%	0.00000
1%	0.00000
0% Min	0.00000

The SAS System

The UNIVARIATE Procedure
Variable: frustrated

Group = Sans

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
0.00000	10	6.79483	8
6.79483	8	17.17530	11
17.17530	11	26.56060	12
26.56060	12	46.94450	7
46.94450	7	53.77500	9

The SAS System

The UNIVARIATE Procedure
Variable: Guidance (Guidance)
Group = Avec

Moments

N	6	Sum Weights	6
Mean	6.18227167	Sum Observations	37.09363
Std Deviation	7.11120006	Variance	50.5691663
Skewness	1.75116447	Kurtosis	3.28510864
Uncorrected SS	482.168729	Corrected SS	252.845831
Coeff Variation	115.025681	Std Error Mean	2.90313527

Basic Statistical Measures

Location		Variability	
Mean	6.182272	Std Deviation	7.11120
Median	3.839940	Variance	50.56917
Mode	.	Range	19.65310
		Interquartile Range	5.83603

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	2.129516	Pr > |t|	0.0865
Sign	M	2.5	Pr >= |M|	0.0625
Signed Rank	S	7.5	Pr >= |S|	0.0625

Quantiles (Definition 5)

Quantile	Estimate
100% Max	19.65310
99%	19.65310
95%	19.65310
90%	19.65310
75% Q3	7.79834
50% Median	3.83994
25% Q1	1.96231
10%	0.00000
5%	0.00000
1%	0.00000
0% Min	0.00000

The SAS System

The UNIVARIATE Procedure
Variable: Guidance (Guidance)
Group = Avec

Extreme Observations

------Lowest-----		------Highest-----	
Value	Obs	Value	Obs
0.00000	1	1.96231	5
1.96231	5	2.89937	6
2.89937	6	4.78051	3

4.78051	3	7.79834	4
7.79834	4	19.65310	2

The SAS System

The UNIVARIATE Procedure
Variable: Guidance (Guidance)
Group = Sans

Moments

N	6	Sum Weights	6
Mean	0.59062367	Sum Observations	3.543742
Std Deviation	1.08020887	Variance	1.16685121
Skewness	2.10876991	Kurtosis	4.45900485
Uncorrected SS	7.92727395	Corrected SS	5.83425606
Coeff Variation	182.892921	Std Error Mean	0.44099343

Basic Statistical Measures

Location		Variability	
Mean	0.590624	Std Deviation	1.08021
Median	0.045537	Variance	1.16685
Mode	0.000000	Range	2.71591
		Interquartile Range	0.73676

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	1.339303	Pr > |t|	0.2381
Sign	M	1.5	Pr >= |M|	0.2500
Signed Rank	S	3	Pr >= |S|	0.2500

Quantiles (Definition 5)

Quantile	Estimate
100% Max	2.715910
99%	2.715910
95%	2.715910
90%	2.715910
75% Q3	0.736758
50% Median	0.045537
25% Q1	0.000000
10%	0.000000
5%	0.000000
1%	0.000000
0% Min	0.000000

The SAS System

The UNIVARIATE Procedure
Variable: Guidance (Guidance)
Group = Sans

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
0.000000	12	0.000000	11

0.000000	11	0.000000	12
0.000000	10	0.091074	9
0.091074	9	0.736758	8
0.736758	8	2.715910	7

The SAS System

The UNIVARIATE Procedure
Variable: Feedback (Feedback)
Group = Avec

Moments

N	6	Sum Weights	6
Mean	5.12319833	Sum Observations	30.73919
Std Deviation	3.54738658	Variance	12.5839515
Skewness	0.97524472	Kurtosis	-1.654292
Uncorrected SS	220.402725	Corrected SS	62.9197577
Coeff Variation	69.2416406	Std Error Mean	1.44821451

Basic Statistical Measures

Location		Variability	
Mean	5.123198	Std Deviation	3.54739
Median	3.156685	Variance	12.58395
Mode	.	Range	7.74285
		Interquartile Range	6.49975

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	3.537596	Pr > |t|	0.0166
Sign	M	3	Pr >= |M|	0.0313
Signed Rank	S	10.5	Pr >= |S|	0.0313

Quantiles (Definition 5)

Quantile	Estimate
100% Max	10.18660
99%	10.18660
95%	10.18660
90%	10.18660
75% Q3	9.14761
50% Median	3.15669
25% Q1	2.64786
10%	2.44375
5%	2.44375
1%	2.44375
0% Min	2.44375

The SAS System

The UNIVARIATE Procedure
Variable: Feedback (Feedback)
Group = Avec

Extreme Observations

------Lowest-----		------Highest-----	
Value	Obs	Value	Obs
2.44375	3	2.64786	2
2.64786	2	3.00712	4
3.00712	4	3.30625	5

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
0.00000	10	0.00000	10
6.79483	8	6.79483	8
26.56060	12	26.56060	12
46.94450	7	46.94450	7
53.77500	9	53.77500	9

The SAS System

The UNIVARIATE Procedure
Variable: Interested (Interested)
Group = Avec

Moments

N	6	Sum Weights	6
Mean	57.5487167	Sum Observations	345.2923
Std Deviation	28.0004291	Variance	784.024029
Skewness	-0.2839522	Kurtosis	-0.1004605
Uncorrected SS	23791.2489	Corrected SS	3920.12015
Coeff Variation	48.6551755	Std Error Mean	11.4311273

Basic Statistical Measures

Location		Variability	
Mean	57.54872	Std Deviation	28.00043
Median	62.84925	Variance	784.02403
Mode	.	Range	80.06340
		Interquartile Range	32.72040

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	5.034387	Pr > |t|	0.0040
Sign	M	3	Pr >= |M|	0.0313
Signed Rank	S	10.5	Pr >= |S|	0.0313

Quantiles (Definition 5)

Quantile	Estimate
100% Max	95.8414
99%	95.8414
95%	95.8414
90%	95.8414
75% Q3	70.3474
50% Median	62.8493
25% Q1	37.6270
10%	15.7780
5%	15.7780
1%	15.7780
0% Min	15.7780

The SAS System

The UNIVARIATE Procedure

Variable: Interested (Interested)
Group = Avec

Extreme Observations

------Lowest-----		-----Highest-----	
Value	Obs	Value	Obs
15.7780	1	37.6270	5
37.6270	5	56.0623	2
56.0623	2	69.6362	3
69.6362	3	70.3474	4
70.3474	4	95.8414	6

The SAS System

The UNIVARIATE Procedure
Variable: Interested (Interested)
Group = Sans

Moments

N	5	Sum Weights	5
Mean	33.540956	Sum Observations	167.70478
Std Deviation	21.8501931	Variance	477.430936
Skewness	-0.5727874	Kurtosis	-2.7121303
Uncorrected SS	7534.70239	Corrected SS	1909.72375
Coeff Variation	65.144813	Std Error Mean	9.7717034

Basic Statistical Measures

Location		Variability	
Mean	33.54096	Std Deviation	21.85019
Median	44.42360	Variance	477.43094
Mode	.	Range	48.21562
		Interquartile Range	34.56600

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	3.432457	Pr > |t|	0.0265
Sign	M	2.5	Pr >= |M|	0.0625
Signed Rank	S	7.5	Pr >= |S|	0.0625

Quantiles (Definition 5)

Quantile	Estimate
100% Max	54.23770
99%	54.23770
95%	54.23770
90%	54.23770
75% Q3	48.79370
50% Median	44.42360
25% Q1	14.22770
10%	6.02208
5%	6.02208
1%	6.02208
0% Min	6.02208

The SAS System

The UNIVARIATE Procedure
Variable: Interested (Interested)
Group = Sans

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
6.02208	10	6.02208	10
14.22770	9	14.22770	9
44.42360	12	44.42360	12
48.79370	8	48.79370	8
54.23770	7	54.23770	7

The SAS System

The UNIVARIATE Procedure
Variable: Anxious (Anxious)
Group = Avec

Moments

N	6	Sum Weights	6
Mean	7.28491667	Sum Observations	43.7095
Std Deviation	10.7683584	Variance	115.957542
Skewness	2.18047238	Kurtosis	4.92815487
Uncorrected SS	898.207776	Corrected SS	579.787711
Coeff Variation	147.81718	Std Error Mean	4.3961639

Basic Statistical Measures

Location		Variability	
Mean	7.284917	Std Deviation	10.76836
Median	3.298410	Variance	115.95754
Mode	.	Range	28.69310
		Interquartile Range	5.88488

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	1.657108	Pr > |t|	0.1584
Sign	M	2.5	Pr >= |M|	0.0625
Signed Rank	S	7.5	Pr >= |S|	0.0625

Quantiles (Definition 5)

Quantile	Estimate
100% Max	28.69310
99%	28.69310
95%	28.69310
90%	28.69310
75% Q3	7.15223
50% Median	3.29841
25% Q1	1.26735
10%	0.00000
5%	0.00000
1%	0.00000
0% Min	0.00000

The SAS System

The UNIVARIATE Procedure
Variable: Anxious (Anxious)
Group = Avec

Extreme Observations

------Lowest-----		------Highest-----	
Value	Obs	Value	Obs
0.00000	2	1.26735	3
1.26735	3	2.85445	1
2.85445	1	3.74237	6
3.74237	6	7.15223	5
7.15223	5	28.69310	4

The SAS System

The UNIVARIATE Procedure
Variable: Anxious (Anxious)
Group = Sans

Moments

N	5	Sum Weights	5
Mean	14.091416	Sum Observations	70.45708
Std Deviation	7.90958579	Variance	62.5615473
Skewness	1.78375511	Kurtosis	3.47297723
Uncorrected SS	1243.08621	Corrected SS	250.246189
Coeff Variation	56.130525	Std Error Mean	3.5372743

Basic Statistical Measures

Location		Variability	
Mean	14.09142	Std Deviation	7.90959
Median	12.33060	Variance	62.56155
Mode	.	Range	19.96680
		Interquartile Range	3.96092

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	3.983693	Pr > |t|	0.0164
Sign	M	2.5	Pr >= |M|	0.0625
Signed Rank	S	7.5	Pr >= |S|	0.0625

Quantiles (Definition 5)

Quantile	Estimate
100% Max	27.64510
99%	27.64510
95%	27.64510
90%	27.64510
75% Q3	13.38200
50% Median	12.33060
25% Q1	9.42108
10%	7.67830
5%	7.67830
1%	7.67830
0% Min	7.67830

The SAS System

The UNIVARIATE Procedure
Variable: Anxious (Anxious)
Group = Sans

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
7.67830	7	7.67830	7
9.42108	9	9.42108	9
12.33060	8	12.33060	8
13.38200	12	13.38200	12
27.64510	10	27.64510	10

The SAS System

The UNIVARIATE Procedure
Variable: Guidance (Guidance)
Group = Avec

Moments

N	6	Sum Weights	6
Mean	6.18227167	Sum Observations	37.09363
Std Deviation	7.11120006	Variance	50.5691663
Skewness	1.75116447	Kurtosis	3.28510864
Uncorrected SS	482.168729	Corrected SS	252.845831
Coeff Variation	115.025681	Std Error Mean	2.90313527

Basic Statistical Measures

Location		Variability	
Mean	6.182272	Std Deviation	7.11120
Median	3.839940	Variance	50.56917
Mode	.	Range	19.65310
		Interquartile Range	5.83603

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	2.129516	Pr > |t|	0.0865
Sign	M	2.5	Pr >= |M|	0.0625
Signed Rank	S	7.5	Pr >= |S|	0.0625

Quantiles (Definition 5)

Quantile	Estimate
100% Max	19.65310
99%	19.65310
95%	19.65310
90%	19.65310
75% Q3	7.79834
50% Median	3.83994
25% Q1	1.96231
10%	0.00000
5%	0.00000

1%	0.00000
0% Min	0.00000

The SAS System

The UNIVARIATE Procedure
Variable: Guidance (Guidance)
Group = Avec

Extreme Observations

------Lowest-----		------Highest-----	
Value	Obs	Value	Obs
0.00000	1	1.96231	5
1.96231	5	2.89937	6
2.89937	6	4.78051	3
4.78051	3	7.79834	4
7.79834	4	19.65310	2

The SAS System

The UNIVARIATE Procedure
Variable: Guidance (Guidance)
Group = Sans

Moments

N	5	Sum Weights	5
Mean	0.7087484	Sum Observations	3.543742
Std Deviation	1.16357772	Variance	1.35391312
Skewness	1.88805129	Kurtosis	3.51110227
Uncorrected SS	7.92727395	Corrected SS	5.41565248
Coeff Variation	164.173594	Std Error Mean	0.52036778

Basic Statistical Measures

Location		Variability	
Mean	0.708748	Std Deviation	1.16358
Median	0.091074	Variance	1.35391
Mode	0.000000	Range	2.71591
		Interquartile Range	0.73676

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	1.362014	Pr > |t|	0.2449
Sign	M	1.5	Pr >= |M|	0.2500
Signed Rank	S	3	Pr >= |S|	0.2500

Quantiles (Definition 5)

Quantile	Estimate
100% Max	2.715910
99%	2.715910
95%	2.715910
90%	2.715910
75% Q3	0.736758
50% Median	0.091074
25% Q1	0.000000

10%	0.000000
5%	0.000000
1%	0.000000
0% Min	0.000000

The SAS System

The UNIVARIATE Procedure
Variable: Guidance (Guidance)
Group = Sans

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
0.000000	12	0.000000	10
0.000000	10	0.000000	12
0.091074	9	0.091074	9
0.736758	8	0.736758	8
2.715910	7	2.715910	7

The SAS System

The UNIVARIATE Procedure
Variable: Joy (Joy)
Group = Avec

Moments

N	6	Sum Weights	6
Mean	0.15099067	Sum Observations	0.905944
Std Deviation	0.22519231	Variance	0.05071158
Skewness	1.21670144	Kurtosis	-0.2790894
Uncorrected SS	0.39034698	Corrected SS	0.25355789
Coeff Variation	149.143202	Std Error Mean	0.09193438

Basic Statistical Measures

Location		Variability	
Mean	0.150991	Std Deviation	0.22519
Median	0.021701	Variance	0.05071
Mode	0.000000	Range	0.52203
		Interquartile Range	0.34052

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	1.642374	Pr > |t|	0.1614
Sign	M	1.5	Pr >= |M|	0.2500
Signed Rank	S	3	Pr >= |S|	0.2500

Quantiles (Definition 5)

Quantile	Estimate
100% Max	0.5220270
99%	0.5220270
95%	0.5220270
90%	0.5220270
75% Q3	0.3405160

50% Median	0.0217005
25% Q1	0.0000000
10%	0.0000000
5%	0.0000000
1%	0.0000000
0% Min	0.0000000

The SAS System

The UNIVARIATE Procedure
Variable: Joy (Joy)
Group = Avec

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
0.000000	5	0.000000	4
0.000000	4	0.000000	5
0.000000	2	0.043401	1
0.043401	1	0.340516	3
0.340516	3	0.522027	6

The SAS System

The UNIVARIATE Procedure
Variable: Joy (Joy)
Group = Sans

Moments

N	5	Sum Weights	5
Mean	2.586156	Sum Observations	12.93078
Std Deviation	3.7637557	Variance	14.165857
Skewness	1.09823064	Kurtosis	-0.5543266
Uncorrected SS	90.1044422	Corrected SS	56.6634279
Coeff Variation	145.534751	Std Error Mean	1.68320272

Basic Statistical Measures

Location		Variability	
Mean	2.586156	Std Deviation	3.76376
Median	0.000000	Variance	14.16586
Mode	0.000000	Range	8.26843
		Interquartile Range	4.66235

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	1.53645	Pr > |t|	0.1992
Sign	M	1	Pr >= |M|	0.5000
Signed Rank	S	1.5	Pr >= |S|	0.5000

Quantiles (Definition 5)

Quantile	Estimate
100% Max	8.26843
99%	8.26843
95%	8.26843

90%	8.26843
75% Q3	4.66235
50% Median	0.00000
25% Q1	0.00000
10%	0.00000
5%	0.00000
1%	0.00000
0% Min	0.00000

The SAS System

The UNIVARIATE Procedure
Variable: Joy (Joy)
Group = Sans

Extreme Observations

------Lowest-----		-----Highest-----	
Value	Obs	Value	Obs
0.00000	12	0.00000	9
0.00000	10	0.00000	10
0.00000	9	0.00000	12
4.66235	8	4.66235	8
8.26843	7	8.26843	7

The SAS System

The UNIVARIATE Procedure
Variable: Calm (Calm)
Group = Avec

Moments

N	6	Sum Weights	6
Mean	0	Sum Observations	0
Std Deviation	0	Variance	0
Skewness	.	Kurtosis	.
Uncorrected SS	0	Corrected SS	0
Coeff Variation	.	Std Error Mean	0

Basic Statistical Measures

Location		Variability	
Mean	0	Std Deviation	0
Median	0	Variance	0
Mode	0	Range	0
		Interquartile Range	0

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	.	Pr > |t|	.
Sign	M	.	Pr >= |M|	.
Signed Rank	S	.	Pr >= |S|	.

Quantiles (Definition 5)

Quantile	Estimate
100% Max	0

99%	0
95%	0
90%	0
75% Q3	0
50% Median	0
25% Q1	0
10%	0
5%	0
1%	0
0% Min	0

The SAS System

The UNIVARIATE Procedure
Variable: Calm (Calm)
Group = Avec

Extreme Observations

----Lowest----		----Highest---	
Value	Obs	Value	Obs
0	6	0	2
0	5	0	3
0	4	0	4
0	3	0	5
0	2	0	6

The SAS System

The UNIVARIATE Procedure
Variable: Calm (Calm)
Group = Sans

Moments

N	5	Sum Weights	5
Mean	0.1355988	Sum Observations	0.677994
Std Deviation	0.30320813	Variance	0.09193517
Skewness	2.23606798	Kurtosis	5
Uncorrected SS	0.45967586	Corrected SS	0.36774069
Coeff Variation	223.606798	Std Error Mean	0.1355988

Basic Statistical Measures

Location		Variability	
Mean	0.135599	Std Deviation	0.30321
Median	0.000000	Variance	0.09194
Mode	0.000000	Range	0.67799
		Interquartile Range	0

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	1	Pr > |t|	0.3739
Sign	M	0.5	Pr >= |M|	1.0000
Signed Rank	S	0.5	Pr >= |S|	1.0000

Quantiles (Definition 5)

Quantile Estimate

100% Max	0.677994
99%	0.677994
95%	0.677994
90%	0.677994
75% Q3	0.000000
50% Median	0.000000
25% Q1	0.000000
10%	0.000000
5%	0.000000
1%	0.000000
0% Min	0.000000

The SAS System

The UNIVARIATE Procedure
Variable: Calm (Calm)
Group = Sans

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
0.000000	12	0.000000	7
0.000000	10	0.000000	8
0.000000	8	0.000000	10
0.000000	7	0.000000	12
0.677994	9	0.677994	9

The SAS System

The UNIVARIATE Procedure
Variable: Angry2 (Angry2)
Group = Avec

Moments

N	6	Sum Weights	6
Mean	0.13186183	Sum Observations	0.791171
Std Deviation	0.2193833	Variance	0.04812903
Skewness	1.50093023	Kurtosis	1.22835461
Uncorrected SS	0.34497041	Corrected SS	0.24064515
Coeff Variation	166.373612	Std Error Mean	0.08956286

Basic Statistical Measures

Location		Variability	
Mean	0.131862	Std Deviation	0.21938
Median	0.000000	Variance	0.04813
Mode	0.000000	Range	0.52207
		Interquartile Range	0.26911

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	1.472283	Pr > |t|	0.2009
Sign	M	1	Pr >= |M|	0.5000
Signed Rank	S	1.5	Pr >= |S|	0.5000

Quantiles (Definition 5)

Quantile	Estimate
100% Max	0.522066
99%	0.522066
95%	0.522066
90%	0.522066
75% Q3	0.269105
50% Median	0.000000
25% Q1	0.000000
10%	0.000000
5%	0.000000
1%	0.000000
0% Min	0.000000

The SAS System

The UNIVARIATE Procedure
Variable: Angry2 (Angry2)
Group = Avec

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
0.000000	6	0.000000	4
0.000000	5	0.000000	5
0.000000	4	0.000000	6
0.000000	1	0.269105	3
0.269105	3	0.522066	2

The SAS System

The UNIVARIATE Procedure
Variable: Angry2 (Angry2)
Group = Sans

Moments

N	5	Sum Weights	5
Mean	23.5972234	Sum Observations	117.986117
Std Deviation	23.9738733	Variance	574.746599
Skewness	0.41825053	Kurtosis	-1.0598255
Uncorrected SS	5083.13116	Corrected SS	2298.9864
Coeff Variation	101.596162	Std Error Mean	10.7214421

Basic Statistical Measures

Location		Variability	
Mean	23.59722	Std Deviation	23.97387
Median	26.04180	Variance	574.74660
Mode	.	Range	57.04350
		Interquartile Range	32.92298

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	2.200937	Pr > |t|	0.0926
Sign	M	2	Pr >= |M|	0.1250
Signed Rank	S	5	Pr >= |S|	0.1250

Quantiles (Definition 5)

Quantile	Estimate
100% Max	57.043500
99%	57.043500
95%	57.043500
90%	57.043500
75% Q3	33.911900
50% Median	26.041800
25% Q1	0.988917
10%	0.000000
5%	0.000000
1%	0.000000
0% Min	0.000000

The SAS System

The UNIVARIATE Procedure
Variable: Angry2 (Angry2)
Group = Sans

Extreme Observations

-------Lowest------		------Highest------	
Value	Obs	Value	Obs
0.000000	10	0.000000	10
0.988917	8	0.988917	8
26.041800	12	26.041800	12
33.911900	7	33.911900	7
57.043500	9	57.043500	9

Wilcoxon Two-Sample Test

Group (6, 6)

With and without Jessie

The SAS System

The NPAR1WAY Procedure

Wilcoxon Scores (Rank Sums) for Variable Angry
Classified by Variable Group

Group	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
Avec	6	46.0	39.0	6.244998	7.666667
Sans	6	32.0	39.0	6.244998	5.333333

Wilcoxon Two-Sample Test

Statistic (S)	46.0000
Normal Approximation	
Z	1.0408
One-Sided Pr > Z	0.1490
Two-Sided Pr > |Z|	0.2980
t Approximation	
One-Sided Pr > Z	0.1601
Two-Sided Pr > |Z|	0.3203
Exact Test	
One-Sided Pr >= S	0.1548
Two-Sided Pr >= |S - Mean|	0.3095

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test

Chi-Square	1.2564
DF	1
Pr > Chi-Square	0.2623

The SAS System

The NPAR1WAY Procedure

Wilcoxon Scores (Rank Sums) for Variable Angry2
Classified by Variable Group

Group	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
Avec	6	29.0	39.0	5.850408	4.833333
Sans	6	49.0	39.0	5.850408	8.166667

Average scores were used for ties.

Wilcoxon Two-Sample Test

Statistic (S)	29.0000
Normal Approximation	
Z	-1.6238
One-Sided Pr < Z	0.0522
Two-Sided Pr > |Z|	0.1044
t Approximation	
One-Sided Pr < Z	0.0663
Two-Sided Pr > |Z|	0.1327
Exact Test	
One-Sided Pr <= S	0.0498
Two-Sided Pr >= |S - Mean|	0.0996

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test

Chi-Square	2.9216
DF	1
Pr > Chi-Square	0.0874

The SAS System

The NPAR1WAY Procedure

Wilcoxon Scores (Rank Sums) for Variable Anxious
Classified by Variable Group

Group	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
Avec	6	27.0	39.0	6.244998	4.50
Sans	6	51.0	39.0	6.244998	8.50

Wilcoxon Two-Sample Test

Statistic (S)	27.0000
Normal Approximation	
Z	-1.8415
One-Sided Pr < Z	0.0328
Two-Sided Pr > |Z|	0.0656
t Approximation	
One-Sided Pr < Z	0.0463
Two-Sided Pr > |Z|	0.0927
Exact Test	
One-Sided Pr <= S	0.0325
Two-Sided Pr >= |S - Mean|	0.0649

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test

Chi-Square	3.6923
DF	1
Pr > Chi-Square	0.0547

The SAS System

The NPAR1WAY Procedure

Wilcoxon Scores (Rank Sums) for Variable Arousal
Classified by Variable Group

Group	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
Avec	6	47.0	39.0	6.244998	7.833333
Sans	6	31.0	39.0	6.244998	5.166667

Wilcoxon Two-Sample Test

Statistic (S)	47.0000
Normal Approximation	
Z	1.2010
One-Sided Pr > Z	0.1149
Two-Sided Pr > |Z|	0.2298
t Approximation	
One-Sided Pr > Z	0.1275
Two-Sided Pr > |Z|	0.2550
Exact Test	
One-Sided Pr >= S	0.1201
Two-Sided Pr >= |S - Mean|	0.2403

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test

Chi-Square	1.6410
DF	1
Pr > Chi-Square	0.2002

The SAS System

The NPAR1WAY Procedure

Wilcoxon Scores (Rank Sums) for Variable Calm
Classified by Variable Group

Group	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
Avec	6	33.0	39.0	4.062019	5.50
Sans	6	45.0	39.0	4.062019	7.50

Average scores were used for ties.

Wilcoxon Two-Sample Test

Statistic (S)	33.0000
Normal Approximation	
Z	-1.3540
One-Sided Pr < Z	0.0879
Two-Sided Pr > |Z|	0.1757
t Approximation	
One-Sided Pr < Z	0.1014
Two-Sided Pr > |Z|	0.2029
Exact Test	
One-Sided Pr <= S	0.2273
Two-Sided Pr >= |S - Mean|	0.4545

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test

Chi-Square	2.1818
DF	1
Pr > Chi-Square	0.1396

The SAS System

The NPAR1WAY Procedure

Wilcoxon Scores (Rank Sums) for Variable Disengaged
Classified by Variable Group

Group	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
Avec	6	29.0	39.0	6.244998	4.833333
Sans	6	49.0	39.0	6.244998	8.166667

Wilcoxon Two-Sample Test

Statistic (S)	29.0000
Normal Approximation	
Z	-1.5212
One-Sided Pr < Z	0.0641
Two-Sided Pr > |Z|	0.1282
t Approximation	
One-Sided Pr < Z	0.0782
Two-Sided Pr > |Z|	0.1564
Exact Test	
One-Sided Pr <= S	0.0660
Two-Sided Pr >= |S - Mean|	0.1320

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test

Chi-Square	2.5641
DF	1
Pr > Chi-Square	0.1093

The SAS System

The NPAR1WAY Procedure

Wilcoxon Scores (Rank Sums) for Variable Disgusted
Classified by Variable Group

Group	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
Avec	6	51.0	39.0	6.244998	8.50
Sans	6	27.0	39.0	6.244998	4.50

Wilcoxon Two-Sample Test

Statistic (S)	51.0000
Normal Approximation	
Z	1.8415
One-Sided Pr > Z	0.0328
Two-Sided Pr > |Z|	0.0656
t Approximation	
One-Sided Pr > Z	0.0463
Two-Sided Pr > |Z|	0.0927
Exact Test	
One-Sided Pr >= S	0.0325
Two-Sided Pr >= |S - Mean|	0.0649

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test

Chi-Square	3.6923
DF	1
Pr > Chi-Square	0.0547

The SAS System

The NPAR1WAY Procedure

Wilcoxon Scores (Rank Sums) for Variable Encouragement
Classified by Variable Group

Group	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
Avec	6	57.0	39.0	6.201173	9.50
Sans	6	21.0	39.0	6.201173	3.50

Average scores were used for ties.

Wilcoxon Two-Sample Test

Statistic (S)	57.0000
Normal Approximation	
Z	2.8220
One-Sided Pr > Z	0.0024
Two-Sided Pr > |Z|	0.0048
t Approximation	
One-Sided Pr > Z	0.0083
Two-Sided Pr > |Z|	0.0166
Exact Test	
One-Sided Pr >= S	0.0011
Two-Sided Pr >= |S - Mean|	0.0022

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test

Chi-Square	8.4255
DF	1
Pr > Chi-Square	0.0037

The SAS System

The NPAR1WAY Procedure

Wilcoxon Scores (Rank Sums) for Variable Feedback
Classified by Variable Group

Group	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
Avec	6	41.0	39.0	6.244998	6.833333
Sans	6	37.0	39.0	6.244998	6.166667

Wilcoxon Two-Sample Test

Statistic (S)	41.0000
Normal Approximation	
Z	0.2402
One-Sided Pr > Z	0.4051
Two-Sided Pr > |Z|	0.8102
t Approximation	
One-Sided Pr > Z	0.4073
Two-Sided Pr > |Z|	0.8146
Exact Test	
One-Sided Pr >= S	0.4091
Two-Sided Pr >= |S - Mean|	0.8182

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test

Chi-Square	0.1026
DF	1
Pr > Chi-Square	0.7488

The SAS System

The NPAR1WAY Procedure

Wilcoxon Scores (Rank Sums) for Variable frustrated
Classified by Variable Group

Group	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
Avec	5	19.50	30.0	5.464763	3.900
Sans	6	46.50	36.0	5.464763	7.750

Average scores were used for ties.

Wilcoxon Two-Sample Test

Statistic (S)	19.5000
Normal Approximation	
Z	-1.8299
One-Sided Pr < Z	0.0336
Two-Sided Pr > |Z|	0.0673
t Approximation	
One-Sided Pr < Z	0.0486
Two-Sided Pr > |Z|	0.0972
Exact Test	
One-Sided Pr <= S	0.0281
Two-Sided Pr >= |S - Mean|	0.0541

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test

Chi-Square	3.6918
DF	1
Pr > Chi-Square	0.0547

The SAS System

The NPAR1WAY Procedure

Wilcoxon Scores (Rank Sums) for Variable Feedback
Classified by Variable Group

Group	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
Avec	6	41.0	39.0	6.244998	6.833333
Sans	6	37.0	39.0	6.244998	6.166667

Wilcoxon Two-Sample Test

Statistic (S)	41.0000
Normal Approximation	
Z	0.2402
One-Sided Pr > Z	0.4051
Two-Sided Pr > |Z|	0.8102
t Approximation	
One-Sided Pr > Z	0.4073
Two-Sided Pr > |Z|	0.8146
Exact Test	
One-Sided Pr >= S	0.4091
Two-Sided Pr >= |S - Mean|	0.8182

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test

Chi-Square	0.1026
DF	1
Pr > Chi-Square	0.7488

The SAS System

The NPAR1WAY Procedure

Wilcoxon Scores (Rank Sums) for Variable frustrated
Classified by Variable Group

Group	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
Avec	5	19.50	30.0	5.464763	3.900
Sans	6	46.50	36.0	5.464763	7.750

Average scores were used for ties.

Wilcoxon Two-Sample Test

Statistic (S)	19.5000
Normal Approximation	
Z	-1.8299
One-Sided Pr < Z	0.0336
Two-Sided Pr > |Z|	0.0673
t Approximation	
One-Sided Pr < Z	0.0486
Two-Sided Pr > |Z|	0.0972
Exact Test	
One-Sided Pr <= S	0.0281
Two-Sided Pr >= |S - Mean|	0.0541

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test

Chi-Square	3.6918
DF	1
Pr > Chi-Square	0.0547

The SAS System

The NPAR1WAY Procedure

Wilcoxon Scores (Rank Sums) for Variable Guidance
Classified by Variable Group

Group	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
Avec	6	51.50	39.0	6.134848	8.583333
Sans	6	26.50	39.0	6.134848	4.416667

Average scores were used for ties.

Wilcoxon Two-Sample Test

Statistic (S)	51.5000
Normal Approximation	
Z	1.9560
One-Sided Pr > Z	0.0252
Two-Sided Pr > |Z|	0.0505
t Approximation	
One-Sided Pr > Z	0.0382
Two-Sided Pr > |Z|	0.0763
Exact Test	
One-Sided Pr >= S	0.0216
Two-Sided Pr >= |S - Mean|	0.0433

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test

Chi-Square	4.1516
DF	1
Pr > Chi-Square	0.0416

The SAS System

The NPAR1WAY Procedure

Wilcoxon Scores (Rank Sums) for Variable Happy
Classified by Variable Group

Group	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
Avec	6	41.0	39.0	6.244998	6.833333
Sans	6	37.0	39.0	6.244998	6.166667

Wilcoxon Two-Sample Test

Statistic (S)	41.0000
Normal Approximation	
Z	0.2402
One-Sided Pr > Z	0.4051
Two-Sided Pr > |Z|	0.8102
t Approximation	
One-Sided Pr > Z	0.4073
Two-Sided Pr > |Z|	0.8146
Exact Test	
One-Sided Pr >= S	0.4091
Two-Sided Pr >= |S - Mean|	0.8182

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test

Chi-Square	0.1026
DF	1
Pr > Chi-Square	0.7488

The SAS System

The NPAR1WAY Procedure

Wilcoxon Scores (Rank Sums) for Variable Interested
Classified by Variable Group

Group	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
Avec	6	45.0	39.0	6.244998	7.50
Sans	6	33.0	39.0	6.244998	5.50

Wilcoxon Two-Sample Test

Statistic (S)	45.0000
Normal Approximation	
Z	0.8807
One-Sided Pr > Z	0.1892
Two-Sided Pr > |Z|	0.3785
t Approximation	
One-Sided Pr > Z	0.1987
Two-Sided Pr > |Z|	0.3973
Exact Test	
One-Sided Pr >= S	0.1970
Two-Sided Pr >= |S - Mean|	0.3939

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test

Chi-Square	0.9231
DF	1
Pr > Chi-Square	0.3367

The SAS System

The NPAR1WAY Procedure

Wilcoxon Scores (Rank Sums) for Variable Joy
Classified by Variable Group

Group	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
Avec	6	39.0	39.0	5.600325	6.50
Sans	6	39.0	39.0	5.600325	6.50

Average scores were used for ties.

Wilcoxon Two-Sample Test

Statistic (S)	39.0000
Normal Approximation	
Z	0.0000
One-Sided Pr < Z	0.5000
Two-Sided Pr > |Z|	1.0000
t Approximation	
One-Sided Pr < Z	0.5000
Two-Sided Pr > |Z|	1.0000
Exact Test	
One-Sided Pr <= S	0.5379
Two-Sided Pr >= |S - Mean|	1.0000

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test

Chi-Square	0.0000
DF	1
Pr > Chi-Square	1.0000

The SAS System

The NPAR1WAY Procedure

Wilcoxon Scores (Rank Sums) for Variable Neutral
Classified by Variable Group

Group	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
Avec	6	31.0	39.0	6.244998	5.166667
Sans	6	47.0	39.0	6.244998	7.833333

Wilcoxon Two-Sample Test

Statistic (S)	31.0000
Normal Approximation	
Z	-1.2010
One-Sided Pr < Z	0.1149
Two-Sided Pr > |Z|	0.2298
t Approximation	
One-Sided Pr < Z	0.1275
Two-Sided Pr > |Z|	0.2550
Exact Test	
One-Sided Pr <= S	0.1201
Two-Sided Pr >= |S - Mean|	0.2403

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test

Chi-Square	1.6410
DF	1
Pr > Chi-Square	0.2002

The SAS System

The NPAR1WAY Procedure

Wilcoxon Scores (Rank Sums) for Variable Others
Classified by Variable Group

Group	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
Avec	6	45.0	39.0	6.244998	7.50
Sans	6	33.0	39.0	6.244998	5.50

Wilcoxon Two-Sample Test

Statistic (S)	45.0000
Normal Approximation	
Z	0.8807
One-Sided Pr > Z	0.1892
Two-Sided Pr > |Z|	0.3785
t Approximation	
One-Sided Pr > Z	0.1987
Two-Sided Pr > |Z|	0.3973
Exact Test	
One-Sided Pr >= S	0.1970
Two-Sided Pr >= |S - Mean|	0.3939

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test

Chi-Square	0.9231
DF	1
Pr > Chi-Square	0.3367

The SAS System

The NPAR1WAY Procedure

Wilcoxon Scores (Rank Sums) for Variable RawScores
Classified by Variable Group

Group	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
Avec	6	42.0	39.0	6.201173	7.0
Sans	6	36.0	39.0	6.201173	6.0

Average scores were used for ties.

Wilcoxon Two-Sample Test

Statistic (S)	42.0000
Normal Approximation	
Z	0.4031
One-Sided Pr > Z	0.3434
Two-Sided Pr > |Z|	0.6868
t Approximation	
One-Sided Pr > Z	0.3473
Two-Sided Pr > |Z|	0.6946
Exact Test	
One-Sided Pr >= S	0.3496
Two-Sided Pr >= |S - Mean|	0.6991

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test

Chi-Square	0.2340
DF	1
Pr > Chi-Square	0.6285

The SAS System

The NPAR1WAY Procedure

Wilcoxon Scores (Rank Sums) for Variable Sad
Classified by Variable Group

Group	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
Avec	6	43.0	39.0	6.244998	7.166667
Sans	6	35.0	39.0	6.244998	5.833333

Wilcoxon Two-Sample Test

Statistic (S)	43.0000
Normal Approximation	
Z	0.5604
One-Sided Pr > Z	0.2876
Two-Sided Pr > |Z|	0.5752
t Approximation	
One-Sided Pr > Z	0.2932
Two-Sided Pr > |Z|	0.5864
Exact Test	
One-Sided Pr >= S	0.2944
Two-Sided Pr >= |S - Mean|	0.5887

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test

Chi-Square	0.4103
DF	1
Pr > Chi-Square	0.5218

The SAS System

The NPAR1WAY Procedure

Wilcoxon Scores (Rank Sums) for Variable Scared
Classified by Variable Group

Group	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
Avec	6	37.0	39.0	6.244998	6.166667
Sans	6	41.0	39.0	6.244998	6.833333

Wilcoxon Two-Sample Test

Statistic (S)	37.0000
Normal Approximation	
Z	-0.2402
One-Sided Pr < Z	0.4051
Two-Sided Pr > |Z|	0.8102
t Approximation	
One-Sided Pr < Z	0.4073
Two-Sided Pr > |Z|	0.8146
Exact Test	
One-Sided Pr <= S	0.4091
Two-Sided Pr >= |S - Mean|	0.8182

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test

Chi-Square	0.1026
DF	1
Pr > Chi-Square	0.7488

The SAS System

The NPAR1WAY Procedure

Wilcoxon Scores (Rank Sums) for Variable Surprised
Classified by Variable Group

Group	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
Avec	6	32.0	39.0	6.244998	5.333333
Sans	6	46.0	39.0	6.244998	7.666667

Wilcoxon Two-Sample Test

Statistic (S)	32.0000
Normal Approximation	
Z	-1.0408
One-Sided Pr < Z	0.1490
Two-Sided Pr > |Z|	0.2980
t Approximation	
One-Sided Pr < Z	0.1601
Two-Sided Pr > |Z|	0.3203
Exact Test	
One-Sided Pr <= S	0.1548
Two-Sided Pr >= |S - Mean|	0.3095

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test

Chi-Square	1.2564
DF	1
Pr > Chi-Square	0.2623

The SAS System

The NPAR1WAY Procedure

Wilcoxon Scores (Rank Sums) for Variable ScoreCompetences
Classified by Variable Group

Group	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
Avec	6	46.0	39.0	6.201173	7.666667
Sans	6	32.0	39.0	6.201173	5.333333

Average scores were used for ties.

Wilcoxon Two-Sample Test

Statistic (S)	46.0000
Normal Approximation	
Z	1.0482
One-Sided Pr > Z	0.1473
Two-Sided Pr > |Z|	0.2946
t Approximation	
One-Sided Pr > Z	0.1585
Two-Sided Pr > |Z|	0.3170
Exact Test	
One-Sided Pr >= S	0.1548
Two-Sided Pr >= |S - Mean|	0.3095

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test

Chi-Square	1.2742
DF	1
Pr > Chi-Square	0.2590

GROUPE (6, 5)

With and without Jessie

The SAS System

The UNIVARIATE Procedure
Variable: RawScores (RawScores)
Group = Avec

Moments

N	6	Sum Weights	6
Mean	45.5555555	Sum Observations	273.333333
Std Deviation	22.6732016	Variance	514.074073
Skewness	-0.6905959	Kurtosis	-0.8857934
Uncorrected SS	15022.2222	Corrected SS	2570.37036
Coeff Variation	49.7704427	Std Error Mean	9.25629581

Basic Statistical Measures

Location		Variability	
Mean	45.55556	Std Deviation	22.67320
Median	50.00000	Variance	514.07407
Mode	63.33333	Range	56.66667
		Interquartile Range	30.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	4.921575	Pr > |t|	0.0044
Sign	M	3	Pr >= |M|	0.0313
Signed Rank	S	10.5	Pr >= |S|	0.0313

Quantiles (Definition 5)

Quantile	Estimate
100% Max	66.6667
99%	66.6667
95%	66.6667
90%	66.6667
75% Q3	63.3333
50% Median	50.0000
25% Q1	33.3333
10%	10.0000
5%	10.0000
1%	10.0000
0% Min	10.0000

The SAS System

The UNIVARIATE Procedure
Variable: RawScores (RawScores)
Group = Avec

Extreme Observations

------Lowest-----		-----Highest-----	
Value	Obs	Value	Obs
10.0000	2	33.3333	3
33.3333	3	36.6667	4
36.6667	4	63.3333	1

63.3333	5	63.3333	5
63.3333	1	66.6667	6

The SAS System

The UNIVARIATE Procedure
Variable: RawScores (RawScores)
Group = Sans

Moments

N	5	Sum Weights	5
Mean	35.3333334	Sum Observations	176.666667
Std Deviation	23.8746727	Variance	569.999995
Skewness	0.1752709	Kurtosis	-2.1386638
Uncorrected SS	8522.22222	Corrected SS	2279.99998
Coeff Variation	67.5698282	Std Error Mean	10.6770782

Basic Statistical Measures

Location		Variability	
Mean	35.33333	Std Deviation	23.87467
Median	26.66667	Variance	569.99999
Mode	.	Range	56.66667
		Interquartile Range	33.33333

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	3.30927	Pr > |t|	0.0297
Sign	M	2.5	Pr >= |M|	0.0625
Signed Rank	S	7.5	Pr >= |S|	0.0625

Quantiles (Definition 5)

Quantile	Estimate
100% Max	63.33333
99%	63.33333
95%	63.33333
90%	63.33333
75% Q3	56.66667
50% Median	26.66667
25% Q1	23.33333
10%	6.66667
5%	6.66667
1%	6.66667
0% Min	6.66667

The SAS System

The UNIVARIATE Procedure
Variable: RawScores (RawScores)
Group = Sans

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
6.66667	10	6.66667	10

23.33333	12	23.33333	12
26.66667	9	26.66667	9
56.66667	7	56.66667	7
63.33333	8	63.33333	8

The SAS System

The UNIVARIATE Procedure
Variable: ScoreCompetences (ScoreCompetences)
Group = Avec

Moments

N	6	Sum Weights	6
Mean	83.1060605	Sum Observations	498.636363
Std Deviation	11.7416911	Variance	137.86731
Skewness	-2.0690358	Kurtosis	4.58994485
Uncorrected SS	42129.0403	Corrected SS	689.33655
Coeff Variation	14.1285618	Std Error Mean	4.79352532

Basic Statistical Measures

Location		Variability	
Mean	83.10606	Std Deviation	11.74169
Median	86.36364	Variance	137.86731
Mode	86.36364	Range	31.66667
		Interquartile Range	7.57576

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	17.33715	Pr > |t|	<.0001
Sign	M	3	Pr >= |M|	0.0313
Signed Rank	S	10.5	Pr >= |S|	0.0313

Quantiles (Definition 5)

Quantile	Estimate
100% Max	91.6667
99%	91.6667
95%	91.6667
90%	91.6667
75% Q3	90.9091
50% Median	86.3636
25% Q1	83.3333
10%	60.0000
5%	60.0000
1%	60.0000
0% Min	60.0000

The SAS System

The UNIVARIATE Procedure
Variable: ScoreCompetences (ScoreCompetences)
Group = Avec

Extreme Observations

------Lowest-----		-----Highest-----	
Value	Obs	Value	Obs

60.0000	2	83.3333	3
83.3333	3	86.3636	1
86.3636	5	86.3636	5
86.3636	1	90.9091	6
90.9091	6	91.6667	4

The SAS System

The UNIVARIATE Procedure
Variable: ScoreCompetences (ScoreCompetences)
Group = Sans

Moments

N	5	Sum Weights	5
Mean	65.7272726	Sum Observations	328.636363
Std Deviation	17.8647864	Variance	319.150593
Skewness	-0.5192236	Kurtosis	-0.1432096
Uncorrected SS	22876.9742	Corrected SS	1276.60237
Coeff Variation	27.180173	Std Error Mean	7.98937536

Basic Statistical Measures

Location		Variability	
Mean	65.72727	Std Deviation	17.86479
Median	66.66667	Variance	319.15059
Mode	.	Range	46.36364
		Interquartile Range	18.93939

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	8.226835	Pr > |t|	0.0012
Sign	M	2.5	Pr >= |M|	0.0625
Signed Rank	S	7.5	Pr >= |S|	0.0625

Quantiles (Definition 5)

Quantile	Estimate
100% Max	86.3636
99%	86.3636
95%	86.3636
90%	86.3636
75% Q3	77.2727
50% Median	66.6667
25% Q1	58.3333
10%	40.0000
5%	40.0000
1%	40.0000
0% Min	40.0000

The SAS System

The UNIVARIATE Procedure
Variable: ScoreCompetences (ScoreCompetences)
Group = Sans

Extreme Observations

------Lowest----- -----Highest-----

Value	Obs	Value	Obs
40.0000	10	40.0000	10
58.3333	12	58.3333	12
66.6667	9	66.6667	9
77.2727	7	77.2727	7
86.3636	8	86.3636	8

The SAS System

The UNIVARIATE Procedure
Variable: Neutral (Neutral)
Group = Avec

Moments

N	6	Sum Weights	6
Mean	0.279602	Sum Observations	1.677612
Std Deviation	0.0772092	Variance	0.00596126
Skewness	2.06494623	Kurtosis	4.68123531
Uncorrected SS	0.49886997	Corrected SS	0.0298063
Coeff Variation	27.6139654	Std Error Mean	0.03152052

Basic Statistical Measures

Location		Variability	
Mean	0.279602	Std Deviation	0.07721
Median	0.253742	Variance	0.00596
Mode	.	Range	0.21723
		Interquartile Range	0.02963

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	8.870474	Pr > |t|	0.0003
Sign	M	3	Pr >= |M|	0.0313
Signed Rank	S	10.5	Pr >= |S|	0.0313

Quantiles (Definition 5)

Quantile	Estimate
100% Max	0.431670
99%	0.431670
95%	0.431670
90%	0.431670
75% Q3	0.276825
50% Median	0.253742
25% Q1	0.247198
10%	0.214436
5%	0.214436
1%	0.214436
0% Min	0.214436

The SAS System

The UNIVARIATE Procedure
Variable: Neutral (Neutral)
Group = Avec

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
0.214436	2	0.247198	5
0.247198	5	0.249283	1
0.249283	1	0.258200	4
0.258200	4	0.276825	6
0.276825	6	0.431670	3

The SAS System

The UNIVARIATE Procedure
Variable: Neutral (Neutral)
Group = Sans

Moments

N	5	Sum Weights	5
Mean	0.4166702	Sum Observations	2.083351
Std Deviation	0.22969346	Variance	0.05275909
Skewness	1.98327861	Kurtosis	4.26020138
Uncorrected SS	1.07910663	Corrected SS	0.21103635
Coeff Variation	55.1259639	Std Error Mean	0.10272204

Basic Statistical Measures

Location		Variability	
Mean	0.416670	Std Deviation	0.22969
Median	0.341622	Variance	0.05276
Mode	.	Range	0.58422
		Interquartile Range	0.01718

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	4.056288	Pr > |t|	0.0154
Sign	M	2.5	Pr >= |M|	0.0625
Signed Rank	S	7.5	Pr >= |S|	0.0625

Quantiles (Definition 5)

Quantile	Estimate
100% Max	0.818635
99%	0.818635
95%	0.818635
90%	0.818635
75% Q3	0.352930
50% Median	0.341622
25% Q1	0.335751
10%	0.234413
5%	0.234413
1%	0.234413
0% Min	0.234413

The SAS System

The UNIVARIATE Procedure
Variable: Neutral (Neutral)
Group = Sans

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
0.234413	7	0.234413	7
0.335751	12	0.335751	12
0.341622	8	0.341622	8
0.352930	10	0.352930	10
0.818635	9	0.818635	9

The UNIVARIATE Procedure
Variable: Happy (Happy)
Group = Avec

Moments

N	6	Sum Weights	6
Mean	0.10132983	Sum Observations	0.607979
Std Deviation	0.07185974	Variance	0.00516382
Skewness	-0.4648785	Kurtosis	-1.7852311
Uncorrected SS	0.08742552	Corrected SS	0.02581911
Coeff Variation	70.9166641	Std Error Mean	0.02933661

Basic Statistical Measures

Location		Variability	
Mean	0.101330	Std Deviation	0.07186
Median	0.118030	Variance	0.00516
Mode	.	Range	0.17361
		Interquartile Range	0.13841

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	3.45404	Pr > |t|	0.0182
Sign	M	3	Pr >= |M|	0.0313
Signed Rank	S	10.5	Pr >= |S|	0.0313

Quantiles (Definition 5)

Quantile	Estimate
100% Max	0.180943
99%	0.180943
95%	0.180943
90%	0.180943
75% Q3	0.161026
50% Median	0.118030
25% Q1	0.022614
10%	0.007337
5%	0.007337
1%	0.007337
0% Min	0.007337

The UNIVARIATE Procedure

Variable: Happy (Happy)
Group = Avec

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
0.007337	5	0.022614	4
0.022614	4	0.105211	2
0.105211	2	0.130848	3
0.130848	3	0.161026	6
0.161026	6	0.180943	1

The SAS System

The UNIVARIATE Procedure
Variable: Happy (Happy)
Group = Sans

Moments

N	5	Sum Weights	5
Mean	0.103374	Sum Observations	0.51687
Std Deviation	0.07810209	Variance	0.00609994
Skewness	1.95872506	Kurtosis	3.9454049
Uncorrected SS	0.07783066	Corrected SS	0.02439974
Coeff Variation	75.5529306	Std Error Mean	0.03492831

Basic Statistical Measures

Location		Variability	
Mean	0.103374	Std Deviation	0.07810
Median	0.072591	Variance	0.00610
Mode	.	Range	0.19015
		Interquartile Range	0.03790

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	2.959605	Pr > |t|	0.0416
Sign	M	2.5	Pr >= |M|	0.0625
Signed Rank	S	7.5	Pr >= |S|	0.0625

Quantiles (Definition 5)

Quantile	Estimate
100% Max	0.239381
99%	0.239381
95%	0.239381
90%	0.239381
75% Q3	0.096783
50% Median	0.072591
25% Q1	0.058883
10%	0.049232
5%	0.049232
1%	0.049232
0% Min	0.049232

The SAS System

The UNIVARIATE Procedure
Variable: Happy (Happy)
Group = Sans

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
0.049232	7	0.049232	7
0.058883	12	0.058883	12
0.072591	9	0.072591	9
0.096783	8	0.096783	8
0.239381	10	0.239381	10

The SAS System

The UNIVARIATE Procedure
Variable: Sad (Sad)
Group = Avec

Moments

N	6	Sum Weights	6
Mean	0.02138683	Sum Observations	0.128321
Std Deviation	0.0209219	Variance	0.00043773
Skewness	1.61599965	Kurtosis	2.76731226
Uncorrected SS	0.00493301	Corrected SS	0.00218863
Coeff Variation	97.826068	Std Error Mean	0.00854133

Basic Statistical Measures

Location		Variability	
Mean	0.021387	Std Deviation	0.02092
Median	0.016290	Variance	0.0004377
Mode	.	Range	0.05603
		Interquartile Range	0.01888

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	2.503923	Pr > |t|	0.0542
Sign	M	3	Pr >= |M|	0.0313
Signed Rank	S	10.5	Pr >= |S|	0.0313

Quantiles (Definition 5)

Quantile	Estimate
100% Max	0.060381
99%	0.060381
95%	0.060381
90%	0.060381
75% Q3	0.024944
50% Median	0.016290
25% Q1	0.006064
10%	0.004352
5%	0.004352
1%	0.004352
0% Min	0.004352

The SAS System

The UNIVARIATE Procedure
Variable: Sad (Sad)
Group = Avec

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
0.004352	3	0.006064	4
0.006064	4	0.010025	2
0.010025	2	0.022555	6
0.022555	6	0.024944	5
0.024944	5	0.060381	1

The SAS System

The UNIVARIATE Procedure
Variable: Sad (Sad)
Group = Sans

Moments

N	5	Sum Weights	5
Mean	0.0234952	Sum Observations	0.117476
Std Deviation	0.04067886	Variance	0.00165477
Skewness	2.16970279	Kurtosis	4.76112954
Uncorrected SS	0.0093792	Corrected SS	0.00661908
Coeff Variation	173.136905	Std Error Mean	0.01819214

Basic Statistical Measures

Location		Variability	
Mean	0.023495	Std Deviation	0.04068
Median	0.008381	Variance	0.00165
Mode	.	Range	0.09525
		Interquartile Range	0.00952

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	1.291503	Pr > |t|	0.2661
Sign	M	2.5	Pr >= |M|	0.0625
Signed Rank	S	7.5	Pr >= |S|	0.0625

Quantiles (Definition 5)

Quantile	Estimate
100% Max	0.095827
99%	0.095827
95%	0.095827
90%	0.095827
75% Q3	0.011104
50% Median	0.008381
25% Q1	0.001585
10%	0.000579
5%	0.000579
1%	0.000579
0% Min	0.000579

The SAS System

The UNIVARIATE Procedure
Variable: Sad (Sad)
Group = Sans

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
0.000579	9	0.000579	9
0.001585	12	0.001585	12
0.008381	10	0.008381	10
0.011104	8	0.011104	8
0.095827	7	0.095827	7

The SAS System

The UNIVARIATE Procedure
Variable: Angry (Angry)
Group = Avec

Moments

N	6	Sum Weights	6
Mean	0.11397733	Sum Observations	0.683864
Std Deviation	0.11280192	Variance	0.01272427
Skewness	1.02025037	Kurtosis	-0.0403852
Uncorrected SS	0.14156636	Corrected SS	0.06362136
Coeff Variation	98.9687266	Std Error Mean	0.04605119

Basic Statistical Measures

Location		Variability	
Mean	0.113977	Std Deviation	0.11280
Median	0.073971	Variance	0.01272
Mode	.	Range	0.29276
		Interquartile Range	0.15654

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	2.475014	Pr > |t|	0.0562
Sign	M	3	Pr >= |M|	0.0313
Signed Rank	S	10.5	Pr >= |S|	0.0313

Quantiles (Definition 5)

Quantile	Estimate
100% Max	0.300294
99%	0.300294
95%	0.300294
90%	0.300294
75% Q3	0.192315
50% Median	0.073971
25% Q1	0.035777
10%	0.007536
5%	0.007536

1%	0.007536
0% Min	0.007536

The SAS System

The UNIVARIATE Procedure
Variable: Angry (Angry)
Group = Avec

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
0.007536	2	0.035777	1
0.035777	1	0.041378	3
0.041378	3	0.106564	6
0.106564	6	0.192315	4
0.192315	4	0.300294	5

The SAS System

The UNIVARIATE Procedure
Variable: Angry (Angry)
Group = Sans

Moments

N	5	Sum Weights	5
Mean	0.061924	Sum Observations	0.30962
Std Deviation	0.05735696	Variance	0.00328982
Skewness	0.12391699	Kurtosis	-2.0739658
Uncorrected SS	0.03233219	Corrected SS	0.01315929
Coeff Variation	92.6247736	Std Error Mean	0.02565081

Basic Statistical Measures

Location		Variability	
Mean	0.061924	Std Deviation	0.05736
Median	0.068242	Variance	0.00329
Mode	.	Range	0.13056
		Interquartile Range	0.09217

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	2.414114	Pr > |t|	0.0732
Sign	M	2.5	Pr >= |M|	0.0625
Signed Rank	S	7.5	Pr >= |S|	0.0625

Quantiles (Definition 5)

Quantile	Estimate
100% Max	0.134825
99%	0.134825
95%	0.134825
90%	0.134825
75% Q3	0.097230
50% Median	0.068242
25% Q1	0.005056

10%	0.004267
5%	0.004267
1%	0.004267
0% Min	0.004267

The SAS System

The UNIVARIATE Procedure
Variable: Angry (Angry)
Group = Sans

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
0.004267	9	0.004267	9
0.005056	10	0.005056	10
0.068242	7	0.068242	7
0.097230	8	0.097230	8
0.134825	12	0.134825	12

The SAS System

The UNIVARIATE Procedure
Variable: Surprised (Surprised)
Group = Avec

Moments

N	6	Sum Weights	6
Mean	0.20846017	Sum Observations	1.250761
Std Deviation	0.09783797	Variance	0.00957227
Skewness	1.09174299	Kurtosis	2.08910124
Uncorrected SS	0.30859519	Corrected SS	0.04786134
Coeff Variation	46.9336538	Std Error Mean	0.03994219

Basic Statistical Measures

Location		Variability	
Mean	0.208460	Std Deviation	0.09784
Median	0.206856	Variance	0.00957
Mode	.	Range	0.28731
		Interquartile Range	0.07957

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	5.219048	Pr > |t|	0.0034
Sign	M	3	Pr >= |M|	0.0313
Signed Rank	S	10.5	Pr >= |S|	0.0313

Quantiles (Definition 5)

Quantile	Estimate
100% Max	0.381727
99%	0.381727
95%	0.381727
90%	0.381727
75% Q3	0.220238

50% Median	0.206856
25% Q1	0.140665
10%	0.094420
5%	0.094420
1%	0.094420
0% Min	0.094420

The SAS System

The UNIVARIATE Procedure
Variable: Surprised (Surprised)
Group = Avec

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
0.094420	5	0.140665	1
0.140665	1	0.199973	6
0.199973	6	0.213738	3
0.213738	3	0.220238	4
0.220238	4	0.381727	2

The SAS System

The UNIVARIATE Procedure
Variable: Surprised (Surprised)
Group = Sans

Moments

N	5	Sum Weights	5
Mean	0.2354134	Sum Observations	1.177067
Std Deviation	0.05669683	Variance	0.00321453
Skewness	1.12618713	Kurtosis	1.59727852
Uncorrected SS	0.28995547	Corrected SS	0.01285812
Coeff Variation	24.0839449	Std Error Mean	0.02535559

Basic Statistical Measures

Location		Variability	
Mean	0.235413	Std Deviation	0.05670
Median	0.226586	Variance	0.00321
Mode	.	Range	0.14919
		Interquartile Range	0.04289

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	9.284476	Pr > |t|	0.0007
Sign	M	2.5	Pr >= |M|	0.0625
Signed Rank	S	7.5	Pr >= |S|	0.0625

Quantiles (Definition 5)

Quantile	Estimate
100% Max	0.325561
99%	0.325561
95%	0.325561

90%	0.325561
75% Q3	0.245717
50% Median	0.226586
25% Q1	0.202830
10%	0.176373
5%	0.176373
1%	0.176373
0% Min	0.176373

The SAS System

The UNIVARIATE Procedure
Variable: Surprised (Surprised)
Group = Sans

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
0.176373	9	0.176373	9
0.202830	8	0.202830	8
0.226586	12	0.226586	12
0.245717	10	0.245717	10
0.325561	7	0.325561	7

The SAS System

The UNIVARIATE Procedure
Variable: Scared (Scared)
Group = Avec

Moments

N	6	Sum Weights	6
Mean	0.00963933	Sum Observations	0.057836
Std Deviation	0.01392235	Variance	0.00019383
Skewness	2.21929995	Kurtosis	5.08120749
Uncorrected SS	0.00152666	Corrected SS	0.00096916
Coeff Variation	144.432727	Std Error Mean	0.00568378

Basic Statistical Measures

Location		Variability	
Mean	0.009639	Std Deviation	0.01392
Median	0.004245	Variance	0.0001938
Mode	.	Range	0.03701
		Interquartile Range	0.00666

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	1.695938	Pr > |t|	0.1507
Sign	M	3	Pr >= |M|	0.0313
Signed Rank	S	10.5	Pr >= |S|	0.0313

Quantiles (Definition 5)

Quantile	Estimate
100% Max	0.0374280

99%	0.0374280
95%	0.0374280
90%	0.0374280
75% Q3	0.0090790
50% Median	0.0042445
25% Q1	0.0024220
10%	0.0004180
5%	0.0004180
1%	0.0004180
0% Min	0.0004180

The SAS System

The UNIVARIATE Procedure
Variable: Scared (Scared)
Group = Avec

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
0.000418	6	0.002422	2
0.002422	2	0.003437	5
0.003437	5	0.005052	3
0.005052	3	0.009079	4
0.009079	4	0.037428	1

The SAS System

The UNIVARIATE Procedure
Variable: Scared (Scared)
Group = Sans

Moments

N	5	Sum Weights	5
Mean	0.0097334	Sum Observations	0.048667
Std Deviation	0.01206082	Variance	0.00014546
Skewness	1.40987121	Kurtosis	1.31989654
Uncorrected SS	0.00105555	Corrected SS	0.00058185
Coeff Variation	123.911685	Std Error Mean	0.00539376

Basic Statistical Measures

Location		Variability	
Mean	0.009733	Std Deviation	0.01206
Median	0.003016	Variance	0.0001455
Mode	.	Range	0.02909
		Interquartile Range	0.01090

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	1.804566	Pr > |t|	0.1455
Sign	M	2.5	Pr >= |M|	0.0625
Signed Rank	S	7.5	Pr >= |S|	0.0625

Quantiles (Definition 5)

Quantile	Estimate

100% Max	0.029233
99%	0.029233
95%	0.029233
90%	0.029233
75% Q3	0.013588
50% Median	0.003016
25% Q1	0.002689
10%	0.000141
5%	0.000141
1%	0.000141
0% Min	0.000141

The SAS System

The UNIVARIATE Procedure
Variable: Scared (Scared)
Group = Sans

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
0.000141	9	0.000141	9
0.002689	7	0.002689	7
0.003016	8	0.003016	8
0.013588	10	0.013588	10
0.029233	12	0.029233	12

The SAS System

The UNIVARIATE Procedure
Variable: Disgusted (Disgusted)
Group = Avec

Moments

N	6	Sum Weights	6
Mean	0.14326533	Sum Observations	0.859592
Std Deviation	0.07270204	Variance	0.00528559
Skewness	-0.923415	Kurtosis	0.59252373
Uncorrected SS	0.14957767	Corrected SS	0.02642793
Coeff Variation	50.7464282	Std Error Mean	0.02968048

Basic Statistical Measures

Location		Variability	
Mean	0.143265	Std Deviation	0.07270
Median	0.164237	Variance	0.00529
Mode	.	Range	0.20488
		Interquartile Range	0.08297

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	4.82692	Pr > |t|	0.0048
Sign	M	3	Pr >= |M|	0.0313
Signed Rank	S	10.5	Pr >= |S|	0.0313

Quantiles (Definition 5)

Quantile	Estimate
100% Max	0.226781
99%	0.226781
95%	0.226781
90%	0.226781
75% Q3	0.182701
50% Median	0.164237
25% Q1	0.099732
10%	0.021905
5%	0.021905
1%	0.021905
0% Min	0.021905

The SAS System

The UNIVARIATE Procedure
Variable: Disgusted (Disgusted)
Group = Avec

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
0.021905	3	0.099732	6
0.099732	6	0.150186	5
0.150186	5	0.178287	1
0.178287	1	0.182701	2
0.182701	2	0.226781	4

The SAS System

The UNIVARIATE Procedure
Variable: Disgusted (Disgusted)
Group = Sans

Moments

N	5	Sum Weights	5
Mean	0.0580908	Sum Observations	0.290454
Std Deviation	0.06633345	Variance	0.00440013
Skewness	0.92703169	Kurtosis	-0.9971432
Uncorrected SS	0.03447321	Corrected SS	0.0176005
Coeff Variation	114.189247	Std Error Mean	0.02966522

Basic Statistical Measures

Location		Variability	
Mean	0.058091	Std Deviation	0.06633
Median	0.026815	Variance	0.00440
Mode	.	Range	0.15368
		Interquartile Range	0.08886

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	1.958212	Pr > |t|	0.1218
Sign	M	2.5	Pr >= |M|	0.0625
Signed Rank	S	7.5	Pr >= |S|	0.0625

Quantiles (Definition 5)

Quantile	Estimate
100% Max	0.155212
99%	0.155212
95%	0.155212
90%	0.155212
75% Q3	0.097876
50% Median	0.026815
25% Q1	0.009019
10%	0.001532
5%	0.001532
1%	0.001532
0% Min	0.001532

The SAS System

The UNIVARIATE Procedure
Variable: Disgusted (Disgusted)
Group = Sans

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
0.001532	9	0.001532	9
0.009019	10	0.009019	10
0.026815	12	0.026815	12
0.097876	7	0.097876	7
0.155212	8	0.155212	8

The SAS System

The UNIVARIATE Procedure
Variable: Others (Others)
Group = Avec

Moments

N	6	Sum Weights	6
Mean	4.96666667	Sum Observations	29.8
Std Deviation	2.77464712	Variance	7.69866667
Skewness	0.64355662	Kurtosis	-1.8208419
Uncorrected SS	186.5	Corrected SS	38.4933333
Coeff Variation	55.8653783	Std Error Mean	1.13274495

Basic Statistical Measures

Location		Variability	
Mean	4.966667	Std Deviation	2.77465
Median	4.100000	Variance	7.69867
Mode	.	Range	6.40000
		Interquartile Range	5.60000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	4.384629	Pr > |t|	0.0071
Sign	M	3	Pr >= |M|	0.0313

Signed Rank	S	10.5	Pr >= |S|	0.0313

Quantiles (Definition 5)

Quantile	Estimate
100% Max	8.6
99%	8.6
95%	8.6
90%	8.6
75% Q3	8.2
50% Median	4.1
25% Q1	2.6
10%	2.2
5%	2.2
1%	2.2
0% Min	2.2

The SAS System

The UNIVARIATE Procedure
Variable: Others (Others)
Group = Avec

Extreme Observations

----Lowest----		----Highest---	
Value	Obs	Value	Obs
2.2	2	2.6	6
2.6	6	3.9	4
3.9	4	4.3	5
4.3	5	8.2	1
8.2	1	8.6	3

The SAS System

The UNIVARIATE Procedure
Variable: Others (Others)
Group = Sans

Moments

N	5	Sum Weights	5
Mean	2.72	Sum Observations	13.6
Std Deviation	2.89257671	Variance	8.367
Skewness	1.05480953	Kurtosis	-0.3155188
Uncorrected SS	70.46	Corrected SS	33.468
Coeff Variation	106.344732	Std Error Mean	1.29359963

Basic Statistical Measures

Location		Variability	
Mean	2.720000	Std Deviation	2.89258
Median	1.400000	Variance	8.36700
Mode	.	Range	6.80000
		Interquartile Range	3.60000

Tests for Location: Mu0=0

Test	-Statistic-	-----p Value------

Student's t	t	2.10266	Pr > |t|	0.1033
Sign	M	2.5	Pr >= |M|	0.0625
Signed Rank	S	7.5	Pr >= |S|	0.0625

Quantiles (Definition 5)

Quantile	Estimate
100% Max	7.1
99%	7.1
95%	7.1
90%	7.1
75% Q3	4.2
50% Median	1.4
25% Q1	0.6
10%	0.3
5%	0.3
1%	0.3
0% Min	0.3

The SAS System

The UNIVARIATE Procedure
Variable: Others (Others)
Group = Sans

Extreme Observations

----Lowest----		----Highest---	
Value	Obs	Value	Obs
0.3	7	0.3	7
0.6	9	0.6	9
1.4	8	1.4	8
4.2	10	4.2	10
7.1	12	7.1	12

The SAS System

The UNIVARIATE Procedure
Variable: Valence (Valence)
Group = Avec

Moments

N	6	Sum Weights	6
Mean	-0.0387192	Sum Observations	-0.232315
Std Deviation	0.15166514	Variance	0.02300232
Skewness	0.87591498	Kurtosis	-0.1919746
Uncorrected SS	0.12400662	Corrected SS	0.11501158
Coeff Variation	-391.7056	Std Error Mean	0.06191704

Basic Statistical Measures

Location		Variability	
Mean	-0.03872	Std Deviation	0.15167
Median	-0.08524	Variance	0.02300
Mode	.	Range	0.40532
		Interquartile Range	0.20297

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	-0.62534	Pr > |t|	0.5592
Sign	M	-1	Pr >= |M|	0.6875
Signed Rank	S	-2.5	Pr >= |S|	0.6875

Quantiles (Definition 5)

Quantile	Estimate
100% Max	0.206954
99%	0.206954
95%	0.206954
90%	0.206954
75% Q3	0.066278
50% Median	-0.085243
25% Q1	-0.136695
10%	-0.198366
5%	-0.198366
1%	-0.198366
0% Min	-0.198366

The SAS System

The UNIVARIATE Procedure
Variable: Valence (Valence)
Group = Avec

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
-0.198366	1	-0.136695	2
-0.136695	2	-0.131159	6
-0.131159	6	-0.039327	5
-0.039327	5	0.066278	3
0.066278	3	0.206954	4

The SAS System

The UNIVARIATE Procedure
Variable: Valence (Valence)
Group = Sans

Moments

N	5	Sum Weights	5
Mean	-0.1023326	Sum Observations	-0.511663
Std Deviation	0.14559646	Variance	0.02119833
Skewness	-1.1625717	Kurtosis	2.54515677
Uncorrected SS	0.13715312	Corrected SS	0.08479332
Coeff Variation	-142.27769	Std Error Mean	0.06511272

Basic Statistical Measures

Location		Variability	
Mean	-0.10233	Std Deviation	0.14560
Median	-0.08984	Variance	0.02120
Mode	.	Range	0.39857
		Interquartile Range	0.03937

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	-1.57162	Pr > |t|	0.1911
Sign	M	-1.5	Pr >= |M|	0.3750
Signed Rank	S	-5.5	Pr >= |S|	0.1875

Quantiles (Definition 5)

Quantile	Estimate
100% Max	0.060685
99%	0.060685
95%	0.060685
90%	0.060685
75% Q3	-0.052626
50% Median	-0.089837
25% Q1	-0.092000
10%	-0.337885
5%	-0.337885
1%	-0.337885
0% Min	-0.337885

The SAS System

The UNIVARIATE Procedure
Variable: Valence (Valence)
Group = Sans

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
-0.337885	10	-0.337885	10
-0.092000	8	-0.092000	8
-0.089837	7	-0.089837	7
-0.052626	12	-0.052626	12
0.060685	9	0.060685	9

The SAS System

The UNIVARIATE Procedure
Variable: Arousal (Arousal)
Group = Avec

Moments

N	6	Sum Weights	6
Mean	0.483688	Sum Observations	2.902128
Std Deviation	0.03878781	Variance	0.00150449
Skewness	-0.9478721	Kurtosis	1.098605
Uncorrected SS	1.41124696	Corrected SS	0.00752247
Coeff Variation	8.01918054	Std Error Mean	0.01583506

Basic Statistical Measures

Location		Variability	
Mean	0.483688	Std Deviation	0.03879
Median	0.493907	Variance	0.00150
Mode	.	Range	0.11198
		Interquartile Range	0.03861

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	30.54539	Pr > |t|	<.0001
Sign	M	3	Pr >= |M|	0.0313
Signed Rank	S	10.5	Pr >= |S|	0.0313

Quantiles (Definition 5)

Quantile	Estimate
100% Max	0.529737
99%	0.529737
95%	0.529737
90%	0.529737
75% Q3	0.502717
50% Median	0.493907
25% Q1	0.464106
10%	0.417755
5%	0.417755
1%	0.417755
0% Min	0.417755

The SAS System

The UNIVARIATE Procedure
Variable: Arousal (Arousal)
Group = Avec

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
0.417755	3	0.464106	5
0.464106	5	0.486821	6
0.486821	6	0.500992	2
0.500992	2	0.502717	1
0.502717	1	0.529737	4

The SAS System

The UNIVARIATE Procedure
Variable: Arousal (Arousal)
Group = Sans

Moments

N	5	Sum Weights	5
Mean	0.4688	Sum Observations	2.344
Std Deviation	0.02754261	Variance	0.0007586
Skewness	-0.3891129	Kurtosis	-0.1591868
Uncorrected SS	1.10190158	Corrected SS	0.00303438
Coeff Variation	5.8751304	Std Error Mean	0.01231743

Basic Statistical Measures

Location		Variability	
Mean	0.468800	Std Deviation	0.02754
Median	0.471716	Variance	0.0007586

Mode	.	Range	0.07230
		Interquartile Range	0.02810

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	38.05989	Pr > |t|	<.0001
Sign	M	2.5	Pr >= |M|	0.0625
Signed Rank	S	7.5	Pr >= |S|	0.0625

Quantiles (Definition 5)

Quantile	Estimate
100% Max	0.502282
99%	0.502282
95%	0.502282
90%	0.502282
75% Q3	0.484061
50% Median	0.471716
25% Q1	0.455963
10%	0.429978
5%	0.429978
1%	0.429978
0% Min	0.429978

The SAS System

The UNIVARIATE Procedure
Variable: Arousal (Arousal)
Group = Sans

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
0.429978	7	0.429978	7
0.455963	9	0.455963	9
0.471716	12	0.471716	12
0.484061	10	0.484061	10
0.502282	8	0.502282	8

The SAS System

The UNIVARIATE Procedure
Variable: Disengaged (Disengaged)
Group = Avec

Moments

N	6	Sum Weights	6
Mean	9.76794667	Sum Observations	58.60768
Std Deviation	8.08943201	Variance	65.4389103
Skewness	0.21999707	Kurtosis	-1.8543757
Uncorrected SS	899.671244	Corrected SS	327.194551
Coeff Variation	82.8160952	Std Error Mean	3.30249679

Basic Statistical Measures

Location Variability

Mean	9.767947	Std Deviation	8.08943
Median	8.605995	Variance	65.43891
Mode	.	Range	20.44370
		Interquartile Range	13.39961

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	2.957746	Pr > |t|	0.0316
Sign	M	2.5	Pr >= |M|	0.0625
Signed Rank	S	7.5	Pr >= |S|	0.0625

Quantiles (Definition 5)

Quantile	Estimate
100% Max	20.44370
99%	20.44370
95%	20.44370
90%	20.44370
75% Q3	17.17580
50% Median	8.60600
25% Q1	3.77619
10%	0.00000
5%	0.00000
1%	0.00000
0% Min	0.00000

The SAS System

The UNIVARIATE Procedure
Variable: Disengaged (Disengaged)
Group = Avec

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
0.00000	5	3.77619	4
3.77619	4	5.11799	1
5.11799	1	12.09400	3
12.09400	3	17.17580	2
17.17580	2	20.44370	6

The SAS System

The UNIVARIATE Procedure
Variable: Disengaged (Disengaged)
Group = Sans

Moments

N	5	Sum Weights	5
Mean	34.20424	Sum Observations	171.0212
Std Deviation	18.1079575	Variance	327.898126
Skewness	-0.2934502	Kurtosis	-2.6152789
Uncorrected SS	7161.24267	Corrected SS	1311.5925
Coeff Variation	52.9406808	Std Error Mean	8.0981248

Basic Statistical Measures

Location		Variability	
Mean	34.20424	Std Deviation	18.10796
Median	38.68850	Variance	327.89813
Mode	.	Range	41.03970
		Interquartile Range	29.81000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	4.223723	Pr > |t|	0.0134
Sign	M	2.5	Pr >= |M|	0.0625
Signed Rank	S	7.5	Pr >= |S|	0.0625

Quantiles (Definition 5)

Quantile	Estimate
100% Max	53.6536
99%	53.6536
95%	53.6536
90%	53.6536
75% Q3	47.9376
50% Median	38.6885
25% Q1	18.1276
10%	12.6139
5%	12.6139
1%	12.6139
0% Min	12.6139

The SAS System

The UNIVARIATE Procedure
Variable: Disengaged (Disengaged)
Group = Sans

Extreme Observations

------Lowest-----		-----Highest-----	
Value	Obs	Value	Obs
12.6139	7	12.6139	7
18.1276	10	18.1276	10
38.6885	8	38.6885	8
47.9376	12	47.9376	12
53.6536	9	53.6536	9

The SAS System

The UNIVARIATE Procedure
Variable: Feedback (Feedback)
Group = Avec

Moments

N	6	Sum Weights	6
Mean	5.12319833	Sum Observations	30.73919
Std Deviation	3.54738658	Variance	12.5839515
Skewness	0.97524472	Kurtosis	-1.654292
Uncorrected SS	220.402725	Corrected SS	62.9197577
Coeff Variation	69.2416406	Std Error Mean	1.44821451

Basic Statistical Measures

Location		Variability	
Mean	5.123198	Std Deviation	3.54739
Median	3.156685	Variance	12.58395
Mode	.	Range	7.74285
		Interquartile Range	6.49975

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	3.537596	Pr > |t|	0.0166
Sign	M	3	Pr >= |M|	0.0313
Signed Rank	S	10.5	Pr >= |S|	0.0313

Quantiles (Definition 5)

Quantile	Estimate
100% Max	10.18660
99%	10.18660
95%	10.18660
90%	10.18660
75% Q3	9.14761
50% Median	3.15669
25% Q1	2.64786
10%	2.44375
5%	2.44375
1%	2.44375
0% Min	2.44375

The SAS System

The UNIVARIATE Procedure
Variable: Feedback (Feedback)
Group = Avec

Extreme Observations

------Lowest-----		------Highest-----	
Value	Obs	Value	Obs
2.44375	3	2.64786	2
2.64786	2	3.00712	4
3.00712	4	3.30625	5
3.30625	5	9.14761	1
9.14761	1	10.18660	6

The SAS System

The UNIVARIATE Procedure
Variable: Feedback (Feedback)
Group = Sans

Moments

N	5	Sum Weights	5
Mean	3.619232	Sum Observations	18.09616
Std Deviation	1.44856	Variance	2.09832607
Skewness	-1.8915945	Kurtosis	3.70685598
Uncorrected SS	73.8875056	Corrected SS	8.39330428
Coeff Variation	40.0239609	Std Error Mean	0.64781573

Basic Statistical Measures

Location		Variability	
Mean	3.619232	Std Deviation	1.44856
Median	4.118970	Variance	2.09833
Mode	.	Range	3.53498
		Interquartile Range	0.81153

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	5.586823	Pr > |t|	0.0050
Sign	M	2.5	Pr >= |M|	0.0625
Signed Rank	S	7.5	Pr >= |S|	0.0625

Quantiles (Definition 5)

Quantile	Estimate
100% Max	4.64864
99%	4.64864
95%	4.64864
90%	4.64864
75% Q3	4.51321
50% Median	4.11897
25% Q1	3.70168
10%	1.11366
5%	1.11366
1%	1.11366
0% Min	1.11366

The SAS System

The UNIVARIATE Procedure
Variable: Feedback (Feedback)
Group = Sans

Extreme Observations

------Lowest-----		-----Highest-----	
Value	Obs	Value	Obs
1.11366	10	1.11366	10
3.70168	7	3.70168	7
4.11897	8	4.11897	8
4.51321	9	4.51321	9
4.64864	12	4.64864	12

The SAS System

The UNIVARIATE Procedure
Variable: Encouragement (Encouragement)
Group = Avec

Moments

N	6	Sum Weights	6
Mean	26.12295	Sum Observations	156.7377
Std Deviation	9.10216482	Variance	82.8494044
Skewness	-0.4732032	Kurtosis	1.08802688

Uncorrected SS	4508.69812	Corrected SS	414.247022
Coeff Variation	34.8435564	Std Error Mean	3.71594323

Basic Statistical Measures

Location		Variability	
Mean	26.12295	Std Deviation	9.10216
Median	27.31745	Variance	82.84940
Mode	.	Range	27.23330
		Interquartile Range	8.40950

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	7.029965	Pr > |t|	0.0009
Sign	M	3	Pr >= |M|	0.0313
Signed Rank	S	10.5	Pr >= |S|	0.0313

Quantiles (Definition 5)

Quantile	Estimate
100% Max	38.6723
99%	38.6723
95%	38.6723
90%	38.6723
75% Q3	30.2005
50% Median	27.3175
25% Q1	21.7910
10%	11.4390
5%	11.4390
1%	11.4390
0% Min	11.4390

The SAS System

The UNIVARIATE Procedure
Variable: Encouragement (Encouragement)
Group = Avec

Extreme Observations

------Lowest-----		-----Highest-----	
Value	Obs	Value	Obs
11.4390	2	21.7910	4
21.7910	4	26.1140	5
26.1140	5	28.5209	6
28.5209	6	30.2005	1
30.2005	1	38.6723	3

The SAS System

The UNIVARIATE Procedure
Variable: Encouragement (Encouragement)
Group = Sans

Moments

N	5	Sum Weights	5
Mean	1.0791002	Sum Observations	5.395501

Std Deviation	1.64630469	Variance	2.71031913
Skewness	1.7859004	Kurtosis	3.09038254
Uncorrected SS	16.6635627	Corrected SS	10.8412765
Coeff Variation	152.562727	Std Error Mean	0.73624984

Basic Statistical Measures

Location		Variability	
Mean	1.079100	Std Deviation	1.64630
Median	0.295061	Variance	2.71032
Mode	0.000000	Range	3.88612
		Interquartile Range	1.21432

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	1.465671	Pr > |t|	0.2166
Sign	M	1.5	Pr >= |M|	0.2500
Signed Rank	S	3	Pr >= |S|	0.2500

Quantiles (Definition 5)

Quantile	Estimate
100% Max	3.886120
99%	3.886120
95%	3.886120
90%	3.886120
75% Q3	1.214320
50% Median	0.295061
25% Q1	0.000000
10%	0.000000
5%	0.000000
1%	0.000000
0% Min	0.000000

The SAS System

The UNIVARIATE Procedure
Variable: Encouragement (Encouragement)
Group = Sans

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
0.000000	10	0.000000	8
0.000000	8	0.000000	10
0.295061	7	0.295061	7
1.214320	9	1.214320	9
3.886120	12	3.886120	12

The SAS System

The UNIVARIATE Procedure
Variable: frustrated
Group = Avec

Moments

N	5	Sum Weights	5
Mean	2.612788	Sum Observations	13.06394
Std Deviation	1.68667482	Variance	2.84487196
Skewness	-0.9599347	Kurtosis	0.93565057
Uncorrected SS	45.5127935	Corrected SS	11.3794878
Coeff Variation	64.5545993	Std Error Mean	0.75430391

Basic Statistical Measures

Location		Variability	
Mean	2.612788	Std Deviation	1.68667
Median	2.784350	Variance	2.84487
Mode	.	Range	4.37888
		Interquartile Range	1.53389

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	3.46384	Pr > |t|	0.0257
Sign	M	2	Pr >= |M|	0.1250
Signed Rank	S	5	Pr >= |S|	0.1250

Quantiles (Definition 5)

Quantile	Estimate
100% Max	4.37888
99%	4.37888
95%	4.37888
90%	4.37888
75% Q3	3.71730
50% Median	2.78435
25% Q1	2.18341
10%	0.00000
5%	0.00000
1%	0.00000
0% Min	0.00000

The SAS System

The UNIVARIATE Procedure
Variable: frustrated
Group = Avec

Extreme Observations

------Lowest-----		-----Highest-----	
Value	Obs	Value	Obs
0.00000	3	0.00000	3
2.18341	1	2.18341	1
2.78435	2	2.78435	2
3.71730	5	3.71730	5
4.37888	4	4.37888	4

Missing Values

Missing Value	Count	-----Percent Of----- All Obs	Missing Obs

.	1	16.67	100.00

The UNIVARIATE Procedure
Variable: frustrated
Group = Sans

Moments

N	5	Sum Weights	5
Mean	26.814986	Sum Observations	134.07493
Std Deviation	23.7273814	Variance	562.98863
Skewness	0.01393449	Kurtosis	-2.5964372
Uncorrected SS	5847.17189	Corrected SS	2251.95452
Coeff Variation	88.4855261	Std Error Mean	10.6112076

Basic Statistical Measures

Location		Variability	
Mean	26.81499	Std Deviation	23.72738
Median	26.56060	Variance	562.98863
Mode	.	Range	53.77500
		Interquartile Range	40.14967

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	2.527044	Pr > |t|	0.0649
Sign	M	2	Pr >= |M|	0.1250
Signed Rank	S	5	Pr >= |S|	0.1250

Quantiles (Definition 5)

Quantile	Estimate
100% Max	53.77500
99%	53.77500
95%	53.77500
90%	53.77500
75% Q3	46.94450
50% Median	26.56060
25% Q1	6.79483
10%	0.00000
5%	0.00000
1%	0.00000
0% Min	0.00000

The UNIVARIATE Procedure
Variable: frustrated
Group = Sans

Wilcoxon Two-Sample Test
Group (6, 5)
With and without Jessie

The SAS System

The NPAR1WAY Procedure

Wilcoxon Scores (Rank Sums) for Variable Calm
Classified by Variable Group

Group	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
Avec	6	33.0	36.0	2.738613	5.50
Sans	5	33.0	30.0	2.738613	6.60

Average scores were used for ties.

Wilcoxon Two-Sample Test

Statistic (S)	33.0000
Normal Approximation	
Z	0.9129
One-Sided Pr > Z	0.1807
Two-Sided Pr > |Z|	0.3613
t Approximation	
One-Sided Pr > Z	0.1914
Two-Sided Pr > |Z|	0.3828
Exact Test	
One-Sided Pr >= S	0.4545
Two-Sided Pr >= |S - Mean|	0.4545

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test

Chi-Square	1.2000
DF	1
Pr > Chi-Square	0.2733

The NPAR1WAY Procedure

Wilcoxon Scores (Rank Sums) for Variable Angry2
Classified by Variable Group

Group	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
Avec	6	25.0	36.0	5.222330	4.166667
Sans	5	41.0	30.0	5.222330	8.200000

Average scores were used for ties.

Wilcoxon Two-Sample Test

Statistic (S)	41.0000
Normal Approximation	
Z	2.0106
One-Sided Pr > Z	0.0222
Two-Sided Pr > |Z|	0.0444
t Approximation	
One-Sided Pr > Z	0.0361
Two-Sided Pr > |Z|	0.0721
Exact Test	
One-Sided Pr >= S	0.0216
Two-Sided Pr >= |S - Mean|	0.0455

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test

Chi-Square	4.4367
DF	1
Pr > Chi-Square	0.0352

The SAS System

The NPAR1WAY Procedure

Wilcoxon Scores (Rank Sums) for Variable Joy
Classified by Variable Group

Group	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
Avec	6	34.50	36.0	5.022676	5.750
Sans	5	31.50	30.0	5.022676	6.300

Average scores were used for ties.

Wilcoxon Two-Sample Test

Statistic (S)	31.5000
Normal Approximation	
Z	0.1991
One-Sided Pr > Z	0.4211
Two-Sided Pr > |Z|	0.8422
t Approximation	
One-Sided Pr > Z	0.4231
Two-Sided Pr > |Z|	0.8462
Exact Test	
One-Sided Pr >= S	0.4026
Two-Sided Pr >= |S - Mean|	0.8377

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test

Chi-Square	0.0892
DF	1
Pr > Chi-Square	0.7652

The SAS System

The NPAR1WAY Procedure

Wilcoxon Scores (Rank Sums) for Variable Guidance
Classified by Variable Group

Group	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
Avec	6	46.0	36.0	5.427204	7.666667
Sans	5	20.0	30.0	5.427204	4.000000

Average scores were used for ties.

Wilcoxon Two-Sample Test

Statistic (S)	20.0000
Normal Approximation	
Z	-1.7504
One-Sided Pr < Z	0.0400
Two-Sided Pr > |Z|	0.0800
t Approximation	
One-Sided Pr < Z	0.0553
Two-Sided Pr > |Z|	0.1106
Exact Test	
One-Sided Pr <= S	0.0390
Two-Sided Pr >= |S - Mean|	0.0801

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test

Chi-Square	3.3951
DF	1
Pr > Chi-Square	0.0654

The SAS System

The NPAR1WAY Procedure

Wilcoxon Scores (Rank Sums) for Variable Anxious
Classified by Variable Group

Group	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
Avec	6	26.0	36.0	5.477226	4.333333
Sans	5	40.0	30.0	5.477226	8.000000

Wilcoxon Two-Sample Test

Statistic (S)	40.0000
Normal Approximation	
Z	1.7345
One-Sided Pr > Z	0.0414
Two-Sided Pr > |Z|	0.0828
t Approximation	
One-Sided Pr > Z	0.0567
Two-Sided Pr > |Z|	0.1135
Exact Test	
One-Sided Pr >= S	0.0411
Two-Sided Pr >= |S - Mean|	0.0823

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test

Chi-Square	3.3333
DF	1
Pr > Chi-Square	0.0679

The SAS System

The NPAR1WAY Procedure

Wilcoxon Scores (Rank Sums) for Variable Interested
Classified by Variable Group

Group	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
Avec	6	45.0	36.0	5.477226	7.50
Sans	5	21.0	30.0	5.477226	4.20

Wilcoxon Two-Sample Test

Statistic (S)	21.0000
Normal Approximation	
Z	-1.5519
One-Sided Pr < Z	0.0603
Two-Sided Pr > |Z|	0.1207
t Approximation	
One-Sided Pr < Z	0.0759
Two-Sided Pr > |Z|	0.1517
Exact Test	
One-Sided Pr <= S	0.0628
Two-Sided Pr >= |S - Mean|	0.1255

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test

Chi-Square	2.7000
DF	1
Pr > Chi-Square	0.1003

The SAS System

The NPAR1WAY Procedure

Wilcoxon Scores (Rank Sums) for Variable frustrated
Classified by Variable Group

Group	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
Avec	5	19.50	27.50	4.772607	3.90
Sans	5	35.50	27.50	4.772607	7.10

Average scores were used for ties.

Wilcoxon Two-Sample Test

Statistic (S)	19.5000
Normal Approximation	
Z	-1.5715
One-Sided Pr < Z	0.0580
Two-Sided Pr > |Z|	0.1161
t Approximation	
One-Sided Pr < Z	0.0753
Two-Sided Pr > |Z|	0.1505
Exact Test	
One-Sided Pr <= S	0.0516
Two-Sided Pr >= |S - Mean|	0.1032

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test

Chi-Square	2.8098
DF	1
Pr > Chi-Square	0.0937

The SAS System

The NPAR1WAY Procedure

Wilcoxon Scores (Rank Sums) for Variable Encouragement
Classified by Variable Group

Group	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
Avec	6	51.0	36.0	5.464763	8.50
Sans	5	15.0	30.0	5.464763	3.00

Average scores were used for ties.

Wilcoxon Two-Sample Test

Statistic (S)	15.0000
Normal Approximation	
Z	-2.6534
One-Sided Pr < Z	0.0040
Two-Sided Pr > |Z|	0.0080
t Approximation	
One-Sided Pr < Z	0.0121
Two-Sided Pr > |Z|	0.0242
Exact Test	
One-Sided Pr <= S	0.0022
Two-Sided Pr >= |S - Mean|	0.0043

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test

Chi-Square	7.5342
DF	1
Pr > Chi-Square	0.0061

The SAS System

The NPAR1WAY Procedure

Wilcoxon Scores (Rank Sums) for Variable Feedback
Classified by Variable Group

Group	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
Avec	6	35.0	36.0	5.477226	5.833333
Sans	5	31.0	30.0	5.477226	6.200000

Wilcoxon Two-Sample Test

Statistic (S)	31.0000
Normal Approximation	
Z	0.0913
One-Sided Pr > Z	0.4636
Two-Sided Pr > |Z|	0.9273
t Approximation	
One-Sided Pr > Z	0.4645
Two-Sided Pr > |Z|	0.9291
Exact Test	
One-Sided Pr >= S	0.4654
Two-Sided Pr >= |S - Mean|	0.9307

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test

Chi-Square	0.0333
DF	1
Pr > Chi-Square	0.8551

The SAS System

The NPAR1WAY Procedure

Wilcoxon Scores (Rank Sums) for Variable Disengaged
Classified by Variable Group

Group	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
Avec	6	24.0	36.0	5.477226	4.00
Sans	5	42.0	30.0	5.477226	8.40

Wilcoxon Two-Sample Test

Statistic (S)	42.0000
Normal Approximation	
Z	2.0996
One-Sided Pr > Z	0.0179
Two-Sided Pr > |Z|	0.0358
t Approximation	
One-Sided Pr > Z	0.0311
Two-Sided Pr > |Z|	0.0621
Exact Test	
One-Sided Pr >= S	0.0152
Two-Sided Pr >= |S - Mean|	0.0303

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test

Chi-Square	4.8000
DF	1
Pr > Chi-Square	0.0285

The SAS System

The NPAR1WAY Procedure

Wilcoxon Scores (Rank Sums) for Variable Arousal
Classified by Variable Group

Group	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
Avec	6	41.0	36.0	5.477226	6.833333
Sans	5	25.0	30.0	5.477226	5.000000

Wilcoxon Two-Sample Test

Statistic (S)	25.0000
Normal Approximation	
Z	-0.8216
One-Sided Pr < Z	0.2057
Two-Sided Pr > |Z|	0.4113
t Approximation	
One-Sided Pr < Z	0.2152
Two-Sided Pr > |Z|	0.4305
Exact Test	
One-Sided Pr <= S	0.2143
Two-Sided Pr >= |S - Mean|	0.4286

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test

Chi-Square	0.8333
DF	1
Pr > Chi-Square	0.3613

The SAS System

The NPAR1WAY Procedure

Wilcoxon Scores (Rank Sums) for Variable Valence
Classified by Variable Group

Group	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
Avec	6	38.0	36.0	5.477226	6.333333
Sans	5	28.0	30.0	5.477226	5.600000

Wilcoxon Two-Sample Test

Statistic (S)	28.0000
Normal Approximation	
Z	-0.2739
One-Sided Pr < Z	0.3921
Two-Sided Pr > |Z|	0.7842
t Approximation	
One-Sided Pr < Z	0.3949
Two-Sided Pr > |Z|	0.7898
Exact Test	
One-Sided Pr <= S	0.3961
Two-Sided Pr >= |S - Mean|	0.7922

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test

Chi-Square	0.1333
DF	1
Pr > Chi-Square	0.7150

The SAS System

The NPAR1WAY Procedure

Wilcoxon Scores (Rank Sums) for Variable Others
Classified by Variable Group

Group	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
Avec	6	44.0	36.0	5.477226	7.333333
Sans	5	22.0	30.0	5.477226	4.400000

Wilcoxon Two-Sample Test

Statistic (S)	22.0000
Normal Approximation	
Z	-1.3693
One-Sided Pr < Z	0.0855
Two-Sided Pr > |Z|	0.1709
t Approximation	
One-Sided Pr < Z	0.1004
Two-Sided Pr > |Z|	0.2009
Exact Test	
One-Sided Pr <= S	0.0887
Two-Sided Pr >= |S - Mean|	0.1775

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test

Chi-Square	2.1333
DF	1
Pr > Chi-Square	0.1441

The SAS System

The NPAR1WAY Procedure

Wilcoxon Scores (Rank Sums) for Variable Disgusted
Classified by Variable Group

Group	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
Avec	6	46.0	36.0	5.477226	7.666667
Sans	5	20.0	30.0	5.477226	4.000000

Wilcoxon Two-Sample Test

Statistic (S)	20.0000
Normal Approximation	
Z	-1.7345
One-Sided Pr < Z	0.0414
Two-Sided Pr > |Z|	0.0828
t Approximation	
One-Sided Pr < Z	0.0567
Two-Sided Pr > |Z|	0.1135
Exact Test	
One-Sided Pr <= S	0.0411
Two-Sided Pr >= |S - Mean|	0.0823

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test

Chi-Square	3.3333
DF	1
Pr > Chi-Square	0.0679

The NPAR1WAY Procedure

Wilcoxon Scores (Rank Sums) for Variable Scared
Classified by Variable Group

Group	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
Avec	6	37.0	36.0	5.477226	6.166667
Sans	5	29.0	30.0	5.477226	5.800000

Wilcoxon Two-Sample Test

Statistic (S)	29.0000
Normal Approximation	
Z	-0.0913
One-Sided Pr < Z	0.4636
Two-Sided Pr > |Z|	0.9273
t Approximation	
One-Sided Pr < Z	0.4645
Two-Sided Pr > |Z|	0.9291
Exact Test	
One-Sided Pr <= S	0.4654
Two-Sided Pr >= |S - Mean|	0.9307

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test

Chi-Square	0.0333
DF	1
Pr > Chi-Square	0.8551

The NPAR1WAY Procedure

Wilcoxon Scores (Rank Sums) for Variable Surprised
Classified by Variable Group

Group	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
Avec	6	31.0	36.0	5.477226	5.166667
Sans	5	35.0	30.0	5.477226	7.000000

Wilcoxon Two-Sample Test

Statistic (S)	35.0000
Normal Approximation	
Z	0.8216
One-Sided Pr > Z	0.2057
Two-Sided Pr > |Z|	0.4113
t Approximation	
One-Sided Pr > Z	0.2152
Two-Sided Pr > |Z|	0.4305
Exact Test	
One-Sided Pr >= S	0.2143
Two-Sided Pr >= |S - Mean|	0.4286

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test

Chi-Square	0.8333
DF	1
Pr > Chi-Square	0.3613

The SAS System

The NPAR1WAY Procedure

Wilcoxon Scores (Rank Sums) for Variable Angry
Classified by Variable Group

Group	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
Avec	6	41.0	36.0	5.477226	6.833333
Sans	5	25.0	30.0	5.477226	5.000000

Wilcoxon Two-Sample Test

Statistic (S)	25.0000
Normal Approximation	
Z	-0.8216
One-Sided Pr < Z	0.2057
Two-Sided Pr > |Z|	0.4113
t Approximation	
One-Sided Pr < Z	0.2152
Two-Sided Pr > |Z|	0.4305
Exact Test	
One-Sided Pr <= S	0.2143
Two-Sided Pr >= |S - Mean|	0.4286

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test

Chi-Square	0.8333
DF	1
Pr > Chi-Square	0.3613

The NPAR1WAY Procedure

Wilcoxon Scores (Rank Sums) for Variable Sad
Classified by Variable Group

Group	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
Avec	6	40.0	36.0	5.477226	6.666667
Sans	5	26.0	30.0	5.477226	5.200000

Wilcoxon Two-Sample Test

Statistic (S)	26.0000
Normal Approximation	
Z	-0.6390
One-Sided Pr < Z	0.2614
Two-Sided Pr > |Z|	0.5228
t Approximation	
One-Sided Pr < Z	0.2686
Two-Sided Pr > |Z|	0.5372
Exact Test	
One-Sided Pr <= S	0.2684
Two-Sided Pr >= |S - Mean|	0.5368

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test

Chi-Square	0.5333
DF	1
Pr > Chi-Square	0.4652

The NPAR1WAY Procedure

Wilcoxon Scores (Rank Sums) for Variable Happy
Classified by Variable Group

Group	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
Avec	6	37.0	36.0	5.477226	6.166667
Sans	5	29.0	30.0	5.477226	5.800000

Wilcoxon Two-Sample Test

Statistic (S)	29.0000
Normal Approximation	
Z	-0.0913
One-Sided Pr < Z	0.4636
Two-Sided Pr > |Z|	0.9273
t Approximation	
One-Sided Pr < Z	0.4645
Two-Sided Pr > |Z|	0.9291
Exact Test	
One-Sided Pr <= S	0.4654
Two-Sided Pr >= |S - Mean|	0.9307

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test

Chi-Square	0.0333
DF	1
Pr > Chi-Square	0.8551

The SAS System

The NPAR1WAY Procedure

Wilcoxon Scores (Rank Sums) for Variable **Neutral**
Classified by Variable Group

Group	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
Avec	6	29.0	36.0	5.477226	4.833333
Sans	5	37.0	30.0	5.477226	7.400000

Wilcoxon Two-Sample Test

Statistic (S)	**37.0000**
Normal Approximation	
Z	1.1867
One-Sided Pr > Z	0.1177
Two-Sided Pr > |Z|	0.2353
t Approximation	
One-Sided Pr > Z	0.1314
Two-Sided Pr > |Z|	0.2628
Exact Test	
One-Sided Pr >= S	0.1234
Two-Sided Pr >= |S - Mean|	**0.2468**

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test

Chi-Square	1.6333
DF	1
Pr > Chi-Square	0.2012

The SAS System

The NPAR1WAY Procedure

Wilcoxon Scores (Rank Sums) for Variable **RawScores**
Classified by Variable Group

Group	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
Avec	6	42.0	36.0	5.427204	7.00
Sans	5	24.0	30.0	5.427204	4.80

Average scores were used for ties.

Wilcoxon Two-Sample Test

Statistic (S)	**24.0000**
Normal Approximation	
Z	-1.0134
One-Sided Pr < Z	0.1554
Two-Sided Pr > |Z|	0.3109
t Approximation	
One-Sided Pr < Z	0.1674
Two-Sided Pr > |Z|	0.3348
Exact Test	
One-Sided Pr <= S	0.1623
Two-Sided Pr >= |S - Mean|	**0.3268**

Z includes a continuity correction of 0.5.

Kruskal-Wallis Test

Chi-Square	1.2222
DF	1
Pr > Chi-Square	0.2689

3.30625	5	9.14761	1
9.14761	1	10.18660	6

The SAS System

The UNIVARIATE Procedure
Variable: Feedback (Feedback)
Group = Sans

Moments

N	6	Sum Weights	6
Mean	3.01602667	Sum Observations	18.09616
Std Deviation	1.96514653	Variance	3.8618009
Skewness	-0.9862168	Kurtosis	-1.102296
Uncorrected SS	73.8875056	Corrected SS	19.3090045
Coeff Variation	65.1568024	Std Error Mean	0.80226771

Basic Statistical Measures

Location		Variability	
Mean	3.016027	Std Deviation	1.96515
Median	3.910325	Variance	3.86180
Mode	.	Range	4.64864
		Interquartile Range	3.39955

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	3.759377	Pr > |t|	0.0132
Sign	M	2.5	Pr >= |M|	0.0625
Signed Rank	S	7.5	Pr >= |S|	0.0625

Quantiles (Definition 5)

Quantile	Estimate
100% Max	4.64864
99%	4.64864
95%	4.64864
90%	4.64864
75% Q3	4.51321
50% Median	3.91033
25% Q1	1.11366
10%	0.00000
5%	0.00000
1%	0.00000
0% Min	0.00000

The SAS System

The UNIVARIATE Procedure
Variable: Feedback (Feedback)
Group = Sans

Extreme Observations

------Lowest-----		-----Highest-----	
Value	Obs	Value	Obs
0.00000	11	1.11366	10

1.11366	10	3.70168	7
3.70168	7	4.11897	8
4.11897	8	4.51321	9
4.51321	9	4.64864	12

The SAS System

The UNIVARIATE Procedure
Variable: Encouragement (Encouragement)
Group = Avec

Moments

N	6	Sum Weights	6
Mean	26.12295	Sum Observations	156.7377
Std Deviation	9.10216482	Variance	82.8494044
Skewness	-0.4732032	Kurtosis	1.08802688
Uncorrected SS	4508.69812	Corrected SS	414.247022
Coeff Variation	34.8435564	Std Error Mean	3.71594323

Basic Statistical Measures

Location		Variability	
Mean	26.12295	Std Deviation	9.10216
Median	27.31745	Variance	82.84940
Mode	.	Range	27.23330
		Interquartile Range	8.40950

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	7.029965	Pr > |t|	0.0009
Sign	M	3	Pr >= |M|	0.0313
Signed Rank	S	10.5	Pr >= |S|	0.0313

Quantiles (Definition 5)

Quantile	Estimate
100% Max	38.6723
99%	38.6723
95%	38.6723
90%	38.6723
75% Q3	30.2005
50% Median	27.3175
25% Q1	21.7910
10%	11.4390
5%	11.4390
1%	11.4390
0% Min	11.4390

The SAS System

The UNIVARIATE Procedure
Variable: Encouragement (Encouragement)
Group = Avec

Extreme Observations

------Lowest-----		-----Highest-----	
Value	Obs	Value	Obs
11.4390	2	21.7910	4
21.7910	4	26.1140	5
26.1140	5	28.5209	6

28.5209	6	30.2005	1
30.2005	1	38.6723	3

The SAS System

The UNIVARIATE Procedure
Variable: Encouragement (Encouragement)
Group = Sans

Moments

N	6	Sum Weights	6
Mean	0.89925017	Sum Observations	5.395501
Std Deviation	1.5369878	Variance	2.36233151
Skewness	2.00581561	Kurtosis	3.9974923
Uncorrected SS	16.6635627	Corrected SS	11.8116575
Coeff Variation	170.918823	Std Error Mean	0.62747264

Basic Statistical Measures

Location		Variability	
Mean	0.899250	Std Deviation	1.53699
Median	0.147531	Variance	2.36233
Mode	0.000000	Range	3.88612
		Interquartile Range	1.21432

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	1.43313	Pr > |t|	0.2113
Sign	M	1.5	Pr >= |M|	0.2500
Signed Rank	S	3	Pr >= |S|	0.2500

Quantiles (Definition 5)

Quantile	Estimate
100% Max	3.886120
99%	3.886120
95%	3.886120
90%	3.886120
75% Q3	1.214320
50% Median	0.147531
25% Q1	0.000000
10%	0.000000
5%	0.000000
1%	0.000000
0% Min	0.000000

The SAS System

The UNIVARIATE Procedure
Variable: Encouragement (Encouragement)
Group = Sans

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
0.000000	11	0.000000	10

0.000000	10	0.000000	11
0.000000	8	0.295061	7
0.295061	7	1.214320	9
1.214320	9	3.886120	12

The SAS System

The UNIVARIATE Procedure
Variable: Disgusted (Disgusted)
Group = Avec

Moments

N	6	Sum Weights	6
Mean	0.14326533	Sum Observations	0.859592
Std Deviation	0.07270204	Variance	0.00528559
Skewness	-0.923415	Kurtosis	0.59252373
Uncorrected SS	0.14957767	Corrected SS	0.02642793
Coeff Variation	50.7464282	Std Error Mean	0.02968048

Basic Statistical Measures

Location		Variability	
Mean	0.143265	Std Deviation	0.07270
Median	0.164237	Variance	0.00529
Mode	.	Range	0.20488
		Interquartile Range	0.08297

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	4.82692	Pr > |t|	0.0048
Sign	M	3	Pr >= |M|	0.0313
Signed Rank	S	10.5	Pr >= |S|	0.0313

Quantiles (Definition 5)

Quantile	Estimate
100% Max	0.226781
99%	0.226781
95%	0.226781
90%	0.226781
75% Q3	0.182701
50% Median	0.164237
25% Q1	0.099732
10%	0.021905
5%	0.021905
1%	0.021905
0% Min	0.021905

The SAS System

The UNIVARIATE Procedure
Variable: Disgusted (Disgusted)
Group = Avec

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
0.021905	3	0.099732	6
0.099732	6	0.150186	5
0.150186	5	0.178287	1

0.178287	1	0.182701	2
0.182701	2	0.226781	4

The SAS System

The UNIVARIATE Procedure
Variable: Disgusted (Disgusted)
Group = Sans

Moments

N	6	Sum Weights	6
Mean	0.05383617	Sum Observations	0.323017
Std Deviation	0.06023879	Variance	0.00362871
Skewness	1.18687799	Kurtosis	0.2162956
Uncorrected SS	0.03553356	Corrected SS	0.01814356
Coeff Variation	111.8928	Std Error Mean	0.02459238

Basic Statistical Measures

Location		Variability	
Mean	0.053836	Std Deviation	0.06024
Median	0.029689	Variance	0.00363
Mode	.	Range	0.15368
		Interquartile Range	0.08886

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	2.18914	Pr > |t|	0.0802
Sign	M	3	Pr >= |M|	0.0313
Signed Rank	S	10.5	Pr >= |S|	0.0313

Quantiles (Definition 5)

Quantile	Estimate
100% Max	0.155212
99%	0.155212
95%	0.155212
90%	0.155212
75% Q3	0.097876
50% Median	0.029689
25% Q1	0.009019
10%	0.001532
5%	0.001532
1%	0.001532
0% Min	0.001532

The SAS System

The UNIVARIATE Procedure
Variable: Disgusted (Disgusted)
Group = Sans

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
0.001532	9	0.009019	10

0.009019	10	0.026815	12
0.026815	12	0.032563	11
0.032563	11	0.097876	7
0.097876	7	0.155212	8

The SAS System

The UNIVARIATE Procedure
Variable: Disengaged (Disengaged)
Group = Avec

Moments

N	6	Sum Weights	6
Mean	9.76794667	Sum Observations	58.60768
Std Deviation	8.08943201	Variance	65.4389103
Skewness	0.21999707	Kurtosis	-1.8543757
Uncorrected SS	899.671244	Corrected SS	327.194551
Coeff Variation	82.8160952	Std Error Mean	3.30249679

Basic Statistical Measures

Location		Variability	
Mean	9.767947	Std Deviation	8.08943
Median	8.605995	Variance	65.43891
Mode	.	Range	20.44370
		Interquartile Range	13.39961

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	2.957746	Pr > |t|	0.0316
Sign	M	2.5	Pr >= |M|	0.0625
Signed Rank	S	7.5	Pr >= |S|	0.0625

Quantiles (Definition 5)

Quantile	Estimate
100% Max	20.44370
99%	20.44370
95%	20.44370
90%	20.44370
75% Q3	17.17580
50% Median	8.60600
25% Q1	3.77619
10%	0.00000
5%	0.00000
1%	0.00000
0% Min	0.00000

The SAS System

The UNIVARIATE Procedure
Variable: Disengaged (Disengaged)
Group = Avec

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
0.00000	5	3.77619	4
3.77619	4	5.11799	1
5.11799	1	12.09400	3

12.09400	3	17.17580	2
17.17580	2	20.44370	6

The SAS System

The UNIVARIATE Procedure
Variable: Disengaged (Disengaged)
Group = Sans

Moments

N	6	Sum Weights	6
Mean	28.5794928	Sum Observations	171.476957
Std Deviation	21.2637058	Variance	452.145185
Skewness	-0.1062209	Kurtosis	-1.9745425
Uncorrected SS	7161.45039	Corrected SS	2260.72592
Coeff Variation	74.4019705	Std Error Mean	8.68087155

Basic Statistical Measures

Location		Variability	
Mean	28.57949	Std Deviation	21.26371
Median	28.40805	Variance	452.14518
Mode	.	Range	53.19784
		Interquartile Range	35.32370

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	3.292238	Pr > |t|	0.0217
Sign	M	3	Pr >= |M|	0.0313
Signed Rank	S	10.5	Pr >= |S|	0.0313

Quantiles (Definition 5)

Quantile	Estimate
100% Max	53.653600
99%	53.653600
95%	53.653600
90%	53.653600
75% Q3	47.937600
50% Median	28.408050
25% Q1	12.613900
10%	0.455757
5%	0.455757
1%	0.455757
0% Min	0.455757

The SAS System

The UNIVARIATE Procedure
Variable: Disengaged (Disengaged)
Group = Sans

Extreme Observations

-------Lowest------		-----Highest-----	
Value	Obs	Value	Obs
0.455757	11	12.6139	7

12.613900	7	18.1276	10
18.127600	10	38.6885	8
38.688500	8	47.9376	12
47.937600	12	53.6536	9

The SAS System

The UNIVARIATE Procedure
Variable: Arousal (Arousal)
Group = Avec

Moments

N	6	Sum Weights	6
Mean	0.483688	Sum Observations	2.902128
Std Deviation	0.03878781	Variance	0.00150449
Skewness	-0.9478721	Kurtosis	1.098605
Uncorrected SS	1.41124696	Corrected SS	0.00752247
Coeff Variation	8.01918054	Std Error Mean	0.01583506

Basic Statistical Measures

Location		Variability	
Mean	0.483688	Std Deviation	0.03879
Median	0.493907	Variance	0.00150
Mode	.	Range	0.11198
		Interquartile Range	0.03861

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	30.54539	Pr > |t|	<.0001
Sign	M	3	Pr >= |M|	0.0313
Signed Rank	S	10.5	Pr >= |S|	0.0313

Quantiles (Definition 5)

Quantile	Estimate
100% Max	0.529737
99%	0.529737
95%	0.529737
90%	0.529737
75% Q3	0.502717
50% Median	0.493907
25% Q1	0.464106
10%	0.417755
5%	0.417755
1%	0.417755
0% Min	0.417755

The SAS System

The UNIVARIATE Procedure
Variable: Arousal (Arousal)
Group = Avec

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
0.417755	3	0.464106	5
0.464106	5	0.486821	6
0.486821	6	0.500992	2

0.500992	2	0.502717	1
0.502717	1	0.529737	4

The SAS System

The UNIVARIATE Procedure
Variable: Arousal (Arousal)
Group = Sans

Moments

N	6	Sum Weights	6
Mean	0.44773033	Sum Observations	2.686382
Std Deviation	0.05718795	Variance	0.00327046
Skewness	-1.5240183	Kurtosis	2.53309007
Uncorrected SS	1.21912702	Corrected SS	0.01635231
Coeff Variation	12.7728555	Std Error Mean	0.02334688

Basic Statistical Measures

Location		Variability	
Mean	0.447730	Std Deviation	0.05719
Median	0.463840	Variance	0.00327
Mode	.	Range	0.15990
		Interquartile Range	0.05408

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	19.17731	Pr > |t|	<.0001
Sign	M	3	Pr >= |M|	0.0313
Signed Rank	S	10.5	Pr >= |S|	0.0313

Quantiles (Definition 5)

Quantile	Estimate
100% Max	0.502282
99%	0.502282
95%	0.502282
90%	0.502282
75% Q3	0.484061
50% Median	0.463840
25% Q1	0.429978
10%	0.342382
5%	0.342382
1%	0.342382
0% Min	0.342382

The SAS System

The UNIVARIATE Procedure
Variable: Arousal (Arousal)
Group = Sans

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
0.342382	11	0.429978	7

0.429978	7	0.455963	9
0.455963	9	0.471716	12
0.471716	12	0.484061	10
0.484061	10	0.502282	8

The SAS System

The UNIVARIATE Procedure
Variable: Angry2 (Angry2)
Group = Avec

Moments

N	6	Sum Weights	6
Mean	0.13186183	Sum Observations	0.791171
Std Deviation	0.2193833	Variance	0.04812903
Skewness	1.50093023	Kurtosis	1.22835461
Uncorrected SS	0.34497041	Corrected SS	0.24064515
Coeff Variation	166.373612	Std Error Mean	0.08956286

Basic Statistical Measures

Location		Variability	
Mean	0.131862	Std Deviation	0.21938
Median	0.000000	Variance	0.04813
Mode	0.000000	Range	0.52207
		Interquartile Range	0.26911

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	1.472283	Pr > |t|	0.2009
Sign	M	1	Pr >= |M|	0.5000
Signed Rank	S	1.5	Pr >= |S|	0.5000

Quantiles (Definition 5)

Quantile	Estimate
100% Max	0.522066
99%	0.522066
95%	0.522066
90%	0.522066
75% Q3	0.269105
50% Median	0.000000
25% Q1	0.000000
10%	0.000000
5%	0.000000
1%	0.000000
0% Min	0.000000

The SAS System

The UNIVARIATE Procedure
Variable: Angry2 (Angry2)
Group = Avec

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
0.000000	6	0.000000	4
0.000000	5	0.000000	5
0.000000	4	0.000000	6

0.000000	1	0.269105	3
0.269105	3	0.522066	2

The SAS System

The UNIVARIATE Procedure
Variable: Angry2 (Angry2)
Group = Sans

Moments

N	6	Sum Weights	6
Mean	19.6643528	Sum Observations	117.986117
Std Deviation	23.5074904	Variance	552.602105
Skewness	0.77726541	Kurtosis	-0.7124143
Uncorrected SS	5083.13116	Corrected SS	2763.01052
Coeff Variation	119.543677	Std Error Mean	9.59689277

Basic Statistical Measures

Location		Variability	
Mean	19.66435	Std Deviation	23.50749
Median	13.51536	Variance	552.60210
Mode	0.00000	Range	57.04350
		Interquartile Range	33.91190

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	2.049033	Pr > |t|	0.0958
Sign	M	2	Pr >= |M|	0.1250
Signed Rank	S	5	Pr >= |S|	0.1250

Quantiles (Definition 5)

Quantile	Estimate
100% Max	57.0435
99%	57.0435
95%	57.0435
90%	57.0435
75% Q3	33.9119
50% Median	13.5154
25% Q1	0.0000
10%	0.0000
5%	0.0000
1%	0.0000
0% Min	0.0000

The SAS System

The UNIVARIATE Procedure
Variable: Angry2 (Angry2)
Group = Sans

Extreme Observations

-------Lowest------		------Highest------	
Value	Obs	Value	Obs
0.000000	11	0.000000	11

0.000000	10	0.988917	8
0.988917	8	26.041800	12
26.041800	12	33.911900	7
33.911900	7	57.043500	9

The SAS System

The UNIVARIATE Procedure
Variable: Anxious (Anxious)
Group = Avec

Moments

N	6	Sum Weights	6
Mean	7.28491667	Sum Observations	43.7095
Std Deviation	10.7683584	Variance	115.957542
Skewness	2.18047238	Kurtosis	4.92815487
Uncorrected SS	898.207776	Corrected SS	579.787711
Coeff Variation	147.81718	Std Error Mean	4.3961639

Basic Statistical Measures

Location		Variability	
Mean	7.284917	Std Deviation	10.76836
Median	3.298410	Variance	115.95754
Mode	.	Range	28.69310
		Interquartile Range	5.88488

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	1.657108	Pr > |t|	0.1584
Sign	M	2.5	Pr >= |M|	0.0625
Signed Rank	S	7.5	Pr >= |S|	0.0625

Quantiles (Definition 5)

Quantile	Estimate
100% Max	28.69310
99%	28.69310
95%	28.69310
90%	28.69310
75% Q3	7.15223
50% Median	3.29841
25% Q1	1.26735
10%	0.00000
5%	0.00000
1%	0.00000
0% Min	0.00000

The SAS System

The UNIVARIATE Procedure
Variable: Anxious (Anxious)
Group = Avec

Extreme Observations

------Lowest-----		------Highest-----	
Value	Obs	Value	Obs
0.00000	2	1.26735	3
1.26735	3	2.85445	1
2.85445	1	3.74237	6

3.74237	6	7.15223	5
7.15223	5	28.69310	4

The SAS System

The UNIVARIATE Procedure
Variable: Anxious (Anxious)
Group = Sans

Moments

N	6	Sum Weights	6
Mean	13.0900733	Sum Observations	78.54044
Std Deviation	7.48768059	Variance	56.0653607
Skewness	1.96498171	Kurtosis	4.11587259
Uncorrected SS	1308.42692	Corrected SS	280.326803
Coeff Variation	57.201212	Std Error Mean	3.0568328

Basic Statistical Measures

Location		Variability	
Mean	13.09007	Std Deviation	7.48768
Median	10.87584	Variance	56.06536
Mode	.	Range	19.96680
		Interquartile Range	5.29864

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	4.282234	Pr > |t|	0.0078
Sign	M	3	Pr >= |M|	0.0313
Signed Rank	S	10.5	Pr >= |S|	0.0313

Quantiles (Definition 5)

Quantile	Estimate
100% Max	27.64510
99%	27.64510
95%	27.64510
90%	27.64510
75% Q3	13.38200
50% Median	10.87584
25% Q1	8.08336
10%	7.67830
5%	7.67830
1%	7.67830
0% Min	7.67830

The SAS System

The UNIVARIATE Procedure
Variable: Anxious (Anxious)
Group = Sans

Extreme Observations

------Lowest------		------Highest-----	
Value	Obs	Value	Obs
7.67830	7	8.08336	11

8.08336	11	9.42108	9
9.42108	9	12.33060	8
12.33060	8	13.38200	12
13.38200	12	27.64510	10