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Development and Application of a Nutrition Education Game for Preschoolers

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ABSTRACT

This study was conducted to develop and apply a computer-based multimedia nutrition education program for preschoolers based on the Dick and Carey model of instructional design. The Dick and Carey model included 4 phases: analysis, design, development, and evaluation. The program's instructional goals, objectives, assessment instruments, content, examples, and practice questions with feedback were written in the design phase. To be familiar with the 5 food groups, "Nutrition exploration" were programmed using Hyperstudio. "Nutrition exploration" was designed as a five-session, interactive multimedia game, with each session taking about 5 minutes to complete. Nineteen preschoolers, aged 6, volunteered to participate formative evaluation. The effectiveness of the program was examined using a pre-post test design. Participants were recruited by personal contact at the individual preschool education center. The application was carried out during 4 weeks. The results showed that intervention participants significantly increased knowledge between pre-test and post-test. The results support using IMM (interactive multimedia) to disseminate nutrition education to the target population. This research provides the basis for continuing development of computer-based nutrition education materials. (*J Community Nutrition* 8(4): 165~170, 2006)

KEY WORDS: nutrition education · interactive multimedia · preschoolers · Dick and Carey model.

Introduction

The American Dietetic Association (ADA) and the Society for Nutrition Education (SNE) acknowledge the need for resource development and creative new programs to reach and influence consumers (American Dietetic Association 1990; Contento 1995). To be successful, the programs should be behaviorally based, meet a need within the target population, be personalized, and involve active learner participation by teaching skills consumers can use. Computers offer a viable means for educating the public about diet and nutrition (Kolasa, Miller 1996). Computers offer privacy, 24-hour availability, and self-paced, individualized learning (Kolasa, Miller 1996; Milheim 1993). Computer programs have been effective and well received when used to teach adults about nutrition (Bell 2002; Carlton et al. 2000; Jantz et al. 2002; Kolasa et al. 1999). Although computers have been used extensively for nutrient calculations, a limited number has been used for nutrition education in schools, clinics, and homes; even fewer programs have been developed specifically for preschoolers (Brug et al. 1999; Onema et al. 2001; Winett et al. 1997). Food-related preferences and practices start in the earliest years (Birch 1998), channels need to be found that deliver nutrition education programs more directly to children (Baranowski et al. 2003). One channel that interacts with children directly is computer-based, interactive multimedia education (IMME) (Morris et al. 1996). IMME is an attractive educational modality because it can combine visual, aural, and text-based messages (Morris et al. 1996) and incorporate entertainment into education (edutainment), thereby making the messages more acceptable and the activities more enjoyable. Interactive multimedia uses audio, text, video, and/or graphics to facilitate 2-way communication between a user and a computer. In addition, using audio, video, and graphics decreases the literacy requirement of the user compared to text-based computer programs (Jantz et al. 2002).

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Computers have been suggested as a possible means for overcoming the literacy barriers since all responses can be presented by audio to the participant, and graphics, especially photographs, can be used to enhance understanding (Bock et al. 1999).

To ensure the development of effective and innovative nutrition-education computer programs, systematic models of instructional design should be used (Carlton 2000). The Dick and Carey (Dick, Carey 1996) model of instructional design uses a systematic, step-by-step approach that novice programmers and non programmers can use to design effective instruction. This model, in use since 1968 (Dick 1996), is based on more than 25 years of research on the learning process and instructional design. The purpose of this study was to develop and formatively evaluate a computer-based multimedia nutrition education game for preschoolers based on the Dick and Carey (Dick, Carey 1996) model of systematic instructional design.

Methods

1. Development

The interactive multimedia nutrition education is based on Dick and Carey (1969). The overall instructional goal of the target population is to decide by analyzing of pre study and other studies (Koo 1999; Lee 2001; Lee et al. 2001). The most needed nutrition topic was particularly that children understood why they have to eat an unlike food. This led to the overall instructional goal of "Nutrition Exploration": the learner will choose to apply the principles of the Food Guide Pyramid to his or her daily food choices. To make children more comfortable with foods they disliked, these foods were chosen as food characters for the game. This nutrition education program is designed to enable preschoolers to enhance food knowledge and classification. The program was designed to teach the knowledge of food groups then modifying a person's diet based on human body and principles of the Food Guide Pyramid (Korean Nutrition Society 2000); thus, it was named "Nutrition Exploration". This program is offered as an innovative nutrition education strategy that will enable preschoolers to enhance food knowledge.

The development was throughout 5 steps: instructional analysis, analysis of the learner and context in which the learner will perform the skill, writing performance objectives, developing assessment instruments, and developing the instructional strategy (Carlton et al. 2000). In the instructional analysis, the instructional goal from phase 1 was broken down first into 5 steps. Second, each step was divided into sub-skills by asking: "What does the learner have to know or be able to do in order to perform this step?" Fig. 1 shows the instructional goal and the initial breakdown of the second step in the instructional goal. Each step in the sub-skills analyses (Fig. 1) was further broken down. It shows the complete breakdown of step 2. For every step, a performance objective was written in the 3-part format outlined by Mager (Mager 1984), which included the skill or behavior identified in the instructional analysis, conditions existing while the learner carried out the task, and criteria used for evaluation. During the development phase the instruction was programmed into the computer by the first author using Hyperstudio (version 3.1, 1997, Roger Wagner Publishing, Santee, CA), an authoring software program. One to 2 practice questions for each objective were programmed immediately after learners reviewed the information. Branching was also programmed in as much as possible to individualize the lesson; branching was

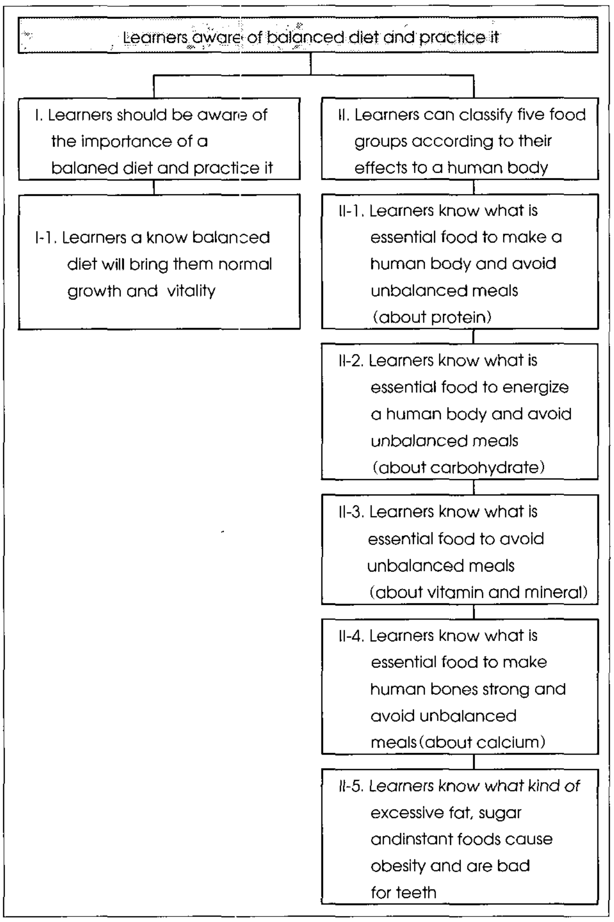

Fig. 1. Analysis of sub-objectives.

designed for a selected response to lead to a new segment of information. The first draft of the program was reviewed by 3 nutrition professionals, an instructional designer, and a member of the target population. Spelling errors, navigational errors, content clarity, and screen design suggestions were made.

2. Application

The application of the program was evaluated using a pre-post test design. The program was tested with the 19 participants aged 6. Participants were recruited by personal contact at the individual preschool education center. The application was carried out during 4 weeks (from 2003. 10. 6 – 10. 29). Four university students majoring in food and nutrition science observed and interviewed the subjects one by one. Subjects received the food knowledge questionnaires, average time to complete, learning response and depth of exploration at specific points throughout the unit were analyzed. On-line tracking data were used to determine which parts of the program were most accessed and the expected time to complete the module and evaluations. For the knowledge test, five questions asked the subjects to identify the number of servings from each food group. First, learners identified good food sources of five food groups. Learning response questionnaire for preschoolers (Miyashita, Knezek 1992) used for subject's program response (fun and comprehension) which has 1 (strongly negative) to 4 (strongly positive) Likert-type scale.

3. Statistical analysis

A combination of Microsoft Access, Microsoft Excel (Microsoft Corp, Seattle, WA) in the nutrition education game set. Microsoft Access was used to create the database and calculate on-line tracking data for measuring education time. Time, fun, and comprehension score showed mean and standard deviation. The knowledge scores of before and after education were analyzed using paired t-test by SPSS for Windows (SPSS Inc, Englewood Cliffs, NJ). The level of significance for all tests was set at $p < .05$.

Results

1. Development

1) Nutrition education game goal

"Nutrition exploration" was designed as a five-session, interactive multimedia game, with each session taking about 5 minutes to complete. The story line for the "Nutrition exploration" was as follows: the Kingdom of 5 Towns was being invaded by the Wind which was attempting to destroy the 5 towns. 5 towns need help to be healthy. In the first session, the learner committed to becoming an explorer to find health. The explorer had to face challenges in his/her quest. The challenges involved skills and goals related to eating balanced food. Before the end of each session, the child set goals to select 5 food groups during that session. The goal is that learners can get colored jewels after completing a game in 5 sessions.

2) Learning screen

Fig. 2 shows learning screen. Each icon plays a role as follows: ① Character who learner decorated himself, ② Now learning session in 5 food groups, ③ Goal and rule explanation, ④ Move to other food groups, ⑤ Learning site,

Fig. 2. Structure of learning screen.

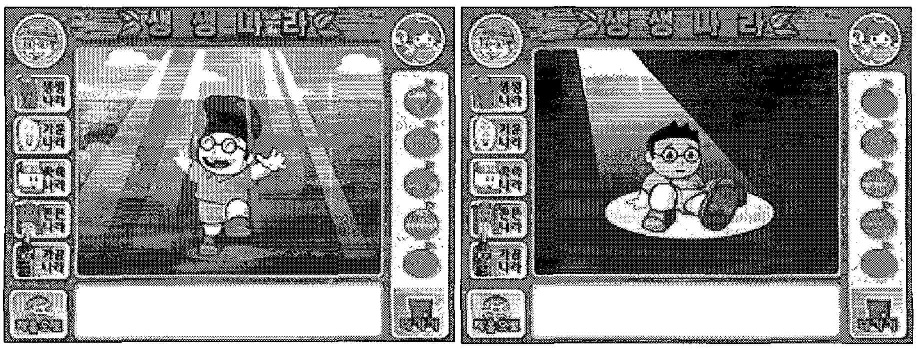

Fig. 3. Feedback for correct and wrong answer.

⑥ Food groups which learner had already learned, ⑦ 'First' icon, ⑧ Narration for learning, ⑨ 'Exit' icon.

3) Feedback for learning

Evaluation screen and feed back screen, performance information screen shows that Fig. 3 and 4 About the subject's learning, the game gives feedback which is provided based on each learner's individual response. When learners answered correctly, applause was sounded, and additional information was provided to enrich the lesson. For incorrect responses, corrective feedback was provided, including proper responses and the reasons behind them. Navigation buttons (forward, back, exit, and main menu) appeared on every screen.

2. Application

Table 1 shows the percent knowledge at pre-test and post-test for the subjects. Nutrition knowledge significantly increased after a multimedia nutrition education ($p < 0.01$). Nineteen participants significantly improved the total score at post-test, with a mean from 67.0 to 71.8 ($p = .000$). The average time taken to complete the "Adventure of Nutrition" module was approximately 20 minutes. The average time to complete each of the demographic and "Nutrition exploration" computer-based questionnaires was approximately 2.5 minutes. The learning response was positive (Table 2). The learner's fun rate on the multimedia nutrition education was 3.63/4.00 on average. The learner's comprehension rate was 3.20/4.00.

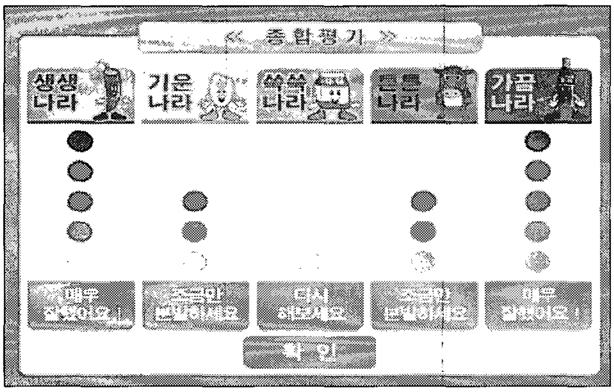

Fig. 4. Performance information.

Discussion

The preschool years are an important period in life during which children may develop healthy eating habits that are essential for normal growth and the prevention of nutrition-related diseases later in life (Matheson et al. 2002). Interactive multimedia (IMM) is an attractive educational modality for preschoolers because it can combine visual, aural, and text-based messages (Morris et al. 1996). It incorporates entertainment into education (edutainment) (Baranowski et al. 2003), thereby making the messages more acceptable and the activities more enjoyable. "Nutrition exploration" developed for preschoolers. The children participated in a decision-making activity between their favorite fruit, juice, or vegetable and a more common snack. A problem-solving routine was employed to help the child assess how he/she might change practices to increase the likelihood of goal attainment. But, a limited number of game makes subjects get bored quickly, and they have different abilities for using computers. Further development of nutrition education game needs more game modules.

Table 2. Learning response of participants toward multimedia nutrition education

Food groups	Fun	Comprehension	Time (min)
Protein	3.41 ± 0.71[1)2)]	3.58 ± 0.74[2)]	5.30 ± 1.06
Carbohydrate	3.29 ± 0.85	3.16 ± 0.62	4.27 ± 1.05
Vitamin	3.53 ± 0.72	2.74 ± 0.79	3.51 ± 0.59
Calcium	3.41 ± 0.94	2.52 ± 0.88	7.04 ± 1.55
Sugar and lipids	3.41 ± 0.71	4.00 ± 0.82	3.44 ± 2.26
Mean	3.63 ± 0.60	3.20 ± 0.74	4.18 ± 1.51

[1)]Mean ± SD
[2)]4 Likert: 1: 'strongly disagree', 2: 'disagree', 3: 'agree' 4: 'strongly agree'

Table 1. Comparison of pre and post mean knowledge within the "Nutrition Exploration" participants

Food groups	Learning		Changes	t-value	p-value
	Before	After			
Protein	61.40 ± 27.81[1)]	71.93 ± 31.94	10.53	1.46	0.163
Carbohydrate	54.39 ± 25.36	75.44 ± 26.86	21.05	3.62	0.002**
Vitamin	71.93 ± 33.82	87.72 ± 22.80	15.79	2.46	0.025*
Calcium	63.16 ± 26.98	82.46 ± 28.04	19.30	3.28	0.004**
Sugar and lipids	64.91 ± 30.38	89.47 ± 22.37	24.56	4.38	0.000**

[1)]Mean ± SD
*: $p<0.05$, **: $p<0.01$

Data analysis showed that the average completion time for the "Nutrition Exploration" module was approximately 20 minutes. Furthermore, nutrition education animation and game in each session took approximately 4 to 4.5 minutes. The completion time for IMM delivery is shorter than the time for delivery by an educator. This may be especially applicable to overcoming the barriers to nutrition education among lack of concentration of preschoolers. Barriers that have been noted include conflicts with child care. Learning nutrition on the computer may be less intimidating, especially for low-literate audiences. No reading skills were required to learn "Nutrition Exploration". A few participants commented on how much they liked the computer-based nutrition education. They felt that it was more interesting and more private than traditional education. Specifically, limited computer access for testing and recruiting participants for the test and retest portions made assessing reliability and validity difficult.

Effect of "Nutrition Exploration" modules on knowledge and learning response: It was noted that preschoolers don't like vegetables and don't have balanced diets. This confirms the need for nutrition education about the importance of the 5 food groups in humans for balanced diets in this population. Overall, the "Nutrition Exploration" module was effective in increasing knowledge scores about the 5 food groups among program participants. Over 96% of participants improved their total knowledge score from pretest (67.0 scores) to post-test (71.8 scores). This finding was similar to that reported by Taylor and colleagues when measuring knowledge change among participants who were taught the *La Cocina Saludable* curriculum by an *abuela* trained as a nutrition educator (Taylor et al. 2000). These results indicate that IMM format is a comparable alternative to nutrition education taught by an abuela. Other research projects using IMM have shown similar positive increases in knowledge and/or attitude scores following an intervention. Campbell and colleagues reported significant increases in knowledge of low-fat foods and self-efficacy among participants completing the Stamp Smart program, a nutrition education program targeted at low-income, high-risk audiences (Campbell et al. 1999). There are several possible explanations for the greater knowledge increases seen in participants exposed to IMM versus the classroom version, including the incorporation of interactive activities and the addition of a review section to reinforce key concepts.

Health educators can benefit from more contact with developers who create games for children and by integrating theoretical behavioral frameworks into educational games. Creating such educational games is very expensive, requiring large teams of educational, dietary, and behavioral professionals, with subcontracting for professional artists and programmers. Periodically updating the program, based on feedback from children and teachers, could enhance the program but would add to cost. Alternatively, the possible conversion of this educational technology to the Internet holds out the promise of reaching large numbers of individuals, thereby minimizing marginal cost per new participant. Some technologic challenges need to be overcome (e.g., the lengthy download time that discourages participation) before a smooth transition from CD-ROM to the Internet can be made. Future uses of Squire's Quest! could include refinement and continued use in the classroom or conversion to an individual sequential game that does not have defined sessions on CD-ROM or the Internet. Overall, IMM is a comparable alternative to other methods of delivering nutrition education for preschoolers. The use of IMM conveys several advantages over other methodologies. A primary advantage is the ease of access owing to computers that used timeliness. In the future, computers will be positioned in many settings. Other advantages include decreased instructional time, which helps to overcome transportation and child care barriers, cost effectiveness, incorporation of interactive games and activities, and the use of computer-based evaluations that require no reading skills (Gould, Anderson 2000).

Summary and Conclusion

"Nutrition Exploration" was designed as a five-session, interactive multimedia game, with each session taking about 5 minutes to complete. To give learning feedback, when learners answered correctly, applause was sounded, and additional information was provided to enrich the lesson. For incorrect responses, corrective feedback was provided. Nutrition knowledge significantly increased after a multimedia nutrition education ($p < 0.01$). The average time taken to complete the module was approximately 20 minutes. The learner's fun rate on the multimedia nutrition education was 3.63/4.00 in average. The learner's comprehension rate was 3.20/4.00, which means that there were no difficulties to understand the content of a multimedia nutrition education. The "Nutrition Exploration" module was effective in increasing knowledge scores about the 5 food groups among program participants. But, there were 2 limitations of this study that should be noted. One is that the participants were not randomly assigned. The study used a convenient sample from the pre-selected sites. Participants could refuse participation; therefore, equal numbers were not obtained at each site. The other is owing to the small sample size and nonrandomized design, the results of this study may not be generalized to other populations.

Future research should concentrate on the development and evaluation of computer-based materials to learning to improve health and food behavior changes in the target population. Although the results of this study showed highly significant changes in knowledge after using the module, it would be interesting to determine the effects of the program long term on dietary behaviors. The addition of a tool to measure behavior changes would enhance the reported effectiveness of the module. Furthermore, it would increase the scope of its use in nutrition assistance programs sincemany programs require a behavior measurement as part of program evaluation.

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