# Using Interactive Multimedia to Teach Pedestrian Safety: An Exploratory Study

**Ann Glang, PhD; John Noell, PhD; Dennis Ary, PhD; Lynne Swartz, MPH, CHES**

***Objectives*: To evaluate an interactive multimedia (IMM) program that teaches young children safe pedestrian skills. *Methods*: The program uses IMM (animation and video) to teach children critical skills for crossing streets safely. A computer-delivered video assessment and a real-life street simulation were used to measure the effectiveness of the program in teaching safe street-crossing skills. *Results*: Significant effects were found on the computer-delivered and behavioral measures. *Conclusion*: Findings suggest that children can learn to discriminate dangerous elements in traffic situations using the IMM program and transfer that knowledge to real-life environments.**

***Key words*: interactive multimedia, pedestrian safety, safety education, child safety**

***Am J Health Behav.* 2005;29(5):435-442**

Injuries are the leading cause of death in children in the United States.[1] More years of potential life are lost due to death from injuries than from any other cause, including congenital anomalies and all forms of disease.[2] Injuries are also the leading cause of head trauma in children in the United States[3] and account for over 12 million emergency room visits and 600,000 hospitalizations annually.[4] The costs of childhood injury and disability are staggering: an estimated $347 billion each year.[6]

For children over 5, injuries from pedestrian-motor vehicle collisions (ie, when children are walking along, playing in, or crossing the street) are the second most common cause of death from injury.[1] In 2001, approximately 39,000 children aged 5-9 were injured in pedestrian/motor vehicle collisions; 11,000 of these injuries were incapacitating.[5] Although rates of unintentional injury and death from trauma have decreased over the past several decades,[1] the prevention of childhood injuries, especially pedestrian/motor vehicle injuries, remains an important public health issue.

Strategies for the prevention of childhood injuries can be placed on a continuum from passive to active injury control.[7] Passive strategies involve the manipulation of environmental variables in order to protect the individual from injury and minimize the need for individual behavior change.[8] Common examples of passive strategies are traffic engineering measures such as sidewalk overpasses and roundabouts to change traffic direction. Passive devices have been shown to be effective in preventing injuries, but are not available in all situations.[9] More active strategies involve having individuals — either children or their caregivers — take some active step to reduce the risk of injury. Health education and behaviorally based training programs are examples of active strategies. Most effective interventions to reduce

*Ann Glang; Dennis Ary; Lynne Swartz, Research Scientists, Oregon Center for Applied Science, Inc., Eugene, OR. John Noell, Research Scientist, Oregon Research Institute, Eugene, OR.*

*Address correspondence to Dr Glang, Oregon Center for Applied Science, Inc., 1839 Garden Avenue, Eugene, OR 97403. E-mail: aglang@orcasinc.com*

childhood injury combine elements of both active and passive strategies.[10]

Safety education for primary school children is common practice and has been recommended by a wide range of child pedestrian safety experts.[11,12] Education is one important aspect of effective injury prevention efforts, used in conjunction with engineering and law enforcement. These 3 E's form a comprehensive approach to reducing childhood injury.[13] Traditionally, injury-prevention educational efforts have been characterized by brief persuasive messages (eg, in brochures from a pediatrician). These approaches are inadequate because they do not teach children how to discriminate the dangerous elements in the situation.[14] Classroom-based injury-prevention strategies have used book and lecture formats to teach children safety rules and general safety information. Some curricula include parent materials so that safety skills can be reinforced at home. Given that most parents overestimate their child's pedestrian safety skills,[15] interventions that include a parent component can be particularly effective.[16]

The use of well thought-out behaviorally based training programs can be effective in promoting and maintaining behavioral change in children. Several studies have shown the efficacy of approaches that teach children safe pedestrian behaviors including (1) modeling combined with social reinforcement, descriptive feedback, and prompts;[17,18] (2) practice in simulated traffic environments;[19] and (3) training in the real traffic environment.[17,18,20-22] Although these instructional methods have been effective in training children to use safe street-crossing behaviors in real traffic situations[17,21-23] and, in some cases, have been associated with reductions in pedestrian injury,[24] such behavioral instruction is also staff intensive[17] and therefore quite expensive.

Increased access to computers in schools offers new solutions for designing pedestrian safety curricula. A recent study[25] used virtual reality technology to teach children safe street-crossing behavior, demonstrating that students could learn key skills in this simulated environment and could transfer those skills to street crossing in suburban neighborhoods. A second, perhaps more cost-effective and widely available approach to active pedestrian safety instruction is the use of interactive multimedia (IMM) programs.[11] Simulated training packages using real-life imagery have been used to teach other health-related behaviors.[26] As computer technology and Internet connections become more accessible to teachers and parents,[27] the use of IMM to teach children safety and health behaviors is becoming quite feasible.

IMM makes it possible to design the presentation of instructional material to optimize learning and allows the presentation of increasingly more realistic scenarios, following empirically based instructional design principles.[28] For example, simple situations, presented in graphics and animations, can focus attention on critical details and specific elements in the environment. Once core rules have been firmly established, additional variables and image complexity can be added progressively, ending with real-life situations shown in videos. The use of complex and dynamic real-life examples of pedestrian scenarios enables the effective teaching of fully generalizable pedestrian skills. A key advantage of IMM for use as an educational tool is the ability to actively engage the viewer. IMM requires the learner to attend carefully and respond overtly and frequently—behaviors that relate to increased performance.[29] In addition, the branching capabilities of interactive programs allow material to be tailored based on user performance. Immediate corrective feedback can be given when a concept has not been mastered, and the program can dynamically branch to review content as needed.

The intent of the present study was to evaluate an IMM program in CD-ROM format that was designed to teach children one of the most important pedestrian skills—safe street crossing. The primary objective was to determine whether use of the program led to an increased ability to apply safe street-crossing behaviors to traffic situations.

## METHODS

This study involved elementary students in a suburban community in the Pacific Northwest. Flyers describing the study were sent home with each student in grades K-3 (approximately 700 students enrolled in 3 local elementary schools). Given the tight timeline for

**Table 1**
**Program Content**

| | |
|---|---|
| **Traffic Signal Practice** | |
| | Presents range of signals found in intersections |
| | Provides practice responding quickly to "walk"signal |
| **Traffic Direction** | |
| | Teaches viewer to discriminate which vehicles can turn into path |
| | Provides practice identifying unsafe vehicles |
| **Traffic Distance** | |
| | Provides practice judging when it's safe to cross when vehicle is approaching from different distances |
| **Skill Integration** | |
| | Integrates previously taught skills |
| | Provides practice responding to video examples of actual street-crossing scenarios |

implementing the study in the schools, only the first 36 students whose parents responded to the flyer were accepted for participation in the study. Twenty-one of the participants were male (58%). Fifty-three percent (N=19) of the children were in kindergarten or first grade. The rest of the students (N=16) were in second grade and third grade. In addition, one fourth-grade student whose sibling participated was included in the study. Each student was paid $10 for his or her participation.

### The Program

*Walk Smart* is a 40-minute IMM CD-ROM program designed to teach children the critical skills involved in safe street crossing. The program was developed with input from safety education experts, injury prevention specialists, teachers, parents, and children. What differentiates the Walk Smart program from traditional safety curricula is its emphasis on breaking down the complex skill of street crossing into its component parts—responding to signals, discriminating dangerous vehicles, and understanding traffic distance—and then teaching each of these skills to mastery before integrating them into the more complex whole (walking safely across a busy street). Preteaching the component skills involved in a complex response is a critical feature of effective instructional programs.[30]

The program begins with an introductory segment presented by 2 child narrators on the importance of safe street-crossing skills. In this segment, the program emphasizes that children should always cross with an adult until they are 10 years old. Next, the viewer practices using the mouse (by responding to prompts to click on different stimuli) to insure that he or she can navigate the computer environment. A pretest assessment follows the mouse practice segment.

The intervention segment of the IMM program consists of 4 major instructional units (Table 1). Each unit builds on the previous units, reviewing key skills and providing practice and remediation. The program uses empirically validated instructional design principles[28] to teach the program content efficiently and effectively. These include careful selection of teaching examples, instructional pacing, maintaining high rates of learner success, sufficient practice, immediate corrective feedback, cumulative review of learned material, and systematic evaluation.

Animated graphics are used to present the prerequisite skills for each unit. Following the animated instructional examples, the viewer practices the skills that have been taught on test examples. The program identifies any errors made and then presents remedial instructional examples tailored to fit the viewer's errors. Once the viewer demonstrates mastery of the skills in the animated environment, the program presents real-life video situations representing an array of intersections. In the final skill integration unit, the viewer responds to a real-life example using all of the skills that have been taught. That is, for each situation, children are asked to (1) respond to the traffic signal (stop sign, traffic light, or pedestrian signal), (2) indicate whether or not it is safe to cross, given the position and distance of each vehicle, and (3) iden-

**Figure 1**
***Walk Smart* Street-Crossing Scenario**

tify (by clicking the mouse on each of the cars) any dangerous cars that could hit them if they crossed the street. A posttest assessment follows the skill integration unit.

**Measures**

In evaluating the effects of interventions designed to reduce child pedestrian injury, it is critical to utilize outcome measures of observable behavior, as change based in knowledge, attitude, or reported behavior change correlate poorly with actual behavior change.[3] Both a computer-delivered video assessment and a real-life street simulation were used to measure the effectiveness of the *Walk Smart* program in teaching the critical skill involved in safe street crossing: the ability to discriminate which vehicles pose the most threat in a given traffic situation.[14]

The computer video assessment presented 5 street-crossing scenarios in which one or more dangerous cars that could hit the user were depicted (see Figure 1 for sample scenario). The measure of the user's ability to integrate the 3 skill areas taught in the program (traffic distance, traffic signals, traffic direction) was assessed by asking the children to identify (by clicking the mouse on each of the cars) any dangerous cars that could hit them if they crossed the street. Each child completed a pretest and posttest measure. The IMM program segment on mouse practice was included prior to the pretest to ensure that any pretest to posttest differences were not due to enhanced keyboarding skill gained while using the program.

To determine the degree to which the skills learned in the IMM program generalized to traffic situations, pretest and posttest observations of children in simulated real-life traffic situations were conducted. A simulated intersection was created in the parking lot of the study site so that the number, placement, and movement of vehicles could be controlled. Each child, accompanied by a research assistant (RA), was taken to 3 different mock intersections that represented a range of intersection types (eg, traffic light, stop sign, uncontrolled). As they approached the intersection, the RA asked the child, "Are there any cars that could hit me if I cross the street now? Which cars?" The RA then indicated on the assessment protocol which vehicles the child identified as dangerous.

**Procedure**

The study took place on 2 consecutive Saturdays at a local church. Children were brought to the study site by a parent. While the parent read and completed the informed consent, the child was escorted to a classroom in the church by an RA. Each RA had experience conducting evaluations of this nature, and had been trained by the first author in the research protocol. In addition, each RA used a written protocol to ensure consistent fidelity of procedures. Parents were welcome to stay in a waiting area or to leave their child and return after their child completed the study, which took approximately 90 minutes.

Children viewed the introductory portion of the IMM program and completed the mouse practice section. In an effort to control for order and practice effects, study participants were randomly assigned to then complete either the real-life pretest followed by the computer video pretest or vice versa. Following completion of both pretests, participants viewed the intervention section of the IMM program (a 40-minute lesson). The RA assigned to the child sat next to the child as the program was completed. The first author observed to ensure that no specific cues were given with program tasks. If the child had difficulty with a task, the RA provided encouragement (eg, by saying, "Try to figure it out" or "Take a guess"). After the child completed the IMM program, the video and outdoor posttests were administered in the same order in which the pretests were given.

**Satisfaction with Program**

Each subject completed a social validation measure following the completion of the program. This measure was designed to assess the children's' sense that the IMM program was important and helpful. The RA asked each child the following questions:

1. How did you like this program?
2. How important is the information in the program?
3. How easy was it to use this program?
4. Would you tell your sister/brother/friend to use this program?
5. Would you look at a program like this at home if you had it?
6. Would you look at a program like this at school if your teacher had it?

Subjects responded by pointing to a Likert-type 4-point scale of "faces," ranging from most or very much (happy face/smile) to least or not at all (unhappy face/frown).

## RESULTS

This study utilized a within-subject pretest-posttest design. Both video and real-life simulation assessments were completed prior to the IMM intervention (ie, pretests) and immediately following completion of the intervention (ie, posttests). The primary outcome measures were the proportion of dangerous vehicles correctly identified, averaged across each of the 5 computer-video traffic situations (video assessment) and averaged across each of the 3 simulated real-life outdoor intersections (behavioral assessment). Treatment effects were evaluated by examining subject gains on these measures from pretest to posttest.

Table 2 shows the average percentage of dangerous vehicles correctly identified by participants at pretest and posttest for both the video and behavioral assessments. Across the 5 video scenarios, the average percentage of dangerous vehicles correctly identified improved about 40 percentage points from pretest to posttest. Paired t-test analysis indicated that this improvement was highly significant ($t(35) = 6.525$, $P<.001$). The mean score at posttest represented an increase of more than one standard deviation ($SD=.33$), yielding an effect size of $d=1.20$ (Cohen[31] defines an effect of $d=.80$ as a large effect). Separate paired t-test analyses were carried out for each of the 5 situations as well. The results were highly significant for each measure with all P-values less than .002.

As shown in Table 2, similar effects were found for the behavioral measure—the average of the 3 simulated real-life outdoor measures. The average behavioral posttest score represented an improvement of about 38 percentage points and an increase of more than one standard deviation ($SD=.34$) above the pretest

**Table 2**
**Proportion of Dangerous Vehicles Correctly Identified**

| | 5 Video Scenarios (Video Measure) | 3 Real-Life Simulations (Behavioral Measure) |
|---|---|---|
| **Pretest** | 27.2% | 44.4% |
| **Post-test** | 66.9% | 82.4% |

score. Paired t-test analysis indicated that this change was highly significant (t (35)= 5.32, P<.001). The effect size was d=1.12. Separate paired t-test analyses were carried out for each of the 3 real-life situations. The results were highly significant for each measure with p-values less than .002.

**Gender/Age Differences**

To determine if there were gender or age differences, separate analyses were carried out for boys (N=21) and for girls (N=15), and for grades K-1 (n=19) and 2-3 (N=17). Effects were significant regardless of gender or age. For boys the average percentage of dangerous vehicles correctly identified was significantly higher at posttest for both the video assessment (t (20)=7.61, P<.001) and the behavioral assessment (t (20)=3.52, P<.001). Similarly, for girls the average percentage of dangerous vehicles correctly identified was significantly higher at posttest for the video assessment (t (14)=2.34, P<.035) and for the behavioral assessment (t (14)=4.32, P<.001). For students in kindergarten and first grade, the average percentage of dangerous vehicles correctly identified was significantly higher at posttest for both the video assessment (t (18)=3.83, P<.001) and the behavioral assessment (t (18)=2.73, P<.014). Similarly, for students in second and third grades, the average percentage of dangerous vehicles correctly identified was significantly higher at posttest for the video assessment (t (16)=5.57, P<.001) and for the behavioral assessment (t (16)=5.20, P<.001).

**Program Satisfaction**

Results of the posttest questionnaire indicated that the children felt very positive about the IMM program. On a scale of 1 to 4 (1=not at all, 4=very much), children reported that the information was important (mean=3.85) and that they would be likely to tell a friend or sibling about the program (mean = 3.52). They also indicated that they would watch the program again if it were available at home (mean = 3.64) or school (mean = 3.61). Children also thought that the program was easy to use (mean = 3.52). RAs observed that the children's attentiveness to the program was quite notable.

**CONCLUSION AND DISCUSSION**

Each year, more children are killed or injured in pedestrian-motor vehicle crashes than in any other way. Crashes most frequently occur while children walk along, play near, or cross the street.[1] The prevention of pedestrian injury requires a comprehensive program that includes environmental change, legislation, and caregiver training. Another key component should be safety education for children; however, traditional approaches to traffic safety education, which focus primarily on imparting knowledge, have not led to significant behavior change.[29,32]

IMM represents a promising approach to traffic safety education, using interactive animations and video. The purpose of this study was to determine if use of such an IMM program, *Walk Smart,* led to an increased ability to use critical street-crossing skills in simulated traffic situations. The results of the study show that children did in fact learn these critical skills from the 40-minute IMM program and successfully transferred that knowledge to the simulated environment. In addition, the children reported that the program was engaging and reinforcing. Observers noted a high degree of learner attentiveness and noted that children had no difficulty using the computer mouse. The children reported that they liked the program, would view it again, and would recommend it to a friend or sibling.

The main criticism of available behaviorally based safety education programs involves their staff-intensive nature and related high costs.[17] The major advantages of a behaviorally based multimedia program for teaching pedestrian safety are its potential efficiency, cost-effectiveness, and the ability to practice street crossing in a safe environment. If children can be taught key street-crossing skills in a computerized environment, and if these skills generalize to traffic situations, teachers can teach students these important safety skills much more efficiently. The IMM approach represents a potentially significant improvement over other currently available safety curricula.

Although this exploratory study demonstrated significant subject improvement from pretest to posttest, it did have limitations. The study participants were self-selected by their families' willingness to respond to the flyer and may have been more aware of the importance of safety issues and more responsive to the intervention than a randomly selected group of children would be. Also, although the study's findings are encouraging, it should be noted that the children did not fully master the critical skill of identifying dangerous vehicles. At posttest, children were able to correctly identify 66.9% of the dangerous vehicles in the video assessment and 82.4% in the behavioral assessment. Clearly, this is inadequate and additional program refinements will be required in order for children to fully master this skill. Further, because there was no follow-up measure, it is impossible to know if skill gains would maintain over time.

The within-subject design is also somewhat less robust than a randomized experiment. Thus, future research might utilize a randomized design to further establish the efficacy of the IMM approach. Future studies should also examine both the cost-effectiveness and efficacy of the IMM approach compared with other safety instruction (eg, training in the real traffic environment, safety videos, and worksheets). Further, future research could examine more systematically the relationship between the ability to identify dangerous vehicles and the ability to cross streets safely in real-life situations. For example, would an IMM intervention that teaches responding to traffic signals and the behaviors associated with safe street crossing (stop at the curb, look left-right-left) result in similar findings as those demonstrated here?

Despite the study's limitations, the results indicate that the children who viewed *Walk Smart* significantly improved in their ability to discriminate dangerous vehicles in a variety of types of mock traffic intersections. This is the missing component from most safety education programs.[14] Two factors contributed to the effectiveness of the *Walk Smart* IMM program. First, the design of the program included a careful analysis of what children must do when they cross streets. This analysis—determining what children must think and do in situations to avoid injury—is absent from most literature on childhood injury prevention.[14] Second, the program incorporated empirically validated instructional design features[26] to teach the program content efficiently and effectively. As a result, the program teaches skills, which is a step beyond imparting information or knowledge. The fact that children were able to generalize this skill to street-crossing situations suggests that computer-simulated programs are a promising approach to teaching pedestrian safety skills.

## Acknowledgment

This work was supported by Grant 2 R44 HD35018-02 from the National Institute of Child Health and Human Development. ■

## REFERENCES

1. Center for Disease Control and Prevention, National Center for Injury Prevention and Control. U.S injury mortality statistics page (on-line). Available at: http://www.cdc.gov/ncipc/osp/usmort.htm. Accessed February 5, 2004.
2. Sondik EJ. National Center for Health Statistics. Healthy people 2000 progress review on unintentional injuries August 1999. Available at: http://www.cdc.gov/nchs/about/otheract/hp2000/injury/injurycharts.htm. Accessed February 5, 2004.
3. Harborview Injury Prevention and Research Center. Child pedestrian injury intervention skills training programs (on-line). Available at: http://depts.washington.edu/hiprc/childinjury. Accessed February 5, 2004.
4. Schieber RA, Vegega ME, (Eds). Reducing childhood pedestrian injuries: summary of a multidisciplinary conference. Injury Prevention. London: BMJ Publishing Group, 2002;8. Available at: http://www.cdc.gov/ncipc/pubres/childhood_pedestrian/index.htm .

Accessed November 4, 2004.
5.Brain Injury Association of Oklahoma. Traffic Safety Facts 1997from the U.S Department of Transportation National Highway Traffic Safety Administration (NHTSA) (online). Available at: http://www.braininjuryoklahoma.org/intro/Transportation/traffic%20safety%20facts%201997.htm. Accessed October 29, 2004.
6.Danseco ER, Miller TR, Spicer RS. Incidents and costs of 1987-1994 childhood injuries: demographic breakdowns. *Pediatrics.* 2000;105(2):2.
7.Wilson M, Baker S. Structural approach to injury control. *J Soc Issues.* 1987;43:73-86.
8.Rivara FJ. Prevention of injuries to children and adolescents. In Wallace HM, Patrick K, Parcel GS, et al. (Eds). Principles and Practices of Student Health. Vol 1. Foundations. Oakland, CA: Third Party, 1992:89-102
9.Tuchfarber BS, Zins JE, Jason LA. Prevention and control of injuries. In Weissberg RP, Gullotta TP, Hampton RL, et al. (Eds). Enhancing Children's Wellness. Thousand Oaks, CA: Sage Publications, 1997:250-277.
10.Rivara FP, Aitkens M. Prevention and Injuries to Children and Adolescents. Seattle, Washington: University of Washington, 1998:37-63.
11.Rosenberg, ML. Statement for the Record on Unintentional Childhood Injury and Death. Assistant Secretary for Legislation (ASL) Department of Health & Human Services (online). Available at: http://www.hhs.gov/asl/testify/t980505b.html . Accessed November 9, 2004.
12.Global Road Safety Partnership (on-line). Available at: www.grsproadsafety.org/. Accessed February 5, 2004.
13.Dowd MD, Keenan HT, Bratton SL. Epidemiology and prevention of childhood injuries. *Crit Care Medical.* 2002;30(11): S385-S390.
14.Peterson L, Schick B. Empirically derived injury prevention rules. *J Appl Behav Anal.* 1993;26(4):451-460.
15.Dunne RG, Asher KN, Rivara, FP. Behavior and parental expectations of child pedestrians. *Pediatrics.* 1992;89(3):486-490.
16.Thomson JA, Ampofo-Boateng K, Lee DN, et al. The effectiveness of parents in promoting the development of road crossing skills in young children. *J Educ Psychol.* 1998;68:475-491.
17.Rivara FJ, Booth CL, Bergman AB, et al. Prevention of pedestrian injuries to children: Effectiveness of a school training program. *Pediatrics.* 1991;88(4):770-775.
18.Yeaton WH, Bailey JS. Teaching pedestrian safety skills to young children: an analysis and one-year follow-up. *J Appl Behav Anal.* 1978;11(3):315-329.
19.Renaud L, Suissa S. Evaluation of the efficacy of simulation games in traffic safety education of kindergarten children. *Am J Public Health.* 1989;79(3):307-309.
20.Young DS, Lee DN. Training children in road crossing skills using a roadside simulation. *Accid Anal & Prev.* 1987;19(5):327-341.
21.Rothengatter T. A behavioral approach to improving traffic behavior of young children. *Ergonomics.* 1984;27(2):147-160.
22.Van der Molen HH, Van den Herik J, Van der Klaauw C. Pedestrian behavior of children and accompanying parents during school journeys: an evaluation of training programs. *Br J Educ Psychol.* 1983;53(Pt2):152-168.
23.Limbourg M, Gerber D. A parent training program for the road safety education of preschool children. *Accid Anal & Prev.* 1981;13(3):255-267.
24.Fortenberry JC, Brown DB. Problem identification, implementation and evaluation of a pedestrian safety program. *Accid Anal & Prev.* 1982;14(4):315-322.
25.McComas J, MacKay M, Pivik J. Effectiveness of virtual reality for teaching pedestrian safety. *Cyber Psychology & Behavior.* 2002;5(3):185.
26.Woodward J, Carnine D. Closing the performance gap: CAI in secondary education of mildly handicapped students. *J Educ Comput Res.* 1988;4(3):265-283.
27.Abramson T, Kagan E. Familiarization of content and differential response modes in programmed instruction. *J Educ Psychol.* 1975;67:83-88.
28. Adams GL, Englemann, S. Research on Direct Instruction: 25 Years Beyond DISTAR. Seattle: Educational Achievement Systems 1996:1-23.
29.Frase LT, Schwartz BJ. Effect of question production and answering on prose recall. *J Educ Psychol.* 1975;67:628-635.
30.Englemann S, Carnine D. Theory of Instruction: Principles and Applications. New York, NY: Irvington Publishers, Inc., 1982:264-266.
31.Cohen J. Statistical Power Analysis for the Behavioral Sciences (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc., 1988:26.
32.Finney J, Christophersen E, Friman P, et al. Society of pediatric psychology task force report: pediatric psychology and injury control. *J Pediatr Psychol.* 1993;18(4):499-426.