AN EVALUATION OF THE EFFECTIVENESS AND FEASIBILITY OF NEWLY PROPOSED ACTIVITIES EDUCATING SCHOOL-AGED CHILDREN ON THE OCULAR SIDE EFFECTS OF ULTRAVIOLET EXPOSURE

by

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Has been approved

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I, Lindsay Basler/Elizabeth Tonkery, hereby release this Paper as described above to Ferris State University with the understanding that it will be accessible to the general public. This release is required under the provisions of the Federal Privacy Act.

ABSTRACT

Purpose. Excessive ultraviolet (UV) exposure as children has been linked to ocular diseases such as cataracts, pterygia, and macular degeneration in adults. This link indicates the importance of education for parents, teachers, and caretakers on the necessity of children wearing UV protective eyewear as a preventative measure. The feasibility of educating children through activities done in school as well as the effectiveness of such an activity will be measured through pre and post activity quizzes on their knowledge. **Methods.** Pre and post activity quizzes were administered on a convenience sampling of 7 kindergarten and 22 2nd grade students before and after educational activities on UV protection and side-effects of UV damage. **Results.** Pre and post quiz data was compared to measure effectiveness of the educational activities, noting an increased awareness of the side-effects and prevention of ocular UV exposure in each of the ten quiz items. Feasibility measures compared time spent to outreach success and found the activities to have taken between 20 and 30 minutes to complete with minimal teacher assistance. Analysis included monitoring short term results for increased knowledge via newly introduced ocular UV activities and confirmed that each item questioned indeed showed an increase in knowledge base of participating students. **Conclusions.** Education on the importance of UV protective eyewear in children is

essential, and this research displayed these activities will provide heightened awareness among children on ocular UV exposure, damage, and protection. Each participating classroom was given a sample of the Environmental Protection Agency's "SunWise" educational activity kit and executive summary with recommendations was provided to the "SunWise" program for school-aged children.

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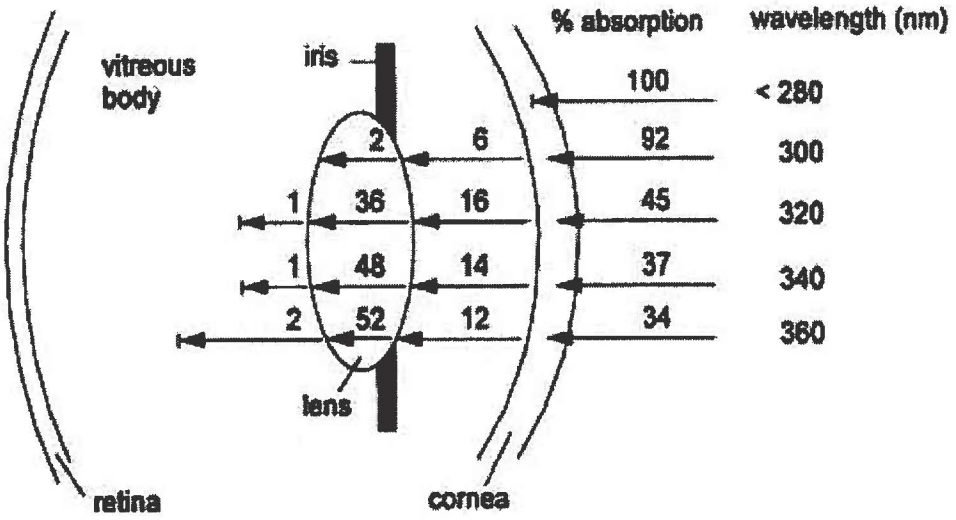
INTRODUCTION

Excessive ultraviolet (UV) exposure as children has been linked to ocular diseases such as photokeratitis, pterygia, cortical cataracts, and macular degeneration.[1,2] UV radiation (UVR) includes radiation within the spectrum of 100-400 nm. UVR can be divided into UVA (315-400 nm), UVB (280-315 nm), and UVC (100-280 nm).[2] The cornea absorbs UVC and a substantial amount of UVB. The UVB that does pass through the cornea is absorbed by the lens and vitreous humor, thus protecting the retina from most UVR. [3]

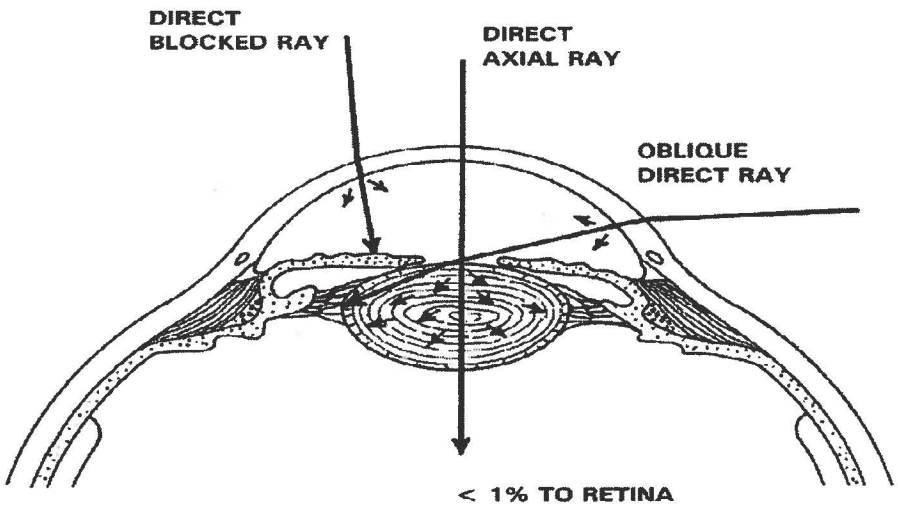
Figure 1 - Absorption of different wavelengths of UV radiation by the structures of the eye. [1]



The primary acute effect of UVR is photokeratitis which is also known as "snow-blindness" or "welders flash". [2, 3] Photokeratitis is a painful inflammatory condition that is caused by primarily UVC damage to the corneal epithelium which generally resolves within 48 hours without long-term consequences. [2,3] There are two types of cataracts which have been linked in part to UV exposure. Nuclear sclerotic cataracts are more prevalent in the tropics while cortical cataracts are more prevalent in the mid-latitudes. [4] Cortical cataracts have been linked to excessive UVB exposure in at least 10% of cases

and it is hypothesized that due to the refraction of light around the ocular structures, it is the lens edge that is most affected, causing cortical changes to the inferior nasal lens.[4]

Figure 2 - Rays entering the pupil from the extreme temporal region of the cornea have an ability to arrive at the equatorial zone of the lens as they bend around the iris.[4]



However, some studies have found insufficient evidence that nuclear sclerotic cataracts are indeed caused by UV exposure.[2] These experiments have suggested that rapid temperature increase secondary to solar exposure through the cornea is likely responsible for cataract formation.[2]

During the summer months the average child receives three times the annual UVB than the average adult.[5] The sun exposure during the first 10-20 years of life greatly increases the chance of developing skin cancer later in life, specifically melanoma if the child suffered two blistering sunburns before the age of 18.[5,6] Studies have shown that the use of sunscreen with a sun protection factor of 15 during the first 18 years of life would reduce the incidence of non-melanoma skin cancer by 78-80%.[5,6] This link indicates the importance of education for parents, teachers, and caretakers on the necessity of children

wearing UV protective eyewear as a preventative measure. However, Geller et al (2003) found that 61% of their surveyed population, aged 5-13, reported having a severe sunburn the previous summer due to very low (<25%) rate of sun protection. [7]

"SunWise" was the first national health and sun safety program developed by the Environmental Protection Agency (EPA) in 1998 to educate school aged children in the United States. The goal of this program is to educate children on the effects of the thinning ozone with respect to preventing sun damage to the skin and eyes. [6] Once a school or group has joined the program a tool-kit is provided which includes panel-approved activities aimed to educate kids on UV radiation effects, risk factors for over exposure, and sun safety habits. [6] Initial research done by the SunWise Program revealed that hats, sunglasses, and sunscreen are used as sun safety measures by less than 1/3 of children. [6]

The UV Index which is used commonly today was designed by the EPA along with the National Weather Service as a guideline for sun safety measures during different times of the day and year.[8] This index is adjusted daily to reflect the changes in UV intensities that occur as a natural part of changing weather conditions. For instance, it is higher at mid-day and during the summer solstice, and at higher altitudes. [8] In these high risk times and situations, the UV index is elevated warning that sun damage is likely when out-of-doors unless proper precaution is taken. [8]

Figure 3 - UV index with suggested sun protection actions.[9]

UV Index	Description	Sun Protection Actions
0 - 2	Low	• Minimal sun protection required for normal activity • Wear sunglasses on bright days. • If outside for more than one hour, cover up and use sunscreen.
3 - 5	Moderate	• Take precautions: cover up, wear a hat, sunglasses, and sunscreen, especially if you are going to be outside for 30 minutes or more. • Look for shade near midday.
6 - 7	High	• Protection required. This level of UV damages the skin and can cause sunburn. • Reduce time in the sun between 11 am and 4 pm and take full precautions: cover up, wear a hat, sunglasses, and sunscreen.
8 - 10	Very High	• Extra precautions required; unprotected skin will be damaged and can burn quickly. • Avoid the sun between 11 am and 4 pm and take full precautions: cover up, wear a hat, sunglasses, and sunscreen.
11+	Extreme	• Take full precautions; unprotected skin will be damaged and can burn in minutes. • Avoid the sun between 11 am and 4 pm. Cover up, wear a hat, sunglasses, and sunscreen.

While "SunWise" makes a noteworthy effort and has proven success with regards to sun protection and safety of the skin, education on UV eye protective measures and damage is limited within the tool-kit. This research includes pilot activities on ocular UV diseases, exposure, and protection which are aimed to enhance the knowledge base of participating school aged children.

METHODS

A convenience sampling of 7 kindergarten students and 22 2nd grade students were selected based upon teacher and parental consent (APPENDIX H). Parental informed consent forms were sent home with students in selected classrooms, and pending parent/guardian signature, they were allowed to participate in the activities as well as a pre and post quiz assessments (APPENDIX I). Participating teachers were asked to first give the pre-activity quiz which consisted of 10 questions on basic knowledge of ocular

UV damage, exposure, and protective measures. Teachers were then asked to lead short educational activities, in total taking less than 30 minutes, for all participating students. Participating students then completed an identical post-activity quiz on their knowledge of ocular UV damage, exposure, and protective measures. The purpose of repeating the survey was to determine if the students learned from the activities presented in the classroom.

For 2nd grade students the activities include: definitions (APPENDIX J) of common ocular anatomy terms and diseases followed by a word search (APPENDIX O) with the same items, a simulation of cataracts and macular degeneration (APPENDIX K) using paper cut out spectacles with yellow cellophane to simulate a cataract and a black central dot to simulate macular degeneration, and a poster activity where students were asked to tape sun safety items on a sunny beach scene (APPENDIX L,M, N). For the 2nd grade students, the pre and post activity quiz was completed individually, with minimal teacher instruction only to clarify words and directions. Each student completed a pre activity quiz three days before the activities were administered, and a post activity quiz immediately following the lessons.

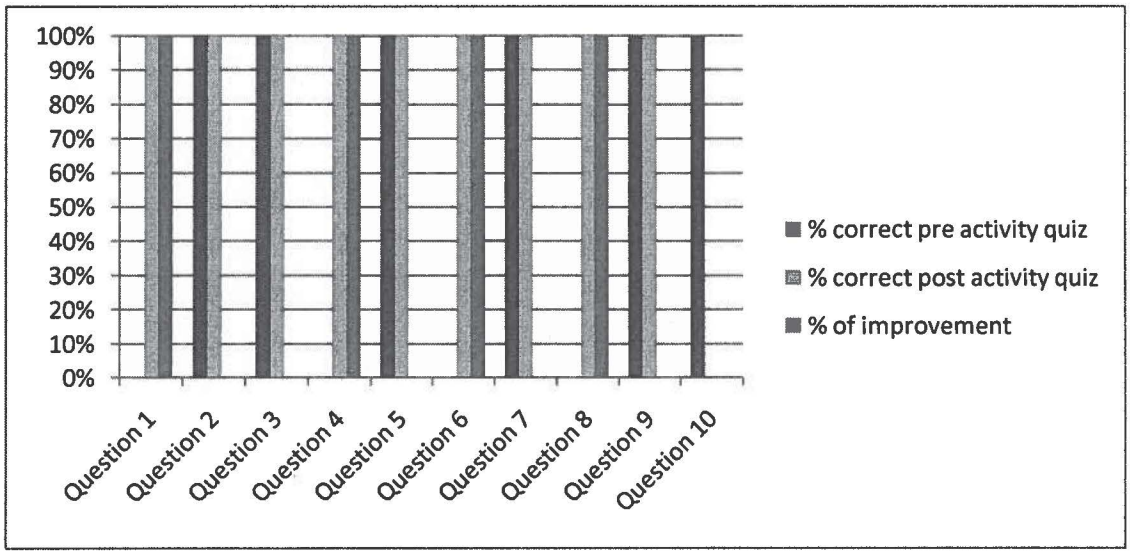
Kindergartners completed all of the aforementioned activities, with the exception of the word search due to their illiteracy. Minimal instruction was given during these lessons to help the students complete each activity and data was collected from pre and post activity surveys. For the kindergarten students, the pre and post activity quiz was completed as a class, with the teacher orally asking each question, and then recording each student response by a show of hands.

Data collected was used to determine the effectiveness of the activities presented at teaching students as well as the feasibility of conducting these activities in a classroom setting. An executive summary of our results was provided to the Environmental Protection Agency's "SunWise" program for school aged children along with sample activities and recommendations. Sample "SunWise" kits as well as the pilot activities were provided to each participating classroom.

RESULTS

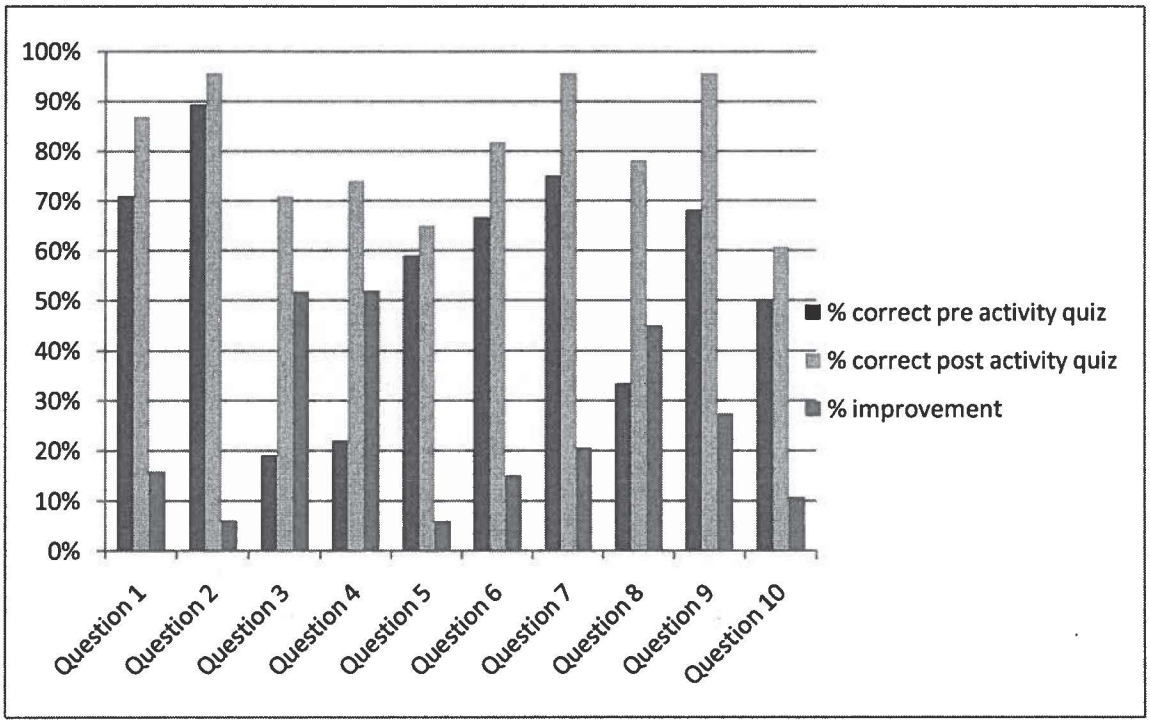
The pre and post activity quizzes showed a marked increase in the percentage of correct answers for both the kindergarten sample population as well as the 2nd grade sample population. The kindergarten students all answered six of the ten items correctly on the pre activity quiz. On the post activity quiz, they were able to answer the remaining four items correct. The one exception was item number ten, which they all answered correctly on the pre activity quiz, and all answered incorrectly on the post activity quiz.

Table 1 – Kindergarten pre and post activity quiz data. Data below is reflected as a percent improvement from pre-activity quiz answers correct to post-activity quiz answers correct for each quiz item.



The 2nd grade classroom also showed improvements on each of the ten survey items, with more significant improvements on quiz questions 3, 4, and 8.

Table 2 – 2nd Grade pre and post activity quiz data. Data below is reflected as a percent improvement from pre-activity quiz answers correct to post-activity quiz answers correct for each quiz item.



DISCUSSION

While the literature on the SunWise program shows its effectiveness at educating school aged children on the damages of excessive skin UV exposure, at this time it does not include detailed activities to increase the knowledge base of specific ocular UV damages or protective measures. The current tool-kit includes an activity for all age groups to make your own sunglasses with different colors of cellophane lenses, but it lacks an emphasis on protecting ocular structures from UV damage and does not educate students on possible ocular diseases which could result from excessive UV exposure. The tool-kit also includes a crossword puzzle for upper elementary children only which includes non-ocular specific words describing sun protection, but the younger elementary students are not exposed. This lack of information provided within the tool-kit combined with current

literature linking excessive UV exposure to ocular diseases prompted the pilot of new educational activities aimed specifically at ocular UV damage and protection. Limitations of testing these pilot activities include a small sample size and difficulty assessing kindergarten knowledge base due to their illiteracy. The small sample size of seven kindergarteners and twenty-two second graders may not accurately represent all school-aged children, making it difficult to prove significance. Also, in our initial planning, we overlooked the issue of kindergarten literacy. They were given the exact same pre activity and post activity quiz as the second graders, but were unable to read the quiz items. Thus, the teacher read each question orally and children responded to the correct answer by a show of hands. However there is significant potential for results to be contaminated by this method, as the students were able to observe other students' responses. While we still believe there was an improvement in the knowledge of the kindergarten students in the areas of ocular UV exposure, damage, and protection the percentage of improvement on each quiz item was difficult to measure for accuracy. Kindergarten students showed improvement on all of items except one, and this is more than likely due to poor writing of the question than to the lesson actually teaching incorrect information.

CONCLUSIONS

Kindergarten students were able to correctly answer 60% of the questions correctly on the pre-activity quiz, and 100% on the post-activity quiz once question 10 data was removed from the data set due to poor writing. The activities were successful in educating the students on ocular UV exposure, damage, and protection. Pre activity quizzes revealed large gaps in the knowledge of 2nd grade students, especially with

respect to reflections of UV light from snow (51% improvement on post activity quiz), ability for cancer to form in the eye (52% improvement on post activity quiz), and the definition of cataracts, a common eye disease related to UV exposure (45% improvement on post activity quiz). While these improvements are the most dramatic, there was a marked improvement in each of the quiz items, proving an increase in knowledge of ocular UV exposure, damage, and protection following educational activities.

Based upon the effectiveness measured by percentage of improvement of knowledge on each quiz item, we recommend that these activities are reviewed by the SunWise educational panel of professionals and is then incorporated into the SunWise tool-kit and distributed to participating schools and programs. Each activity administered took between 20 and 30 minutes to complete and discuss, thus making the time spent feasible considering the knowledge gained. Future research in this area should be done to further assess the validity of the results found in our study. A larger sample population would be ideal for assessing the knowledge base, and all age groups (K-8) should be incorporated. Furthermore, the cost effectiveness of providing sun protective eyewear to participating classrooms should be explored since we are acutely aware of the exposure children receive between the ages of 10 and 20.

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APPENDIX H

PARENTAL CONSENT

PARENTAL CONSENT FORM

"Dear Parents/Guardians,

Our names are Lindsay Basler and Elizabeth Tonkery and we are 4th year optometry students at the Michigan College of Optometry at Ferris State University. We would like your permission to survey your child on his/her current perceptions and practices regarding protecting their eyes from Ultraviolet (UV) light, as well as their knowledge of UV effects on the eye. We also will be giving an activity/lesson about UV eye protection and side effects of UV radiation, followed by a post-lesson survey of their knowledge.

Participation is strictly voluntary and there are no consequences for choosing to not participate. The results of the data collected will help us develop and suggest activities aimed at teaching children how to protect their eyes from UV rays.

YES – I give my permission for my child to be involved in a survey and lesson/activities regarding eye protection and side effects of ultraviolet radiation.

NO - I DO NOT give my permission for my child to be involved in a survey and lesson/activities regarding eye protection and side effects of ultraviolet radiation.

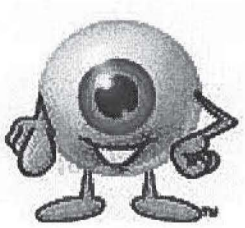
If you have any concerns with the conduct of this project, you may contact the Human Subjects Research Committee at Ferris State University, chaired by Dr. Connie Meinholdt (231-591-2759 or email connie_meinholdt@ferris.edu).

Parent/Guardian signature_____

Student Name_____

APPENDIX I

PRE AND POST ACTIVITY SURVEY



Pre-Post Activity Survey:

Eye Survey

1. Sunlight does not damage the eye, only the skin. T F
2. A hat helps protect your eyes from the sun. T F
3. Reflections from the snow can hurt your eyes. T F
4. Cancer cannot be found in your eye. T F
5. What type of eye problems are possible from sunlight damage
    a. Eye color change
    b. Eye growth
    c. Cataracts
    d. Broken nose
6. The lens, cornea, and retina are all parts of the eye that can all be damaged by sunlight. T F
7. Sunglasses do not protect your eyes from the sunlight. T F
8. A cataract is when the lens of the eye turns yellow T F
9. What is the best thing to do to protect your eyes from the sun?
    a. Hat
    b. Sunglasses
    c. Sunglasses and hat together
    d. Shoes and socks
10. The most exposure to sunlight happens before age 10. T F

APPENDIX J

DEFINITIONS

Definitions

Lens	-	the natural focusing system of the eye, which sits directly behind the pupil
Cataracts	-	yellowing of the eyes natural lens, which can be made worse by UV exposure
Cornea	-	the clear, curved front part of the eye which acts as the 'windshield'
Ptyerygium	-	white tissue growth over the cornea, which can be made worse by UV exposure
Sclera	-	white part of the eye
Pinguecula	-	yellow-ish tissue growth over the white part of the eye
Macula	-	area of the eye that gives detailed, central vision
Macular degeneration	-	changes at the back of the eye where detailed, central vision comes from
Iris	-	the colored part of the eye
Conjunctiva	-	a clear tissue covering the white part of the eye
Retina	-	very thin tissue lining that back part of the eye, acts as the 'film' in a camera and captures the information to send to the brain

APPENDIX K

WORD SEARCH

Eye Word Search

G	B	E	S	S	E	V	E	I	T	Z	H	W	U	G	W	X	V	N	A	U	V	A	X
U	Q	D	A	M	A	G	E	G	R	P	A	Y	P	D	E	P	O	Y	Y	B	X	M	U
K	I	E	H	S	E	Y	Z	C	V	C	L	Y	J	Q	T	I	T	X	I	G	T	A	N
Z	Z	U	K	S	S	A	Z	T	W	K	S	O	L	B	T	N	L	K	I	Z	B	A	D
P	G	D	L	F	K	O	E	L	V	T	H	U	Q	A	N	T	A	X	S	C	Z	S	H
F	G	I	Q	T	J	P	H	B	C	D	N	I	R	U	Q	Y	Q	M	A	W	N	F	O
M	A	E	O	G	R	Z	A	A	B	S	L	E	R	Z	H	O	R	J	I	O	G	A	R
M	Q	S	M	T	A	A	R	S	T	L	N	U	A	A	G	I	N	G	I	C	P	O	V
C	C	R	W	F	J	A	V	A	I	E	I	A	C	H	B	G	Y	T	N	L	W	U	S
C	L	N	U	A	T	J	T	I	G	L	D	N	H	O	V	O	C	W	Q	A	Z	E	Q
A	C	O	B	A	O	B	B	E	O	G	T	A	D	Z	N	E	O	T	W	B	Y	P	I
N	C	J	C	A	E	N	D	T	Z	L	U	Z	U	N	L	J	U	R	Z	A	Y	M	E
C	S	N	O	W	B	L	I	N	D	N	E	S	S	F	E	F	U	G	F	W	H	U	G
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B	R	P	V	V	C	K	D	F	O	I	U	U	F	W	T	P	G	Q	A	A	V	V	L
E	J	Z	G	B	X	M	L	W	R	T	N	U	M	N	U	B	R	L	N	C	G	C	A
R	X	U	V	P	A	C	I	R	N	Z	X	A	E	K	M	L	I	P	V	U	X	D	S
Z	O	U	R	N	Z	R	R	I	E	G	R	V	P	F	N	Z	E	K	F	L	K	S	S
N	S	F	H	W	O	J	L	K	A	D	E	U	K	B	M	K	D	N	E	A	C	J	E
L	E	P	Z	O	N	H	E	P	N	R	Q	C	M	E	J	V	L	M	S	R	Z	N	S
A	N	Z	F	U	R	Q	A	G	P	W	O	S	U	N	L	I	G	H	T	Q	M	Q	E

CORNEA
CONJUNCTIVA
CATARACTS
SUNLIGHT
SUNGLASSES
HAT
SNOWBLINDNESS
REFLECTIONS
LENS
CANCER
UVA
UVB
ULTRAVIOLET
DAMAGE
PROTECTION
PREVENTION
MACULAR
DEGENERATION
BLINDNESS
AGING

APPENDIX L

CATARACT AND MACULAR DEGENERATION SIMULATION

CATARACT AND MACULAR DEGENERATION SIMULATION

Materials
Yellow cellophane
Black permanent marker
1 pair of paper scissors
1 piece of construction paper
Assorted markers/crayons
Tape

Time

15-20 minutes

Directions

1. Divide the class into groups of four
2. Have each group make 1 pair of paper frames (from the attached cut-out directions) and decorate.
3. Cut out enough cellophane to make the 'lens' portion of the frames.
4. Have each group fasten put the yellow cellophane to frames by taping to the top, bottom, left, and right sides.
5. Tell the students this represents a cataract, which is the yellowing of the lens made worse by exposure to the sun without adequate sun protection.
6. Color a black circle in the center of the yellow cellophane of each eye, directly in front of the pupil, and instruct the groups to read any material on their desk.
7. This is simulating macular degeneration, which is a deterioration of the central vision, and also can be caused in part by excessive UV exposure.
8. After the activity is completed discuss with students the importance of wearing sunglasses and hats to protect their eyes from harmful side effects such as macular degeneration and cataracts.

APPENDIX M

SUN SAFETY BEACH ACTIVTY INSTRUCTIONS

Beach Poster Instructions

Materials
Beach poster (supplied)
Beach accessories cut-outs (supplied)
Tape

Time

15 minutes

Directions

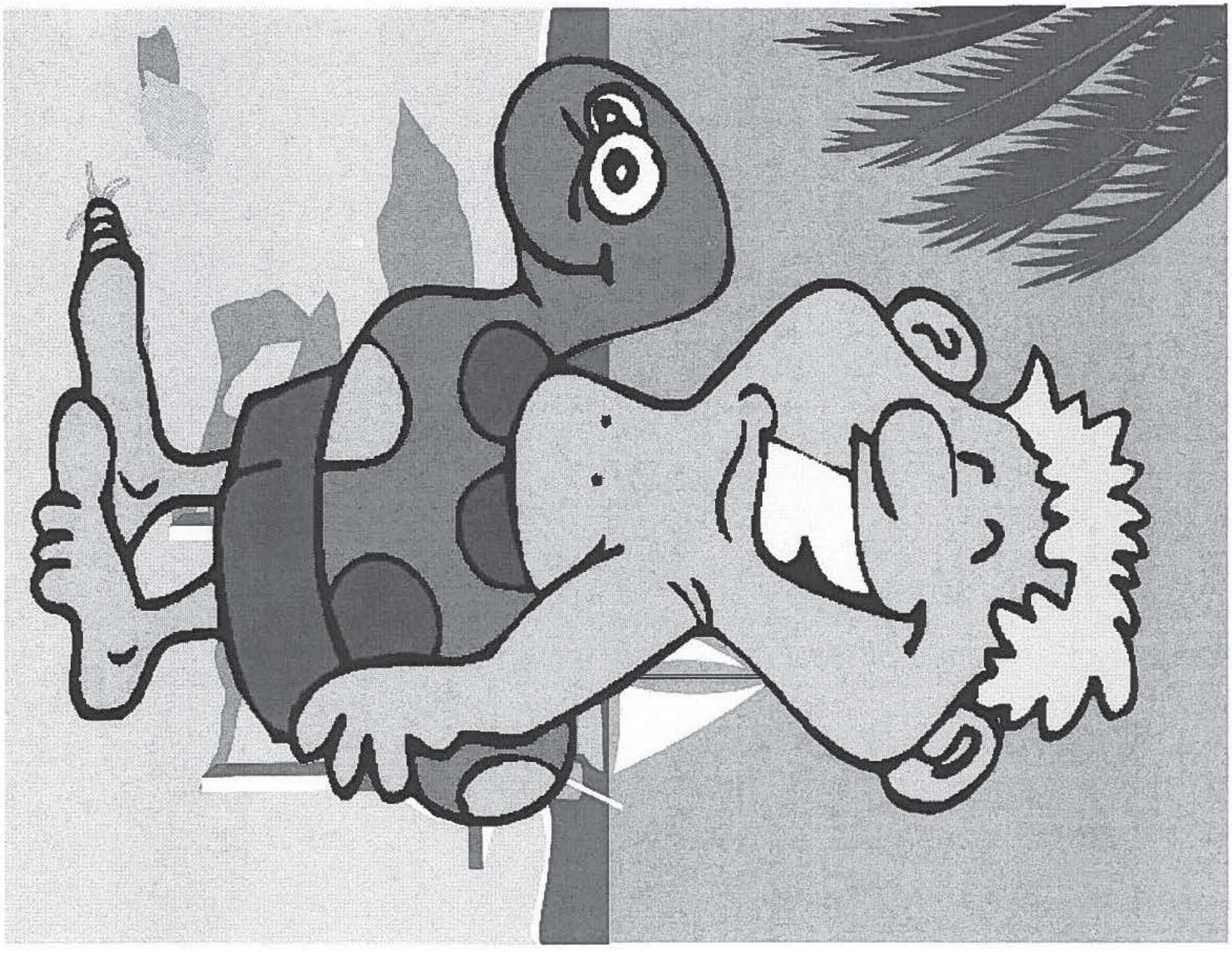
1. Ask the students to analyze the poster, and then prompt "what is wrong with this picture?" or similar question.
2. Have the students guess what the child pictured needs to have a fun and safe day at the beach with respect to SUN SAFETY.
3. When a correct answer is guessed, hand the student the accessory with a piece of tape on the back, and suggest he/she add it to the poster.

Answers:

Sunscreen, hat, long sleeved t-shirt, sunglasses, and beach umbrella. (included)

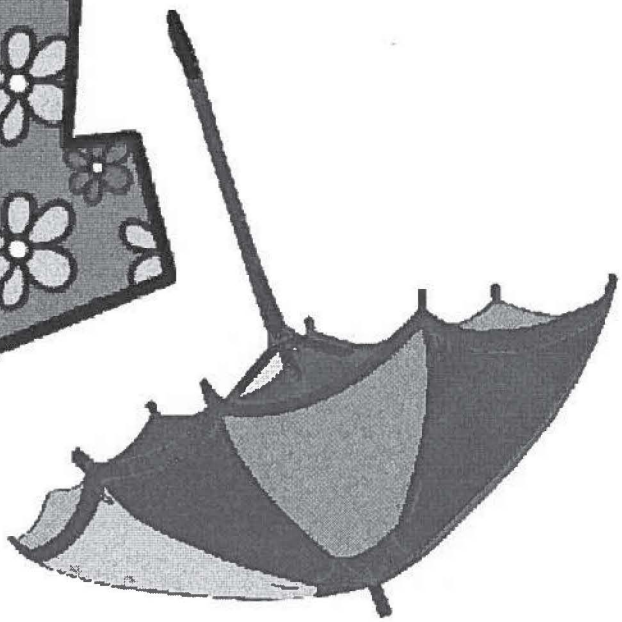
APPENDIX N

SUN SAFETY BEACH ACTIVITY POSTER



APPENDIX O

SUN SAFETY BEACH ACTIVITY ACCESSORIES

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