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TITLE: **An Iterative 4 Step Experiential ID Process (4xEID)**

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An Iterative 4 Step Experiential ID Process (4xEID)

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Abstract

This paper lays out an Instructional Development process specifically targeting the design of complex experiential learning environments such as those found in face-to-face (teacher-student) or virtual game contexts (virtual environment-student). A virtual game named *iKIDS: Slices in Time* focusing on STEM learning is used for illustration. This 4-Step Experiential ID Process (4xEID) uniquely integrates content hierarchies, learning level taxonomies, teaching methodology, storyline development, experiential mode analysis, and offers a unique incorporation of learning vectors. The iterative nature of the process allows for a vector analysis of both the design and of learning during game play.

Outline of the 4xEID Process

Key to developing an Immersive Learning Environment (ILE) is the adherence to a specialized 4-Step Experiential Instructional Design Process (4xEID) . In the case referred to in this document the ultimate outcome of the design is envisioned to be a hybrid Board Game combined with a 3D game-like virtual space. This learning environment is envisioned to be incorporated in-class with groups of students, or played outside of class on an individual learning basis. As the players move through the mechanics of game-play on the board, they will encounter options to also interact with a computer that provides responses and scenarios relative to what the player inputs into the computer. The reasons for our selection of such an environment is to offer the levels of dynamic design challenges to appropriately illustrate the 4xEID process, and to offer adequate access to content resources. The 4xEID process could just as well be used to aid students learning how to interact with customers in a store environment, to learn strategies and techniques of playing soccer, or to learn any other decision, or skill, based content.

The 4xEID process begins as does ADDIE and many HPT procedures:

1. *Define the Goals* of the learning environment and *Bound the Specific Content*

All learning design begins with the objectives of the individual student, a group of students, the needs of a teacher to meet curricular goals, or the goals of an institution or organization. A thorough analysis will list goals for each level of the hierarchy. For instance, the organization may simply be focused on meeting standards for every student, whereas the teacher's goals may be to both meet standards, but to have the student also apply knowledge. Such a difference could create a tension between the teacher and administration relative to the amount of time devoted to the content selected. Even the amount and which content is selected may be contentious, so a careful and honest analysis at this stage is critical upon starting the design process.

2. *Operationalize the Content*: Creating a *Content Hierarchy* targeting *Learning Levels*

Experiential Learning involves hands-on interactions by the student that should trigger specific levels of cognition and actions. In other words, the content must be arranged such that it is evident which chunk is most coupled to the goals laid out in the previous step. Such an exercise involves not only prioritization of content, but also the targeting of the level of cognition and specific action requierd to meet that goal. Fortunately Bloom and Krawthwhol developed a Master Design Chart (MDC) that provides an effective worksheet to accomplish both tasks at the same time (see Figure 1). In short, chunks of content are placed in one spreadsheet column while numbers of importance are placed under column headings matching the levels of cognition or action desired (D. Jonassen, Tessmer, & Hannum, 1990; D. H. Jonassen, Hannum, & Tessmer, 1989)

- **Recalls** data or information
- **Understands** the meaning and interpolation of a problem
- **Applies** a concept in a new situation
- **Analyzes** component parts, facts, and inferences
- **Synthesizes** a new instance of a structure or model

- **<u>Evaluates</u>** existing data, relationships, or models

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	V
1		CONTENT	1. RECALL			2. UNDERSTAND			3. APPLY						TOTALS
2			A	B	C	D	E	F	G	H	I	J	K	L	
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									4
6	OBJECTS:	Density	3	1		2									6
7	MATERIALS:	Their EFFECT on WEIGHT		3				5	2						10
8	MATERIALS:	DIFFERENCES in SIZE		3				5	2						10
9	WEIGHING TOOLS:	Appropriate SCALE	1		1	1				1		2			6
10	WEIGHING TOOLS:	Functionality of Tool	1		1	1				1		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	3		6
14	FALLING OBJECT:	UNITS of Measure	1		1	1				1		2	3		9
66		LEVEL TOTALS	79	110	98	104	116	78	61	102	6	21	40		

Figure 1
Master Design Chart for STEM content

By coupling a Learning Level to each Learner Task, it will allow for the design of appropriate level challenges for a learner as they progress through the content within the Learning Environment (LE). For example, as learners first encounter information or problems, they will need to operate mostly within the first two levels of the learning hierarchy, i.e. they will be primarily identifying, recognizing, distinguishing, and possibly selecting an appropriate example that would predict success as they know it. Through both access to resources that educate them or through failure, they may move up the hierarchy to more complex tasks. Just how far up this hierarchy a learner will progress will be a factor of the skill of the learning environment designer, and also the intelligence and motivation of the learner. Identifying the skill of the LE Designer is often left out of the equation, but just as in any teaching environment there is a wide variance of teaching styles, epistemology embraced, methodology chosen, and implementation of that methodology (Hannafin & Hill, 2005). The MDC aids the designer who wrestles with a multitude of pedagogical decisions by keeping the learning goals in the forefront of the design decisions. As is often the case, the teacher or LE Designer wants to jump to the implementation phase and act intuitively based on what he or she "knows". Such an approach does not embrace a learner-centered epistemology because unless one knows the specific capacity of the learner to comprehend each chunk of information, the process of teaching a body of knowledge can only offer a "hit-or-miss" result. This is especially true for virtual learning environments that are not face-to-face. In face-to-face environments adjustments may be made through interaction with students that offer the option of mid-stream corrections (Thiagarajan, 1994). For instance, as Gagne points out (Gagne, 1968; D. H. Jonassen et al., 1989), a content hierarchy may be constructed that allows for the appropriate sequencing of content for the learner (see Figure 2).

Because the operationalizing of content involves such micro pains-taking decisions, many teachers and designers do not have the patience to engage in this process. However, for complex learning environments that are virtual, i.e. programmed, step two is an essential step that allows the designer to layout a very workable environment that meets the instructional and engagement goals. Once the goals and content are defined, a very iterative, brainstorming process begins where the design process itself is immersed in replications of the learning experience being created. The iteration and immersion is the primary difference between typical ID approaches and this EID approach. Constant observation of the interactions with content and other collaborators within the LE allow for revisions of priorities of the MDC and the methods used in implementing it.

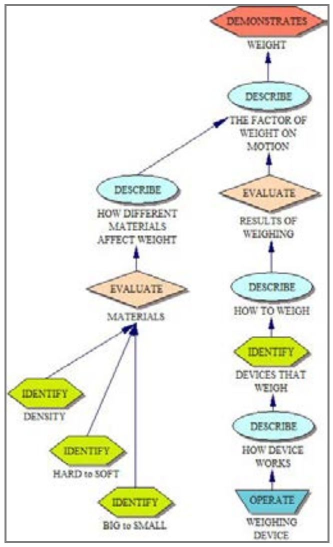

Figure 2
Content Hierarchy

3. *Define Specific Methodologies* that establish overall *Treatment* of content and student *Interaction*s

Because the Master Design Chart is created in a spreadsheet that has a total column at the right (see Figure 1), it is possible to sort on the totals column resulting in the most desirable content acquisitions appearing at the top of the spreadsheet. In other words, the content is now prioritized. The design process begins with these prioritized chunks by determining what tasks students could perform that would demonstrate acquisition of the concepts, procedures, or principles. Brainstorming a variety of tasks that meet these goals will allow for certain tasks to resonate with each other and allow for a "treatment" to emerge. Treatments are often referred to as storylines or learning contexts, but multiple treatments should be pursued through the first couple of iterations of the design process to assure that when content is added to the scenarios of the learning experience the selection chosen achieves the most effective results. The goals are not only to achieve the highest cognitive functionality, but also to create an engaging learning environment. I must clarify here that when I use the word engaging, I do not mean "fun". Engagement to me means that the student is focused and involved in working through the content tasks found in the LE. For a "Serious Game" I always presuppose a "Serious Student" who is engaged with the game for learning purposes and not a "gamer" who is primarily seeking entertainment. The key is in picking the right storyline and/or context for the LE such that the student will be engaged (Csikszentmihalyi, 1990).

For illustration purposes, we will use a storyline example involving a multi-player game called *iKIDS: Slices in Time*. This game allows each player to negotiate their game-play strategies with other players as they seek out each other's strengths in Physics, Earth Science, Math, or History. During game-play their character will need to choose appropriate solutions to questions or strategy problems in collaboration with the other iKIDS. In this STEM learning game the content problems would target the problems of "Free Falling Objects" and would require that the learning environment allows for "time travel" plus an encounter with Aristotle in Athens Greece, Galileo in Pisa Italy, and Sir Isaac Newton in Cambridge England. This complex learning environment allows for the basic physics of falling objects to be encountered, and it also allows for the historical development of scientific inquiry to be encountered as well. Situating the learning in the authentic historical context that the scientist derived his or her conclusions within brings home the realities that in all ages there are conformist ideologies that must be reckoned with when innovative discoveries are made. This layering of related meanings is so complex that designing *"in situ"* , i.e. designing while playing the game or re-enacting a face-to-face scenario with actual students, is the only way that the designer will be able to uncover the subtle options to include or exclude challenges and context that the students will ultimately encounter.

Designing *in situ* also requires that one begin along an iterative development path that requires the creation and testing of a series of increasingly authentic replications of the final environment (Schon, 1983). For instance, in the game described above, we have first written out a storyline where students have given us feedback as to their interest in solving problems for science in this context. Based on their feedback we made revisions and designed a board game where game mechanics drove the play and encounters with the problems to be solved. We brought teachers, students, and fellow designers in to play this board game and received enough feedback to completely redesign the board and add the idea of a computer environment that is coupled to the board game play. During each of these iterations we examined the MDC to check off which chunks of content we were able to address with each version. The higher level learning skills and the levels of engagement desired drove our move to the more complex environment described in the outline. We still are only at the "mock-up" stage from a visual fidelity point-of-view, but we found that the hardest things to design are the game mechanics (see Figure 3).

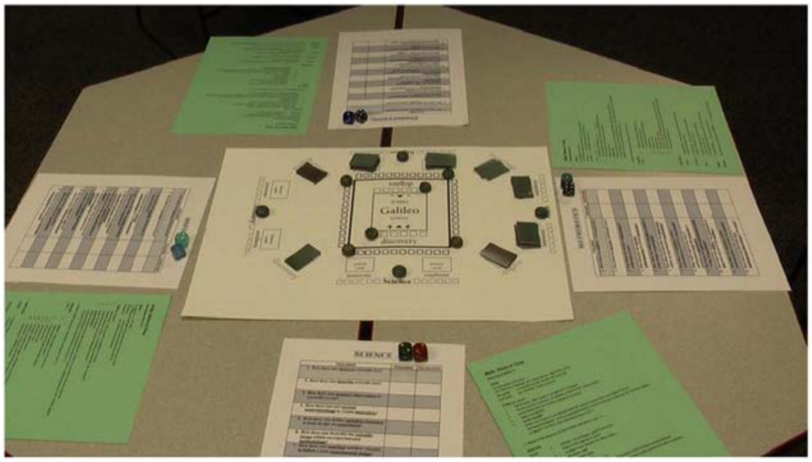

Figure 3
Game Board (2nd Iteration)

Mechanics can only be designed by observing students playing a game and making choices within that context. Tweaking the mechanics, making content more or less available, creating more functionality within the game, are all elements we are focusing on at this stage and in subsequent iterations. Once we have the game-play running the way we want, then we will make it even more engaging via higher resolution graphics and animated cut-scenes on the computer.

4. *Define Learning Vectors* that couple to an *Experiential Mode Framework* as well as linking game challenges to the student interactions.

The Learning Vectors are defined as the actions a student engages in that match with the prioritized content chunks in the Master Design Chart. For instance the concept of "Weight" is pertinent in the comparison between Aristotelian concepts of weight as it affects a falling object, and Galilean teleology which is counter to Aristotle's view. In a dynamic learning environment where students have many choices to pursue, any action may be considered a vector. Only those actions moving them closer to achieving a level of learning as stated in the MDC is considered a learning vector. During game-play analysis there are often actions identified that are not productive for the student's learning, and when a perponderance of non-learning vectors are identified, this may signal the need for redesign of the mechanics, the LE, or a change in the storyline. A classic case of this may be found through observing the game-play of *Oregon Trail* (Company, 1986), where it was intended to offer functionality to gather food via a deer hunt, but students traditionally never make adequate progress toward reaching Oregon because they spend too much time shooting deer. Thus gathering food would be considered a learning vector, but slaughtering deer heards would be a non-learning vector.

Once the desired level of learning vectors are observed in game-play, or in any other context desired, a script should be constructed that describes a successful path through the learning environment. This script may be in a word processing document consisting of a table with 3 columns and many many rows. The entire experience may be broken down into Scenes and these broken into Scenarios. The Scenarios describe all of the actions that take place within a scene, and there are many games where multiple scenarios may take place depending upon the choices of the students playing the game. This brings up the need for a script technique that handles branching, and I recommend the "jump to page ___" technique preceded by a statement such as " if a player selects X, go to page

____". It is true that hard-copy scripts may end up being cumbersome, but this is a necessary evil if groups of people are working together in the design (see Figure 4). To increase efficiency in design group collaboration during the last two steps, a web site that allows for postings by each of the development teams (most often the Instructional Design Team, the Story and Game/Play Team, the Engineering Team, and the Graphics/Sound Team) (Appelman, 2008). Using a web resource such as this allows for any member to review the MDC, linkages to the mechanics, story, graphics, and programming functionality. For instance, for the iKIDS game it is envisioned that the computer addition to the board game will allow for the running of simulations on falling objects such that trial and error learning may be utilized to determine the correct challenge questions that is drawn from the "Physics"card stack. The development of this simulation module would need input from all the other teams to play and offer critique.

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INFO Elements	INTERACTIONS	STORY
o	o PC could ask to know more about Aristotle's Philosophy that triggers either a short explanation from Galileo, the History NPC, or they decide to beam to Aristotle's Timeframe	BRANCHING: to cut scene of GALILEO's explanation --OR -- BRANCHING: to iKIDS HUDDLE and cut scene of HISTORY NPC -- OR -- BRANCHING: to ARISTOTLE -- OR -- They continue as follows ...
o FORMULA o VARIABLES o Defining a CONTEXT for INQUIRY that matches the problem o BLENDING MATH and PHYSIC to solve a problem	o Looking at resources o Turning pages o Pointing at critical elements through cursor roll-overs where key elements highlight o MAPs of ITALY that show location of PIZZA	At this point our Physics NPC can look at one of the resources he brought and look up "WHEN THINGS DROP". S/he comes across the formula for calculating the speed of a falling object that has distance, & mass times a constant. The Math NPC then says ohh that's easy and says all we need is a known height of something and drop two different mass objects. Galileo says that he knows the perfect place for this … the Leaning Tower of Pizza. One of the other NPC's says "It's made of PIZZA?" and GALILEO, after laughter stops, says it's named after the town we are in.
o Experience SCENES IN ITALY	o Either move outside and use period travel or hop into their transporter	There is a choice here to take time to travel to PIZZA via period methods, or to use their transporter
o What Galileo invented o The state of science at that time period o What did people eat back then	o Unlimited objects to create and interact with o Consume period food	There is also time while Galileo gathers the objects he wants to "drop" for the PC to look around Galileo's lab and play with tools and objects there. Galileo might also offer them food and they may need to up their "health meters" at that point

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INFO Elements	INTERACTIONS	STORY
o Structural Engineering Content	o Navigating around tower	The group goes to the town of PIZZA and navigate to the Tower. One of our NPC's asks why it is leaning and Galileo explains that they did not test the ground adequately under the structure because they thought it was stone. Galileo could also quip that he "told them so, but they would not listen to him".
o TOOLS THAT MEASURE DISTANCE o TOOLS THAT MEASURE ANGLES	o Locating tools in backpack	Our PC asks how tall it is, and Galileo says that he does not know that. At that point our PC says don't worry, that's what we are here for, and then looks in his backpack for two things … a pedometer and a sextant, which are labeled "HOW FAR DO I WALK" and "WHAT IS THE ANGLE".
o TRIGONOMETRY FORMULA FOR SIDES AND ANGLES OF TRIANGEL	o Find Formula in Math Reference	The Math NPC mentions she has the formula for determining height and shows it to everyone
o HOW A PEDOMETER WORKS o HOW A SEXTANT WORKS	o ENTERING PACE INTO PEDOMETER o Navigating to base of Tower and then taking measured steps back to group o SIGHTING THROUGH SEXTANT and reading output	Our PC walks to the base of the tower and sets the PEDOMETER to his STRIDE distance, and walks back to the group. He then asks his Math NPC to enter the result displayed on the PEDOMETER into the correct location in the formula. Then our PC takes the SEXTANT and sights up the top of the tower and reads the angle which is given to the Math NPC.
o TRIGONOMETRY FUNCTIONS o FORMULA FOR HEIGHT o VARIABLES OF SIDES AND ANGLES	o Entering data into the formula o Interactions with Galileo and group o	Everyone gathers around the formula and our PC clicks on calculate, which gives us the height of the tower. We now take a picture of the tower and the data is now displayed over the tower with distance and height.

Figure 4
Scenario Script

The LE is complete when game-play includes adequate levels of learning vectors observed, and the engagement is such that the students want to learn more content in the same manner. It also is complete when teachers and school systems wish to include these types of learning environments. If the design is adequate, then national and state standards in the specific content areas will be met, and the same style of learning environment can be applied to other content. The connections in scientific inquiry for Aristotle, Galileo, and Newton relative to falling objects, can also be made for Leonardo DaVinci, and the Wright Brothers for air-foil physics. Not only does this strategy lend itself to develop LEs on a wide variety of topics, the 4xEID Process provides a development process that works equally well with any subject-matter.

In this paper an attempt has been made to stress that if an instructional designer wishes to venture into experiential education (Dewey, 1938) with a constructivist epistemology (D. Jonassen, 1999) an adherence to a specialized 4-Step Experiential Instructional Design Process (4xEID) is advisable. This is because dealing with the levels of dynamic design challenges to appropriately offer adequate access to content resources in an engaging manner, the complexity requires both a structured content analysis and a design process that can be used *in situ*. The 4xEID process is designed for multiple *in situ* iterations and is not content specific. In other words it can be used to aid students learning how to interact with customers in a store environment, to learn strategies and techniques of playing soccer, to teach science knowledge, or to learn any other decision, or skill, based content.

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