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E-LEARNING BASED MOBILE APPLICATION FOR KIDS WITH AUTISM SPECTRUM DISORDER

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E-LEARNING BASED MOBILE APPLICATION FOR KIDS WITH AUTISM SPECTRUM DISORDER

By

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Tarik Mohammed ABDULJABAR

DEDICATION

I devote and pledge this research work to my supervisor who is salient for guiding me through whole research work as well as my family for always assisting me in my hard time.

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ABSTRACT

E-LEARNING BASED MOBILE APPLICATION FOR KIDS WITH AUTISM SPECTRUM DISORDER

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In the developmentally disabled population, smart phones have become famous. Unlike the 'worn', complicated and 'I-am not-normal-looking' adaptive equipment, these mobile phones are the latest and innovative devices with which to see them. These handheld devices are said to act in the pockets as a contact system, a training tool on the go even a big help for others. In this thesis i focused on the E-learning based mobile application for kids with autism spectrum disorder using Python. This Application Amongst the Its versatile digital material and space, functionality, versatility and accessibility are characteristics. The touchpad display, especially for anyone with impaired motor ability, makes it more attractive and easier to use. Practical correspondence is provided Developments with autism people in comparison to their family and those in the group. Digital mobile technology versatility and innovative technologies are providing new opportunities for further study in the field of desktop treatment for students with Autism. Several eyewitness accounts offered an early glimpse of the increase flexibility of how these instruments could be made available. In enhancing their quality of life, the level of treatment of adolescents and their families plays a major part. We would create applications to improve the development of children with ASD. Particularly when framework, consistency and consistency are important to monitor actions. With this knowledge, Labelled and Freely

Available Dataset from Open-Source Repository will be used and it is possible to make E-learning based mobile application for kids with autism spectrum disorder. We will use Python for implementing our results in this thesis.

Keywords-autism; computer technology, mobile technology, E-Learning

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LIST OF ABBREVIATIONS

AES	:	Advance Encryption Standards
ATM	:	Automated Teller Machine
CNN	:	Convolutional Neural Network
DL	:	Deep Learning
EER	:	Equal Error Rate
GR	:	Gesture Recognition
ID	:	Identification
MAC	:	Message Authentication Code
OTP	:	One Time Password
PIN	:	Personal Identification Number
SR	:	Speaker Recognition
PKI	:	Public Key Infrastructure
TAR	:	True Accept Rate

1. INTRODUCTION

Schooling for children with special education traditionally focuses on the issue indicated by the infant (s). Diagnosing science, however, is also the beginning of special needs for students. The fourth version of Psychiatric and Behavioral Illnesses is used as a starting point to enroll a child in a specially trained kindergarten, as provided in [1]. This is followed by the development of a reading lesson tailored to the diagnosed disorder (s). In addition, teacher training for disorders with learning disabilities is based on teaching in a clinical disability-adapted environment. Educators learn how to deal with the normal things that are followed by a diagnosis as offered in [2]. This also extends to teaching children with recognized Autism Spectrum Disorder ('ASD' in the future). ASD children are placed with a severe behavior disorder in so-called 'cluster kindergarten'. Elementary ed. for students with developmental difficulties and/or disabilities. One of the disabilities observed in these studies is ASD, as given in [3].

The complicated aspect with ASD is that throughout the autism continuum, every single identified child has its own normal pattern. This means that issues manifest in multiple ways for children with ASD, because every ASD pupil does have a distinct pattern of condition as described in [4]. Teachers in cluster 4 education have to work with these types with mainly standard rules, such as structuring and being transparent. Coupled with other conditions or issues, the complexity within the continuum also makes it impossible to deal with this group. It is important to obtain further insight into the traditional nature of ASD groups and their impact on the study of ASD learners, as given in [5].

Sensor node schools prefer to build classes for ASD only in order to adapt to the learning disabilities of ASD pupils. In this setting, teaching ASD children includes: dealing with metal

alloys, utilizing graphical encouragement, structure providing, and decreasing stimuli variables. This is to help with the problems with transitions and unforeseen circumstances that ASD pupils have. Groups in ASD Individual Education also focus on this and educators are taught to take care of it in a contained manner, providing clear instruction to be compliant with actions. These premises are the subject of a method developed in the early 1970s, such as TEACCH (Treatment and Learning of Autism and Associated Language Disabled Children), as provided in [6]. TEACCH is often used to develop predictive capacity, repetition, order and continuity in an ASD learning environment. In specific, operating in special ASD groups is organized in this way. Even then, when ASD is a spectrum disorder, can one ask if educating children with Autism in a systematic setting is prudent? Especially when this approach is not based on the social interaction and written language production of various pupils, which, as set out in [7], are crucial factors for the success of pupils in school. Since learner behavior influences each other, and such personal relationships are essential to the student's achievement, how does this evolve in the specially generated area of ASD sensors?

An unused field of study is teacher and ASD student engagement. The disability, in this case contact and engagement, which can trigger difficulties researching this topic as given in[8], may be an explanation for this. Despite these issues, studies may provide more insight into the opportunities in educational circumstances for Young children. The action of teachers is studied from an emotional point of view to conceptualize the school culture between educators and ASD pupils. In addition to this, in comparison to the presumed behavioral instructor actions as given in[9], the way ASD students are inspired. The instruction of ASD students relies on consistency and is consistent in adapting to the unique provisions involved with autism. This is focused on 60 years of study into autism. Much of the literature centers on disability within the autism

continuum, culminating in extensive guidelines as given in [10] for forms of autism. Study for ASD pupils in advanced courses mainly focuses on the framework and clarification described earlier. There are no details of advanced ASD-settings of researching teacher pupil engagement and its association with encouragement.

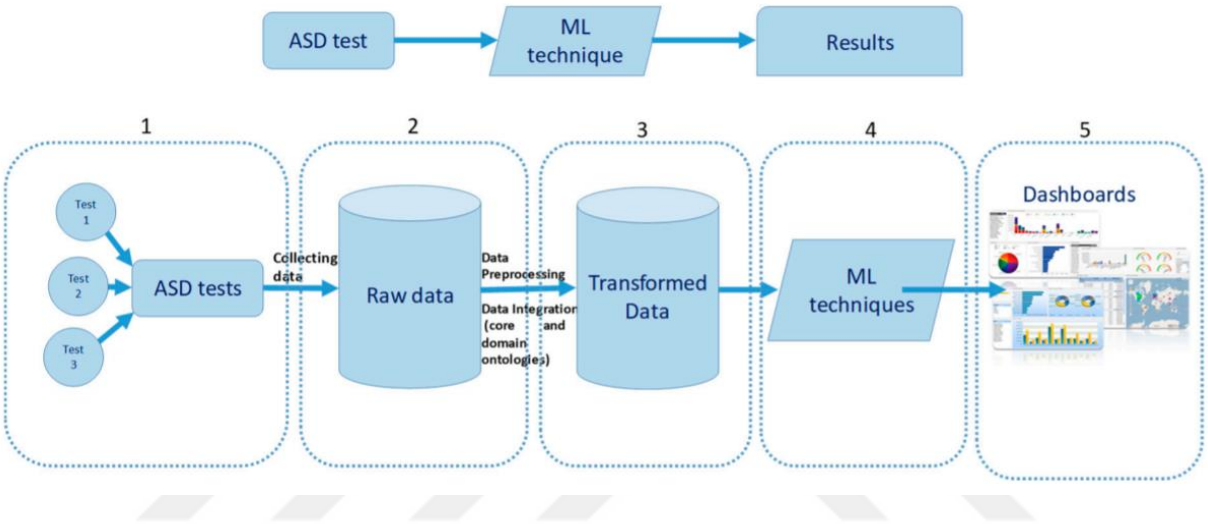

Figure 1.1: A brief modeling of machine learning based autism spectrum disorder classification system with dashboard [11].

The answer to cellular networks is the premise that contact is any action that anyone shows in the midst of somebody else, as described in [12]. This means that "one cannot interact when others infer significance from this system in the context of someone else, but whatever purposes of a person are." For a condition like autism, this suggests that there is contact, while social interaction and speech are troublesome. The problem arose from this viewpoint: how do ASD pupils interpret their professor's behavioral interaction? This leads to some other query; which protocols occur when such conduct is exhibited by a teacher Pupil morale is also a subject of this research to offer clarity into this field, as given in [13]. It is the quest for the behavioral instructor actions exhibited and how pupils are inspired. The explanation for encouragement is that the instructor is often listened to by pupils to illustrate their performance levels for a subject.

Because of its effect on the success of students, inspiration is an essential part. This provides insights into mechanisms that impact pupils' educational attainment or relapse from education. When it falls to inspiration or lack of encouragement, pupils frequently turn to their instructors. It is important from this perspective to investigate whether there is a connection between the actions of relational teachers and the encouragement of pupils, as seen in [14]. In fact, how this happens in classroom styles for ASD. In this research: What is the outcome of the interpersonal trainer shown to inspire children with ASD? In view of their speech and engagement difficulties, the task is to select promising information or proof for the current approaches of teaching pupils with ASD.

The current study reflects on the meaning of classroom teaching since, for most ASD students, this topic reacts to the previously stated need for an organized and consistent way. The explanation for this is that knowledge and guidance can conveniently be placed in a simple structure through mathematical classes, stressing particular research content with little triviality. . This is the instructional atmosphere in which instructor pupil engagement and inspiration are investigated. This thesis answers two issues, one about the actions of relational teachers and another about how students are influenced by the instructor in their setting. The fact that relational instructor activity in ASD educational experiences and the interaction with encouragement has not been observed before renders this research exploratory in scope. Learning for students with Autism, relational instructor actions, and inspiration are addressed in the subsequent paragraph in sequence. [15].

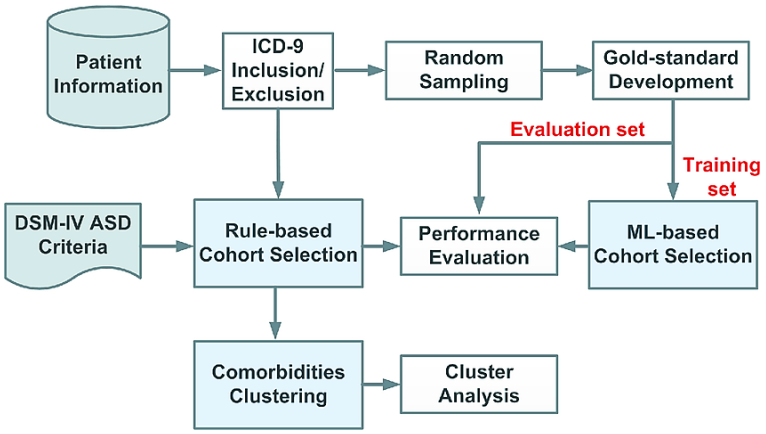

Figure 1.2: The proposed electronic health record-based algorithm to identify the ASD [16].

1.1 PROBLEM STATEMENT

Autism has a history of literature going back to the mid to twentieth century 1940s. Studies focus on one aspect of ASD in that period, such as the extension of interactions with people and the environment. They used the term autism to describe this behavior. Further research in the 1970's find that autism is a triad of disorders. . This culminated in the adoption of the term autistic spectrum disorder and consensus on ASD clinical guidelines. Two very comprehensive and widely used autistic diagnostic methods. Depending in these systems, a condition includes deficiency in the fields of speech, cognitive abilities and versatility in actions. With any person with ASD, the disability pattern differs as given in [17]. That is why autism is called a ‘spectrum’ of disorders with a variety of symptoms and degrees of disability involved. The triad of impairment makes it possible to investigate and diagnose ASD. Overtime research led to the discovery of several forms of autism. Because there is no cure for ASD, treatment is focused on adequate interventions to improve the quality of life adapted to the typical form of ASD That is why autism is called a ‘spectrum’ of disorders with a variety of symptoms and degrees of disability involved. The triad of impairment makes it possible to investigate and diagnose ASD. Overtime research led to the discovery of several forms of autism. As there is no remedy for

ASD, rehabilitation focuses on effective approaches to make life better adjusted to the traditional type of ASD, and care focuses on targeted solutions to make life better tailored to the full form of ASDA standard approach has been established from the first reports of autism to adapt to the learning disabilities of autistics. In school contexts, this has its implications as well.

1.2 AIM OF CONTRIBUTION

Different school environments provide unique needs tailored to ASD students. The preference for a given environment is dependent on the type of autism and how the behavior exhibited is influenced by this. Pupils with autism spectrum disorder, especially 75% with other conditions and/or disabilities, going to schools, in general. Schools are for kids with vision disability and schools with developmental disabilities. In order to address the individual needs associated with the mental and/or physical challenges involved, neighborhood schools may be formed and designed. ASD students who are less seriously affected go to regular schools or community education. . Many of these students are identified with ASD. Normal school is an alternative for ASD learners with no difficulties in transitioning to the community and little behavioral issues. For these learners and their instructors, it is possible to receive supplementary assistance from experts in the adaptation of education and the setting. When it is impossible for students to deal with the system of normal school with behavioral issues at the time, cluster 4 education is sufficient. We will create a mobile to improve the learning of children with ASD. Especially when there is a need for order, consistency and repeatability to control behavior. Irrespective of the national plan to compel the transfer of students back to learning disabilities needs classrooms, the use of clusters continues to expand. One of the reasons for this is the transfer of ASD students from standard schools in boarding classes in the need of support. The explanation for this is that the mental problems of these students cannot be fulfilled by standard education.

Inside clustered software school there is a trend to respond to the increasing community of ASD learners by developing special categories for ASD learners.

1.3 FORMATIVE TEACHING ASSESSMENT

The need to combine qualitative and quantitative evaluations poses concerns about the efficacy of instructor tests. Analysis has shown that educators can be affected by influences that are not linked to the child's learning. Scientists in [18] have defined gender and specific instructional needs as such influences. Investigator in [19] addresses the question of fairness in regards to the practices used by educators to gather data on the evaluation. For example, she suggests that assumptions and questions can be harmful to those who do not have a communication service. Scientists in [20] showed that the decisions of educators can be affected by the activities of teachers that they form. , Which, even in the face of growing evidence, are reluctant to adapt. These involve a number of situations in which charter schools of published work differ on the basis of their respective world views.

Investigators at [21] questioned educators to list five terms that would define a participant who was "good at logic." Over majority of the sample listed behaviors that participants exhibited in classroom that were irrelevant to their mathematics achievement: "involved, intrigued, inspired, eager, excited, enjoyable, and tested". It is interesting, though, that if the same research that advice of the drawbacks of standardized testing often consider their need as part of the overall evaluation plan. The cost of removing all contradictions by focusing solely on written assessments is a limited focus of the appraisal material.

Experts in [22] performed a detail discussion of teacher-based student performance judgments. They observed that, on balance, instructor forecasts were well linked to student performance on a

typical performance parameter. The average standard error was 0.66, while the scale in the 16 experiments was 0.28 to 0.92. . Distinctions in the subject material as well as between instructors have been shown to compensate for much of the variation. In arithmetic, "teachers were significantly more effective in assessing academic performance than in math concepts." Investigator in [23] also describes the extent of student success as a mediating factor. The paper [24] finds the teachers most effective in forecasting the success of high-performance pupils. .

This question surveyed schools to create decisions that investigators had made in [25] that would be participant and straightforward. That's because the educators have not been asked to rate their learners in comparison to each other. Rather, for each segment of the subject, a projected mark of 1 to 10 was given. On the other hand, an implicit assessment would consist of a rating on "good math," without defining any specific ability.

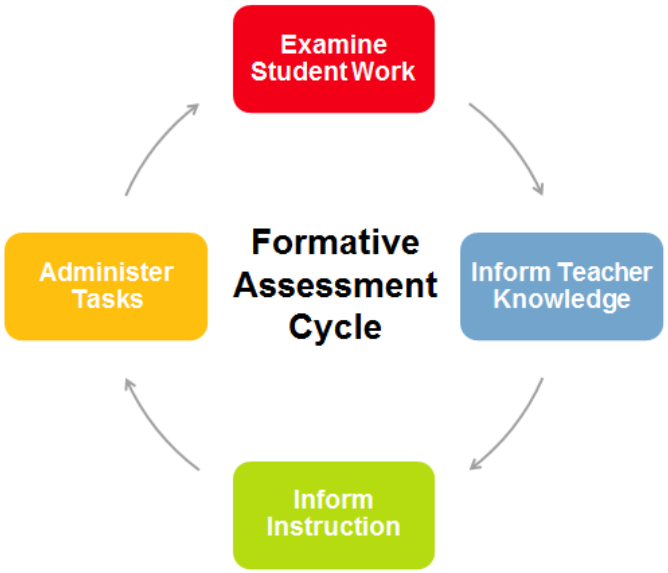

Figure 1.3: The diagram shows the formative assessment purpose and function cycle for teaching [26].

Abnormality is a minor part of the field that is occasionally observed. The remaining three types are sometimes referred to as autism without use of distinctive criteria. The primary explanation for this is that elements of autism (typical voice, obsession with such objects, problems with communication) can be found in autistic disorders. Yet there are still distinct variations next to comparisons. The first to be listed is autism condition. Common with this type of ASD is that 75% of these identified autistic individuals have low IQ and other psychiatric disorders. This goes hand in hand with at least 6 aspects of the continuum the second is Asperger's disease, which was first identified by Asperger in 2018. In this type, people with autism have a very well voice and have no communication difficulties. They also talk very structured and time-consuming, their intellect is normal or average, and they typically go to normal schools as arranged for in [27]. Third type is a generalized developmental condition also not defined (PDD-NOS). This evaluation is provided when a person shows a lack of coping abilities, people graces and behavioral versatility. The ASD diagnosis is used where the autism parameters do not meet the other continuum types. . Indicative of ASD is that a minimum of 3 facets of the continuum contribute to the asd as given in [28]. This does not mean that human and environmental challenges are less relevant to other types. ASD is for defining threshold PDD issues that do not fit other types.

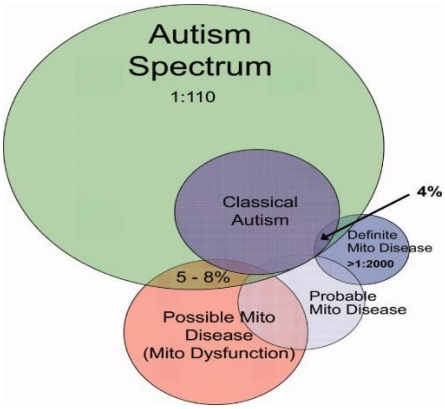

Figure 1.4: Early detection and classification of Autism and mitodys faction disease [27].

As a consequence, ASD is often referred to as the remainder of the party. The sample of this sample is associated with these three classes of autism; developmental illness, Asperger and PDD-NOS. Although its variety in school environments, these three characteristics of autism are largely approached by a wide public to adapting to the unique welfare of the student with ASD.

1.4 APPLICATION FOR ASD

Teachers dealing for ASD children are functioning in compliance with instructional standards and cognitive constructs linked to autism. Communication and socialization are the teaching fields on which cluster 4 teachers center their actions. Interventions in these fields, such as structuring through the usage of pictograms and systems, have a beneficial impact on the third region of disability, core coherence. All in all, these approaches usually contribute to a rigid and consistent treatment strategy of core disorder as given in [29]. This awareness in relation to the significant community of identified ASD students only contributed to the development of separate education for autism. . While these groups react to the specific requirements of ASD and are widely found in the 4-school group sample, this method has hardly been supported by facts. The concern emerges as to the effect of such unique ASD courses on learners and their educators. How are the guidelines changing in practice? There is yet another issue next to this. A shift in emphasis has evolved over time in students with disabilities. Typically, the issue identified was the point of focus for the students. Now there is a desire to take a close look at the condition of the infant and his or her climate. This is an ecological interpretation of a child's learning disabilities. Communication between participants and the community in the children's setting offers useful insight about how to respond to problems due to their illness. This entire awareness is used to connect the particular needs of the child with the actions of the instructor

and the modification of the environment as laid out in [30]. The consequence of this is that the atmosphere of the pupils is also a significant source of knowledge. That means the state is also part of the scheme. Compared to the conventional ASD approach, the more behavioral process of cluster government school has no theoretical context. Both methods have in general the modified educator student relationship to react to particular ASD requires. This is important to promote the growth of ASD pupils. This is therefore seen as a starting point in this review. Despite challenges for all people with ASD, regardless of the knowledge study in the ASD classroom setting with contact in the middle, it is important to get new directions for the future. This helps one to gain insight into different existence and influence of ASD teachers and pupils in an integrated setting.

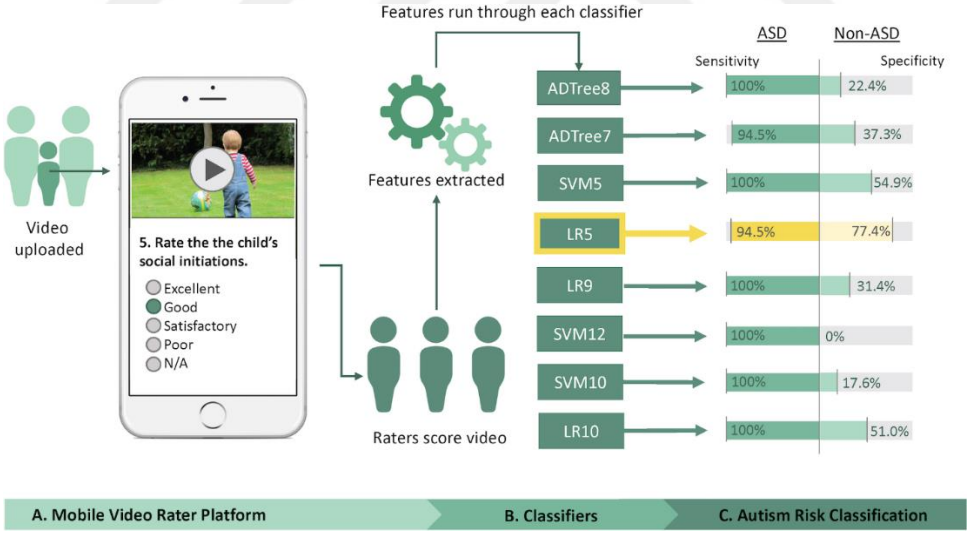

Figure 1.5: The mobile detection of autism through machine learning [30].

2. RELATED WORK

2.1 LITERATURE REVIEW

Generally, group schooling is a setting in which the mood in the classroom is controlled by control, tension. The approach for coping with classroom problems is largely based on realistic knowledge with no scientific proof. The educator group reflects on the interaction with the learners. Appropriate teacher-student skills are vital for students as well as their instructors, as given in [31]. An instructor is, consciously or unwittingly, a student's teaching element. The relationship between the instructor and the student is an invaluable part in this phase of development. Particularly for students who have always had a poor relationship experience. Researching the actions of relational teachers affects the interaction between teachers and students. Work in this field has contributed to research into student performance, teaching methods, avoidance of disciplinary issues, burden on students, scorch of instructors, and advancement of instructor career advancement. . The goal of the research on relational teacher behavior in clusters training is to educate by expressing concern about educating learners, more leading sector for ASD students. .

Personal and social school environment relies on two components: an introduction towards knowledge structures and a paradigm to explain teacher-student interactions in terms of classroom behavior as presented in [32]. The method to conversational processes struggles with the impact on those participating in conversation. The fundamental principle is that all activity in the presence of some other person is contact. It is also not capable of interacting with each other as individuals interact with each other. The teacher-student contract is known in the interactive teacher model theory. This idea is built on research [33] on 'relational character evaluation.' Mcleod concentrated on explaining interactions between people by the use of two axes; distance

and power.. The reference for use in education is the 'Disorganized Program Requirements' report. They concluded that certain of the instructor's characteristics relate to the class's unity and climate. More research has demonstrated that this is also capable of finding the characteristics of an educator who breaks the destructive vortex of chaos and improves the atmosphere in the teacher's study. [34]. these features are all composed of two information exchange; the strength of dominance and obedience, the similarity of partnership and resistance.

The axes are the basis for the description of the eight segments of the relational teacher actions. The control axis shows the degree of dominance and obedience displayed by the instructor, while the familiarity axis determines the level of contact and resistance between the instructor and the pupil. The two points form the basis for the eight behavioral elements of the method. . Each part will have its own characteristics, as set out in [35]. Communication with these axes can be explored in the classroom, as all interview questions can be described in this sense. The connection between personal and social instructors can be described in two ways. First, an interface may be made between the edges of the modules in the sector. . There are various frameworks within the system of supremacy and collaboration as given in [36]. The business nearest to supremacy begins with supremacy accompanied by collaboration (Dominance Cooperation, DC). Rationally, the other field continues with collaboration followed by domination. (CD, Superiority Cooperation). There is a difference in eight various industries in this sense.

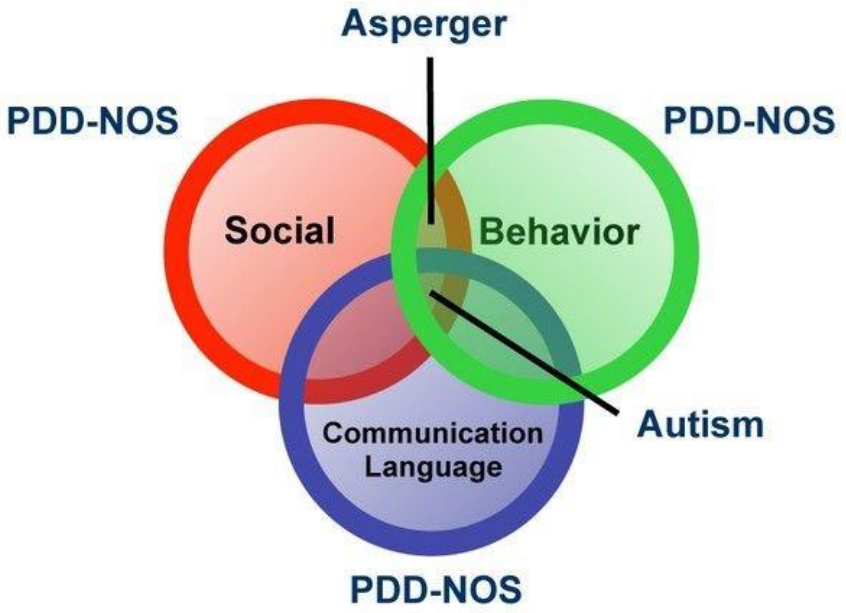

Figure 2.1: The Ven Model on Autistic Spectrum Disorder [36].

Second, the poles to be used without separating the actions of the divisions. The two axes describe the behavior of the instructor. Teacher actions may be defined as dominant (axis of influence), obedient (axis of impact), and collaborative (axis of closeness) or oppositional (proximity axe.

Table 2.1: Sectors, Behavior types and Examples of Interpersonal Teacher Behavior for ASD kids.

Sector	**Behavior types**	**Example**
DC Dominance/ Cooperation	Leadership	He/ she is a good leader
CD Cooperation/ Dominance	Helpful/ Friendly	He/ she is someone we can count on

CS Cooperation/ Submission	Understanding	If we want to say something he/she will listen to us
SC Submission/ Cooperation	Pupil Responsibility/ Freedom	He/ she gives us lots of free time in the classroom
SO Submission/ Opposition	Uncertain	He/ she is uncertain
OS Opposition/ Submission	Dissatisfied	He/ she looks dissatisfied
OD Opposition/ Dominance	Admonishing	He/ she gets angry
DO Dominance/ Opposition	Strict	He/ she is strict

For School leaders, a teacher with a consistent and correct layout refers to the specific needs of the established disease. When this behavior is explained at the end of the two axis of 'Social and Personal Teacher Model Theory,' the tutor must be strong and constructive as stated in the document. [37]. Influential actions (strict score with a trailing construct) to react to the use of order and transparency. Collaboration actions (beneficial dass-21 with awareness of the score) to react to the specific requirements of the learners. In this manner, an instructor develops an acceptable atmosphere and personality.. Instructors must not exhibit obedient behavior (Obligation dass-21 with ambiguous score) since this leads ASD learners to unexpected behavior and circumstances as described in [38]. It is challenging for ASD students to perceive feelings that go along with obedient behavior. That's also true of instructor actions that can be linked to

the aspect of resistance (dissatisfied subscale with admonishing subscale). The conduct that goes together with this is difficult for ASD learners to perceive..

2.2 EXPECTANCY COMPONENTS OF ASD

For ASD students, the motivational aspect of the hope relies on the problems involved with the condition identified. Problems attributable to poor speech, impaired social contact and uncommon circumstance resulting in an unforeseeable atmosphere as given in [39]. In ability to answer to this, ASD training environments are focused on command and preparation, culminating in a structured atmosphere for learners. When it comes to personal, the very first aspect of the positive portion of optimism, this is an essential part. Self-efficiency is the understanding with one's own ability. For ASD students, the trained atmosphere has a beneficial effect on sense of security since it provides physical comfort. Procedures and frameworks offer clarity in the chaotic universe of autistics as given for in [35]. This helps in maintaining stable development and success and with this strong confidence in one's own skills and competencies, and For a while but then, a reasonable view on results. This method is being addressed with ASD learners because of their challenges in moving knowledge from one circumstance to the next.

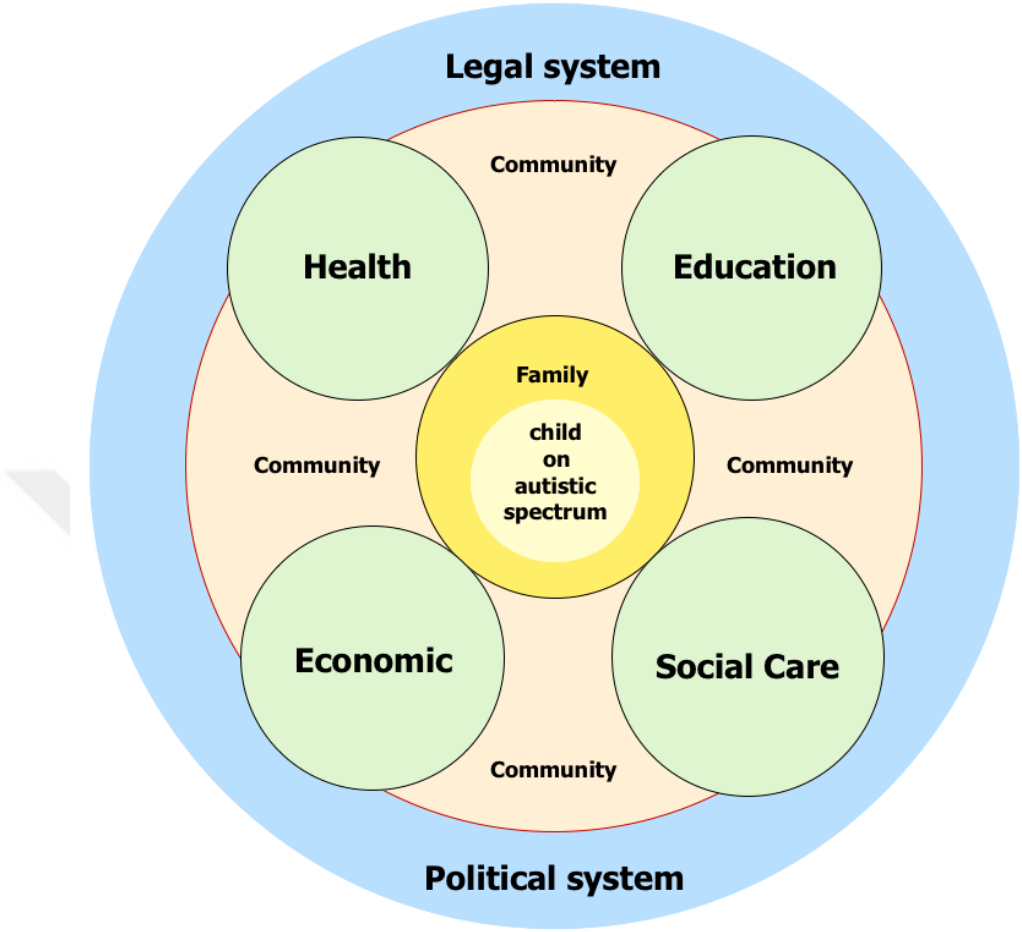

Figure 2.2: Comparison of different expectancy components of autism disorder spectrum system [38].

The hope aspect is a mixture of autonomy and identification hypotheses. Self-efficiency is the understanding of one's own ability. It's linked to cognitive psychology, because it's about attending training attitudes. Both personality and identification have to do with self-perception of the capacity to accomplish different as set out in [39]. It is based on personality mixed with initial childhood, which is informed by contact (by example pupil teacher interaction). Interpretation, other part of the motivating hope aspect is all about power, reliability and consistency. From the ASD viewpoint, the last two dimensions of consistency and reliability can be related to a stable educational process. Stable world presupposes the creation of continuity for

ASD, since nothing much fluctuates as given in [40]. Processes and regulations remain the same as they are due to various issues with improvements. It is also often unclear whether the ratings agency has a positive effect on the inspiring ASD learners. This is due to their issues with the changes between events and the absence of causal relationships. It is also not to be assumed that the ASD learners balance their commitment with the outcome when it applies to the manifestation of influence. Overall, the expectation aspect of encouragement for ASD learners is supposed to be reduced.

2.3 GOAL ORIENTATION AND STRATEGIES FOR ASD KIDS LEARNING

Essential target alignment is linked to academic, more precisely when a person needs to learn. Intrinsic target alignment has been established in terms of significance for a specific topic of action, mood, value and pleasure. Psychologically, the underlying target orientation is linked to the freewill of a single project or issue... A Teachers have a major part to perform in establishing the same kind of independence in educational environments as given in [40]. Students, who are fundamentally inspired, have optimistic traits of accomplishment, such as the use of broader system integrators, connect new information to early knowledge and resilience when faced with difficult activities.

External target focus is linked to understanding when an individual wants to learn from an environmental entity; i.e. a successful score in arithmetic is really important to me. External target motivation is to pursue selling points and escape sanctions via an emphasis on ratings and the acceptance of others.. Irreducible students display serious concerns for how their talents are evaluated by many others, such as their coach. External rewards may evolve as teachers associate students with one another, or when rewards and recognition are included. Adulation has a far

more consistent impact, annotate to ratings and equate students External formative assessment has also been correlated with an inherent achievement motivation. Primarily the external incentives in educational environments can be used as pressuring or blackmailing learners to understand. This inhibits and limits the production of getting support and is not consistent over the years. Use of external encouragement can have an impact on students to design plan. Scientists in [41] also propose that an educator can use a mix of positive and negative motivating variables that is ideally suited to particular pupils. Keeping in mind the extrinsically motivated practices that have a detrimental effect on the student's mental condition must be used thrifty.

The importance of the job has to do with the value that one provides to a single project. As a consequence, it is typically conceptualized as traits of the person. Features may rely on choice for a particular topic or assignment; i.e. It's essential for me to study math’s in this classroom. In summary, the meaning variable is about the motives why the learners are engaged in a project which varies based on the individual and the situation.

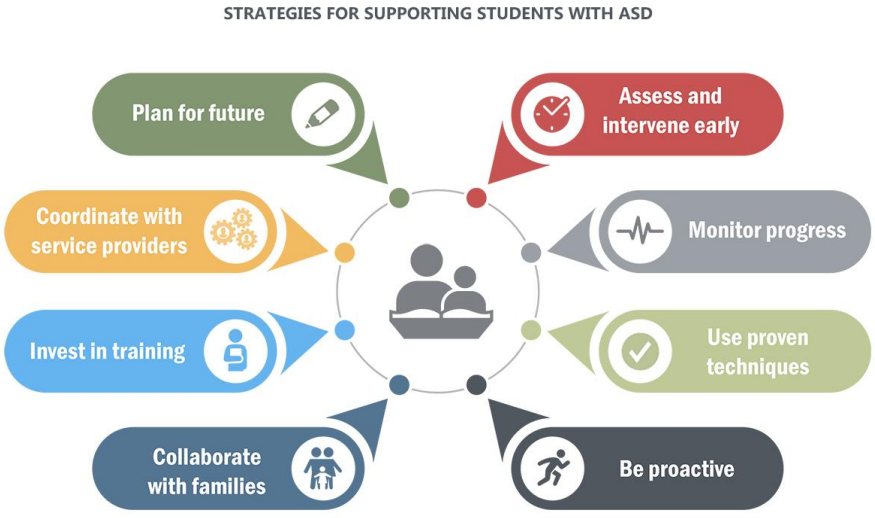

Figure 2.3: Depiction of series of strategies mainstream schools can support students with Autism spectrum disorder [42].

The importance of the challenge is crucial to greater information literacy skills. It refers to the importance of success, the value of significance and the quality of usefulness. Achievement worth is really about the relevance of the task to the participant. Ability quality has to do with the degree to which a person is involved in the operation. It has parallels with an innate inspiration, and it is a selfish ambition toward success. Power benefit, on the other side, is connected to intangible incentive and is the expected benefit of an operation. The consequence of a beneficial impact on the elements of mission quality is an improvement in the resources for pupil instruction and curriculum involvement.

2.4 VALUE COMPONENTS FOR ASD

There are some consequences for the meaning aspect of inspiration defined from the ASD perspective. Again, this relies highly on the trained learning atmosphere and the balanced method of the teachers. The first element of the meaning variable, the motivators of the ASD learners, obviously depends on the adjustment of the atmosphere and the curiosity with a particular topic as given in [43]. The provision of chosen resources, together with framework and transparency, allows ASD students more chances to participate in educational scenarios. Given the same disability, the teaching method is ready to work and this has a beneficial impact on the inner planning system.

It's difficult to tell whether the two reputation and financial, the external target focus, influences ASD learners. Practically, they do not pursue incentives or escape penalties that are essential to the external target orientation. This is highly motivated by their lack of appetite for interactions with people. Mostly ASD students shouldn't get emotions that go with compliments or

corrections Disorder of contact is a barrier to this. Thus it is predicted that ASD students would not offer much of the external stimulus that influences thoughts as given in [44].

The third value variable, the mission quality, is much more complex when it comes to its relationship with the ASD. The importance of the project relies on the motivations for accomplishing the job and is categorized into success, interest and usefulness. Achievement has to do with the value of a mission for just a participant. Math's, for instance, is essential to me. Value is about the fascinating essence of the mission. Both achievement and motivation are greatly influenced when an ASD student is involved in the subject, but this can be somewhat different between individuals. It is not clear if the importance of the utility has an effect on ASD pupils. Usefulness is the desired benefit of an operation. Autism people experience problems and see links between behavior and consequences. The association between how advantageous it is to take action on the basis of the anticipated result is not relevant for ASD learners. When contributing to the task value of ASD students, the teacher must focus on accomplishment and inspiration through the use of the same curiosity as set out in [45]. For example, when a pupil is fascinated by planes, make a display of aircraft training. Leading to injury, it is doubtful that a successful use of utility can be made to extend early results to changed situations. The result of having an effect on the sense of the construction methods, such as achievement and inspiration, is to enhance rewards for academic achievement and educational participation.

2.5 ANXIRTY FACTOR DURING LEARNING

Nervousness is the most placing value of the ASD student's learning opportunity. It relies on a man's individual attributes and psychological response. This can thus be different for topics, as well as for circumstances. Panic attacks or fear examination is really about the worrying of

students regarding assignments, examinations, or studies. This is about the confidence in loss or the accomplishment of a given mission as laid out in [46].

Nervousness may be split into anxiety and rage. Grim thoughts, worries and desires whose signs of anxiety have a major influence on students' work. As stress plays a major part, it is a hindrance to students' desire to study work. Next to this, it also negatively impacts the inner self. Nervousness is also a central contributor to empowering learners due to lack of ASD and unexpected cases of anxiety in college, educational situations are often encountered. The condition occurs when the educational climate is dysfunctional, as set out in [47]. This may also be the case for ASD learners where materials do not fulfil their particular specifications. . For instance, where a challenge has unanswered queries, it contributes to the imagination and self-interpretation of an individual that is challenging for ASD learners. It's difficult for them all to make their own framework out of unorganized circumstances. This is also the source of anxiety and fear. The clarification, arrangement and tailored actions of the instructor described earlier decreases the distress of learners in teaching scenarios. . When this is done, it decreases the negative emotions and the sustainable community well-being of ASD pupils. People with autism who get what they want in their education system are less stressed and more balanced. This is the primary justification for ASD students and their guardians to take interest in early ed. Expectations are that ASD students have considerably lower distress in specialized ASD schools.

On the basis of the study sense, both anxiety, respect and expectations as motivational components seem to have their own approach to empowering ASD learners. In this study, teaching methods are tailored to the unique circumstances of the asd as set out in [48]. It will have a positive effect on the well-being and progress of ASD students in the classroom. It is also assumed that students will have high expectations and value combined with low tension during

arithmetic. In brief, students with disabilities with autistic children have a framework for the same degree of creativity.

The goal of this research, as mentioned above, is to examine the behavioral actions of teachers in ASD educational experiences and how students are empowered by them. Conceivably, the action of the social trainer is based on two poles; one of the control dimensions. (Superiority – statement) and the other dimension linked to distance (cooperation – objection). Ambition is shown as a consequence of the anticipation, importance and insecurity seen in [49].

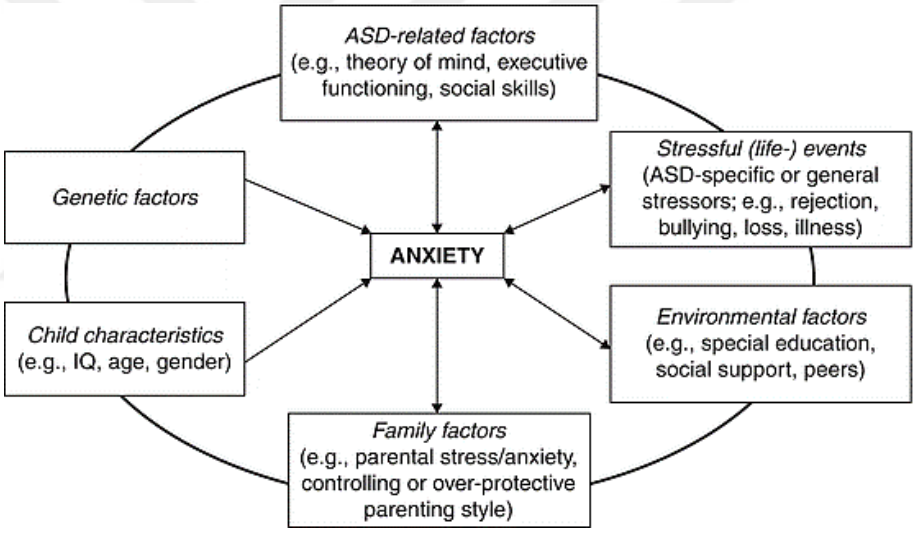

Figure 2.4: Example of anxiety in individuals with ASD disorder [49].

2.6 COMPUTING TECHNOLOGY AND ASSISTIVE TECHNOLOGY FOR CHILDREN OF AUTISM SPECTRUM DISORDER

Focusing on this capacity, many practitioners and schools use technology as an aiding technology to help children with Autism. Assistant innovation is described as 'any item, piece of kit or network of goods, either purchased professionally, off the rack, updated or personalized. This is used to improve, sustain or enhance the adaptive ability of children with autism." In fact, technology can be any tool used on a daily basis to enhance or enhance the functional capacity of

autistic children, whether they are academic, mental, behavioral or physiological. The concept of using digital technologies as a child care system, for those with ASD, is not recent. For instance, Goldenberg reviewed the use of a device for contact for people with severe communication issues. (e.g. sensorineural hearing loss, autism or intense physical difficulties) and confirmed experimental study work with 10 children with various disabilities (5-16 years of age). [50] According to him, machines are like prosthesis to these unique children, who can dramatically change their standard of living, If you can monitor your device, you have a tools help mechanism and exposure to a wide variety of useful academic, technical and recreational time"

2.6.1 Big patterns and challenges

There appears to be a big rise in academic papers written in the last ten years on the development of computer technologies by students with Autism relative to the early 1980s and early 1970s average (see Figure 2.5). [51] It is noticed that most computer-based approaches resolve the main problems encountered by students with Autism.

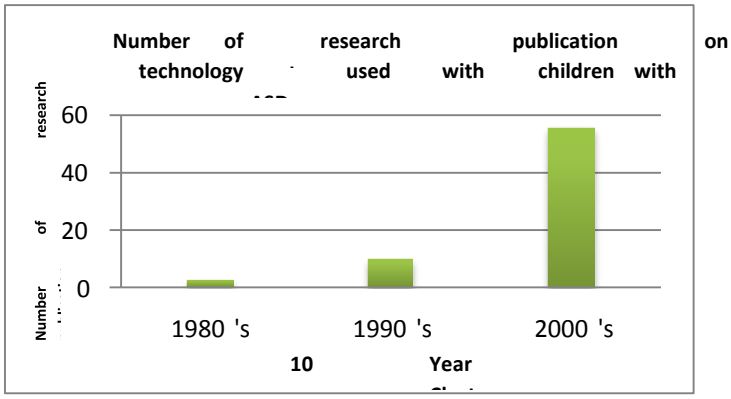

Figure 2.5: Number of research publication [52]

Such as listening skills, reading and learning skills, cognitive skills and understanding of feelings. Other abilities include practical life skills, e.g. the use of task plans. Independent task

accomplishment, enhanced focus, awareness of simulated worlds, imagery and creativity, sense of self, declining behavioral difficulties and role playing.

2.6.2 COMPUTER TECHNOLOGY TO MOBILE TECHNOLOGY:

Current developments in information technologies in electronic devices have opened up tremendous opportunities for children with ASD. Smart phones function as an add-on and substitute connectivity (AAC) in the wallet and have since grown in popularity due to their portable digital content and memory, functionality, versatility and accessibility The interface chosen for the development of the application is Android, which consists of ordering first aid sequences, associating images with medical specialties, and steps to travel inside a hospital or medical Centre.[53] The study architecture consisted of a multiple baseline across the subjects. Experiments were run on 10 youth and adolescents with ASD, males and females, who have shown the capabilities to function activities individually. The findings suggest that the application aims to enrich and strengthen educational and clinical awareness, both from a social point of view (by increasing motivation with educational games, especially children) Study says that people with ASD have responded better to interactive digital communication than sound messaging Smartphones and tablets may use all sound aids, worthy of holding images and shifting images that can be viewed often and more easily. As a result, the use of computers and tablets for Asd Children tends to be a natural match. Computer systems are physically and mentally sensitive and address the discomfort that people with disabilities commonly experience as they want to communicate with someone in person or in volatile social circumstances. Stimulates and utterly lacks the other signals of their environment. As a result, students have a hard time recognizing and knowing the social dimensions of the signals. Applied Behavioral Therapy (ABA) is a scientific proof psychotherapy approach utilized to enhance autism

problems. Pivotal Reaction Training (PRT) is an ABA strategy that can develop the learning abilities of children with autism in the physical world. Using PRT, we can teach daily skills, successfully integrate the method with the assistance of family as co-therapists, along with the usual style of instruction, and develop children's literacy and conversational conversation abilities [54] . Video games focused on PRT strategies would concentrate on checking if individualized cues could be used to enhance non-verbal contact with children with autism with serious developmental disabilities. Today, ASD children have been detected with computer-assisted methods. This innovative prevention method is becoming a vital aspect of treating children with special needs and helping them learn how to socialize with others in the neighborhood. Holding this in mind, several video games have been designed to meet the desires and concerns of children with autism, as games have become an enticing platform for the involvement of special needs children. The use of real games is complimentary to conventional face-to-face psychiatry. Highly specialized apps have been created in latest days and several experts are leading to the growth of instructional and recreational apps to support precious kids. Computers and handheld computers have now progressed from heavy keys and cursor to smart touch screens and interactive processing techniques.

2.6.3 Happy getting to learn

'Teaching critical literacy skills such as vocabulary, quantitative and vocational skills to children with autism is crucial to a well of the autism community. Even so, it is also complicated because of their "stimulation over specificity," The propensity to draw and distract from specific environmental cue to an extreme extent. They have a low process of learning assignments, mostly obsessed with their own world of thought. The device created appealing, vibrant, colorful images of daily necessities, figures, alphanumeric, fruit, veggies, pets, etc. It will encourage the

ASD child learn how to narrate and retrieve alternatives at ease before the right answers are given. The module helps the child develop auditory, mathematical, subject and technical input. Fig. Shows the Alphabetical Learning Study [55].

2.6.4 Mobile technology for autism

Mobile apps are used to support people with ASD and their families learn how to properly cope with ASD (e.g. interpersonal interference), overcome challenges (e.g. national health assistance) and strengthen their well-being and day-to-day behaviors (e.g., communication, social, and problem-solving skills) In the last decade, there have been several efforts to utilize mobile devices to support them in the areas of learning and wellness. For eg, "vSked," a shared visual planning and reinforcing framework developed for ASD child's schools. The system was verified with a high level of satisfaction by nine students with autism. Instructors appreciated the device to minimize the effort required to use visual aid when producing simple records. [56] MOSOCO, the Handheld Social Compass System intended to support the social abilities of children with ASD. MOSOCO used the virtual reality (AR) and visual reinforcement in the Emotional Compass Cognitive Skills Program. This platform has helped users to learn how to interact in diverse environments through immersive applications that encourage small talk and other people's graces (e.g., space and proximity, sharing interests). Social networks have also been used as a form of social support as a result of high connectivity through smartphones. In comparison to digital devices, smart objects have been used to include improved identification and socialization to individuals with Asd, WearSeanse has been developed to track autistic symptoms and promote better clinical evaluation. Procom has been designed to improve the social contact of individuals with autism by enhancing their understanding of the real geographical proximity in the social context. A handheld software intended to assist learners

with high - functioning autism. It offers strategies with targeted alerts to help them plan, participate and interact in the classroom. Secure mobile devices have been found to have a significant effect on children and adults with ASD.[57]

Figure 2.6: A Smartphone App to treat and track Autism [58]

2.6.5 Gamification techniques as health intervention

Gamification is defined as 'the use of gaming contexts. Gamified mobile games use game-like technologies, such as animated characters, problem-solving and interactive storylines, to trigger inner motivation. Research has found that gamification can have a beneficial impact on emotional, physiological and health attitudes and outcomes.[59] Gamified smartphone games have been shown to have the ability to boost customer experience and goal behavior by presenting consumers with feelings of happiness, pleasure and attraction. As a PA play, a gamified smartphone game intended to inspire travelers to sit on public transportation in Taiwan. In this method, respondents can gain new abilities to obtain encoding process for their animations by sitting throughout their journey. However, although users enjoyed the system's gamification capabilities early in the user analysis, the usage decreased after all the objects were

gathered. Plunder World," adaptive workout fitness instruction for children and teenagers. This system was developed to be played with body movement controls via visible or hand motion feedback gestures. Via a series of motions and actions, users can play plays by traveling on ships or avoiding hazards and at the same time supporting PA. Gamification is indeed common in popular smartphone applications for commercial health/fitness. However, our literature survey reveals that there is no statistical data to show their usefulness and effectiveness in raising the PA standard. By pursuing the design investigation phase in our work, we hope to clarify the reasons and rationales behind the design of the gamified components that could contribute to sustainable PA action for adults with ASD [60].

3. METHODOLOGY

To complete this project, it was necessary to research possible methods of development and begin the development of the app simultaneously. After doing preliminary research on assistive technology developed for individuals on the autism spectrum and on similar, preexisting approaches for accessible technology within both local and national museums, I brought my findings to Peter Laurin, a senior game design and develop student at RIT and the app developer on this project, and he began coding the app layout. Throughout the development process, we consistently held meetings to ensure that the new information and findings I came across in my research was applied to the app, so as to enhance the quality of its design and content. Various educational settings provide special needs adapted to ASD pupils. The choice for a specific setting is based on the form of autism and how this influences the behavior displayed. Pupils with autistic disorder, especially the 75% with other disorders and/or handicaps, mostly go to schools. Schools are for pupils with physical handicaps and schools for mental handicaps. The learning system will be developed and are equipped to respond the special needs which come along with the mental and/or physical disabilities involved. Once the prototype of the app was completed, I held two rounds of user testing. The first was with a general audience off-site, and the second was with our specific target audiences— individuals on the autism spectrum and their families—on site at the Strong National Museum of Play. Following both of these rounds of user testing, participants filled out a Google Forms survey online to give their feedback on the quality and effectiveness of the app (Fig. 3.1). In addition to the survey, after I conducted the user testing with the target audience, I held follow-up interviews with each participating family to ask more in-depth questions about their previous museum experiences, as well as to elaborate on the feedback they had given on the user testing survey they completed after their museum visit.

Using the information collected from each round of user testing, I then evaluated the current prototype and compiled a list of improvements and changes to implement in future iterations of this app-concept using python.

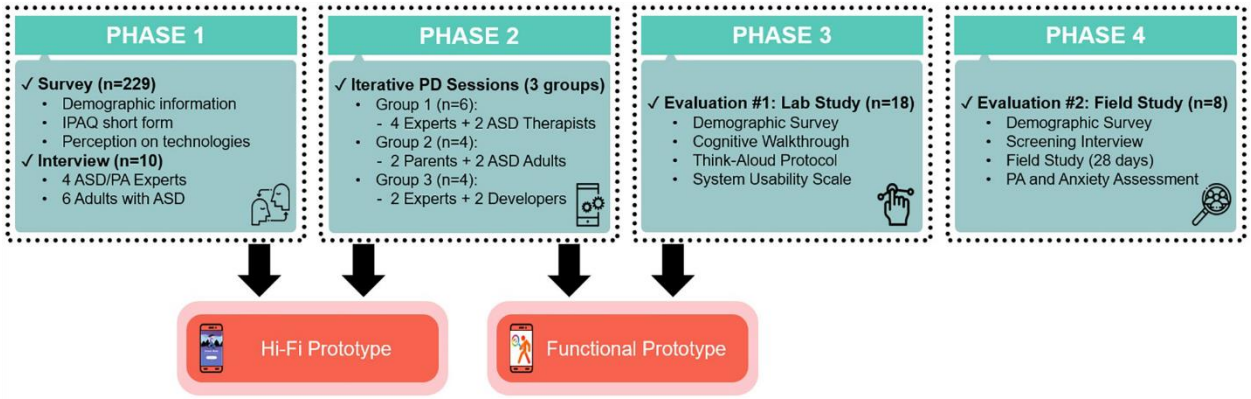

Figure 3.1: Overall research procedure across four phases of the study. In Phase 2, "PD" = participatory design, "Parents" = parents of a child with ASD, and "Experts" = ASD/PA experts. We held three iterative PD sessions with each group, totaling nine PD sessions

3.1 DEVELOPING THE CONCEPT OF APP

We have a case study to make it happen, seeing someone you love miss out on opportunities because of their disability can be infuriating, but, when these feelings are channeled effectively, can also be inspiring. The idea for Sense Ease began with this feeling. In the Case Study:

My younger cousin, Leo, was diagnosed with autism spectrum disorder when he was about 2-years-old. Since his diagnosis, my uncle and the rest of my family have done everything in our power to ensure that he has the same positive experiences as his neurotypical peers. He has been sledding, played on a Slip n' Slide, and even went on a short Christmas tour at a museum to meet Santa Claus. All of the efforts we made to get him involved with the community and other children were successful, until one Christmas when we found our first glaring roadblock to his interpersonal interactions.

Around Christmas in 20, we decided to take him to the Strong National Museum of Play, and it did not go well. There were more visitors than usual because of the holiday breaks, meaning larger crowds around interactive exhibits and, most importantly, more noise. After two difficult hours at the museum, Leo finally had enough and hit his threshold of sensory stimulation. He was trying to enjoy himself, but the noise and the other children moving around him pushed him over the edge and, ultimately, we had to leave.

In contrast to Leo's experience, I fondly remembered how, growing up, my other family members and I loved the Strong Museum. We had so many great memories there, and knowing that Leo would not be able to make his own memories at the museum broke my heart, particularly because of my background in museum studies. However, instead of accepting defeat and never bringing Leo to the museum again, I started thinking. What changes could I make to the museum experience that would enable Leo to have fun at the museum? How could I make museum experiences more manageable for him? Thus, the initial ideas that would become Sense Ease were conceived.

3.2 CHOOSING A MEDIUM

When it came to choosing a medium, a mobile app to be used on a cellphone seemed the most obvious choice for a number of reasons. First, and most importantly, a mobile app allowed for more flexibility when it came to utilizing the app. Most people carry their phones in their pockets or purses, making the device easily accessible during a museum visit; the same cannot be said for other devices like laptops or tablets.

When walking through a museum, it is unlikely that anyone would be carrying a laptop with them because they are large and not as easily used when one is moving from exhibit to exhibit. If

this digital tool was to be created via a website, where visitors would need to access the content via a computer, it would render much of the site-specific content within the app useless. Additionally, if a child is on the verge of sensory overload and an emotional outburst, taking time to open a laptop, connect to Wi-Fi, and navigate the website would take too much time and concentration. A similar argument can be made for tablets. While they are smaller and more mobile than a laptop, not all visitors may want to carry their tablet around a museum.

Another influencing factor behind my choice in medium was a study published in the journal, Computers in Human Behavior. Through their research, Lucila Maria Cesti Santarosa and Débora Conforto found that touchscreens were preferred by individuals on the autism. Spectrum over laptop computers, which can be inaccessible for some individuals on the autism

Spectrum because the functions of the mouse, keyboard and screen may not be intuitive due to

Difficulties with sensory processing. In their case studies, they found that the children involved had difficulty connecting the movement of their hand to the cursor on the screen when using a laptop, but when using the touch screen, they had no issues interacting with the provided

Content. They concluded that a touch screen is a more effective method of interaction because

The tablets are “operated with the use of a data input device which is very natural to humans:

Fingers.” They also found that the instantaneous response of a touch screen tablet was easier to

Facilitate interaction, as one simply needs to press one button to turn on the tablet and one to

Open the app rather than having to follow the multiple steps it takes to turn on a laptop and

Access information on a website.

3.3 INITIAL DESIGN

I began thinking about the logistics of this in the summer of 2018, beginning with some minimal background research about different apps that my little cousin enjoyed and how I might adapt the methods employed by those apps to create my own. At the beginning of this process, as is always the case, Sense Ease had lofty goals. Initially, the idea was to create one, catch-all app that could help visitors on the spectrum have a sensory-friendly experience at any given museum. While this would be wonderful in an ideal world, the idea was simply not realistic. Given the variations between types of content, the level of interactivity, and the general setting or environment of the museums just in the Rochester area, it became clear that one app would never be capable of serving different institutions across the United States, or the world for that matter.

Throughout August and September 2018, I began to narrow down my goal from an unattainable deliverable to a feasible, year-long project. After discussing my ideas with my museum studies classmates and my research methods professor, I decided to focus on creating an app for a single museum that had the potential to be recreated and adapted for other institutions. This left me with a decision: what museum should I use for my case study?

To decide which museum would be the best environment to prototype Sense Ease, I looked back on Leo's experience and seriously considered the Strong Museum. However, before I made the decision, I interviewed representatives at the Strong Museum and two other local institutions and discussed their accessibility options for individuals on the autism spectrum. Figure 3.2 shows the Sample images that create a learning environment.

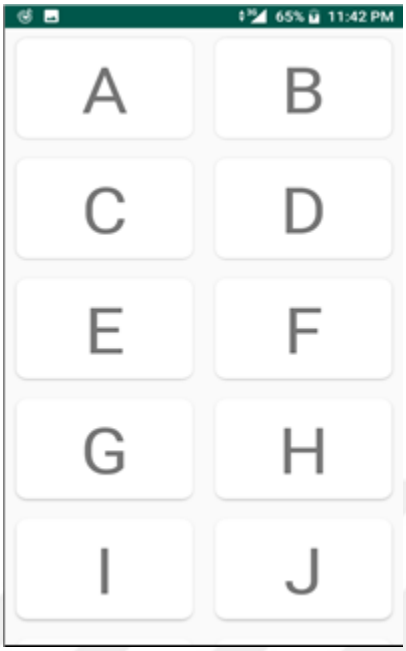

Figure 3.2: Sample images that create a learning environment

An interactive prototype for two devices (iPhone and iPad) was developed using Axure. The Axure prototype was tested with four users to assess usability and to identify areas in need of improvement. In the second stage, a mobile application prototype was developed using jQuery Mobile and tested with two pilot testers and twelve users. The procedures for developing the original prototype and testing it, as well as the procedures involved in the development of the second prototype mobile application and its user tests.

3.4 FIRST PROTOTYPE DEVELOPMENT (AXURE)

This first prototype included a sample program consisting of 10 trials. Users were able to add or remove pictures from the trials and set the correct answer in each trial. The prototype also allowed users to adjust the verbal instruction, reinforcement, and prompt. More specific details about the user interface of the prototype in connection with the results of the first prototype user study and the influence of those results on the design of the second prototype. A convenience

sample was used for evaluating the prototypes. Four users (one male and three females) who already owned an iPhone and/or iPad device participated in the user tests. These users were screened to be familiar with the iPhone/iPad interfaces in order to eliminate the ambiguity factor related to understanding the standard interface conventions, such as navigational tabs at the bottom, split views, and fly-over left panels. Four user testing sessions were conducted using the first prototype. The user testing sessions were aimed at improving the user experience related to creating programs and modifying them. The interviews with the participants were recorded, and the findings were documented to aid in improving the prototype design. Results from the first prototype user tests were used to develop the second prototype of the application. The results of the tests are described in Chapter 4.

3.4.1 Participants

A convenience sample was used for evaluating the prototypes. Four users (one male and three females) who already owned an iPhone and/or iPad device participated in the user tests. These users were screened to be familiar with the iPhone/iPad interfaces in order to eliminate the ambiguity factor related to understanding the standard interface conventions, such as navigational tabs at the bottom, split views, and fly-over left panels.

3.4.2 Procedure

At the beginning of the test, participants were provided with an overview of the user study. The overview included the goal of the user study and discussed the procedures for conducting the interview. To minimize the "order effect," two of the users were asked to start with the iPhone interface, while the other two users were instructed to start with the iPad interface, so that their familiarity with the tasks would not affect their judgment of the interface and its ease of use.

Since the application is capable of delivering various types of training using the DTT method, in order to keep the user tests simpler at this phase, exercises relating to nonverbal social tasks were not used for testing the interface design. Instead, a more general coin-matching exercise was employed using the same procedures. HTML-generated prototypes were uploaded to the Ax Share website for online access. This allowed for the prototypes to be tested by using the device's web browser. By choosing "Add to Home Screen" in the mobile web browser, a link to the prototype was added to the device's home screen so that the prototype could be accessed in similar way to a stand-alone app. The browser's address bar was set to "hidden" in order to allow the prototype app to run in full-screen mode for best performance.

3.4.3 Task Scenarios

The user tests included three task scenarios and a follow-up question for each device type (see Appendix B). After completing these on one device type, users continued to the next device type and carried out the same task scenarios on that device's interface. The following task scenarios were used:

Activity 1: You have already created a program called "Money Concepts." Please go to that program and run it for the child to play.

Activity 2: You are interested in changing an item on the first trial of the Money Concepts program. There is a Canadian nickel among the trial objects that you would like to change with an American nickel from your objects library. How would you change it?

Activity 3: Children can answer a question up to three times in each trial. After each error, a prompt will be provided as a clue to the correct answer (i.e., shaking the correct answer and

zooming in to it). These prompts and the instruction for each of the three tries can be customized. Where would you go to adjust those customizations?

After the activities were completed, a follow-up question was asked: “What do you think about the interface? Do you have any general comments?” The user was then instructed to change to the other device and complete the same activity tasks. Finally, the user was asked these follow-up questions: “Which interface did you like better and why? What would make this app better? Do you have any further comments?”

3.5 SECOND PROTOTYPE DEVELOPMENT (JQUERY MOBILE APP)

In the second stage of the project, jQuery Mobile platform version 1.4.5 was used for developing the prototype mobile application. JQuery Mobile is a touch-optimized mobile framework developed by the jQuery project team based on HTML5. For the purposes of the creating the Wave app, jQuery Mobile was determined to have various advantages. Because it is a web-based, cross-platform framework, it is compatible with various mobile devices, operating systems, and screen resolutions. In addition, both future phones and older browsers are supported, due to jQuery’s progressive enhancement. Mobile web technology allows the app to run on any smartphone or tablet, as well as on desktop computers, eliminating the need for installing applications on specific devices. Using web-based technology also allows for storing data in the cloud, so teaching programs can be shared, assigned, and accessed on different devices at different locations. The only disadvantage to this approach is that using the app will require an active Internet connection.

Since jQuery Mobile is optimized for various screen sizes, the need to create two different interfaces to support both the iPhone and iPad was eliminated. As a result, the findings from the

first prototype user tests could be incorporated into a single interface design that was compatible with both smartphones and tablets. Another benefit, from a design standpoint, is that jQuery Mobile incorporates page transitions powered by AJAX navigation, which allows seamless navigation among pages. From a functional standpoint, the second prototype was designed to allow using media related to the target skills to create programs that can be assigned to students whose progress is then displayed on the Dashboard Figure 3.3.

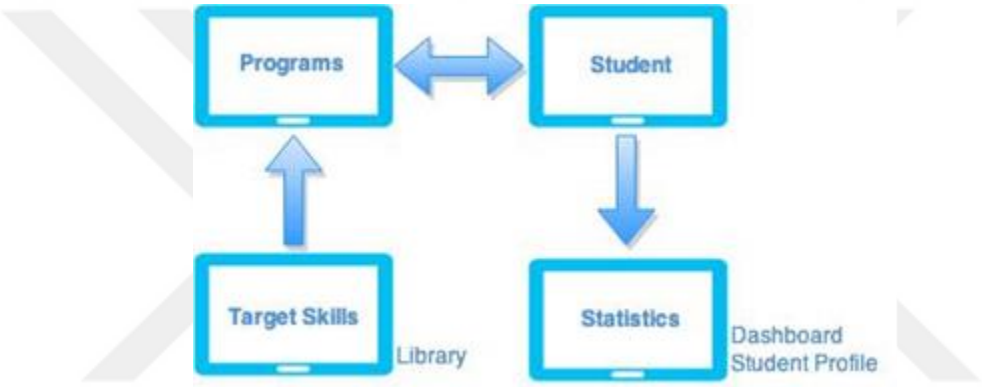

Figure 3.3: Functional components of the application

Media is added to the Library from the device photo library, recorded using the device camera, or downloaded from available packages. Programs can be built in three ways using these media: mass trials target one skill at a time; mixed trials allow the selection of multiple stimuli, and build-your-own (custom) allows teachers to customize each trial in the program. These programs can then be assigned to students. As students complete the programs, their progress is logged on the Dashboard, and an overview of their training history over time becomes available in their Student Profile. A single page design was adopted for developing the application. jQuery Mobile allows creating multiple pages in a single HTML file by separating each page with a unique id and using the href attribute to link between them in the form of <div data-role="page"

id="pageone">Page Content . The single page design allowed a faster development cycle by eliminating the need for developing across several separate pages.

3.6 SECOND PROTOTYPE USER TESTING

Two pilot tests and twelve user tests on the second prototype were conducted, using the app on an iPad. The two pilot users were chosen for convenience and for their experience in user interface design and usability testing. For the twelve user tests, six Discrete Trial Training experts—five from the Kennedy Krieger Institute and one from the Hussmann Institute for Autism—participated in order to give expert feedback on the training method. The other six participants were chosen for their knowledge of user interface design. Interviews were recorded and observations made during the user tests were documented. Results from these tests are provided and discussed in chapter 4.

3.6.1 Participants

The two pilot users were fellow students. In the user study, 12 subjects (8 females and 4 males) participated. Of these 12 subjects, 6 participants had experience with the Discrete Trial Training method, 5 had worked with children with special needs, 4 had provided training to students with autism spectrum disorder, and 1 had a child diagnosed with ASD. Five of the participants had previously used a tablet (e.g., iPad) for teaching purposes. Charts depicting demographic data about the user study participants are provided in Appendix C.

3.6.2 Procedure

The pilot testers performed the tasks (described in the next section) and gave feedback, but did not participate in any of the other procedures, including recording of the test.

User tests were conducted in the form of user interviews. Users were asked to sign a consent form that explained the study and their right to withdraw from the study at any time; by signing, they also agreed to the recording of their interview session for the purposes of the study. A copy of this consent form is provided in Appendix D. Users were then presented with information on the background of the method and the purpose of the user study. Different aspects of the application were discussed in order to provide subjects with an overview of the user test. The interview script is provided in Appendix E.

User interaction with the iPad during the user tests was recorded using a GoPro Hero3 camera that was connected to a Jaws Flex Clamp mount. This mount directly grips the top of an iPad, allowing for the camera to record user interaction from above Figure 3.4. The camera was set to rotate the video captures to remediate for the recording direction.

Figure 3.4: User study set up

3.7 TASK SCENARIOS

Four task scenarios were employed in developing the second prototype user study (see Appendix F). The main functions of the application and four major goals related to them were identified. They included playing an exercise, building an exercise, interacting with the Students section, and interacting with the Library section. These goals were used as the basis for developing relevant tasks. Tasks were then rephrased as scenarios to add context and provide participants with an explanation for each task. During the tests, tasks were referred to as "activities" to avoid making the participants feel they were being tested on their performance. The following task scenarios were used in the second prototype user study:

Activity 1: You have already created an exercise called "Getting Started" to teach three nonverbal gestures: Bye Bye, Come Here, and Be Quiet. Please go ahead and play that exercise.

Activity 2: You are interested in building an exercise to teach Be Quiet, Hello, and Listen, where Be Quiet is presented on the first trial, Be Quiet and Hello are presented on the second trial, and all three stimuli are presented on the third trial.

Activity 3: Naomi Beck is one of the children you are working with. You have assigned a few exercises for her to complete. How would you check her progress and her training history?

Activity 4: You would like to use your own voice for the instruction that is played for the Be Quiet stimulus. How would you do that?

Follow-up: What do you think about the interface? Do you have any suggestions for improving the app?

The findings from the prototype user tests are described in the next chapter (Chapter 4), including a more detailed description of the user interfaces in connection with those findings. In addition, Chapter 4 describes how the outcome of the user tests affected the development of the application; it also documents which findings were incorporated to improve the user experience and which items were discarded or recorded for future implementation.

4. RESULTS

The purpose of this work is to develop an E-learning based mobile application for kids with autism spectrum disorder that will allow educators to create customized training programs based on the Discrete Trial Training method. The design of the application was intended meet the following goals: helping educators to save time by being able to build exercises once and reuse them over time; enabling educators to adjust the programs to meet each student's needs and to monitor student progress; and allowing parents to work on the same exercises with their children. The audience group for the application was considered to be the educators who plan and design intervention programs, the high-functioning autistic children who participate those programs, and the parents and caregivers who assist children in carrying out the tasks in those programs. This chapter describes the interactive prototypes in further detail and examines the results of the user tests that influenced the application development and different aspects of the mobile interface. A preliminary interactive prototype in two versions (iPhone and iPad) was created first in order to test the mobile delivery method. Four user tests were conducted on that prototype to identify requirements for designing the application, and the findings from those tests were used in developing the second prototype of the application. Two pilot tests and twelve user tests were conducted using the second prototype app on an iPad. These user tests resulted in overall improvements to the application.

4.1 FIRST INTERACTIVE PROTOTYPES (AXURE)

Two versions of the first prototype (included on a CD enclosed with this dissertation) were created in order to test the effects of screen size on the interface. The iPad interface involved a split view design Figure 4.1, where trials were listed in the left panel and the content of the active

trial was displayed in the right panel. Selecting each trial in the left panel would refresh the right panel, allowing users to remain within the same interface.

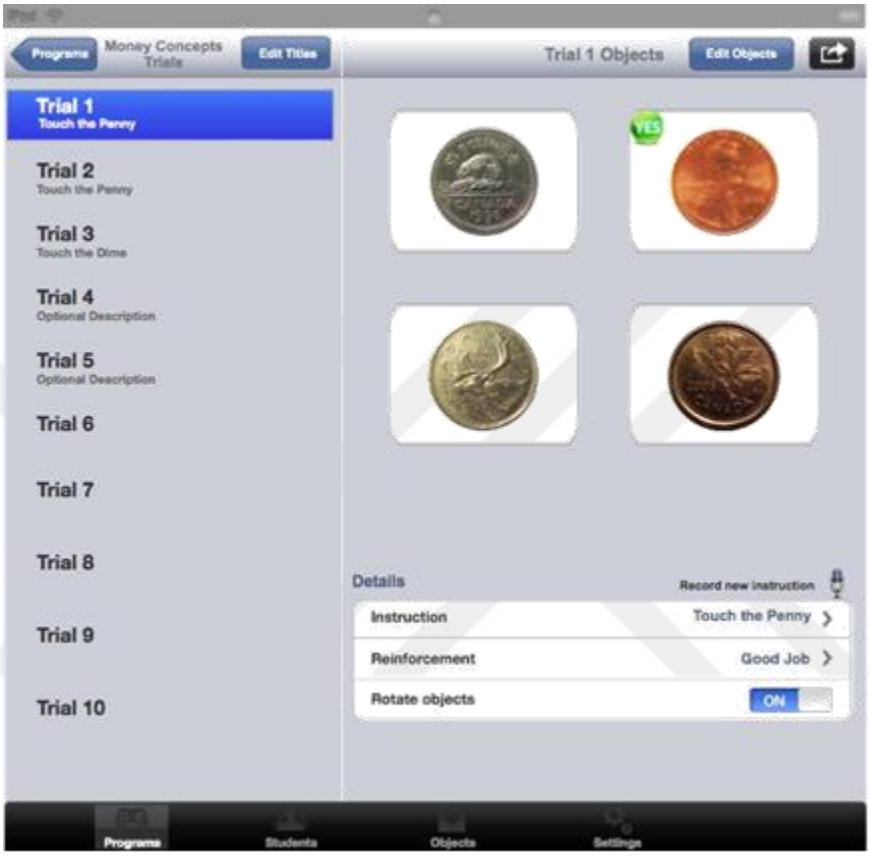

Figure 4.1: iPad interface

The iPhone interface incorporated a drill-down interface design Figure 4.2, where each screen was displayed in a separate window. Users would drill-down in each step and could return back to the previous screen by selecting the back button.

Figure 4.2: iPhone interface

The back button displayed the title of the previous screen to aid users in orienting within their drill-down navigation.

Both interfaces included four tabbed sections: Programs, Students, Objects, and Settings. Programs included a list of available programs, Students included a list of enrolled students, Objects contained the media items that were used in Programs, and Settings enabled users to customize sensory information such as sound and vibration.

4.2 USER STUDY FINDINGS

Based on the participants' feedback, the changes described in this section were implemented. In the case of each change made, the findings of the user study are discussed, along with solutions for addressing each issue. Revisions to the prototype were made while user testing progressed. Note that the findings in this section are not grouped according to iPad or iPhone platforms, since most of the issues addressed both versions. In those instances where different solutions were carried out based on the device platform, the solution is discussed according to its platform. Rename "Stamps" to "Objects": The initial iteration of the first prototype called the stimuli

media “Stamps.” The idea behind using “Stamps” instead of “Flashcards” was to make the title distinctive from existing applications. However, prototype user testing showed that this title was not understandable to the audience, so “Objects” was used instead. (As the study progressed, “Objects” was changed to “Library” in order to emphasize that it was a collection of items.)Differentiate between selectable items and Library items: During the user test, it was observed that one user who hit the Add button and was presented with items from the Library to add to the trial became confused about the connection between the presented interface (the list of available items to add) and the actual library interface (where items are listed, can be organized, removed, and more items downloaded/added etc.). Consequently, the interface architecture was modified to differentiate between the items currently being selected and the Library section. In addition, the Add from Objects Library window was modified to roll up from the bottom of the screen to provide a visual cue that the new screen for selecting Library items is a subset of the main screen.

Use the same discriminative stimuli (SD), reinforcement, and prompting settings across a program: Initially, the interface included three prompting configurations for each trial. While discussing this with a therapist, she suggested using the same configuration for all the trials in each program. She explained that the same instructions should be provided in each try. As a result, these configurations were moved to the Settings section.

Change the correct answer icon: Originally, the interface included a gray checkmark that changed to green when the user selected an option as the correct answer to a trial. These checkmarks were replaced with an icon that displayed the word “Yes.”

Remove the detail disclosure button: The interface failed to make it clear to participants that each row contained two different navigation items and that touching the detail

Disclosure button navigated to a different section than simply touching the row. As a result, the iPhone version was changed to use a disclosure indicator button , with one link for the entire row. In the iPad version, a Start button was added to the rows to start the program.

Add label to the action button: In order to add media, users needed to tap the Action

Button before selecting the media source, but the Action button did not provide participants with any clue to its purpose, unless the participant actually tapped it so that the Action menu was displayed. Consequently, some of the subjects struggled with finding the button for adding media, although they noted that they would remember its function the next time. A label that displayed "Add Media" was added next to the Action button to describe its function.

On the iPad move the start button to the top of the screen: The Start button on the iPad version was originally located at the bottom of the screen? It was relocated to the top of the Programs page in order to provide quicker access to starting a program.

Move trial details below trial objects: The original Trials page included Edit and Action buttons in the toolbar, followed by the Details section and the trial objects at the bottom of the screen. Participants failed to notice that the buttons in the toolbar were used for editing trial objects, since the trial objects were located below the Details section instead of being located directly below the buttons in the toolbar. This finding was in line with the proximity concept in Gestalt laws of grouping, which describes how human "perception tends to group stimuli that are close together as part of the same object, and stimuli that are far apart as two separate objects". As a result, the trial objects were moved above the Details section.

4.3 SECOND INTERACTIVE PROTOTYPE (JQUERY MOBILE APP)

Several design principles were considered in the design of the second prototype's user interface. One of the findings from the first prototype's user tests was that users did not associate controls with elements that were incorporated at a distance from those controls. Gestalt law of proximity states that objects that are closer together are perceived as more related than objects that are further apart. The second prototype's user interface employs the Gestalt law of proximity to place controls and their related elements on the interface close to each other when possible so that users can easily see them as related. For instance, the Add New Program button displays a popup next to it where the program types are grouped together. Similarly, the Start, Assign, and Setup buttons are included next to each other in a separate container and are displayed on top of the existing programs. In order to support the user's mental model and reduce learning time, visual elements and interactive components were employed consistently across all sections of the second prototype's interface. A mental model, is what the user believes about the system at hand and how he or she predicts it to function. Users build their mental models based on their prior knowledge of similar interfaces and their experience with the current interface. In the second prototype application, the left panels employ the same push mechanism to open across all screens, and the controls for opening, closing, and editing them are always in the same location in all the sections that include a left panel; this supports users' expectations once they are familiarized with the interface.

Control buttons across the second prototype interface use text labels with icons. Using icons aids in scan ability, leads to immediate recognition, and facilitates recall. The combination of icons with text allows for disambiguating the meaning of the control choices available on the interface. I found that icons with text labels were easier for participants to recognize correctly. Her study

indicated a learning advantage for the label-only and icon-with-text interfaces as compared to the icon-only interface for correctness, time, and use of help. On this basis, the interface buttons in the second prototype application use simplistic icons with text; these appear consistently across the user interface Figure 4.3.

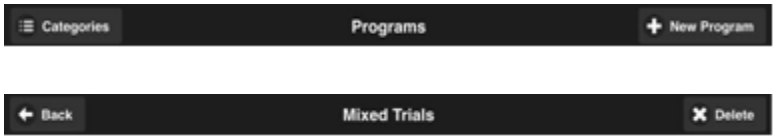

Figure 4.3: Interface buttons

The original four sections (Programs, Students, Objects, and Settings) were modified for the second prototype, and some sections were renamed. The Settings section was removed, and its functions were rolled into the programs themselves. It was replaced with a Notifications section (later renamed Dashboard), which displays progress updates about student activities and their assigned programs. As mentioned earlier, the Objects section was renamed Library, because it contains all the pictures, videos, animations, and multimedia stimuli that can be incorporated into the programs. The Students section still includes a list of enrolled students, and allows accessing their Individualized Education Program (IEP), assigned exercises, and training history. The Programs section displays the available exercises in the system, and allows modifying existing programs or adding new ones.

The next section discusses the results from the second prototype user tests and provides a description of the changes that were incorporated to improve the interaction design of the application.

4.4 DIFFERENT USER STUDY FINDINGS

To evaluate the usability of the second prototype, two pilot tests and twelve user tests were conducted. The pilot tests preceded the user tests and aided in the preparation for the user tests. The findings from the pilot and user tests and a discussion of how these findings were incorporated to improve the interaction design of the application are provided in this section. Two users with expertise in user experience and website usability participated in the pilot tests, and several decisions about the user interface were made based on these pilot tests. For example, the Notifications section was renamed to "Dashboard" and also made the default screen (first tab instead of last) because the pilot test users suggested that would be a better match to its purpose as the application's "homepage," where teachers are able to see an overview of their students' progress. Another change requested by the pilot users was the addition of a thumbnail in the Program list for each program and an indicator of the number of trials in each program. On the Trials screens (once users start a program), an indicator was added to show the remaining number of trials and display the user progress through the trials (e.g., 1/10). On the Program Setup screen and the New Program screens, the Add Media button was relocated from the top right side of the toolbar to the Target Skills section in the middle of the screen. Trial media used to be located on a different screen than the general settings. Moving between the Settings screen and the Objects screen was found confusing. To address that, the interface was redesigned to include Trial media under multiple tabs in the same screen as the general settings. In the Library, users were originally required to tap on the image caption for selecting it, but the pilot users expected to be able to tap on the image itself. The image-select behavior was changed to allow users to tap on the image or the caption area. In addition, the icon for modifying the media items was changed from a gear icon to a pen icon. Another improvement to the application, which was

suggested by the pilot users but not added until after the user tests, was to allow variations of each media to be saved in the Library (Figure 4.4). Although this functionality was initially considered relatively unimportant (and thus not included after the pilot tests), the findings of the user study strongly reinforced the need to include multiple versions of each stimulus in order to provide better generalization of the target stimuli and also allow for customizing target stimuli based on children's special needs.

The following are additional changes that have been incorporated based on the results from the user tests. On the Program Setup screen and the New Program screens, "Randomize" was renamed to "Random Rotation," which is an established term, in order to clarify its purpose. After discussing with DTT specialists, the terms "mass trials" and "mixed trial training" were used instead of "rote teaching" and "MET" (Multiple Exemplar Training), which had initially.

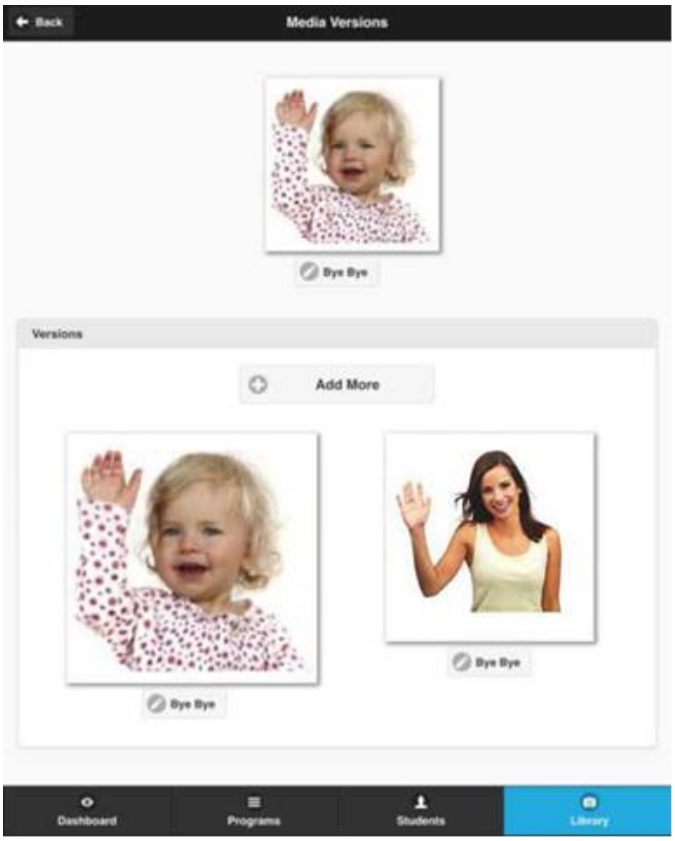

Figure 4.4: Media variations

been employed, based on an article. To provide further clarity, “Initial SD” was renamed to “Initial verbal instruction,” “Reinforcement” was renamed to “Reinforcement praise for correct answer,” and “Prompt” was renamed to “Prompt if wrong answer received.”

It was observed that once users completed configuration of a program, they would arrive at the bottom of the screen, where they expected to be able to save the program. As a result, the Save button, which was originally located in the top right corner of the toolbar, was exchanged with the Delete button, which used to be located at the bottom of the screen, so that users would see the Save button instead of the Delete button after they finished configuring the program. In order to make the Program Setup screen and New Program screens less busy, the verbal instruction, prompt, and reinforcement options for first try, second try, and last try were incorporated in expandable lists (Figure 4.5). After a program was completed, a summary of the results was included, with an option to allow the student to take the program again.

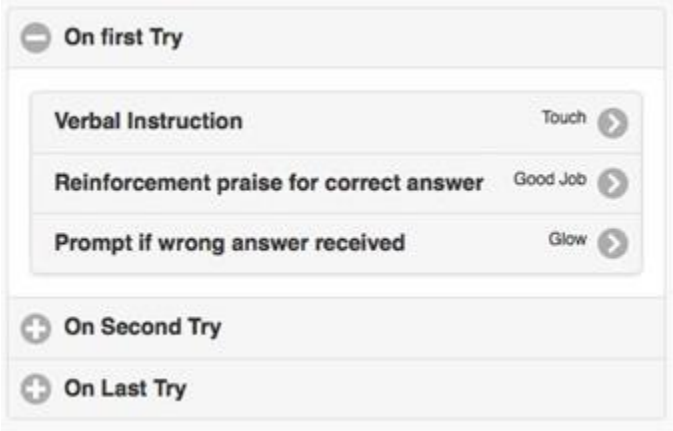

Figure 4.5: Expandable lists

On the Trials screens (once users start a program), the “point to” instruction was changed to “touch,” in order to place stress on touching the interface. The “nice try” reinforcement was

removed, since it was not descriptive of either a correct or an incorrect attempt. In addition, an option was included to limit the field size to fewer stimuli after incorrect answers. Based on the study participants' suggestions, a change was made so that an item was highlighted when it was touched in order to provide visual feedback to indicate that the user had selected the item. For moderated trainings, where the student must perform a skill in imitation of one shown on the device (e.g., video modeling training), the following options were included for the moderator (an instructor, therapist, or parent) to input for the trial: Prompt – Correct – Incorrect – No Response (Figure 4.6).

Figure 4.6: Moderated training options

On the Student Profile screen, the Assign button was added to the top right corner of the toolbar to allow instructors to assign a program to the student. In the Recent Trainings section of the screen, the latest completed programs were displayed and the interface was allowed to expand the list to view more. Based on the participants' feedback, the assigned-date line was expanded to also indicate who assigned the program to the student. A Statistics section with a time range was added that allowed educators to view the student's training progress. A number of findings were considered out of the scope of this project and were recorded for future implementation.

Because most children enjoy visual elements, providing more fun elements such as animations, exploding pictures, dancing characters, balloons, firecrackers, video clips, etc.—to help with their engagement was strongly suggested. A suggestion by one of the specialists was to allow students to pick their own reinforcement based on their preferences. The design of the application was based on allowing educators to customize the training according to the children's needs; however, allowing high-functioning children the option of choose their own reinforcement from a pre-selected list could be useful. In addition to auditory reinforcements, some other examples of positive reinforcements that can be used include tangible items, edible foods, preferred activities, and free time. Timing is important in providing reinforcements. Reinforcers should be provided directly after the successful completion of the trial or program. It is also important to provide reinforcements that the child does not already have free access to. Moreover, it is helpful to choose a reinforcer that can be continual and enhanced. Individuals respond to reinforcements differently and allowing the children to choose their preferred reinforcement can lead to increased motivation and engagement. Two suggestions were discarded among the findings. They included renaming "Media" to "Response Option" and clarifying the difference between "Trials" and "Tries" in each program. The cumulative results from the tests showed that these issues occurred only once and the terms were clear to the rest of the users in the study. Future user studies can be conducted to evaluate if more users share these problems.

Table 4.1 provides a summary of the users' feedback and findings from the user testing and outlines, noting whether they were incorporated to improve the application, discarded, or recorded for future implementation.

Table 4.1: User study findings

Participant	Findings	Outcome
P1	Clarify the role of dashboard in an introduction walkthrough	Accepted
	Clarify "Randomize"	Accepted
P2	Provide templates for programs	Accepted
	Allow custom instructions, reinforcements, prompts, and themes for students	Postponed
	Include more visual fun elements	Postponed
P3	In the prototype match student names on Dashboard and Students sections	Accepted
	Allow programs to be assigned to students from Students section	Accepted
P4	Change "nice try" to a reinforcement that indicates correct answer	Accepted
	Suggest IEP programs based on student needs	Postponed
P5	Incorporate fun animations e.g., exploding pictures and dancing characters	Postponed
	Limit the field size to fewer stimuli on incorrect answers	Accepted
P6	Add more complex activities such as trivia	Postponed
	Randomize SD sound	Accepted
	Allow configuring stimuli size to use bigger or smaller media in trials	Accepted
	Limit the field size to one on the last try	Accepted
	Use engaging animations such as explosions for reinforcement	Postponed
	Illustrate progress using graphs	Accepted
	Store training history over years	Accepted
	Allow students to pick their reinforcement based on their preference	Postponed
P7	Allow using multiple different stimuli for each target in a program	Accepted
	Reduce the field size after each incorrect answer	Accepted
	Use larger pictures	Accepted
	Use larger text	Postponed
	Redesign the new program screen to be less busy	Accepted

5. DISCUSSION AND CONCLUSION

The goal of this thesis was to provide a E-learning based mobile application for kids with autism spectrum disorder. We developed a mobile platform based on Discrete Trial Training for teaching high-functioning autistic children using python. A web-based mobile app was developed and a number of requirement specifications were identified that describe the requirements for building future mobile apps.

Based on the literature review and findings from the user tests, a mobile app that aims at providing training to students with autism needs to be highly customizable to support the unique needs of each individual on the spectrum, including each student's sensory input needs and educational requirements. It needs to be mobile in order to allow learning to occur independent of classroom settings and to help with generalization of the training. Moreover, it needs to record students' progress over time and display the data in graphs, where time is represented on the x-axis and skill acquisition on the y-axis of the graph. And finally, along with all this flexibility, mobility, and reporting capability, the resulting application needs to be easy to use.

To support these requirements, Wave's interface includes four main sections: Dashboard, Programs, Students, and Library. The Dashboard provides a quick overview of ongoing assignments. The Programs section lists the available programs, which can be organized in categories as well as allowing for the creation and customization of new exercises. The Students section lists the currently enrolled students, along with their special education needs, and provides an interface to monitor their progress over time. The Library includes the discriminative stimuli, such as images, videos, animations, etc., that are used to teach the target skills; it allows additional items to be downloaded from the Internet or captured from the device.

The application provides the option to easily create system-generated programs or customize a program to fit the specific needs of individual students. It supports two types of system-generated programs: mass trials and mixed trials. Mixed trials allow for selecting multiple stimuli, while mass trials teach one skill at a time. The build-your-own option allows educators to customize each trial within the program, adjusting them to a student's particular needs.

The Wave mobile app can help to develop basic skills, including attention, perception, reasoning, memory, reading and writing, motor skills through matching skills, imitation exercises, and natural environment trainings. It allows programs to be customized and enables adjustments to be made to fit the specific educational and physical needs of an ASD child. Its portability supports learning at any time and in any location and allows the learning process to be transferred to natural environment settings, including family and public settings. Furthermore, it helps teachers to save time by allowing them to reuse programs and decreases their workload by offering them easy access to monitoring children's data.

According to the specialists who participated in the user testings, the Wave application is practical and usable for teaching children with autism. Having every single trial presented in exactly the same way every time—a need of ASD children—is likely to be impossible for human trainers; however, the Wave app enables that requirement. For parents who are interested in training their children at home or in other natural environments, the app offers programs that are exactly the same as those provided by the teacher, which allows parents to deliver the training in the same manner.

The Wave app makes it easy for the teacher to monitor a student's data and eliminates the variability of different people recording data in different ways. Storage of the training data helps

even new teachers to understand a child's learning history and determine what skills have been mastered in the past, which assists teachers in creating new skill acquisition programs or maintenance programs that focus on the skills that have been previously mastered.

The mobile application still requires a number of components in order to be made functional for educational use. The current Wave app is a working prototype without a database to store information. As a result, several sections of the application had to be statically created to present the interaction design of the interface for the user tests. The app will need a database to be implemented in order to store the application data, including the list of programs, students, and media items, and to allow students' progress data to be displayed in graphs. It will also require an algorithm to execute the programs and present the trials to the users.

In addition, a fully functional version of the application will need to restrict students' access to other sections of the app, as well as any other apps that might be available on the device. Autistic children can be quite well versed in using iPads and could easily navigate away from a training application to their favorite apps. The Wave application will include a Student Mode that will restrict user access to a list of assigned programs that are available for the student. This feature will help by displaying only relevant information to the student and prevents students from altering other sections of the application.

A number of other enhancements should also be considered for future implementations. Most children show interest in visual media, which can be used to increase engagement with the application. Fun animations, exploding pictures, dancing characters, balloons, firecrackers, video clips, etc. could be used as reinforcements for correct answers. During the user tests, ASD educators noted that many autistic children enjoy watching their favorite video clips over and

over again. Allowing kids to choose their preferred reinforcement from a list of preselected items can aid in raising their enthusiasm and increasing their engagement. In addition, it would be helpful to allow custom instructions, reinforcements, prompts, and themes to be set universally for each student, in addition to being able to set those preferences for each program.

In terms of adding enhancements that will assist teachers and parents in using Wave, the functional version of the app should include an introductory walkthrough for first-time users in order to teach them the main components of the interface. Providing popup tips when users hold down an element should also be considered in order to help users learn the different functions of the application. As instructors become more expert in building programs, they can consider adding more complex activities such as trivia, design multi-step programs to teach order, and create social stories that are not provided by the default in order to teach additional types of skills. Instructors should also note that it is beneficial to provide customized verbal instruction in a context (i.e., “We are in the library; be quiet”) in order to allow for further generalization of the training to natural environment situations. Although the target stimuli demonstrated in this version of the app were visual media, instructors could also consider auditory stimuli for the purpose of building programs

It should be noted that using computer-assisted interventions to teach social skills can pose generalization issues. Generalization refers to the transfer of a skill that is learned in one setting—such as a device—to the second setting—such as the natural environment—without explicit teaching in the second transfer setting. Once a skill is learned on a device, it is important that the person is able to naturally start using those skills in the real world. In many cases, social skills generalize naturally, especially in typical child development. However, for individuals with autism generalization may not happen as predictably. Additional research on the generalization

of computer-assisted interventions is required to better evaluate the efficacy of such technology in teaching nonverbal social communication skills to individuals with autism.

Finally, future randomized controlled studies of the application in use by ASD children will be required to evaluate the efficacy of the Wave application in teaching nonverbal social communication skills to high-functioning autistic children using Discrete Trial Training. Controlled trials should include enough participants to yield statistically significant results, and they should employ randomized designs to eliminate the influence of confounding variables.

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