Toward Effective Game-Based Social Skills Tutoring for Children: An Evaluation of a Social Adventure Game

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ABSTRACT
This paper describes a study of a prototype of a novel game-based intelligent tutor that teaches children positive social skills. The results provide considerable support for the potential value of this game as a social skills training tool, despite the comparatively brief play-through duration of the prototype. Key to the initial success is a development framework that fostered deep collaboration and rapid prototyping between the subject matter experts and game designers.

Keywords
Social Skills Learning, Digital Games, Intelligent Tutoring, Interactive Narrative, Data-Driven Design

1. INTRODUCTION

This paper describes the design, development, and evaluation of a prototype game for the intelligent tutoring of social skills to children. The game is called “Adventures Aboard the S.S.GRIN”, as its curriculum is based on Social Skills Group Intervention (S.S.GRIN) [10], a scientifically validated, skill-based social skills training intervention that combines social learning and cognitive-behavioral techniques to build children’s social skills and social relationships. Statistically significant correlations were found between children’s performance within the game and their assessed social skills competencies, even with exposure to the game limited to less than twenty minutes.

This research is significant in that it establishes the usefulness of applying Intelligent Tutoring Systems techniques to children’s social skill development. Furthermore, it shows that such tutoring can be effective within a narrative-rich point-and-click adventure game. Some of the success of the game can be ascribed to the thoughtful collaboration among computer scientists, graphic artists, and psychologists throughout the design and development process. The conceptual distance between these disciplines underscores the significance of highlighting the aspects of software design and architecture that facilitated fruitful collaboration.

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2. BACKGROUND

2.1 Social Skills and Peer Relationships

Children’s relationships with other children are critically important for their sense of well-being and adjustment [31, 24]. From the time children enter school, peers take on an increasingly meaningful and influential role, becoming key providers of support, advice, companionship, and affirmation as children mature through the elementary school years and into adolescence [18]. Positive social skills and relationships promote more positive emotional, behavioral, and academic functioning. Positive peer relations also operate as a protective factor, reducing the likelihood of negative outcomes in the face of stressful life events, such as poverty [23, 25, 31].

In contrast, social problems increase children’s risk of poor adjustment across all areas of functioning. Children who experience peer problems tend to exhibit a wide variety of concurrent behavioral (e.g., disruptive, aggressive), psychological (e.g., low self-esteem, lonely, depressed), and academic (e.g., poor school performance, absenteeism) difficulties. The developmental psychopathology literature underscores the insidious, damaging influence of peer problems which place children at heightened risk for development of numerous negative outcomes, including depression [4], anxiety disorders [14], suicide [7], delinquency and antisocial behavior [5, 15], substance abuse [22, 34], educational underachievement [16, 37], and other mental health difficulties [31].

Children can experience a variety of social difficulties within the peer group. Three common categories of peer problems are: Rejection (active dislike, avoidance, exclusion of a child by the majority peer group), Victimization (bullying, assault, intimidation, teasing, humiliation, rumor spreading), and Social Isolation (lack of stable, close positive friendships). As children experience social failure, many become increasingly negative about themselves and anxious in social situations. They may withdraw, becoming more socially isolated, or they may act out their anger and frustration on others. When children are rejected from the normative peer group, they tend to affiliate with other children also on the out skirts. When antisocial peers affiliate with one another more exclusively, negative behaviors and attitudes are compounded. In effect, a vicious cycle may develop in which poor social skills, social anxiety, and negative attitudes reinforce one another over time [24].

While the particular adjustment difficulties a child exhibits vary depending on the specific peer problems expe-
rienced, as well as child and contextual factors, the research literature indicates that the quality of children’s peer relationships directly influences their academic, behavioral, and emotional adjustment. This influence is not simply an artifact of other associated behaviors, such as aggressiveness, nor environmental factors, such as poverty, but rather peer problems contribute to the development of future problems with unique and independent prediction. As peer problems become more chronic or severe, children’s risk for negative outcomes increases [11]. A key to preventing the development of more serious maladjustment is intervening with problematic social behaviors before they become chronic and intractable [20, 31]. Early intervention is critical in the prevention of severe social skill deficits and entrenched negative peer interaction patterns [8, 30].

2.2 Social Skills Training for Children

A variety of social skills training programs, with differing sets of skills and teaching formats, have been developed over the years [2, 20]. Social skills training may be directed towards children more generally as in school-based universal programs through which all children participate in the intervention regardless of social skills level. Other social skills training interventions are delivered in a small group therapeutic setting and focus on children who are identified as experiencing one or more social problems (i.e., indicated programs). While the research literature clearly supports the use of social skills training, those programs (universal or indicated) that integrate behavioral (what to do or not to do in a social situation), cognitive (assumptions, evaluating consequences, goal setting), and emotional (feelings about/during a social situation) social skills have been found to be most effective. This more integrative approach to social skills training helps children think through a given social situation, consider alternative social problem-solving approaches, and evaluate the success of a selected approach for achieving a social goal. In other words, those interventions that build children’s capacity to actively engage in social problem-solving have the most significant and lasting impact on the quality of their peer relations.

S.S.GRIN was developed and repeatedly tested, starting with one elementary school in 1993 and progressing to longitudinal research within 45 elementary schools across the NC Wake County Public School System. Research supports the effectiveness of S.S.GRIN [9, 12]. For example, in a study of third graders, children with specific peer problems (high peer dislike, victimization by peers) and/or high social anxiety were identified and randomly assigned to Treatment (n=187) or no-treatment Control (n=194). Trained school counselors administered S.S.GRIN in the school setting. Children who participated in S.S.GRIN showed improvement in peer liking, enhanced self-efficacy for dealing with social situations, lower social anxiety, and greater declines in aggressive behavior problems compared to controls [9]. At one-year follow-up, all pre-post benefits were still present and additional benefits were evident, including lower victimization by peers, fewer negative nominations by peers, and more positive outcome expectancy for social situations [12]. Overall, results support the effectiveness of S.S.GRIN not only for enhancing children’s social relationships, but also for improving social-cognitive, behavioral, and emotional functioning, both at immediate and one-year follow-up.

2.3 Intelligent Tutoring Systems

With continuous development spanning the past twenty years, Intelligent Tutoring Systems (ITS) have advanced to the point where many research-based systems exceed the teaching effectiveness of traditional classroom-based instruction [36]. Of particular relevance are those ITS systems that leverage the game paradigm to help guide exploratory learning [17, 6, 20, 3, 1]. Contemporaneous with this success, commercial digital game technologies have shown remarkable advancement in graphics and human-computer interaction, especially in terms of training. Gamers expect to be taught how to use a new game not by reading a printed manual, but rather through sophisticated in-game instruction. The games industry is now more lucrative than the film industry, and that commercial clout has driven the development of innovative in-game training methods. Significant independent voices [19, 32] have noted the potential for extending these training techniques to cover academic subjects.

However, bridging the disparate approaches to learner guidance between games and ITS has proven to be difficult. Straightforward attempts to bolt-on learning content to a game or game play to a learning system are notoriously disappointing. Knowledgeable cynics have noted that in the collaborative efforts to date, excessive focus on learning tends to “suck the fun out” of games, to which the rejoinder is offered that a game design focus often “sucks out the learning”[33]. More successful are approaches that integrate learning content with what the game design community describes as the “core mechanic” of a game.

The ITS game leverages the medium of interactive narrative [27, 26] to tightly integrate the game mechanic with the learning content [35]. In the case of ITS, the learning content of social skills is particularly well expressed through narrative examples. However, adapting interactive narrative for exploratory, constructive learning demands that user autonomy be sufficient to support exploration of specific “hypothesis-generation-testing cycles” [29]. A key feature of the ITS is to support and guide the student in making multiple attempts at solving the same social problems.

Consistent with many successful ITS designs, the ITS required a thorough and thoughtful sequencing of the social challenges, action choices, hints and consequences in the game. Each logical branch in this structure required collaboration with the mental health professionals. Unlike systems in which unpredictable, emergent behaviors [3] could place unpredictable learning demands on the student, the ITS provides a strictly deterministic set of internally consistent learning paths, that are dynamically selected based on student performance.

2.4 The Potential Benefits of Socially-Intelligent Tutoring Systems

A key opportunity for computer-based social learning is to provide a safe environment in which students can explore and practice newly learned social strategies. Unlike in the child’s actual social environment, mistakes made in exploring social relationships in the virtual world will not become persistent impediments to future growth. Thus the learning principle of the “Psychosocial Moratorium” articulated by Gee [19] takes center stage with ITS. This principle states that one of the great benefits of games is that they allow learners to take risks in a space where real-world con-
sequences are lowered. Given the high costs of social mistakes, it is especially useful for children to have a safe place to practice.

3. INNOVATIVE GAME FEATURES

3.1 Overview

The S.S.GRIN intelligent social tutoring system (ISTS) invites the child to participate in a social narrative through an in-game avatar. The ISTS leverages the point-and-click adventure game paradigm to guide the student through a structured narrative of recruiting and maintaining friends while coping with other, unfriendly characters. The development was split into two components: a general-purpose engine that encapsulated the point-and-click game paradigm, and a separate component containing the game content specific to ISTS. Both components were written in ActionScript 3.0 which underlies AdobeFlash.

3.2 Game Mechanics

Before social training begins, the child customizes the appearance of the avatar which will be their visual representation in the game, using an interface depicted in Figure 1. Being able to customize the avatar’s gender and appearance enhances children’s identification with their character, which in turn increases their engagement and learning [9, 51]. Children can select from a diverse set of fun and naturalistic options through a quick and easy selection process.

To communicate with other characters, the child chooses from a menu of dialogue and behavioral options, as shown in Figure 2. As the child moves the cursor over each option in the menu, the avatar’s facial expression changes to reflect the emotional intent of that communication or action. This novel interactive element helps children recognize visual cues associated with non-verbal communication, a key area of social skill development. Avatar facial expressions are built on the work of Dr. Paul Ekman and colleagues who identified facial muscular changes associated with distinct emotional states [13], as shown in Figure 3.

3.3 Calibration and Adaptation

The geography of the game is structured so children must master the basics of avatar navigation and dialogue selection described above before moving into the part of the game where the social problem solving (SPS) challenges are posed. The first scene represents a common, yet moderately difficult social situation where animated wharf rats attempt to bully the avatar. During this interaction, each menu presents the child with a choice of one of three responses: to withdraw (passive response), to escalate the conflict (aggressive response), or to manage the situation in a nonaggressive, yet assertive manner (assertive response). Over the course of three exchanges, the child’s responses are tracked by the software and scored according to type (passive, aggressive, or assertive) and sequence. Because subsequent choices by the child are based on more social information for the situation (i.e., how the rats responded to the child’s prior dialogue choice), children’s first response to the rats is given less weight than later responses when determining the child’s entry difficulty level for subsequent social problem solving tasks. For example, a child who continues to escalate the conflict demonstrates lower social reasoning than a child who adapts from aggressive or passive to more assertive responses over the course of the interaction.

The ISTS prototype focuses on a primary skill of the S.S.GRIN curriculum, known as “Stop & Think” or impulse control. Impulse control is a basic social skill that is centrally important to many other social skills, such as cooperation and communication [28].

The S.S.GRIN intervention stresses the value of using Stop & Think across a variety of situations. During in-person group therapy sessions, children practice Stop & Think via
role-playing of interpersonal situations (e.g., initiating a conversation, resolving a conflict, compromising) and through behaviorally focused problem-solving exercises (e.g., working through a logic puzzle, following instructions to ensure accurate responses). In this way, S.S.GRIN demonstrates the importance of inhibiting impulsive responses more broadly and provides practice in the application of impulse control specifically for social situations. Therefore, the ISTS includes different types of SPS tasks requiring impulse control for both behavioral tasks and social interactions.

For example, to rescue the first crew member (Stop & Think Girl), the child has to successfully negotiate with another character, the “fishing kid”, to borrow a jet ski. However, the scene includes elements designed to interfere with impulse control and encourage the child to impulsively take the jet ski without asking. These elements are more or less difficult depending on the child’s prior performance ranging from (a) the easiest level where the fishing kid initiates conversation to signal that the child needs to talk with him first to (b) the moderate level where the fishing kid no longer initiates conversation and a key is prominently displayed as an added temptation to take the jet ski to (c) the highest difficulty where an element of “peer” pressure is added with a monkey actively encouraging the avatar to ignore the fishing kid and take the jet ski. Performance on this task is based on antisocial behavioral responses towards the fishing kid (e.g., attempts to take the jet ski without permission) and the quality of the child’s negotiation skills (i.e., demanding vs. cooperative).

A more behaviorally focused SPS task is a puzzle where the child must pay attention to details and carefully follow instructions to convince a monkey to let down a bridge along the way to get Stop & Think Girl. This scene pulls for impulsive responding with several red herrings (e.g., cart of bananas, large “Push for Bridge” button) and uncommon twists to the solution (e.g., the monkey does not like bananas). Performance is based on the order, number, and timing of impulsive responses.

A robust content and scoring algorithm, based on theory and research in children’s social development [31], was used to classify the Social Reasoning (SR) performance level represented by the child’s behavior during the ISTS (i.e., high, medium, low). SR levels are calculated for overall performance as well as performance for each SPS task.

### 3.4 Game Engine Responsibilities

The engine tracks and renders the avatar location, directional orientation, locomotion, facial expression, and hand/body position. A “click-to-move” paradigm using a modified A* algorithm is used to plan the path the avatar will walk from one spot to another. This algorithm restricts the path to each scene’s geometrically-defined “walkable area” and avoids collisions between the avatar and objects in the scene. The engine enables a flexible map that represents the connection paths between independent scenes or propositions. Graphics rendering includes shadowing and perspective changes integrated to alter the avatar’s size and shading depending on its location. The avatar moves in front of or behind objects depending on its depth in scene. These are key elements that distinguish 2.5D from standard two-dimensional Flash animations. The engine also provides the set of rules defining the ways characters can interact with clickable, tools that can be used, and communication modes with pedagogical agents and other external characters.

The engine also features an extensive logging system that tracks and records the child’s actions (choices, sequence) for each scene and calculates relevant performance metrics for social problem-solving. This data is used by the software engine to adjust the difficulty level of subsequent scenes in response to the child’s performance in prior scenes as well as to modulate the amount of pedagogical assistance provided for a given scene (e.g., when an S.S.GRIN crew member should provide advice to the child). In this way, the ISTS adapts training to the child’s skill level for more individualized learning. The data gathered through this logging process also form the basis for positive reinforcement and constructive feedback provided to the child during the course of completing the ISTS (e.g., pedagogical comments, Travel Log summary) as well as for the summary reports regarding the child’s ISTS performance in targeted areas.

### 3.5 Evolution of a Data-driven Architecture

When the ISTS presents a child with a set of options for dialogue and/or behaviors, unique paths emerge, branching from each possible option. For example, a series of three choice points with three options each yields 27 unique paths of dialogue/behavior. However, selecting options at explicit choice points is only one factor that influences a child’s course through a scene. The way a child interacts with a scene (where they move, what they click on, and the sequence of these actions) influences what is presented to the child and the subsequent course of action. The scripting system is used to define rules for how ISTS responses are triggered by a child’s interaction pattern with a scene.

An especially useful ISTS software design decision was to specify the dialogue, behavioral choices, facial expressions, text, and system responses (e.g., reaction by external character) for each scene in editable XML (eXtensible Markup Language) files that are then read into the ISTS game engine at run-time. This allowed psychologists and other non-software designers on the development team to easily create and modify all these key aspects of game play without having to work through a software designer.

The value of this data-driven approach extended beyond typical software engineering and maintainability benchmarks. More significantly, it allowed the mental health professionals to quickly iterate through permutations of the dialogue and action trees that formed the basis of the core mechanic of the game without requiring any direct interaction with the software designers. Because the XML files that contained these “guts” of the program structure were fully visible and editable by the mental health professionals. Because the same files were loaded on each new invocation of the ISTS, these subject matter experts could immediately see the results of their edits on the flow of the tutorial on each run.

### 4. EVALUATION

A total of 37 children and their parents participated in an evaluation of the ISTS. Families were selected on a “first come first served” basis after flyers were sent to area elementary schools and pediatricians’ offices. Parent participants were primarily female (67%) with a bachelor’s degree or other college experience (53%) and an average age of 40 years. Children were primarily male (59%) with an average age of 10 years. Families represented the full range of socioeconomic status with a racial/ethnic distribution of
73% White (5% of Hispanic/Latino ethnicity), 22% African American, and 5% Asian American. All families reported having a computer with an Internet connection (98% with high-speed) available to the child at home.

4.1 Methodology

Six groups of parent-child pairs attended a two-hour scheduled meeting at 3-C ISD. Each child was assigned a private kiosk where s/he could interact with the ISTS on a computer (all kiosks had identical set-ups) while the parent observed. Trained research assistants led the groups through a semi-structured three-part data collection process. First, parents and children completed consent forms and demographic and social skills questionnaires. Second, following the project introduction and computer orientation, children were given 30 minutes of free time to interact with the ISTS. Children were asked to go through the SPS tasks twice (i.e., click “Try Again” at least once). Parents were asked to observe only, without providing assistance. Trained observers monitored and recorded children’s level of attention, areas of difficulty, and responses to ISTS tasks. Computer logs tracked the location and time of each mouse click so children’s interactivity could be mapped and examined (e.g., for software usability). Third, children and parents separately completed questionnaires evaluating the ISTS. Research assistants gave instructions, read questions aloud for children, and assisted with completion, as needed. Parents and children wrote comments, suggestions, and criticisms at the bottom of each questionnaire. Once questionnaire data were collected, the PI led group discussions to gather additional comments and suggestions from parents and children.

An important aspect of this study was to examine the degree to which performance was related to external measures of children’s social skills and behavior. To this end, parents and children separately completed the Social Skills Rating Scale [21] prior to interacting with the ISTS. Each item (55 for parents; 34 for children) of the SSRS includes a behavioral description (e.g., “I make friends easily”) to which respondents indicate how often that description is true for the child (0=Never; 1=Sometimes; or 2=Very Often). Factor analysis of the parent-report (P-R) form supported four social behavior scales (Cooperative, Responsible, Assertive, Self-control) and three problem behavior scales (Internalizing, Externalizing, Hyperactivity) each with good internal consistency (mean $\alpha = .71$). Factor analysis of the child-report (C-R) form supported four social behavior scales (Friendly, Polite, Communication, Impulse control) also with good internal consistency (mean $\alpha = .71$).

4.2 Results

The first choices presented to a child using the ISTS are the selection of the visual characteristics of the avatar that represents the child throughout the game. As expected, children tended to select avatars that matched their own appearance. A high correspondence ($\chi^2_{17} = 33.03, p < .0001$) was found between the child’s gender and that of the selected avatar. Also, there was also a high correspondence between the child’s racial/ethnic group and their selection of avatar skin tone ($\chi^2_{12} = 32.94, p < .001$). For example, 100% of African American children chose one of the two darker skin tones and 88% of White children chose one of the two lighter skin tones. Children used the full range of clothing color and hair style options with a strong tendency to select options that reflected their own appearance.

During the work groups, children were observed looking at their own clothing and then selecting colors for the avatar’s clothes to match. During follow-up discussion, children reported that being able to customize their avatar made the ISTS more fun and interesting (e.g., “I like seeing me on the screen”). This inclination of the students to select avatars that match their appearance is encouraging as it indicates a willingness to identify with the avatar, which perhaps links more strongly the behavioral choices made in the game to choices the child would make in real life.

To test whether children’s social skills differed according to how they performed on the first SPS task (bullying by wharf rats), Analyses of Variance (ANOVAs) were conducted with social reasoning (SR) level predicting SSRS scale scores. Reported levels of polite behavior (e.g., “I ask before using other people’s things.”), communication (e.g., “I tell others when I am upset with them.”), and impulse control (e.g., “I ignore others when they tease me.”) were significantly higher for children with higher SR levels. Parents reported that children with high SR were significantly higher on cooperative behavior (e.g., “Volunteers to help”), marginally higher on self-control (e.g., “Receives criticism well”), and marginally lower on externalizing behavior (e.g., “Fights with others”) compared to lower SR levels. A second set of ANOVAs examined whether social skills were related to a child’s initial reaction to the social challenge by the wharf rats: aggressive (n=11), passive (n=9), assertive (n=17). Assertive children’s self-ratings for polite behavior and their parents’ ratings of responsible behavior (e.g., “Asks permission before using another’s property”) were significantly higher than those for passive children. Parents also reported aggressive children displayed significantly more hyperactive and externalizing behavior and significantly less self-control compared to assertive or passive children. A final set of ANOVAs was conducted to examine SR levels across different SPS scenes. As expected, children with lower SR in one scene performed more poorly on subsequent impulse control tasks (e.g., significantly more error clicks).

In addition to SPS performance metrics, three systemic metrics were calculated based on logs generated over the course of ISTS game play to gain a deep understanding of the child’s overall patterns of engagement with the ISTS. First, dialogue speed (DS) is the mean number of times a child clicked to exit a dialogue window before the allotted time. Second, processing time (PT) equals the amount of time spent during SPS tasks minus the number of error clicks. Last, exploration (EX) is the amount of time a child spent exploring the non-SPS areas of the ISTS. Correlations between these systemic metrics and performance metrics were calculated. Given the small sample size and limited power, correlations at up to the .10 p-level were reported. A modest negative correlation was found with DS and performance ($r = -.25, p < .10$) indicating children who clicked to exit a dialogue window prematurely tended to perform poorly in impulse control. In contrast, PT was positively correlated with performance ($r = .55, p < .001$) on SPS tasks suggesting amount of time spent processing an SPS task without excessive or random clicking was associated with higher problem-solving ability. A positive correlation between EX and performance ($r = .40, p < .01$) was also found suggesting that being more investigative may enhance social interaction with characters in the ISTS.
Finally, correlations between the various ISTS performance indices and SSRS scales were run to examine the interrelations among children’s social skills levels and their SPS during the ISTS (due to limited power, correlations greater than .20 are reported). Overall, the pattern of correlations was consistent with expectations. More appropriate responding was associated with being more polite (r = .50, p < .001) and responsible (r = .26, p < .10) and with higher communication (r = .34, p < .05). Inhibiting impulsive responses during the ISTS was associated with greater impulse control (r = .31, p < .05) and lower hyperactivity (r = -.29, p < .10). Quickly moving through dialogue with other characters (DS) was associated with lower communication (r = -.35, p < .05), cooperation (r = -.33, p < .05) and impulse control (r = -.32, p < .05) as well as higher externalizing behavior problems (r = .37, p < .05). Higher processing time (PT) was modestly associated with a trend toward more internalizing behavior problems (r = .24, p < .10). More exploration tended to be associated with higher communication (r = .33, p < .05) and friendliness (r = .25, p < .10) as well as lower hyperactive behavior (r = -.26, p < .10). Though the number of subjects per cell was too low to test statistically, examination of the various findings from these analyses across different genders and racial/ethnic groups indicated that the patterns of results held consistently across different sub-groups.

These results demonstrated that performance on the SPS tasks was related to children’s social skills and behavior, as assessed through an independent standardized instrument, and these inter-relations were meaningfully linked to the intended content of the game (e.g., impulsive behavior problems associated with impulsive responses). Further, the ways in which children interacted with the game (systemic metrics) corresponded with their social reasoning on SPS tasks as well as their social behavior with peers (as measured by the SSRS). Results also showed that the ISTS has been designed in such a way that SPS tasks are sufficiently difficult to challenge children (e.g., variance in response patterns), repeated exposure to SPS tasks results in significant learning, and difficulty level can be effectively modulated to fit the child’s social reasoning level. Test results also provide evidence of convergent validity for the social task performance indices.

It is worth noting that the tested prototype represented only a small portion of the entire S.S.GRIN curriculum. A full game would have eight to ten times the content and play-through time of the prototype. For us to find statistically significant relations with such a reduced set of learning content is strong encouragement for the potential teaching effectiveness of a more complete tutorial.

5. CONCLUSION

This paper described an adventure game that employs intelligent tutoring techniques to teach children positive social skills. An empirical evaluation of the game provided considerable support for the potential value of this game as a social skills training tool, despite the comparatively brief play-through duration of the prototype. This shows that an integration of ITS and games may provide a useful platform for teaching social skills, at least within a thoughtfully scripted interactive narrative.

From a software design standpoint, this study shows the value of encapsulating a game engine independent from game-specific content, and the value of further encapsulating much of the game logic as externally editable data.

Future work should investigate the learning effectiveness of a full game, both with and without supporting classroom-based instruction.

6. REFERENCES


