**Transcript: “AR for Learning and Accessibility” (2023)**

[**https://youtu.be/vrX2eUSZ8C8**](https://youtu.be/vrX2eUSZ8C8)

**YouTube**

0:00

This recording is a pre-session for  the Accessibility Summer Camp 2023.

0:07

The title is "AR for Learning and Accessibility:   Insights from a Systematic Review of  the Literature and an Environmental Scan

0:18

(with an early AR Accessibility Checklist)." This  is by Shalin Hai-Jew at Kansas State University.

0:28

This next slide shows a visual by Deep  Dream Generator. It shows three red

0:37

foxes in front of a green forest.  The visual is a pop-up image from

0:44

either a print or electronic book which  is one application of augmented reality.

0:53

The next visual is also by Deep Dream, and it  shows the biology lab that is a virtual lab.

1:02

The next visual, also by Deep Dream  Generator, shows the design of a

1:11

living room with a digital image and a  very fashionable light in the corner.

1:19

So what is this presentation about? The  presenter conducted a systematic review

1:25

of the academic literature recently. She  also conducted an environmental scan to

1:33

best see how to set up an augmented reality  shop at an institution of higher education.

1:41

The ambition was not only to better understand  the technologies, how to follow accessibility

1:48

guidelines, how to be legal but also to  examine potential positive and negative

1:54

effects of AR on teaching and learning, so some  insights about the scholarship of teaching and

2:01

learning (SoTL) with this technology.  The research did not go past the review

2:07

stage because of a lack of funding, but there  were some insights about accessibility in AR.

2:15

So on the one hand, AR is seen by some as positive  for alternate needs of learners because it's a

2:27

different modality, it's a different channel  that might help with perception and cognition.

2:36

Others, however, find that there may be challenges  with excessive motion, busyness, shapes, and colors.

2:47

There are some inherent challenges with using AR  in teaching and learning based on a few general

2:56

categories which I will elaborate on later in the  slideshow. So these include visual presentation and

3:05

communications, insufficient information such as  in labeling, physical challenges of the AR space,

3:16

unclear navigability, triggering  effects, and cyber sickness.

3:26

So this does provide an overview  and some early thoughts in the space.

3:34

This next image shows falling gummy candy evoked  as three-dimensional chewy yummy looking candies

3:44

that are falling, so it evokes both 3D and 4D.  This was created using the CrAIyon generative

3:53

art-making AI. This next visual shows a  clock that was created using Deep Dream

4:01

Generator. There is a sense of 3D to it as  well as some a sense of it being exploded.

4:13

Section break: What is Augmented Reality?

4:18

Thomas Caudill of the Boeing Company uh cited the  first use of augmented reality in the record back

4:26

in 1990 in industrial manufacturing. AR was used to super impose information on the visual field to make it

4:36

easier for workers to lay aircraft cables. There  is a cited source for this, and all cited sources

4:45

in the slideshow have references in the References  list at the end. R.T. Azuma in 1997 first defined AR

4:59

as a system that requires three components: one, it  has to combine the physical real and the virtual;

5:07

two, it has to be interactive in real time, and  three, it has to include the third dimension, so the

5:16

x-axis, the y-axis, and the z-axis, so showing volume  to emulate the world with more depth. AR does not

5:29

restrict the technologies used, and various  technologies are used for augmentation. These

5:36

include projections, lighting, head-mounted displays,  mobile apps, speakers, and others used in various

5:46

combinations. There are strengths and weaknesses  to all the devices, the methods, the technologies.

5:57

In general, there are two general types  of AR. They are considered marker-based

6:05

or a marker-less based, and in many  cases both coexist in the same app.

6:13

Marker-based AR requires the use of a camera  to acquire particular visual codes or image

6:21

anchors to trigger the AR to display to play  or to spawn. QR codes are a common example.

6:30

Markerless AR spawns without visual triggers but  perhaps with users being detected in a locality

6:40

through proximity triggers. There are other  conditionals that may be set up to act as triggers.

6:50

Section break: Augmented Reality  for Teaching and Learning.

6:57

There have been various practical  documented uses of AR. For example,

7:03

there has been exploratory art spaces, museum  displays, virtual laboratories, interactive gaming,

7:15

simulations, design labs, design studios, learning  modules, campus tours, the electronic publications,

7:28

imaginary immersive worlds, trainings,  practices, sales displays, and many others.

7:40

About AR for Learning: AR enables experiential  learning that combines the real and the virtual.

7:49

This is considered immersive embodied learning.  Disembodied learning is when generally only

7:59

the mind is engaged such as in reading a book or  distance learning. Uh in some cases, the experience

8:10

in AR is visual including 2D 3D and 4D for 4D  refers to to motion or changes over time. Objects

8:24

may be texturally or symbolically labeled in AR.  There may be sound such as a background soundtrack

8:32

or ambient sound. There may be event-based sound.  There may be character-based sound, and so on.

8:43

The experience may be interactive such as  with humans interacting with physical, textural

8:50

objects like tangibles, and humans interacting  with digital objects, and other combinations.

9:01

"Collision detection" is a capability for some  virtual AR that helps simulate the physics of

9:13

the real world, where two physical objects cannot  inhabit the same physical space at the same time.

9:22

The collision detection enables virtual  objects to behave a little more like real

9:30

physical objects based on how they behave when  they run into each other. The AR experience may be

9:40

social and collaborative with people physically  present or virtually telepresent or different

9:49

combinations of human interactivity with some  physically present and others remoting in.

10:00

The AR experiences may be held indoors  or outdoors or a mix of indoors . outdoors.

10:09

One term used for AR spaces is quote "spatial  augmented environment," and there is a citation.

10:18

The external AR experiences may be  in the daytime or at the night time.

10:25

More sophisticated systems enable adaptive  contrast and lighting given light conditions.

10:36

The AR experiences may be location-based locative  in a geographical sense. Some are world world-scale

10:46

experiences, or they could be more local  where there might be an AR walk sequence.

10:55

The AR experiences may also be  non-location based. For example,

11:01

there may be devices that can play various AR  spawns anytime anywhere in a ubiquitous way.

11:14

AR experiences may be delivered  remotely virtually for online learning.

11:22

The designed AR can be exploratory, so people  can go into a space and search for various AR

11:33

visualizations. Or the AR experience may be  guided such as having individuals or small

11:42

groups move from station to station. AR may be  experienced individually or in small groups.

11:51

The AR experience may be dynamic and ever-changing.   Data may be streamed to change the scene or

12:01

parameters of the scene. Human biometrics have also  been used as feeder data to various AR experiences.

12:14

This next slide shows a projector that  was created in the Deep Dream Generator.

12:23

It is an ornate intricate  image with quilling effects.

12:32

Some AR systems are fully built out for  teaching and learning in a physical space.

12:40

Such systems enable instructors to have  administrator level access to change up the AR

12:48

for the learning and to monitor the locations and  behaviors of each of the learners. Some AR systems

12:57

also enable data collection to understand  the dynamics of the teaching and learning.

13:05

Some AR systems are desktop ones such as those  for e-publications, e-books, and print books.

13:12

Others are mass-scale such as projected  displays painted on the sides of skyscrapers.

13:20

And others are larger still, with global-scale  ARs designed around particular themes and / or

13:29

knowledge. These depend on GPS coordinates  or other ways of indicating location.

13:40

Section break: Some Learning Concepts Applied to AR.

13:47

So AR can be applied to formal accredited  learning from preschool to postgraduate school,

13:55

postgraduate studies, to non-formal learning so  non-accredited courses and trainings, modules,

14:06

or to informal learning, so incidental  learning from lived experiences.

14:13

There are various learning theories that  can be applied to augmented reality. I have

14:19

selected some that are very practical to  me uh and make sense to me in the context.

14:27

Bloom's taxonomy of learning objectives  particularly the updated one in 2001

14:34

suggests that humans have a kind of hierarchy  of learning from remembering to understanding

14:42

to applications to analysis to evaluations  to creativity as sort of the highest of human

14:51

thinking, and this seems like a very practical  way of understanding designed learning using AR.

15:04

Piaget's constructivism is also relevant  where learners are not passively receivers

15:12

of information, but they have to actively  engage in order to make sense or to sense-

15:18

make, so they have to uh learn by doing is the  more sort of a recent phrase, so learners have

15:28

to be active agents; they have to be motivated;  they have to care; they have to be respected

15:34

as learners; they have to make decisions on their  own learning and be supported in their endeavors.

15:43

Vygotsky's and Bandura's social constructivism  suggests that meaning is made socially and in

15:51

groups, and so even as individuals feel like they  are learning individually on their own or that

15:58

they've come up with something totally novel on  their own, in most cases, they are in disciplines

16:06

that were built up by the labor of many many  people, and the insights and creativity and and

16:14

personalities of many. Kolb's experiential learning  cycle also very much applies to this augmented

16:25

reality experiential learning. Here, the human being  is engaging in concrete learning in physical and

16:35

AR space. They engage in reflective observation.  They think of abstract conceptualizations from

16:44

their reflections and express their ideas and  then they can go take their hypotheses into

16:52

the world and actively experiment, right,  so it's a continuous cycle of learning.

17:02

Hutchin's distributed cognition also is relevant.  This basic idea is that knowledge and memory can

17:12

be stored external to the learner, so that  their working memory doesn't have to be

17:19

overloaded in trying to remember all the  knowledge and all the memory in order to

17:25

engage in augmented reality space or in  a learning space. So a properly designed

17:32

object has to look a certain way, behave  a certain way, interact a certain way to

17:39

help humans understand the knowledge  in that object in a learning context.

17:48

Mayer and Moreno's uh multimedia learning  theory suggests that properly designed

17:55

learning objects will minimize extraneous  cognitive load so that learners can use

18:03

their working memory on intrinsic and  germane cognitive load, so they have

18:10

more mental energy and resources to apply  to the learning. So that's-- those are the

18:19

ideas that that I think are are relevant  and hopefully helpful and practical uh.

18:28

So Section break: How AR is Generally Designed.

18:34

So Heather Dunaway Smith of Adobe, Inc., has set up  in eight uh seek eight item sequence for setting

18:46

up augmented reality using Aero app. So she begins  perfectly I think with goal setting. So in AR, (the)

18:57

context and ambition of the makers will inform the  design and the development and the deployment, so

19:07

what follows would be sketching and storyboarding.  You know uh perhaps scripting. Then prototypes are

19:15

created. The assets are are created. The AR scene is  laid out or composited; then, there are interactions

19:27

and animations that may be applied to the various  objects in or to the scene. Those various elements

19:33

are all tested. Every functionality that has been  designed in has to be tested. And then there has

19:41

to be sharing and publishing out for others to  appreciate and to benefit the larger community.

19:51

This eight-step sequence is not linear;  it can be recursive clearly but it's

19:59

super helpful I think in understanding process.

20:04

This next slide shows an anteater (armadillo actually) inside the Aero app building space. There are trees that can be

20:18

seen. The shadows uh are below the objects, so the  light is coming from above. And there are polygons

20:27

representing the various shapes. The polygons  are fairly large which gives you an indication

20:36

of just how small these objects have to be to  function with motion, with behaviors, and so on. Uh

20:47

in an AR scenario, um we're not talking 3D objects  with millions of polygons. Let's put it that way.

20:58

So context is important. If an AR experience  uh draws from the physical world, it helps

21:08

to to set the context accurately  for where the visuals will spawn,

21:14

where the sounds will spawn, the interactivity,  the behaviors, uh and so forth,

21:23

And in general, the digital elements of an AR  display are in the foreground and the physical

21:32

spaces in the background although that doesn't  necessarily have to be. You could also have

21:38

digital elements right at the physical space like  standing on a physical rock or something like that.

21:52

So in designing an AR scene, the  human attention has to be guided.

22:01

So the size of an object says something  about its relevance, and it the larger

22:07

something is, the more attention it draws. The  color uh brightness uh also draws attention uh

22:18

versus less bright or dimmer colors. Warm colors  are more attractive than cool ones, and so on.

22:26

Positive space draws human attention whereas  negative space or empty space or white space does

22:36

not as much. Uh motion or movement, changes over  time, they draw the human human eyes and attention.

22:47

And audio can also be used to direct human  attention such as focusing on direction,

22:52

the source of a sound, the change  of a context, that sort of a thing.

22:59

There are visual hierarchies that have to be  designed to point attention to areas of visual

23:07

interest. The visual elements should not compete  among themselves but work together towards a

23:13

certain end and based on the need for simplicity  and sparsity based on how augmented reality works,

23:25

um those should require some  pretty strict uh editing down.

23:33

So lightweight files are needed for multiple  reasons. One is the human attention towards

23:40

transient multimedia is very limited, so if people  are watching something, hearing something, if

23:48

they're touching, smelling, tasting, they are perhaps  limited in how much they can take in and notice.

23:56

Their their ability to see small details goes away  for most people even those with actually special

24:04

training. The screen real estate is small on  mobile devices, so AR has to work within those

24:13

constraints if they are for mobile devices.  And there also the files for AR have to be

24:21

optimized with low file size, low polygon count, low  frame rates, small sound files, and so on, in order

24:31

to convey dynamic information, you know, via the  given devices today. AR is an active medium, so it

24:44

shouldn't be designed for passive consumption.  It should be interactive, social, and engaging.

24:57

Section break: Striving for Accessible AR.

25:03

Earlier, so there are areas we talked  about for accessibility are now being

25:08

readdressed here in more detail. So in terms  of Visual Presentation and Communications...

25:16

and there should be adjustments for low  resolution in outdoors AR. There should be

25:23

sufficient color values, darkness and brightness  and contrasts for a wide range of viewability.

25:33

Color itself should not be used as a  single channel to convey information.

25:39

By offering-- so there should be  offered multi-channel information.

25:46

Digital and physical objects should not occlude  uh other objects. This is for a perception but

25:57

it's also for safety. The scene orientation  should be set up coherently for a person

26:06

entering the augmented reality scene as well  as for them leaving the augmented reality scene.

26:14

And if an AR visual should be experienceable  from various angles and they should be tested

26:24

from all angles for perception. Uh so if  there are there is sound, there is visuals,

26:32

and text, all of that should be tested. Anything  that should be perceivable should be tested.

26:43

People should not be rushed as they go into an  AR scene because they need sufficient time to

26:52

perceive and consider the visuals, the motions, the  sounds, the changes over time, and other aspects.

27:01

Further, it may be helpful to use  familiar layouts and positions of

27:06

objects to lighten cognitive loads so  that there can be understandings. So

27:14

designers of AR need to understand the  visual conventions on 2D and 3D and 4D

27:22

including how these visual conventions (are) expressed in different cultures.

27:35

When labeling various objects in different  languages, for example, or for other learning

27:43

purposes, the text, the symbols, should be consistent  throughout the AR scene. They should be fairly

27:54

comprehensive. t=They should be visible and legible.  And if there is sound or video, there should be

28:04

a text transcription uh and including enriched  transcription with more detailed transcription.

28:16

Augmented reality in physical space has  its own set of challenges: the physical

28:23

physical spaces have to be safe for people  to maneuver through no matter their

28:32

you know their accessibility such as through a  wheelchair, through crutches, or other other means.

28:42

There should not be anything occluding or  covering learner vision uh against any hazards.

28:51

Um there people should not be asked to  walk backwards or sideways. They should

28:57

not be fatigued going through the AR experience  which might if it's too excessive, for example, or

29:05

too overly sensory. If they need directions to  follow, they should receive those just-in-time,

29:12

not have to memorize a long sequence of  directions. And if there are wearables or

29:19

tangibles or headsets, those should not be  unwieldy or dangerous in their own right.

29:27

In terms of interfaces and directions  for navigation, it is important to address

29:34

unclear or absent user interfaces, so people  should be able to be oriented to where they

29:42

are and what is expected of them when they  enter the AR experience and when they exit.

29:49

They should have an ability to re-experience  sections or the whole. They should have clear

29:56

directions for navigating sequences, processes, and  movements, and they should be able to exit at any

30:03

time for example if they are experiencing  nausea or cyber sickness, for example.

30:13

Sensory and cognitive triggers should also be  avoided. So if there are strobe effects, those

30:19

should never ever be included in any visuals  that you create since those could lead to

30:25

seizures, nausea, discomfort. You do not want to  have motions that are uncontrollable, so those

30:34

should be disabled or put into uh the control of  users. Very speedy motions should be removed

30:49

um and if there are no user controls perhaps  that element may be removed. Or if there's a lack

31:01

of clarity on how to engage, that should also be  considered. Anything that is too excessively busy,

31:09

colorful, too action-oriented may cause challenges  for the cognitive neurodivergent, so those should

31:19

especially come with a warning perhaps and  controls or a less excited excitatory uh version.

31:30

Extraneous information may be left off if  they may lead to extraneous cognitive load.

31:39

Also sensitive and controversial  topics should be sensitively addressed.

31:46

There should not be any messages that can be uh  experienced as exclusionary or discriminatory.

31:56

People should be should be  included in the AR experience.

32:05

Cyber sickness refers to feelings of nausea  and dizziness from some AR experiences and

32:12

there's been some recent research that has shown  partly why this occurs. So the the real world has

32:22

a high dimensional light data in the visual field  whereas the emulated AR offers much less. There's

32:33

flicker, and there's contradictory timings, which  can be problematic. There are also vulnerabilities

32:42

based on demographic features of users. And  all of that is important to take into account

32:53

in terms of the learning context.  It would be important to have   alternatives to the AR that enable  the same depth of learning for those

33:03

who would prefer not to do the AR or  would prefer a different experience.

33:10

For example, there can be notes that are  offered for post-AR experience review

33:17

and learning and practice; perhaps there can be  designed activities for post-AR experience review

33:27

and learning and practice and perhaps there  can be pre-AR experiences, right, and so forth.

33:40

So this next slide shows another view of  the internal parts of Aero with starter

33:49

assets here. There's a fox looking at a body  of water, and there's a giant rain cloud above.

33:56

The text reads, "And?" So the prior slides show some of  the known challenges with deploying

34:06

AR for learning. "Shift left" means addressing  accessibility early in the design-development-

34:15

deployment process to head off problems  that might require excessive retrofitting.

34:22

It is important to test and retest against  potential harms prior to going live. It helps

34:29

to have test users with a variety of different  backgrounds and and experiences to test the AR.

34:40

This next slide is made from  Deep Dream Generator, and it

34:45

shows 3D flowers floating around in a circle.

34:52

The References list follows next.

34:58

This next slide shows a bicyclist speeding by  a blur of trees. There's an implied motion. The

35:09

aesthetics of this image is cartoonish a bit, and  this was created with the Deep Dream Generator.

35:18

So the contact information for the presenter  is available on Slide 58. This is Shalin

35:26

Hai-Jew. 785-532-5262 s h a l i n @ksu.edu

35:38

So if there are any questions feel free to email.   Thanks to the organizers of the Accessibility

35:45

Summer Camp 2023 for including me. This is the  pre-recorded session. Thank you for participating!

English

AllListenableFrom Shalin Hai-JewRecently uploadedWatched