Integrating STEM using An Iterative 4 step Experiential ID Process (4xEID)

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STEM LEARNING OBJECTS

- Design Play Objects for HS Science
 Experimental Center (Outside or Inside)
- Students will couple learning with these objects and coursework in STEM
- i.e. students will need to manipulate and make decisions using all the STEM skills

STEM LEARNING OBJECTS

- You've see these type of **play objects** before:
 - Children's Museums, and Science Museums
 - SciPlay







STEM LEARNING OBJECTS

- with the majority of these activities the learner finds them interesting and fun, BUT, the learning (or "take-away") is low
- This is because the *mechanics* of using the play object are designed for a short time-ontask, and with an expectation of reaching a relatively low level on the <u>Bloom, Krathwohl</u>,

Harrow Taxonomy Scale

STEM LEARNING OBJECTS Now let's get started!!!

An Iterative 4 step Experiential ID Process (4xEID)

4 STEP EXPERIENTIAL ID PROCESS



1

Define the **Needs** & **Goals** of the individual, student, group, teacher, community, organization, or institution.





OPERATIONALIZE CONTENT

Create a Content Hierarchy, Prioritize and Target Levels of Learning, and establish Sequencing Flows





3

Brainstorm effective Experiential Modes for each Learning Context, & embed Scenarios & Action Vectors





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Master Design Chart Stakeholder GOALS



	A	В	С	D	E	F	G	Н
1	Stake Holder	1. RECALL	2. UNDERSTAND	3. APPLY	4. ANALYZE	5. SYNTHESIZE	6. EVALUATE	IMPORTANCE
2	INSTITUTION	2	5	5			5	17
3								0
4	INSTITUTION UNIT	2	2	4	5	5		18
5								0
6	UNIT MEMBERS			3	3			6
7								0
8	CLIENTS			4			2	6
9								0
10	SUBJECT-MATTER EXPERTS				5	5	5	15
11								0
12	STAFF / FACULTY	3	5	5	5	5	5	28
13								0
14	MANAGEMENT	2	2				4	8
15								0
16	OPERATIONAL TEAMS	4	5	5	5	5		24
17								0
18	OPERATIONAL SUBGROUPS	2	2	4	4	4	4	20
19								0
20	INDIVIDUALS/USERS	2	5	5	5	5	2	24
21								0

Master Design Chart CONTENT

:di	А	В	С	D	E	F	G	Н	I	J	К	L	М	N	V
1		CONTENT	1. RECALL		2. UNDERSTAND		3. APPL			PLY			TOTALS		
2			А	В	С	D	E	F	G	Н	-	J	К	L	TOTALS
3	KEY CONCEPT	Action Verbs used in TASK description	IDENTIFY	DESCRIBE	RECOGNIZE	DISTINGUISH BETWEEN	GIVE EXAMPLE	PREDICT	DEMONSTRATE	DISCOVER	OPERATE	IMPLEMENT	COMPUTE	OUTLINE	CONTENT TOTALS
4	OBJECTS:	Big to Small	2	1		2									5
5	OBJECTS:	Hard to Soft	1	1		2	2					8.4 A.2			4
6	OBJECTS:	Density	3	1		2					22		ŝ		6
7	MATERIALS:	Their EFFECT on WEIGHT	<i>ú</i>	3		1		5	2	1		a a			10
8	MATERIALS:	DIFFERENCES in SIZE		3				5	2						10
9	WEIGHING TOOLS:	Appropriate SCALE	1	85 - L2	1	1	2			1		2			6
10	WEIGHING TOOLS:	Functionality of Tool	1		1	1				1	23 5	2	2		6
11	WEIGHING TOOLS:	UNITS of Measure	1		1	1				1	3	2			9
12	WEIGHING TOOLS:	TOOL Operation		1							3	2			6
13	WEIGHING TOOLS:	Reporting Results		1		2						2	3		6
14	FALLING OBJECT:	UNITS of Measure	1		1	1			8 8	1		2	3		9
66		LEVEL TOTALS	79	110	98	104	116	78	61	102	6	21	40		

Content Hierarchy





Game Mechanics: Actions

4

#	STATIC	 When a player first enters a scene When a player must analyze the situation When a player is busy looking, listening, or reading When a player is "outside" the game
⁹ #	ΙΛΡυτ	 When a player hears and understands audio When a player reads and understands text When a player interacts with people, places, and/or things that provide meaningful information
" **	STRATIGIZE	 When a player encounters new information or experiences, and stops for metacognition or strategy formation When a player enters into interaction with other elements within the game and then initiates action based on that information When the path of action can be observable as a pattern that suggests a strategy
#	ACTION	 [Action Vector] When a player takes action to move within the environment, to interact, to emote, to fire weapons, or in general anything observable that the player does [Learning Vector] When a player takes actions that correspond to progress within the game that match those goals within the Master Design Chart
*	T& E EXPLORE	 When a player is moving randomly or unpredictably within the game environment When a player is looking for something and must search in a number of locations
۴.	INTERACT	 When a player interacts with people, places, and/or things When a player touches, picks up, or stores items in the environment Interaction may range from shooting, throwing, hitting, touching, confronting, dialoging with, driving a vehicle, or simply moving along side or following another character.

Game Mechanics: Rules



- GOAL:
- To work through the operation of the play object as quickly as possible
- To determine the most appropriate strategy to execute the operation of the play object
 - Analyze the physics involved
 - Analyze the way the physics were engineered
 - Determine which math formula should be used
 - Determine how to operate the technology to execute the appropriate solution
- **TURN** (per player):
 - 1. Choose an individual, group, or competition play mode
 - 2. Follow instructions that are posted for each mode
 - 3. operate the technology to receive input items into the main control interface
 - 4. initiate the execute button
 - 5. analyze the results observed
 - 6. replay from #1 if desired

Play Object : <u>Newton's Law of Motion</u>

- A sphere is supported by a long wire creating a PENDULUM
- The sphere may be raised and held at the end of it's path by a magnet
- When the magnet is released the pendulum swings
- Estimate where the pendulum will swing to at both ends
- Add a slight force at the beginning of the swing and estimate how this will change the path





Science Play Object: <u>VECTORS</u> Scenario: **SEQUENCE OF PLAY**



Ċ	ΙΛΡυτ	1. Observe the instructions on the control board 2. On the LCD screen: is a formula $T = 2 \pi \sqrt{\frac{1}{g}}$ a) and formula $g = (9.8 \text{ m/sec})^2$ b) $\Pi = c) Period(T) = 2 X \pi X SQ Root of the length of the pendulum ()/g$
0	ACTION	The player uses the on-screen calculator to enter the numbers into each space of the formula and receives an answer when s/he selects (SUBMIT)
C	ΙΠΡυτ	The PENDULUM SWINGS and an indicator displays the time it took for the ball to travel the distance (d ²).

Play Object : Waves, Time, & Measurement

- In a RIPPLE TANK, periodic waves are being generated from the center
- Using a STROBOSCOPE, adjust it's frequency until the waves appear motionless
- Determine the correct frequency and enter it into the formula
- Calculate the speed of the waves







Play Object : Space & Measurement

- Determine the height using TRIANGULATION
- Determine distance from object
- Enter the distance into the formula
- Sight through scope to determine angle
- Enter the angle into the formula
- Find and enter the *tanget* of the angle
- Enter the result of the formula
- Submit the result



Play Object : Functions & Scaling

- Using the INVERSE-SQUARE relationship, calculate light intensity on a flat surface
- Based on your calculations from the data presented; Move a surface between two lights to a position where the light intensity on one side is 4 times the intensity of the other side.
- Submit when ready



Play Object : Motion Along a Path

- Two objects travel at different speeds
- The faster object stops for a short period
- Calculate which object will arrive first from the data provided
- Submit your answer
- press the run button







Play Object : Vectors

- From a high platform,
 2 equally shaped balls drop
- One ball is 4 times the density of the other
- One ball is projected sideways
- Calculate when the balls will reach the bottom
- Calculate how far away from the platform the projected ball will fall





Play Object : Mass, Elements

- Determine the DENSITY, VOLUME, and MASS of 3 objects of different size and material
- Estimate the results of placing each into a vat of water
- Place the objects into the vat
- Record the results and compare to your estimate





Play Object : Nature of Gas

- A cylinder is filled with gas and enclosed by a PISTON attached to a platform
- As weights are placed on the platform the piston lowers in the cylinder and compresses the gas
- Calculate the pressure increase, from the data presented, for each weight





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