Game-Based Learning and Health Behavior Change: A Visit to Whisperwell

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Overview

- Public Health Obligation
- Changing Health Behavior
- Dangerous Decibels
- STEM Education
- Serious Games
- A Visit to Whisperwell: "Song of the Starbird"
- Outcomes and Future Plans

Is NIHL a problem for youth?

- 1943: Loch (8-14 years) 15% Males; 5% Females
- 1950: Guild
- 1967: Anderson
- 1972: Lipscomb
- 1974: Cozad et al.
- 1975: Hull et al.
- 1990: Montgomery & Fujikawa
- 1992: Brookhouser et al.
- 1996: League for the Hard of Hearing
- 1997: Holmes
- 1998: Niskar et al.
- 2001: Niskar et al. (6-19 years) 12.5% (12-19 years) 15.5%
- 2011: Henderson et al. (12-19 years) 16.8%
- 2017: Su et al. (12-19 years) 12.8%

Public Health Obligation

- Audiologists are morally and ethically obligated to provide intervention;
- NIHL progresses without intervention
- Some cases of tinnitus may be preventable
- Financial and social costs escalate without intervention
- Prevention is a standard of care

Prevention: Primary, secondary and tertiary

- Primary prevention strategies intend to avoid the development of disease.
- Secondary prevention strategies attempt to diagnose and treat an existing disease in its early stages before it results in significant morbidity.
- Tertiary prevention: These treatments aim to reduce the negative impact of established disease by restoring function and reducing disease-related complications.
Audiology services include—

(i) Identification of children with auditory impairments, using at-risk criteria and appropriate audiologic screening techniques;

(ii) Determination of the range, nature, and degree of hearing loss and communication functions, by use of audiologic evaluation procedures;

(iii) Referral for medical and other services necessary for the habilitation or rehabilitation of an infant or toddler with a disability who has an auditory impairment;

(iv) Provision of auditory training, aural rehabilitation, speech reading and listening devices, orientation and training, and other services;

(v) Provision of services for prevention of hearing loss; and

(vi) Determination of the child's individual amplification, including selecting, fitting, and dispensing appropriate listening and vibrotactile devices, and evaluating the effectiveness of those devices.

Healthy People 2020

- ENT-VSL-6: Increase the proportion of adolescents aged 12 to 19 years who have ever used hearing protection devices (earplugs, earmuffs) when exposed to loud sounds or noise

- ENT-VSL-7: Reduce the proportion of adolescents who have elevated hearing thresholds, or audiometric notches, in high frequencies (3, 4, or 6 kHz) in both ears, signifying noise-induced hearing loss

- ECPB: Increase the proportion of elementary, middle, and senior high schools that provide school health education to promote personal health and wellness in the following areas: hand washing or hand hygiene; oral health; growth and development; sun safety and skin cancer prevention; benefits of rest and sleep; ways to prevent vision and hearing loss; and the importance of health screenings and checkups

Changing Health Behaviors

What is a health behavior you have tried to change?

Does this work?
Health Communication

- Health communication is the study and use of communication strategies to inform and influence choices people make about their health.

- Health communication science provides the evidence basis for intervention programs based on theoretical foundations.


What influences (hearing) health behaviors?

- Knowledge
- Attitudes
- Beliefs
- Self-efficacy
- Access to resources

Relevant Behavior Change Theories

- Theory of Reasoned Action and Planned Behavior
- Social Cognitive Theory
- Health Belief Model
- Socio-Ecological Model

Dangerous Decibels is:

An international, good-faith partnership between experts in hearing science, public health, noise, evaluation and education who are passionately dedicated to preventing noise induced hearing loss and tinnitus

People based, not institution based

International Dissemination Partners:
North America

Other Affiliates/Collaborators/Funders

International Dissemination Partners:
Asia

International Dissemination Partners:
Oceania

International Dissemination Partners:
South America
Developing Partnerships:

Dangerous Decibels®

To reduce the incidence of noise induced hearing loss and tinnitus

EVIDENCE BASED PROGRAM

Dangerous Decibels development

HUNDREDS of contributors

Museum exhibit developers
Hearing scientists
Teachers
Student advisors
Community advisors
Engineers
Evaluation specialists
Health communications scientists
Programmers
Writers

Graphic artists
Cabinet makers
Administrators
Text editors
Grant writers
Nurses
Physicians
Audiologists
Electricians
Outreach specialists

Dangerous Decibels: Support

1999-2018
15 Private foundation/corporate grants
(US, Canada, NZ, Brazil, Singapore)
7 US Government grants NIH & CDC
1 NZ Government grant ACC
1 NUS research grant

To reduce the incidence of noise induced hearing loss and tinnitus

HOW?

By changing knowledge, attitudes, beliefs and behaviors about sound exposure and use of hearing protective strategies

Educate early
K-12 Classroom Program

- 50 minutes duration
- 9 modules
- Highly interactive
- Low-tech
- Portable
- Low cost consumables
- Maximum of 30 participants

Dangerous Decibels® Activities

- K-12 Classroom program
- Educator training
- Website information
- Online Virtual Exhibit
- Dangerous Decibels exhibits
- Jolene
- Public health research

Teaching method:
Inquiry-based learning

“Tell me and I forget,
show me and I remember,
involve me and I understand.”


Classifying safe and dangerous sounds
Measuring sound pressure at different distances

Modeling hair bundle damage from sound exposure

Gaining confidence in using hearing protection

Program adaptations
- Workers (occupational)
- Military
- Parents
- Recreational shooters
- Musicians

Educator Workshops
Educator Training Workshops: Who attends?

- Museum educators
- High school students
- University students
- Audiology students
- Speech Pathologists
- School nurses
- Basic scientists
- Basic scientists
- Nurses
- Physicians
- Administrators
- Industrial hygienists
- School teachers
- Corporate staff
- School hearing screening techs
- Medical safety officers
- Parents

Website Information

WWW.DANGEROUSDECIBELS.ORG

Website users from 231 countries

Number of sessions per city

Virtual Exhibit
First exhibition in the world dedicated to reducing noise-induced hearing loss and tinnitus
- 12 exhibit components - 2000 ft² / 186 m²
- Open June 1, 2002 to May 5, 2011
- Over 5,000,000 visitors

Museum Exhibit

Jolene

Educational Mannequin

www.dangerousdecibels.org/jolene.cfm
Research

Dangerous Decibels Four-Intervention Evaluation
Percent of students who answered 75% or more correctly

STEM Education
**Need for STEM Education**

- Concern about the ability of the United States to compete in the global economy has lent urgency to calls for reform of science, technology, engineering, and mathematics (STEM) education.

- U.S. policymakers have called for increasing the number and diversity of students pursuing degrees and careers in STEM fields

- In the U.S. average mathematics and science literacy scores are below the average scores for all developed countries.

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**Serious Games**

- Function as a bridge technology that converts gaming from a social pastime to a powerful educational tool that challenges students with game-based problem solving, conceptual reasoning and goal-oriented decisions.

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**Benefits of Serious Games**

- Engagement
- Designed for success
- Sharing
- Learn by doing
- Monitoring process
- Risk free

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**Research Objectives**

**PHASE I: FEASIBILITY**
Specific Aims

• To develop and test an engaging video game based on the evidence-based Dangerous Decibels® program.
• To teach STEM concepts associated with the biology and physiology of the auditory system, the physics of sound and wave propagation, and the mathematical constructs that allow problem solving with numbers.
• To convey positive hearing health behaviors by focusing on key educational messages related to the prevention of noise-induced hearing loss (NIHL) and tinnitus.

PROTOTYPE STEM CONCEPTS

• Primary: The amplitude of sound is higher closer to the source of the sound.
• Secondary: Hearing damage depends on two variables: exposure time and sound amplitude.

PROTOTYPE HEALTH CONCEPTS

• Primary: Loud sounds can permanently damage your hearing.
• Secondary: The longer you are exposed to loud sounds, the more you can damage your hearing.

Serious Game Design Assessment Framework (SGDAF)

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Fictional Narrative

You are an alien explorer from planet Whoosawell. The Whoopeaceans need your help to stop singing. Everyone on Whoosawell is a Whoozle - a round, furry creature. The leading theory is that the Songbird exists a friend to sing with. You have been sent to planet Bumpshump to find the legendary songbird that has not been heard for a long time. You must find the 5 buried song disks to build an instrument that will summon the legendary song bird. But first, you will need to hear sounds on Bumpshump, for that you need some work.

Framing

• 5th to 7th graders with minimal gameplay experience
• Touch- or touch-and-drag interactions on a touch screen
• Hearing health is relevant to this age group due to exposures to noisy activities and environments.
• Topic integrates well with physics of sound and hearing is part of common core science curriculum for this age group.
Aesthetics, Mechanics, and Content

Aesthetics, Mechanics, and Content: Decibel Meter

Hearing Health Meter

Song of the Starbird: Main Level
Recovering Hidden Song Disks

Hearing Range and Waves

Game Sound Sources (Creatures)

Inverse Square Law

Qualitative Summative Study: Methods

• 5th-7th grade students (n=26) in 3 groups
• 5th-7th grade teachers (n=6)
• Location: classroom
RESULTS: STEM Concepts:
After the game play

- Primary Concept: The amplitude of sound is higher closer to the source of the sound.
- Interview Question: “What happens when you move closer to the place that sound comes from?”
- 80% (n=20) students responded “It gets louder”
- “Far away it’s quiet, but louder when you get closer.”
- “If you get closer it gets louder if you move far away it gets quiet. And if you get closer and it gets louder it starts to damage your ears.”
- “When you got close, the ring on the side would go higher and you knew it was getting louder.”
STEM Outcome Summary: Game Play

- The concept that sound becomes louder when moving closer to the sound source was clearly and correctly understood by all of the students.
- The concept that hearing damage occurs when getting closer to loud sounds was also well understood.
- The concept of exposure time, while implicit in the game, was probably not as well captured by the students.

Hearing Health Concepts: After the game play

Primary Concept: Loud sounds can permanently damage your hearing.

- “Loud might hurt your hearing.”
- “When we play the game, I know why when you go really close, you have to go back because the hair cells get damaged.”
- “Yes because it is saying that when you have that thing that was saying 18,000 hairs or something like that, every time you got close and your screen got smaller you’d always remove the hairs by the time you go. And whenever you lose all your hairs you become deaf.”

Hearing Health Concepts: After the game play

Secondary Concept: The longer you are exposed to loud sounds, the more you can damage your hearing.

- No question in the survey specifically addressed time spent versus proximity to the loud sounds. However, even with open-ended questions, students did not seem to realize the relationship between time and distance relative to hearing damage.

Hearing Health Outcome Summary: Game Play

- Overall students clearly identified loud sounds as a threat to their health and understood that the hair cells in the ear can get damaged when exposed to loud sounds.
- They also understood that if enough damage occurs, the loss of hair cells could lead to hearing loss and deafness.
- One missing concept was that related to duration of exposure which was not clearly recognized by the students.

Ear Anatomy & Physiology Outcomes

- In general, the students had a poor understanding of how the ear works and labeled the picture incorrectly most of the time.
- Overall, students tended to mix up the various parts of the ear or the order of the sound propagation.
- However, students generally recognized that the sound goes in through the ear and then connects to the brain.
- Students also clearly recognized that the ear includes fragile hair cells that can be damaged by sound, and that the loss of hair cells leads to hearing loss and deafness.
Qualitative Analysis

- To provide a more global analysis of the verbal interview responses, recorded interviews were transcribed and coded into NVivo v. 11.0 for qualitative analysis.

Attitudes toward the game

Interview Questions "Did you have fun playing the game (activity)? Why or why not?"

- A response of "I didn’t get the puzzle at the beginning" was coded as negative attitude. In contrast, a response of "Yes, I had fun playing the game because on the game we had to find the circles" was coded as positive attitude.

Game recommendations from students

- Provide instructions for the game.
- Provide hints for the game.
- Add more levels, more “monsters,” and more disks to find.

Teacher Survey Summary

- Teachers found the game “interesting” and “challenging” or “fun”. Some were worried that players did not really understand what they were doing because the content was implicit instead of explicit.
- Teachers agreed unanimously that students were “very engaged” with the game as well as the activities provided.
- Teachers agreed that the game was very useful as a teaching tool but some wished there had been more opportunity for some instructions and “pre-teaching.”
Teacher Survey Summary

- Interestingly, some of the teachers were more interested in the "explicit" puzzle at the beginning of the game, and feared that the kids did not get much from the game. The outcomes reported above clearly show that the kids learned much from the game, and not much from the more "explicit" puzzle.

- Most teachers (4 out of six) found the game would be very useful to help students understand the danger of loud sounds, but two of them felt that the kids did not necessarily understand the connection between loud sounds and hearing damage.

- Most teachers (5 out of six) felt they would use the game in their classroom if available. One teacher was not sure how to integrate the game in the classroom.

Summary

- Serious gaming looks promising as a means of understanding STEM concepts and hearing health concepts.
- Gaming requires a different approach to education; more implicit and less explicit content.
- Qualitative research design is useful for capturing the implicit knowledge.
- Students and teachers respond positively towards the use of Song of the Starbird in classrooms.

Future Directions

- Phase II proposal underway to further develop and refine the game and associated learning activities.
- Expand STEM concepts
- Stimulate STEM career interest
- Expand and build upon Hearing Health concepts
- Incorporate social behavior constructs and self-efficacy
- Serious game will be designed to be an adjunct to classroom learning.
- Program and game coaching by high school students

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Questions?
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