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DEVELOPMENT ARTICLE

Taking educational games seriously: using the RETAIN model to design endogenous fantasy into standalone educational games

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Abstract We are witnessing a mad rush to pour educational content into games in an ad hoc manner in hopes that player/learners are motivated simply because the content is housed inside a game. A failure to base educational game design on well-established learning and instructional theories increases the risk of the game failing to meet its intended educational goals, and yielding students who are entertained but who have not acquired any academic skills or knowledge. Our review of standalone educational games has shown that they are not always based on sound educational principles and theories. We contend that, if academic learning is to take place, a new design paradigm must be developed. This article discusses the RETAIN design and evaluation model for educational games that was developed to aide in the evaluation of how well academic content is endogenously immersed and embedded within the game's fantasy and story context, promoters transfer of knowledge, and encourages repetitive usage to that content becomes available for use in an automatic way.

Keywords Design formalism · Educational rubric · Game design · Instructional strategies · Instructional design · Serious games · Serious game design

Background

Games have become an important social trend. Others believe they have become an important teaching tool because they can provide a compelling context via interactive, engaging and immersive activities. The literature citing the positive effects that computer games may have in educational settings, however, has been mixed. Reports exist in which

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students have been shown to acquire knowledge in areas such as language arts, science, and history (Paquin 2002; Squire 2004). Simulation games have also been considered important successes in the military (Ricci et al. 1996) and business and industry (Prensky 2003). Simulations are particularly effective in presenting life-like situations to increase psychomotor skills or teach player–learners how to react in specific situations that are either too costly or dangerous to reproduce. Few can deny the positive impact flight simulators have had in increasing cost-efficient ways of teaching skills to pilots. Gee (1999, 2003) correctly contends that, at minimum, games provide the framework for exploring and learning concepts as well as increasing self-efficacy, social values, and others.

We suggest that few games have empirically demonstrated that they can successfully teach academic content when used in the classroom on a standalone basis (Garris et al. 2002). While many agree that most games teach *something*, most of the positive attributions about games used in instructional settings center on motivation, social skill-building, simulations, and changes in attitudes. Broad claims concerning a game's instructional effectiveness are often based on positive outcomes attained in motivating students to play them and positive social interactions rather than their effectiveness as standalone knowledge acquisition mechanisms. Recent research found this to be true of most of the educational games produced in the past 15 years, suggesting further that an educational game's ability to teach, as with any other effective mediated intervention, depends on the extent it is employed as a part of instructional best practices and supplemented with additional curricula (O'Neil et al. 2005). They concluded that a game which educational content is added in as an afterthought or an instructional activity that is supplemented by a non-efficacious game is generally not an effective learning tool. While most games appear to be effective in terms of creating an environment where students stay on task longer while engaged in the process of playing, little empirical evidence exists that demonstrates games providing any more positive, systematic outcomes for content learning than traditional teaching methods.

Some researchers feel that a game's ineffectiveness as an academic learning tool is often the result of confusion over what it intends to teach: academic content or positive, intrinsic, and social attributions that are generally associated with the process of gameplay and interactivity (Fisch 2005; Harlow 2004). There is also much confounding of terminology between game developers and educational technologists. While some games can be successful in creating interactive situations, those intended to transform the acquisition of facts and figures into implicit understanding, analysis, synthesis, and evaluation require designs that support extended and tightly integrated cognitive activities, which have been generally lacking in most educational games produced to date (Shelly et al. 2006).

Several outside factors have contributed to the lack of instructional effectiveness of games used in the classroom. First, many teachers incorporate games into their classrooms because they are reluctantly giving into pressures to use them and also hope that students will be motivated to learn simply because the subject matter is housed inside a video game. Because they do not play games as often or on the same scale as their students, these same teachers do not fully comprehend the subtle nuances of how game developers use terms such as interaction, engagement, and immersion, or the importance of the relationship between endogenous story/fantasy and gameplay, making them less likely to understand how to select appropriate game genres or properly integrate them into their curricula (Squire 2003). As a result, even if the game includes remnants of sound instructional systems design, students often do not learn what the teacher intends to teach through the use of games—yielding an entertained player–learner population that does not acquire the desired skills or knowledge.

Second, developers are either pressured to quickly retrofit existing games with educational content in response to increased demands, or due to the need to make significant profits from each game, they build those that are generic in context so that they can be used in several different learning situations. There is a significant difference between simply representing educational content in a game or building a game like hangman or a one that replicates a popular quiz show and embedding content as an integral part of the game's fantasy context. In short, the act of placing educational content inside a game does not guarantee that it will succeed in achieving a fun, motivating experience; meeting educational goals; or being a commercial success.

The attributions and expectations of habitual game-playing students may be a third contributing factor in the failure of games to successfully teach academic content. Prensky (2003) contends that today's *games generation* is made up of individuals whose constant affinity for and exposure to games has changed how they communicate and learn, resulting in a player population who possess a unique set of cognitive characteristics. Prensky listed many attributes that have been quoted often in popular journals. Below are some of them, followed in parenthesis by a translation of each into potential learner deficiencies:

- A preference for graphics over text and a corresponding increased ability to recognize patterns (i.e., they are text-averse).
- A random and informal approach to information (i.e., linear learning is anathema to them).
- The need to stay connected with their peers and actively participate in the learning process (learning is completely a social activity).
- The need for an immediate payoff (i.e., instant gratification—depth of processing is lacking; making topical relevance more complicated).
- A view towards information as a commodity (i.e., the traditional view of knowledge as an asset that one acquires and retains has been replaced with the idea that it is a consumable item that is retrieved and utilized 'just in time' and is then disposed of until it is needed again).

Prensky alleges that these attributes point to differences in how player–learners acquire knowledge both in and outside of school. The result is a three-way disconnect among game-playing students, their peers who do not play, and non-playing, media-averse teachers who remain true to their traditional teaching methods.

Finally, the hierarchical design techniques used by many game developers may also be contributing to academic failures. Because game level design appears to loosely parallel best educational practices, many game designers falsely believe that all games are intrinsically and educationally sound and, often turn a deaf ear to inputs from the educational community as to which additional design elements may be necessary. Certainly, process learning takes place in most commercially successful games as players move from one level to another: prompting them to recall rules, game mechanics, and processes from previous levels. But few games require players to implicitly and naturally know previously taught academic material in order to be successful at the next higher level. These games fail to require a systematic recall of previous content knowledge in their finished product designs. Hints (or *cheats*, as they are referred to in game parlance) may be provided, but ensuring that the process hierarchy of a game and its proposed hints resemble effective learning taxonomies, structured feedback mechanisms, and instructional event constructs proposed by respected theorists requires considerable forethought (Bloom 1956; Gagné 1985, 1987; Gagné et al. 1992).

Not only does academic content need to be integrated hierarchically, but it also needs to be tightly coupled to the game's fantasy and/or story context. In his influential review of games' motivational aspects, (Lepper and Malone 1987; Malone 1980a, 1980b, 1981, 1983a, b, 1984), concluded that content needs to be intrinsically related to the fantasy/storyline of the game in order to produce the best learning environment. The debate over the utilization of intrinsic, rather than extrinsic (i.e., endogenous versus exogenous) fantasy has not been without controversy as to the actual effect it has on cognition and learning (Asgari and Kaufman 2004). For the purposes of this discussion, the generic term *fantasy context* is used to encompass linear storylines, narrative structure, player experience, dramatic structure, fictive elements, etc. It has been empirically demonstrated that a correlation exists between content learning and fantasy and this integration is a justifiable and fundamental factor in improving the overall effectiveness of games used for educational purposes (Fisch 2005; Ricci et al. 1996). We propose that any analysis of games for their educational value must be evaluated both in terms of how well they immerse academic content within the game's fantasy context and how tightly the game designers couple gameplay with other fundamentally sound instructional strategies.

This paper describes an educationally focused set of standards that are synthesized into a game design and evaluation model that we believe has potential predictive capabilities in determining the eventual success of a game intended for educational settings. The model derives its efficacy from the fact that it provides common definitions and understanding for terminologies and conceptual designs that do not always equate, and sometimes contradict, between game and instructional designers.

Game design and development

Game design can be defined as the formal methods utilized in the specification and planning of a game's content and features. The goal of these methods is to maintain enough intellectual control during the development process that an immersive and entertaining game is produced. The one game idea that is approved for development out of the thousands that are pitched to executive producers in game development companies is the one judged to have the best chance of commercial success. The other nine hundred and ninety-nine never make it to market. The metrics used to determine the commercial success of a game are mostly monetarily based. Profitability can be predicted based on an informed guess as to a game's power to engage players. In other words, the quality of gameplay is generally viewed by game development companies as the most important element contributing to the potential success or failure of a given game and is more important than graphics fidelity, the inclusion of narrative, or any other attribute.

Salen and Zimmerman (2004) define gameplay as the navigation of a suite of choices (i.e., decisions), where each decision leads to an action that has a discernable outcome. In other words, game design boils down to a process of creating a set of critical choices that reinforce the designer's focus of the game (i.e., the designer's description of the fantasy context) and communicate to players how to advance along the game's critical path. We contend that educational games must support Salen and Zimmerman's ideas on gameplay while teaching and reinforcing the intended educational content.

Salen and Zimmerman's (2004) vision of gameplay goes to the root of designing academically sound interactions and content. We propose that the key to creating a successful standalone, educational game is to embed into its interaction design content-based choices that require player–learners to implicitly and naturally learn the desired content in order to advance while, simultaneously remaining true to its ludological (i.e., gameplay) roots. This strategy derives from the fundamental gameplay principles described by Salen and Zimmerman, which are: engagement and immersion in the game's fantasy/story context, and increasing dramatic tension using semiotics, system theory, software engineering, interactivity, and choice design.

Interaction, engagement, immersion

The terms *interaction*, *engagement, and immersion* are concepts that have wide use across disciplines, but the definitions of which vary widely. The definitions of these terms in the context of education and those used in games context are not semantically equivalent, which we believe is a source of disagreement between educators and game designers. To avoid this confound, we define each term rigorously and require that our model strictly adhere to them. Since games have stricter requirements for the use of these three terms, we have opted to employ the connotations associated with games and correlate them back into an educational setting.

Interactivity is the active, two-way flow of information between two entities (Salen and Zimmerman 2004). Interactivity also requires a context, must be repeatable and iterative, and allow for each party to make meaningful contribution to the interaction (Salen and Zimmerman 2004). When viewed as hierarchal constructs (see Table 1), a relationship between these three concepts becomes clear, although the relationship is not causal. Both interaction and engagement are necessary for immersion, but engagement does not guarantee immersion. Similarly, interaction is necessary for engagement, but interaction does not guarantee engagement. All three concepts require active participation from the player–learner, a point that is underscored by the evaluation rubric.

Engagement, according to Laurel (1993), is the willing participation in the pretense that the fictive elements could be real—the willingness to play along. In other words, engagement is active participation in an experience and can be broken into four subgroups: emotional engagement (a willingness to invest emotionally in the experience), intellectual engagement (a willingness to expend energy thinking and problem solving), psychological engagement (a willingness to involve personality traits and respond to challenges, desires, goals, etc.), and physical engagement (a willingness to participate on a kinesthetic level) (Salen and Zimmerman 2004).

Murray (1999) provides an extensive treatment of immersion, defining it as the active creation of a belief in the enveloping fantasy in a digital environment. Extrapolating Murray's definition to a video game environment, we can see that the traditional definition of telepresence (i.e. the feeling of being there) is insufficient for game development, and therefore, insufficient for the development of educational games. Immersion must be defined as the active creation of belief in the game's fantasy context, or as Wirth (1994) would say, an investment in belief.

The chart in Table 1 describes the inter-relationship among interaction, engagement, and immersion. Interaction is a necessary pre-condition for engagement and engagement

Table 1 Immersion hierarchy

	Levels of Immersion		
Immersed	reciprocal action	active participation	belief creation
Engaged	reciprocal action	active participation	
Interacting	reciprocal action		

plays the same role for immersion. Educators often have difficulty understanding these concepts in terms of a hierarchy. In education, engagement is generally evaluated by also taking into account the possibility that learners may be inappropriately engaged, because they are interacting at an inappropriate cognitive level that is needed for recall and deeper processing, or that they are concentrating/focusing on the collateral subject matter not directly related to the learning goals of the lesson. Their ability to grasp content at an appropriate level may be modified by external cognitive loads developed from inappropriate arousal levels caused by the game or by intrinsic loads placed on them by difficult materials. In an entertainment game, this idea of 'inappropriate' engagement is not considered because the game content is rigorously controlled (and finite). Simply generating engagement and immersion is the ultimate goal and, for that reason, consideration for the form of extrinsic cognitive load is not often consciously distinguished. In our model interaction, engagement and immersion are considered necessary (but not necessary and sufficient) conditions to learning in a game and are combined with other principles. The concept of being engaged in collateral or inappropriate content areas, as can happen any mediated interventions, is evaluated and assessed under discussions of relevance that are found later in this article.

Most educators would agree that that any evaluation model used to assess the pedagogical efficacy of a game must pinpoint potential design issues that allow learners to interact without staying on task. In game design, the concept of immersion requires that this rigor is maintained. We have adopted Murray's (1999) definition of immersion which presupposes that a fully immersed player–learner is fully engaged and on-task with targeted academic content. We propose that the engagement generated by full immersion occurs at the appropriate levels that are required for deep cognitive processing (Cermak and Craik 1979; Craik and Lockhart 1972; Krathwohl et al. 1974). We also admit that our definition and usage of the term immersion appears to promote a confound, which is really not true. Upon further review the readers should see that, when we refer to immersion, we are simultaneously describing the learner–players but also the academic content, which will be discussed more fully later in this paper.

Basic assumptions in the design of games used for education

Educational game design needs to be founded on two requirements that create a relevant and holistic model. The first is that targeted academic content needs to be introduced and reused in a hierarchical manner, a reflection of Bloom's concept of the nature of knowledge acquisition and question construction. In most games, advancing to the next higher level requires that the player learn the rules of gameplay and how to apply these rules on the next level. If a game is to be successful in reinforcing the content that it intends for a student player to be learning, it is crucial that the newly learned content is imbedded in the fantasy or story line in such a way that forces the player/earner to readily possess that knowledge to be successful at that next higher level. In other words, player/learners need to learn more than just the rules of gameplay as they level up. Embedding the content or scaffolding the next higher levels creates an environment in which content is reinforced through additional usage so that player/earners begin to internalize newly acquired knowledge. Academic content needs to be embedded in these rules in such a way that it is again used by the player–learner to apply synthesize, and/or create new knowledge on that next higher level, which, in turn, makes that content more automatic and naturalized. Both game and instructional designers share this ideal of hierarchical learning. In our model we added additional weight to the concept to align the model to Bloom's ideas on acquiring cognitive knowledge through levels of a hierarchy.

If a game is intended to teach academic content on a standalone basis, then a second requirement exists. The targeted content needs to be intrinsically coupled with the fantasy context (or story, if one exists) of the game. In educational contexts, fantasy can be studied from two aspects: its effect on motivation and emotional attachment (Malone and Lepper 1987) and how it relates to cognition and cognitive load (Sweller 1994). Malone and Lepper define fantasy as an environment that "evokes mental images of physical or social situations not actually present" (p. 240). They also suggest that what makes games motivational is the proper amalgamation of the fantasy context with an optimal level of information. Games that involve fantasies can be more compelling than games with less emotional constructs and may be initially engaging and influential when a player is in the process of deciding whether to play or not to play (Waal 1995).

Some researchers (Asgari and Kaufman 2004; Cordova 1993; Cordova and Lepper 1996; Parker and Lepper 1992; Malone and Lepper 1987) ascribe to the idea that inculcating content within the context of fantasy provides better opportunity for learning. Experimental research on the positive relationship of fantasy and learning has demonstrated that instructional material that is presented in the context of fantasy leads to increased student interest and learning. Malone and Lepper relate this to the concept as *placing the content on the plotline*, in reference to the better-written television programs in which the writers keep content central, rather than peripheral, to its narrative storyline. For example, a program like *CSI Miami* might use a bit of forensic science or Sherlock Holmes or Monk might utilize their knowledge of literature to supply the crucial clue that solves a mystery. The same plot design should be used in a game that is meant to be educational. It is a far more powerful approach to place the educational content at the heart of gameplay, so that player–learners employ targeted skills and knowledge as an integral part of playing the game.

The differences between these two types of integrating content into a game can best be described through example. In the first type of game, player–learners are taught a particular concept (for example two plus two equals four) and then are given scenarios to practice the concept. Whenever they answer the question or perform correctly, the accomplishment is rewarded. For example, a player–learner may be presented with a depiction of a race car, asked to solve addition problems and rewarded for right answers by having the race car advance in the race. The implied motivation in this scenario is that player–learners will perform correctly because they desire the external reward. In this context, the content of the game can be replaced with any subject, and the premise for the reward is the same. In the second type of the instructional game, player–learners need to solve problems presented to them in context. In contrast to the race scenario presented above, player–learners are seated inside their cars. The learning object is presented in the form of requests from the pit crew to calculate how long it will be before they will need to stop for gas, finish the race or perhaps determine tire wear issues, etc. In this context, the skills to be learned are integrated within the context. A wrong answer will not stop the flow of the race but will diminish a particular player's chances of winning. He or she is provided feedback that the answer was wrong but will be given more chances to make up for the shortcoming.

The former game scenario (solve problems, the race car moves forward) describes a game in which the content is integrated exogenously (i.e., outside of the fantasy). The second type of game (the player–learner is seated in the race car and needs to figure out how much gas is needed) immerses content in an endogenous manner. The concept of not interrupting the flow of the game while providing progressive feedback is the major differentiation between endogenous and exogenous fantasy. In the former, the feedback is not just that the player–learner is right or wrong, but it also provides specific constructive feedback with hints of possible solutions. The concept of 'no-fault' problem solving (where learners are allowed to fail fault-free and are given several chances to get the right solution) does not always fit well within traditional classroom practices but it does foster creativity and inventiveness. Feedback should be scaffolded in such a way as to not deter learners from continuing to try to figure out the right answer. This form of anchored instruction provides the opportunity to learn from previous knowledge or answers in a step-by-step manner.

We recognize that there exists some disagreement about the need for creating fantasy-based games and whether fantasy or story is always a required element. When we speak of fantasy, we do so in a broad sense, and generally include the concept of a storyline—something that game researchers themselves do not always agree on. We agree with Asgari and Kaufman's (2004) suggestion that fantasy (or story) alone is not powerful enough to keep the player motivated and engaged for the long term. From an educational aspect, evidence is not conclusive. There does exist, however, significant evidence that games that include fantasy/story motivate players more and cause them to immerse themselves more fully in a game. Studies into Self-Determination Theory (SDT) have been able to produce a system from which to measure the amount of engagement/immersion that takes place in an interactive activity (Ryan et al. 2006). This theory is based on the ability of the interactor to have what the researchers refer to as autonomy, competency, and relatedness. These terms suggest that what attracts participants to a role-playing activity is for them to be able to identify with the character(s) they are creating, the ability for them to take on their roles without fear of failure, and an environment which they can happily play that role over and over again. What we are suggesting is that, especially in a K-12 classroom with its high stakes accountability, the teacher or the standalone lesson needs to be relevant or to create a sense of wonder in their students, which is a difficult scenario. In training environments, the pull of reality games is usually due to some external motivation, such as wanting to learn how to fly (in the case of flight simulators), survival (in the case of military or public safety games). Proponents of SDT have been able to demonstrate that fantasy games or those with attractive storylines do attract interest as long as they foster the principles outlined in SDT (Rigby and Ryan 2007). We believe that proper embedding and immersion are crucial and that the use of a story line or fantasy increases the chances of setting up the lesson to make the learner 'lesson-ready'. We also recognize that, while embedding content and immersion are necessary, they are also insufficient. Therefore, more weight in the model is placed on those concepts that foster higher order thinking: adaptation and transfer.

The RETAIN model

The Relevance Embedding Translation Adaptation Immersion & Naturalization (RETAIN) model was founded on an appropriate combination of these elements. RETAIN is an acronym derived from a careful comparative review of both genres and represents the terminologies, contexts, and methods representative of both game and instructional designers, while at the same time carefully considering the uniqueness of each. In some cases these terms appear to correlate directly. The elements of motivation, as suggested by Keller's ARCS model are universal to the design of instructional strategies and game events or encounters. The originating ideas behind the Nine Events of Instruction were the result of work performed by Gagné while studying simulation as an educational tool, making them a natural fit for use in evaluating the instructional validity of game architectures. As we reviewed why so many games have failed to realize their potential in educational situations, we discovered that certain subtle but significant anomalies and inconsistencies exist between connotations and assumptions regarding the use of certain terms and definitions used by both the game industry and educators. We believe an analysis of these contradictions serves to enhance the predictive powers of the RETAIN model.

Choosing appropriate elements

Creating an appropriate and comprehensive model is complicated convergence of pedagogies and disciplines. Besides the inclusion of the necessary concepts, the resulting anagrammatic exercise fostered debate and discussion among its creators. The originating thought process had always focused on remembering (i.e., retaining) information being taught in a game. The elements chosen to represent our framework were based in sound principles of both game and instructional design (Shelly et al. 2006). When analyzing the design aspects of games and comparing them to instructional design we found very early that many concepts shared similar aspects and connotations that were closely related. Others, however, were clearly contradictory or used in significantly different ways between game and instructional design domains. For example, we found that the concepts of immersion and engagement were clearly misunderstood by the panel we organized of game designers, instructional designers, and teachers. We also found that the game designers in the group often assumed that just because their games fostered immersion and level design that they sometimes mistakenly assumed their games were always teaching. The group agreed, like Gee (2003), that most games indeed do teach something but what they teach may not always be academic content, but rather, ancillary, affective domain-related concepts. We originally assumed that game designers already were generally proficient in the concepts of making their games relevant and immersing. It is interesting to note that, while many game developers have become adept in these important practices, many have the same need as educators to learn how to become better at the process of development (Rigby and Ryan 2007). The discussions with game designers in the panel also revealed that many of them also had misunderstandings about a game's level design and its relationship to content learning. To a game producer level design is at the heart of creating immersing environments, and if a game designer properly inculcates a level design, that academic learning will automatically take place. While level design is what creates an engaging setting in which players will play repeatedly without tiring of the game, for an educator, engagement and immersion alone are insufficient. To create a true learning situation, level design must also take into account the use and reuse of the academic content in new circumstances (i.e., promote transfer) to the extent that it is internalized and made more automatic (i.e., naturalized).

Having identified the important elements between game and instructional design that were either missing or misunderstood, we arranged the elements in an anagrammatic order so that the model focuses on the main goal of our discussions; to create games that would foster learning, retaining, transferring, and naturalizing academic content. Thus, the acronym RETAIN was agreed to Shelly et al. (2006). To mirror the relative importance we placed on each element in the learning cycle, a weighting system for the rubric was developed, as shown in Table 4.

Selecting appropriate instructional/learning theories

Selecting an instructional theory depends on what needs to be taught, how it is to be taught, and to whom it is being taught (Taylor and Gunter 2006). One of the shortcomings of many instructional theories is that they begin with an assumption that the learner is always ready to learn and/or is motivated to learn in the same ways that the teachers were taught (Gunter and Kenny 2004, 2005; Kenny and Gunter 2004, 2005). A view that knowledge is a consumable item rather than an asset that can be obtained 'just in time' when it is needed from the Internet and the fact that they are motivated by very different methods makes them atypical students to traditional thinking and methods. The key is to bridge the gap between the appropriate learning and game design theories in ways that increase the efficacy of the medium to empower player–learners who are motivated, think, perceive, and learn differently.

We determined that limiting our model to only one instructional theory or method that relies heavily on the intrinsic motivational and level design aspects already found in games would result in an incomplete framework. We felt that the model needed to correlate to instructional methods and learning theories that are most closely aligned with generally accepted game design principles. Our search resulted in the selection of three overarching theories: Keller's ARCS Model and Gagné's Events of Instruction that are applied against a backdrop of Bloom's hierarchical structure for knowledge acquisition, and Piaget's ideas on schema.

ARCS motivational model

John Keller devised a motivational prescription that was based on a synthesis of existing research on psychological motivation (Keller 1983, 1998; Keller and Kopp 1987). The ARCS model relies on four foundational categories that are applied to the design of instructional activities and represent the concepts of Attention, Relevance, Confidence/ Challenge, and Satisfaction/Success. Keller never intended for his model to stand apart as a separate system for instructional design, but one that would be incorporated in accordance with other established historical instructional models, such as Gagné's Events of Instruction (1985). Applying Keller's model to games is not new. Dempsey and Johnson (1998) proposed applying the ARCS model to select and analyze which games are most effectively used in the classroom. Their scale (see Table 2) is an excellent example of a practical application of Keller's ideas.

Karoulis and Dmetriadis (2004) also discussed the aspects of the ARCS model, suggesting that most can be directly correlated into game design and can also serve as a measurable and objective checklist for educational game developers. They relate these features to what is referred to in the literature as *representations* (Van der Meij and de Jong 2004) that provide a practical application and implementation of Keller's theoretical construct. A game-centered implementation of these representations include goal association, arousing curiosity and interest, layered or scaffolded challenges, challenging the imagination by creating an extrinsic and intrinsic fantasy, cognitive modeling, the perception of the freedom to fail, and fidelity in graphics design (Ainsworth and VanLabeke 2004). It would seem that the correct and appropriate manipulation of any of the above attributes in games can lead to an enhanced motivation.

Harlow (2004) classified two broad motivational categories that correlate directly to serious game design: process and reward. Process comprises the actual participation in any

Table 2 Applying Keller's ARCS model to the selection of games (Dempsey and Johnson 1998)

Major category	Sub-category	Instructional questions
Attention	Perceptual arousal	1. What can I do to capture their interest?
	Inquiry arousal	2. How can I stimulate an attitude of inquiry?
	Variability	3. How can I maintain their attention?
Relevance	Goal orientation	1. How can I best meet my learner's needs? (Do I know their needs?)
	Motive matching	2. How and when can I provide my learners with appropriate choices, responsibilities and influences?
	Familiarity	3. How can I tie the instruction to the learners' experiences?
Confidence/challenge	Learning requirements	1. How can I assist in building a positive expectation for success?
	Success opportunities	2. How will the learning experience support or enhance the students' beliefs in their competence?
	Personal control	3. How will the learners clearly know their success is based upon their efforts and abilities?
Satisfaction/success	Natural consequences	1. How can I provide meaningful opportunities for learners to use their newly-acquired knowledge/skill?
	Positive consequences	2. What will provide reinforcement to the learners' successes?
	Equity	3. How can I assist the students in anchoring a positive feeling about their accomplishments?

activity, such as the enjoying interaction and interface with the media, enjoying the increasing level of expertise attained, immersing oneself in the activity, taking pleasure in the mechanics of meaningful interaction with the content, and feeling satisfaction or success through gains from the process of interaction. The reward may be intrinsic or extrinsic, be applied at the completion of participation, and set the stage for further engagement, particularly psychological and emotional engagement.

Mapping motivational design in games to the ARCS model appears to be straightforward, however, matching the basic motivational assumptions in general game design and comparing them against the ARCS model yields some redundancies that can be removed from the model due to their implied inclusion. In a game, for example, simply gaining the player's attention is insufficient. In a learning environment, the scenario exposition and problem setup steps used by game designers must be expanded to also include advanced organizers (Ausubel 1963) to introduce relevant, educational content for the lesson. In a game, many times the situation or storyline is unique, game by game or level by level. Challenge in the ARCS model and events five and six in Gagné's are equivalent to the general tenets of game design, rendering unnecessary their overt inclusion in the model. A similar argument was extended to the Success element of the ARCS model, leaving Relevance as the one ARCS element required to be included in the RETAIN model.

Gagné's events of instruction

Gagné (1985) identified nine events of instruction that serve as a guide for delivering and developing a unit of instruction. In seeking to understand what processes were necessary for individuals to internalize what is being taught, Gagné proposed that component tasks must be hierarchically mastered and sequenced to ensure optimal transfer of one task to another. For example, a teacher must teach phonics or alphabet recognition in order for students to then read words. Only after students learn to interpret or read words, can they then learn to read a sentence, and then two sentences, and then a paragraph, and so on (Taylor and Gunter 2006). Gagné's skill-building hierarchies fit very well into the increasing level of challenge model already followed in successful serious game design and they easily lend themselves to become the basis for standard practice.

Due to this apparent overlap, a comparative analysis among Gagné's and Keller's ideas and generally accepted game design concepts was performed by placing their elements side by side. Table 3 reveals that seven of Gagné's events directly correspond to common game design elements. Two events do not appear to have an exact equivalent in game design: Event Three (stimulate recall) and Event Nine (accommodate transfer). Some game designers might be compelled to object to this analysis, saying that level design in all games stimulates recall. We suggest that this view is short-sighted in most games. Certainly recall of the gameplay process, like the rules, and game mechanics and processes, and certain factoids about the game narrative is often required to progress from one level to another, but little is required to ensure that those facts are generalized in such a way that they can be transferred to external situations, and/or that they are assimilated or made automatic or implicit (i.e. naturalized), as is implied by Gagné in events three and nine. Therefore, the concepts of transfer and naturalization were extrapolated from this analysis and included in the model. The concept of naturalization (i.e., internalizing, developing automasticity) was borrowed and adapted from a taxonomy that was developed for developing psychomotor skills (Krathwohl et al. 1974) and redefined in terms of acquiring cognition skills. This crossing over between learning domains also ensures that the model can be useful in assessing design criteria for games used to teach in both the cognitive and psychomotor domains.

Gagné's Events of Instruction are traditionally used to describe individual lessons, but these events can also be used to describe a curriculum as a whole. When used to describe a curriculum, the presentation of the lesson activity is expanded to include multiple lessons,

Table 3 Comparing Gagné's Events of Instruction, Keller's ARCS model, and common game design elements

Gagné's Nine Events	Keller's ARCS model	Common game elements
Gain attention	Attention	Scenario exposition
Inform of objectives		Problem setup
Stimulate recall	Relevance	No existing game equivalent
Present stimulus/lesson		Offer challenge/choice
Provide learner guidance	Confidence/challenge	Provide direction
Elicit performance		Elicit action/decision
Provide feedback	Satisfaction/success	Discernable outcome
Assess performance		Success/failure screens
Accommodate retention and transfer		No existing game equivalent

each described by the nine events. In this manner, Gagné's Events of Instruction describe both a successful game and individual units of gameplay (i.e., the game as a whole and the levels that compose the game).

Incorporating cognitive schema and hierarchies

In order to refocus general game design specifically towards specific content learning, parts of certain cognitive schema theories were also examined for inclusion both as an individual element and as modifiers in the model. Specifically, Piaget's concept of adaptation (including assimilation and accommodation) and schemes (Satterly 1987; Wood 1998) were adopted. In his attempts to classify learning behaviors and to better understand how knowledge is acquired and how people recall information, Bloom identified six levels of knowledge acquisition, which move from simple to complex and are designed to increase a student's comprehension. Bloom's Taxonomy has been linked to mastery learning (Block 1971; Levine 1985) in which students continue to gain information and develop skills by working through content or activities, and progressing only after they have mastered the content of the previous lessons, activities, and/or modules. Piaget also proposed that learning and brain development occur through schema or pattern recognition (Brainerd 1978), which directly relates to Prensky's (2003) views on how today's games generation learns. The concepts utilizing a taxonomy or hierarchy and requiring mastery prior to proceeding to the next step are well suited for instructional game design and easily fit into an overall model to properly inculcate content learning into gameplay and form the basis of the Levels 0–3 found in the rubric shown in Table 4.

The resulting elements in the RETAIN model

Borrowing a page from Piaget's concept of 'equilibration', the acronym developed for the RETAIN design model was the result of an attempt to obtain a balance between the mental schemes and environment found when comparing game design to educational needs. When analyzing each element from a perspective of their respective domains, slight nuances occur, which are explained and expanded upon within the cells found in the resulting rubric. Evaluation guidelines were constructed on a two-dimensional visual plane. Down the side area of the table are the suggested elements. Like all taxonomies, a bottom-up hierarchy is assumed in which the evaluation of one element builds upon the previous. Table 4 displays the value system associated with the rubric and the evaluation criteria to determine how the proposed designs can be assessed. The values associated with each element represent an initial assessment of the relative value of each element and will be re-evaluated in follow-up studies. Minimum standards can be set for total scores to determine a game's teaching efficacy based on further empirical research.

Most notable in the rating scale is the fact that embedding and immersion, although extensively discussed in the literature as being essential to learning from games, only receive two and three relative strength points. This is due to the fact that these elements, along with adaptation and naturalization, scale were weighted hierarchically in favor of the higher order importance of the latter two assigned to them by Bloom and others, as well as the fact that our review uncovered the fact that these were the very elements missing when comparing games to Gagné's Nine Events. We suggest it is the sum composite of all the elements from which the model derives its power. While immersion and embedding are

Table 4 RETAIN rubric

	Level 0	Level 1	Level 2	Level 3
Relevance	The story/fantasy creates little stimulus for learning and is in a format that is of little interest to the players/learners nor does it utilize advanced organizers. The player/learner does not know the state of the game or the required learning content based on the choices presented.	The story/fantasy is age/content appropriate or it has a limited educational focus and little progression. The pedagogic elements are somewhat defined but occasionally players/learners are allowed by the embedded fantasy to become engaged in inappropriate content or contexts.	In addition to overcoming limitations and/or adding to Level 1 features, the following are also present: Specific didactic content is targeted and learning objectives are clearly defined. Creates interest in what is to be learned and a natural stimulus and desire to learn more.	In addition to overcoming limitations and/or adding to Level 1 & 2 features, the following are also present: Is relevant to players'/learners' lives, (real or imagined) and/or the world around them using characters and themes familiar to them. Matches the players/learners to their appropriate developmental level by providing adequate cognitive challenges.
Embedding	The "teachable" moments disrupt the players/learner's gameplay, that is, flow of the game. Has no interactive focus/hook either on the emotional, psychological, physical, or intellectual level.	Didactic elements are both present but are not cohesively integrated—one or the other is added as an afterthought to the first. Content to be learned is exogenous to the fantasy context of the game.	In addition to overcoming limitations and/or adding to Level 1 features, the following are also present: Allows for extended experiences with problems and contexts specific to the curriculum. Intellectual challenges are presented to players/learners of sufficient level to keep them interested in completing the game.	In addition to overcoming limitations and/or adding to Level 1 & 2 features, the following are also present: Involves the players/learners both mentally and emotionally in such a way that they are conditioned to accept change and invest in the belief. Educational content is fully endogenous to the fantasy context.

Table 4 continued

	Level 0	Level 1	Level 2	Level 3
Transfer	Offers no anchored or scaffolded levels of challenge, no evidence of using integrated content from previous levels, or little challenges at an increasing level of difficulty. Process knowledge is not mapped to targeted academic content.	Offers levels of challenge that emphasize similar lines of thought and problem analysis to be applied to other implied contexts. Contains 3D cues and interactive animation that facilitate the transfer of knowledge during pedagogic events.	In addition to overcoming limitations and/or adding to Level 1 features, the following are also present: Players/learners are able to progress through the levels easily. Active problem solving is required to move to the next level. Players/learners can progress through instructional elements that are introduced in a hierarchical manner so that knowledge gained during gameplay can be transferred to other situations.	In addition to overcoming limitations and/or adding to Level 1 & 2 features, the following are also present: Includes authentic real life experiences that reward meaningful "post-event" knowledge acquisition. Contains "after action reviews" that offers players/learners an opportunity to teach other (computation or actual) players/learners what they have learned.
Adaptation	Fails to involve the players/learners in an interactive context. Information is not structured in a way that can be at least partially grasped by the learner. Does not sequence the material that is to be learned.	Builds upon the player's/learner's existing cognitive structures. New content is sequenced based on the principle of cognitive dissonance—as a result players'–learners' need to interpret events in order to determine what about the new content contradicts what they already know.	In addition to overcoming limitations and/or adding to Level 1 features, the following are also present: Instruction is designed to encourage the player–learners to go beyond the given information and discover new concepts for themselves. Content sequenced in such a way as to require players/learners to identify old schema and transfer it to new ways of thinking.	In addition to overcoming limitations and/or adding to Level 1 & 2 features, the following are also present: Makes learning an active, participatory process in which the players/learners construct new ideas based upon their prior knowledge. Presents information that focuses on external or internal characteristics that enable the learner to associate new information with previous learning.

Table 4 continued

	Level 0	Level 1	Level 2	Level 3
Immersion	Provides no progressive, formative feedback during each unit of gameplay. Presents little or no opportunity for reciprocal action and active participation for players/learners.	Elements of play are not directly involved with the didactic focus, but they do not impede or compete with pedagogic elements. Presents some opportunity for reciprocal action in a defined context, that is, a context that is meaningful, repeatable, and interactive, but players/learners do not feel fully interactive in the learning.	In addition to overcoming limitations and/or adding to Level 1 features, the following are also present: Requires the player–learner to be involved cognitively, physically, psychologically, and emotionally in the game content. The use of mutual modeling creates a shared responsibility for learning among the participants.	In addition to overcoming limitations and/or adding to Level 1 & 2 features, the following are also present: Presents opportunity for reciprocal action and active participation for players/learners. Presents both the environment and the opportunity for belief creation.
Naturalization	Presents little opportunity for the mastery of facts or a particular skill. Target content/skills are rarely revisited. Little opportunity is given to build upon previous knowledge and/or skills in a logical and sequential manner.	Replay is encouraged to assist in retention and to remediate shortcomings. Improves the speed of cognitive response, automaticity, and/or visual processing.	In addition to overcoming limitations and/or adding to Level 1 features, the following are also present: Encourages the synthesis of several elements and an understanding that once one skill is learned it leads to the easier acquisition of later elements. Requires the players/learners to make judgments about ideas and materials.	In addition to overcoming limitations and/or adding to Level 1 & 2 features, the following are also present: Causes players/learners to be aware of the content in such a way that they become efficient users of that knowledge. Causes the player–learners to spontaneously utilize knowledge habitually and consistently.

Copyright 2007, used with permission from the authors certainly important to learning and, more importantly to a game's commercial success the game industry, we believe that they play a supportive role in the learning cycle to transfer and naturalization, which, according to Bloom Gagné, and Sweller are critical for long-term retention of knowledge.

Relevance

Relevance is one of the key tenets in the ARCS model. In addition to presenting learning materials in a way that is relevant to learners, their needs, and their learning styles, instructional units should be relevant to one another. Further, instructional units should be introduced and set in context with previously learned materials (scaffolds), using both introductory materials and advanced organizers (Ausubel 1963). Lepper and Malone (1987) describe relevance in terms of how closely the game activity reminds the player–learners of the importance of targeted activities and functions in terms their real lives. This can be accomplished through repeated play. Making a game relevant to reality seems to contradict the concept of fantasy, but the concept of relevance in terms of ensuring that content is embedded properly and provides a self-check to ensure engagement is with the correct subject matter goes to the heart of fantasy when incorporating it in gameplay. A game with no fantasy element is simply an abstract context—a simulation of reality. Garris et al. (2002) assert that including "imaginary or fantasy context, themes, or characters" and providing "optimal level of informational complexity" can make computer games motivational [i.e., relevant] (p. 447). If the intent of an educational game is to provide an appropriate goal, and using visual effects and/or fantasy can make those goals more compelling, it follows that if the fantasy can be properly integrated with educational goals, then the game will become more personally more meaningful to the player–learners—a concept Malone (1980a, b) refers to as *fantasy relevance*. We extend the definition of fantasy relevance to also mean that the fantasy, while completely engaging, simultaneously protects as much as possible against focus of attention away from targeted content.

Relevance can also be measured in terms of germane load, as suggested by Sweller (1994). The implication is that the more closely the materials are related to the focus of what is to be learned, and the more relevant the topics are to the learner the greater for learning is to take place. The wording in each cell of the rubric table, therefore, also takes into account the perceived germane load, as appropriate.

Embedding

We suggest that the concept of appropriately embedding content into the fantasy cannot be evaluated alone and is tightly integrated with the other elements of the model. The primary connotation of the term 'embedding' is to assess how closely the academic content is coupled with the fantasy/story content. We concur with research that has shown that the relative tightness of the coupling to be a fairly valid and reliable predictor of engagement (Asgari and Kaufman 2004; Malone and Lepper 1987; Rieber 1996, 2001). We suggest that this element also shows how great the potential is that the player–learners will be fully immersed in the action.

The intent is to integrate the educational content in such a way as to make it intrinsic to the fantasy context of the game so that learning and gameplay function together seamlessly. While learning is possible from exogenous content (material that is loosely coupled with fantasy context), it has been suggested that it is less effective educationally because it interrupts the flow of the game and breaks the sense of immersion from the game perspective. Properly embedding the lesson in proscribed manner reinforces the concept of relevance and suspension of disbelief. The act of playing the game should, directly and within the fantasy structure, draw on the knowledge or skills that the game is designed to foster in its player learners. Bloom's idea of cognitive skills progressing or growing through levels is directly correlated to this element of the model. It is important to cast educational content in a way in which spiral learning and successful gameplay progress are simultaneous.

Transfer

Evaluating the ability to teach player–learners how to transfer knowledge from one situation to another requires the answers to several questions. Does the game cause a circumstance in which the targeted knowledge is transferred to similar or new and unique situations so player–learners are able to assimilate and accommodate it? Does the targeted content cause player–learners to be aware of the knowledge in such a way that they will become efficient users of that knowledge? Transfer and adaptation are tightly coupled in their intent in the learning cycle. In a game situation, player–learners might encounter a similar problem to be solved that is restated in other terms or in other contexts that require them to utilize or reapply the information in other formats but not in ways that necessarily map to targeted outcomes.

When comparing those general game design methods that were analyzed and Gagné's Nine Events of Instruction it becomes apparent that steps three (stimulate recall) and nine (accommodate retention and transfer) are generally lacking in most game designs. Learning theory attests to the importance of the transfer and applying knowledge to new situations as a part of the process. In terms of a taxonomy for cognition and memory, this tenet correlates strongly with Bloom's ideas (1956) on analysis, synthesis, and evaluation in which a learner progresses through levels and then transfers the newly learned skill it to other tools, environments and to estimate, judge, and/or predict.

Adaptation

Adaptation is a follow-on concept to transfer. The implied connotation borrows from Piaget's ideas on cognitive structural development, the evolution of pattern recognition skills, and mental actions that take place during learning. According to Piaget, cognitive structures in learners develop and evolve their cognitive skills through assimilation and accommodation (Wadsworth 1978). Assimilation relates to a process in which learners interpret events in terms of what they already know. Accommodation relates to transfer and refers to learners being forced to change or create new knowledge to make sense of something that doe not fit their existing ideas or understandings. Piaget's theory is similar to other learning theories and perspectives such as constructivism, as proposed by Bruner (1966, 1973) and Vygotsky (Wertsch 1985), and elaboration theory (Merrill 1981; Reigeluth 1983). Adaptation is the result of the two processes and implies some type of change of behavior (or knowledge acquisition has taken place. Learning is based on this view of change theory.

Perhaps it is the processes of assimilation and accommodation that Prensky (2003) is noticing when he describes the pattern recognition attributes of the so-called *games generation*. The concept of pattern recognition shares a lot with Piaget's ideas on a learner's abilities to identify old schema that will be eventually transferred to new learning objects in the process of new knowledge creation, and bridges the gap between the taxonomic concepts of *synthesis* and *evaluation*, as described by Bloom (1956). Knowledge creation (transfer) involves higher-order thinking skills than knowledge acquisition in the evolving process of internalizing content.

Immersion

In the RETAIN model the traditional definition of immersion used in interactive media (i.e. the feeling of presence or telepresence) is insufficient. It is also not enough to embed learning in fantasy, although this embedding makes it easier for player–learners to engage themselves at appropriate cognitive levels required to retain and internalize the content introduced by the game. Embedding also makes it easier to create a belief in the fantasy and to maintain their suspension of disbelief—moving towards what Wirth refers to as an "investment of the belief" (1994, p. 2) in what is to be learned. It is in this sense that we use the term full immersion. This view suggests that immersion can be measured hierarchically from a simple interaction/reaction to being fully engaged to an intellectual investing in the context of the game (learning situation) as described previously in Table 1.

Naturalization

Naturalization is a term borrowed from Bloom's psychomotor taxonomy (Krathwohl et al. 1974), translated for use in cognitive domain. The term strongly correlates to the concept of automaticity or spontaneous knowledge, in which a student uses the learned information habitually and consistently, monitors it, but does not have to devote significant mental resources thinking about it. Naturalized content generates a lower cognitive load than newly acquired knowledge, freeing students up to be able to devote cognitive effort to higher order thinking skills. Automaticity does not imply a lack of cognition, but rather references a different cognitive process than what is typically referred to as 'thought' and is usually the result of learning, repetition, and practice. In foreign language acquisition this is sometimes referred to as fluency and is the result of being immersed in that culture. If a game is truly engaging, motivating, and immersing, the player–learner will be willing to play the game repeatedly so that automaticity is developed. The content is now ingrained in the player–learner's natural way of thinking. An analogy is when one learns directions to a driving location. The driver knows implicitly where to turn and stop but may not be able to verbalize the specifics about the directions, such as street names, etc. The driver knows the information so well he or she does not have to think about it. In a cognitive context, this might be analogous to a student who knows how to solve a differential equation or simply 'know' that two and two equals four. The more automatic (i.e., natural) that knowledge is the more easily the learner can utilize that knowledge in new situations for several reasons shown in sound educational theories such as that proposed by Vygotsky (Chaiklin 2003) (zone of proximal development), or Sweller (1994) (reduced intrinsic load).

An evaluation of two games—a case study

The most effective way to demonstrate the appropriateness of the RETAIN model as a game design tool would be to utilize it during the creation of a game as it is being designed for use in educational environment. While the use of each of the elements in the model have been fairly well reviewed in the literature and stand on their own merits, the nature and expense of building such a game from scratch make it prohibitive to test without designing a new game that fully embeds the content into the storyline or fantasy context, especially if an attempt is made to fully embed the content in the storyline or fantasy as described previously. Such an undertaking is being planned and will be the subject of follow-up research. We believe an appropriate short range demonstration of the value of the model is to create a rubric (See Table 4) and apply a weighting scale (See Table 5) to evaluate the comparative effectiveness of already-developed games that have been widely used in educational settings. Using the model in this way also extends its value because it can be used by teachers and instructional designers to comparatively evaluate any commercial off-the-shelf (COTS) game they might be considering for use in their classrooms.

Adopting a weighting scale

Designing a rubric is an interesting exercise, especially if it is to be utilized for the dual purposes of designing a game from scratch and evaluating existing games. In our rubric a twofold weighting was developed. Having said that, building a schema can pay dividends. Even if the specific wording within each cell needs to be adopted/changed, the formulae, once settled upon, remain the same. The first is scaling occurs within the levels across the top. The term *level* was deliberately chosen by the panel to reflect the leveling conceptual design utilized in the gaming milieu. An assumption of weighting is made as the levels increase. The first level (Level 0) implies that the conceptual construct for that element is missing. A level one means that it is there minimally and increases as one moves to levels two and three respectively. Points are awarded as more evidence of that element's construct is observed, according to specifications provided in each cell.

The actual weight assigned to each element was based on the theories and practices found in the literature (Shelly et al. 2006). Just as Bloom's hierarchy assumes more effective and higher order learning takes place as one progresses o to the next higher plane in his taxonomy, we followed the patterns of the concepts of adaptation, transfer and naturalization. While Bloom never quantified his model, we did so in order to focus attention on the hierarchical nature of learning. The rubric represents a first attempt at quantifying the pyramid of learning.

For the purposes of this review, the panel of experts was utilized. The individuals involved were game designers, some of whom had left the industry to become university instructors and professors, instructional designers, undergraduate preservice and inservice teachers, and graduate level researchers. Several discussions were held about the anomalies in definitions between instruction and game design. One graduate class exploring the elements of interactive design learned how to create simple games and then was asked to create design documents for their games to incorporate what they believed to be the most important elements from educational theory and instructional best practices. Those conceptualizations were culled to formulate the specific elements and weighted independently by the groups. The resulting weighting factors were summarized into the scale found in Table 5.

Table 5 RETAIN weighting chart

		Level 0	Level 1	Level 2	Level 3
Relevance	1	0	1	2	3
Embedding	3	0	3	6	9
Transfer	5	0	5	10	15
Adaptation	4	0	4	8	12
Immersion	2	0	2	2	6
Naturalization	6	0	6	12	18
			Total possible points = 63		

The resulting rubric was then utilized to evaluate two popular educational games to determine if some kind of accordance was realized. Two games were selected: *Math Blaster* and *Where in the World is Carmen Sandiego?*—two commercial games that are currently being used in K-12 classrooms. Such a review is not intended to be an endorsement, nor an indictment of either product. We believe the final determination as to the effectiveness of any product is in the hands of the teacher or instructor, something that many have apparently already done with these games, considering their commercial success. The intent of the review is to demonstrate the potential that the rubric has in helping educators make the decisions they need to effectively utilize the games in their classrooms.

In the reviews that were conducted, the evaluators chose to assign partial points, which represents the first minor changes that will be applied in future iterations of the rubric. It was the partial points assigned that led to discussions about the wording in each cell that could be a candidate for more clarification and refinement.

Math Blaster

Knowledge Adventure, by their own accounts, has sold millions of copies of Math Blaster in the past 20 years to parents, teachers and kids. It is an award-winning educational software package that claims to have proven results. The game combines fast-action game play with state standard content. It is a game that has continually been improved on and has solely focused on improving math skills.

Using the rubric to review its predicted overall effectiveness has revealed its apparent strengths and areas in which it could improve. It received 18 out of a potential 63 points. As each element carries its assigned weight, one game could be evaluated higher based on whether it contains the elements deemed important for higher order learning. In the final analysis what determined the total score was the fact that we determined that Math Blaster needs to create more opportunity for naturalization and transfer, an unfortunate anomaly created by the fact that the game is so focused towards improving very specific and focused set of skills (See Table 6 for analysis/scorecard).

Where in the World is Carmen Sandiego

The *Where in the World* game franchise is a series of games intended to teach geography. The game was originally created by Brøderbund Software in the late 1980s into the 1990s.

Table 6 Resulting scores for Math Blaster

Element/Rating Level × Rank = Rating	Discussion
Relevance (2) 2 × 1 = 2 total pts	Overall the focus of learning various math principles is made apparent in the game, and is designed in such a way that it's enjoyable to much younger audiences. As a result, young children will have a desire to learn some principles because of the game's characters, and also because it is designed for that demographic.
Embedding (1) 1 × 3 = 3 total pts	The game world is nicely done, and the learning is made apparent to the player from the start. The feel-good atmosphere of the game's world and characters are attractive to players. However, it also feels as if the game mechanics and pedagogy were developed independently of one another.
Transfer (1) 1 × 5 = 5 total pts	Math is universal, and as a result, the principles learned from playing the game can be easily applied to other venues. The challenge of the game is very much like what would be observed in typical classroom instruction and creates the same sort of transfer. The animations add little to the learning of math during gameplay.
Adaptation (1.5) 1.5 × 4 = 6 total pts	The change in game mechanics for each play style presents a chance to test if the player really did learn the materials when doing it just a moment before in a different play style. In this manner, it builds on what has already been learned, and presents new principles that require the previous knowledge gained. Even though it's improving the player's way of thinking, it's not creating much in the way of discovery. The game does not facilitate the need to look at how else math applies to the real world; and a likely reason for this may be that the game world itself coincides so little with math, that players may not see a reason why another world (real or not) should instead.
Immersion (1) 1 × 2 = 2 total pts	There is some degree of immersion because the player is required to participate in some fashion in order to complete the game, but there is little beyond iteration in the immersion hierarchy. Outside of pedagogy-related mechanics, there are almost no other game elements. The game world does not fully create a compelling fantasy for players to stay active in— it becomes more about getting the math done and enjoying the reward of well-made artwork.
Naturalization (0) 0 × 6 = 0 total pts	Once the player has completed the game once, there is little else left to be accomplished. Certainly repeated play is encouraged but little variation is offered with regards to adding curiosity or novelty to the practice. Replaying the game does not add anything new for the player other than perform the same games over for the same knowledge—possibly acting as a refresher, but with little motivation to do so, once the novelty wears off.

The latest versions were by The Learning Company in 2001. The goal of the game is to track and arrest Carmen and her villains, who travel around the world. The game was not originally designed for the classroom, but was adopted by so many schools that the companies attempted to broaden its appeal by adding other academic content such as math and science, although the latest releases have returned to their original geographical and historical focus.

The rubric reveals that the game embeds content on a moderately high level. It also provides moderately high levels of adaptation and naturalization as well because it allows for repetitive play through its varied content and fantasy context. The reason it received a lower score for immersion was due to the fact that the game does provide as much mutual modeling, a concept deemed valuable to the immersion and transactional feedback effect in

Table 7 Resulting scores for Where in the World is Carmen Sandiego

Element/Rating Level × Rank = Rating	Discussion
Relevance (1.5) 1 × 1.5 = 1.5 total pts	While the game does feature elements of history and geography as players explore various locations in the game, there is no real focus for learning more about those locations. As a matter of fact, the small snippets of information seem based on the belief that players know little to nothing about the area. Overall the fantasy world of Carmen Sandiego is defined well for children. The one negative that caused a lower rating is the player–learners can sometimes get caught up in the detective characters and get sidetracked from the job of learning the geography and history.
Embedding (3) 3 × 3 = 9 total pts	Despite the lack of depth in the educational content, the ability to play in historical environments gives the player something to enjoy as they search for clues in tracking down thieves. The very nature of the chase also builds up knowledge of world geography as the player must follow the thieves all over the world, and while keeping players immersed in the fantasy context. Also, because the fantasy involves the learning material so much, players get to experience both simultaneously as if they are one. However, the challenge of the game is not based on increasingly difficult learning materials, but rather increasingly difficult game mechanics.
Transfer (.5) .5 × 5 = 2.5 total pts	The mechanics of the game focus so heavily on the searching for clues, that it becomes only relevant to this game series, and does little for players seeking to have it applied elsewhere. Nonetheless, the game does feature a number of animations and imagery for players to see the geographical placement of locations across the world, and allows for some transfer in that respect.
Adaptation (2.5) 2.5 × 4 = 10 total pts	As the player ventures across the world, the player is repeatedly asked to find new clues and which leads to the thief and tracking him or her down. This creates a timeline of information learned that causes the layer to continuously look at and build upon as they deduce more and more information about the culprit being tracked down and create a better judgment in terms of where to track them down at. The difficulty with this is the game is that the player is not required to construct new ideas based on the educational content.
Immersion (3) 3 × 2 = 6 total pts	Throughout the game, players are given the feeling of having importance by knowing they are the only detective actively tracking down Carmen Sandiego, and that without doing a good job, she and the other thieves will get away. One element in the game has the player creating a profile for the criminal, and they fail to put all the pieces together, it will affect their final chance of having a proper warrant for arrest.
Naturalization (2) 2 × 6 = 12 total pts	Going along with Adaptation, the game features a wealthy spectrum of information for the player to utilize as they travel to various places, and is constantly revisiting all that information for them to build their future findings on. As a result, they become more knowledgeable of everything they have found.

any collaborative activity (Moreland and Myaskovsky 2000). Overall, the game received 41 points out of a possible 63 (Table 7).

Summary and conclusions

Good game and instructional design and educational theory share a number of essential features, like a properly designed instructional strategy, good games are fun and intrinsically motivating. They incorporate an optimal challenge, have appropriate and unambiguous outcome goals, provide clear, constructive, and encouraging feedback, and offer elements of curiosity. Games take the process one step further through the integration of fantasy. They also provide a sufficient number of choices so as to give players an intermediate control over the features of the game, often found lacking in classroom environments. Unsuccessful educational games, like any other incomplete instructional strategy, have their shortcomings—the most important of which is integrating targeted learning matter into the narrative plotline/fantasy in such a way as to seamlessly and, without interrupting the flow of gameplay, stimulate recall from previous lessons and transferring previously learned knowledge to other situations that encourage higher order thinking skills. Creating an effective serious game intended for educational purposes entails much more than simply creating an engaging atmosphere and incorporating academic content. Considerable thought and planning is required at every stage of design and production to match media to the appropriate content, integrate and intertwine content closely with game play, and support learning through carefully crafted feedback and hints. In addition, support materials need be created to extend student learning beyond the time that they spend in front of the screen.

We submit that if instructional strategies are applied concurrently with appropriate content development in game design, the chances increase exponentially for building a successful game from which player–learners quickly adapt to the process of learning and with which they better enjoy the conditions under which the concepts are learned. The RETAIN model is based on embedding established, well-known, and well-studied instructional design theories during the design and construction of the games, from which better opportunities to teach content to digital, game playing students emerge.

In the future, we intend to further develop a formal research protocol to validate the design process. The RETAIN model will be utilized during prescribed game design projects prior to their implementation. Norms will be developed that are based on the data collected from the numeric values associated with the rubric. It is recognized that, like blueprint maps for learning objectives, not all of the elements of the model are equally important. The research methodology will evaluate the weighting values at this time for each of the design standards to determine if adjustments need to be made. The research will impose conditions on the outcomes to determine which of the elements needs to be weighted more (or less), if necessary, so that a more effective rubric will evolve.

We believe this model is a step in the right direction because it effectively combines game theory, instructional design, and educational learning in ways suggested in a myriad of researchers and theorists (Asgari and Kaufman 2004; Dempsey and Johnson 1998; Karoulis and Dmetriadis 2004; Laurel 1993; Lepper and Malone 1987; Malone 1983; Murray 1999) to immerse, integrate, and inculcate content with the player–

learners in ways that that combines increased motivation and readiness for learning with instructional strategies that have been shown over time to increase opportunities for academic content learning.

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