Games and Simulations in Online Learning: Research and Development Frameworks

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Chapter I

Games and Simulations: A New Approach in Education?

Göknur Kaplan Akili, Pennsylvania State University, USA

Abstract

Computer games and simulations are considered powerful tools for learning with untapped potential for formal educational use. However, the lack of available well-designed research studies about their integration into teaching and learning leaves unanswered questions, despite their more than 30 years of existence in the instructional design movement. Beginning with these issues, this chapter aims to shed light on the definition of games and simulations, their educational use, and some of their effects on learning. Criticisms and new trends in the field of instructional design/development in relation to educational use of games and simulations are briefly reviewed. The chapter intends to provide a brief theoretical framework and a fresh starting point for practitioners in the field who are interested in educational use of games and simulations and their integration into learning environments.
Introduction

It is unanimously acknowledged that we are living in the information age, taking part in the information society (Bates, 2000; Reigeluth, 1996). What makes these two emerging concepts possible is technology, or rather, the rate of progress that has been achieved in technology over the past 50 or so years (Molenda & Sullivan, 2003). Throughout this period, technology has been both the generator and the transmitter of information with an increasingly faster speed and wider audience each and every day. It now dominates most facets of our lives, penetrating into the conduct of normal daily life.

The field of education is not an exception to the permeation of technology. On the contrary, education has always been considered as potentially one of the most productive breeding grounds for technology, where it would perhaps find its finest resonances and lead to revolutionary effects. Yet, high expectations regarding the revolutionary impacts of technology on education have hardly been realized so far. More specifically, instructional technology, or the use of technology in educational environments, has not contributed significantly to the realization of these expectations (Molenda & Sullivan, 2003; Russell, 2003). It may be argued that the relative ineffectiveness of instructional technology thus far has been caused by the application of the same old methods in new educational media—"New wine was poured, but only into old bottles" (Cohen & Ball, 1990, p. 334). The inconclusiveness of the research is illustrated by the Clark and Kozma debate, started by Clark's 1983 statement that media do not influence students' learning (Clark, 1983). Kozma (1991) counter-argued that learning and media are complementary and that interrelationships of media, method, and external environment have influenced learning. Both of them rationalized their arguments by calling on Russell's (2003) study on so-called "no-significant-difference" research. Clark (1983, 1994a, 1994b) uses this phenomenon as evidence for his argument, whereas Kozma (1994) uses this phenomenon as indicative of insufficient evidence for his debate.

Current models and methods of instructional technology are insufficient to meet the consequences of the paradigm shift from industrial age to information age (Bates, 2000; Reigeluth, 1996, 1999). Consequently, instructional designers are faced with the challenge of forcing learning situations to fit an instructional design/development model rather than selecting an appropriate model to fit the needs of varying learning situations (Gustafson & Branch, 1997).

One of the possible novelties in instructional methods is the use of games. Indeed, it may possibly be wrong to call games a novelty in education, since young children, by nature, begin to learn through games and playing from their earliest years (Rieber, 1996). However, as they grow up, their play and games are being replaced by formal education, the transition of which does not always—especially nowadays—seem to be a sharp one to the extent that games are being used also in some educational environments, yet their success is questionable or at least not rigorously established. In another sense the use of games in education is not so much a novelty, because its history may be traced back well over a thousand years (Dempsey, Lucassen, Haynes, & Casey, 1998). It is now known that even in times before history, games and dramatic performances as representations of real life were effective as teaching tools. In our modern day, with the new technological advancements, I strongly believe that traditional games have been replaced by electronic games, and, in a similar manner, dramatic representations of old have been transformed into role-playing in simulation environments.

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Game

Games and simulation, which there is "lea beyond thinking" (I Heinich, Molenda participants follow a challenging goal: basic sense as "any rule-guided" (p. 4) throughout his boo
in simulation environments. Hence, electronic games and simulations have begun to enter contemporary formal education. In addition, the "already-present" new generation of learners have grown up with ever-present games. Prensky (2001) refers to them as the digital natives of the "game generation" (p. 65) He states that this new generation is different from the "digital immigrants" (people born before games were digital and ubiquitous) resulting from their different life experiences with games as a part of the "new media socialization" (Calvert & Jordan, 2001; Prensky, 2001, p. 65) Digital natives who play a lot of games are provided with skills, such as dealing with large amounts of information quickly even at the early ages, using alternative ways to get information, and finding solutions to their own problems through new communication paths. The new "game generation" prefers doing many things simultaneously by using various paths toward the same goal, rather than doing one thing at a time following linear steps. They are less likely to get stuck with frustration when facing a new situation; on the contrary, they probe themselves into a new situation without knowing anything about it and prefer being active, learning by trial and error, and figuring things out by themselves rather than by reading or listening. Lastly, they want to be treated as "creators and doers" rather than "receptacles to be filled with the content." Hence, the game generation is also referred to as the "intellectual-problem-solving-oriented generation" (Prensky, 2001, p. 76)

When the above issues are considered, it leads to three main bodies of questions, which shape the main focus and scope of this chapter:

1. What are games and simulations? What makes something a game or simulation? What are their educational uses? Do they really have an effect on learning?
2. What is happening in the instructional design/development (IDD) field? Is there a place for games and simulations in both the theory and the practices of IDD?
3. If games and simulations are useful educational tools, how can they be used in education? How can instructional designers take them into account, while designing learning environments? Are there any instructional design/development models (IDDDMs) that would light up an instructional designer’s path, guiding their journey to integrate games and simulations into their designs?

Games and Simulations: What are They?

Games and simulations are often referred to as experiential exercises (Gredler, 1996), in which there is "learning how to learn" that provides something more than "plain thinking;" beyond thinking (Turkle, 1984). Prensky (2001) defines games as "organized play" (p. 119). Heinich, Molenda, Russell, and Smaldino (2002) define a game as "an activity, in which participants follow prescribed rules that differ from those of real life [while] striving to attain a challenging goal" (p. 10). Dempsey, Rasmussen, and Lucassen (1996) define gaming in a basic sense as "any overt instructional or learning format that involves competition and is rule-guided" (p. 4). In my opinion, (except for Prensky’s [2001] later and incessant emphasis throughout his book) these definitions are lacking two vital elements: fun and creativity. So
my own definition of “game” becomes “a competitive activity that is creative and enjoyable in its essence, which is bounded by certain rules and requires certain skills.”

As put forth by many researchers, several game genres can be distinguished, such as action, puzzle, educational, fighting/combat, sports, racing, role play/adventure, flight, shoot ‘em, platform games, business, board, word, general entertainment, fantasy violence, human violence, non-violent sports, sports violence, and simulation games (Alessi & Trollip, 2001; Funk, Hagan, & Schimming, 1999; Media Analysis Laboratory, 1999; Prensky, 2001; Yelland & Lloyd, 2001). Many researchers also assert that games have some characteristics such as “one or more players (decision makers), rules of play, one or more goals that the players are trying to reach, conditions introduced by chance, a spirit of competition, a strategy or pattern of action—choices to be taken by the players, a feedback system for revealing the state of the game, and a winning player or team” (Price, 1990, p. 52), “turn-taking, fantasy, equipment, and some combination of skill versus luck” (Alessi & Trollip, 2001, p. 271). Furthermore, Price (1990) categorizes “educational” games as academic games, which aim to teach and provide practice, while motivating the learners, and life simulation games, which are context simulation games including strict rules in real-life contexts, or open-ended life simulation games including flexible rules and goals in social science contexts.

A simulation is defined as an interactive abstraction or simplification of some real life (Baudrillard, 1983; Heinich et al., 2002), or any attempt to imitate a real or imaginary environment or system (Alessi & Trollip, 2001; Reigeluth & Schwartz, 1989; Thurman, 1993). It is “a simulated real life scenario displayed on the computer, which the student has to act upon” (Tessmer, Jonassen, & Cavelly, 1989, p. 89).

Although both games and simulations are terms that refer to different concepts, they have common characteristics, too. On the surface, both contain a model of some kind of system, and in both of them learners can observe the consequences of their actions, such as changes occurred in variable, values, or specific actions (Gredler, 1996; Jacobs & Dempsey, 1993). Jacobs and Dempsey (1993) state that the distinction between simulation and games is often blurred, and that many recent articles in this area refer to a single “simulation game” entity. One of them is Prensky (2001), who argues that “depending on what it is doing, a simulation can be a story, it can be a game, [and] it can be a toy” (p. 128).

Gredler (1996) identifies three important differences between the deep structure of games and simulations. Instead of attempting to win the objective of games, participants in a simulation are executing serious responsibilities with privileges that result in associated consequences. Secondly, the event sequence of a game is typically linear, whereas, according to Gredler (1996), a simulation sequence is non-linear. The player or a team in many games respond to a content-related question and either advance or do not advance depending on the answer, which is repeated for each player or team at each turn. However, in a simulation, participants are confronted with different problems, issues, or events caused mainly by their prior decisions made at each decision point.

The third difference is the mechanisms that determine the consequences to be conveyed for different actions taken by the players. Games consist of rules that describe allowable moves, constraints, privileges, and penalties for illegal (non-permissible) actions. The rules may be totally imaginative, unrelated to real world or events. In contrast, a simulation is based on dynamic set(s) of relationships among several variables that change over time and

Effects

Although the literature whether games in Molenda and Sull systems, games and simulations—fun, play, learning environments—learning is foster elements, such as...

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reflect authentic causal processes. That is, the processes should possess, embody, and result in verifiable relationships.

According to Prensky (2001) simulations and games differ in that, "simulations are not, in and of themselves games. In order to become games, they need additional structural elements—fun, play, rules, a goal, winning, competition, etc." (p 212) Depending on these definitions and characteristics, as an attempt to derive a general term, I will use game-like learning environments, which will be defined as "authentic or simulated places, where learning is fostered and supported especially by seamless integration of motivating game elements, such as challenge, curiosity, and fantasy."

**Effects of Games and Simulations on Learning**

Although the literature on games and simulations is accumulating day by day, the issue of whether games influence students' learning in a positive way is still vague. For instance, Molenda and Sullivan (2003) state that among problem solving and integrated learning systems, games and simulations are among the least used technology applications in education. However, there are some studies that describe the effects of games and simulations on discovery learning strategies; problem solving skills and computer using skills; and effects on students' intellectual, visual, motor skills and indicate how games and simulations impact student engagement and interactivity, which are important for learning environments.

Cole (1996) has shown that long-term game playing has a positive effect on students' learning (cited in Subrahmanyan, Greenfield, Kraut, & Gross, 2001, p 16). Gredler states that intellectual skills and "cognitive strategies" are acquired during academic games (1996, p 525). However, she also states that certain games require only simple skills such as recall of verbal or visual elements rather than higher-order skills and as a result, provide environments for winning by guessing (Gredler, 1994). Similarly, Prensky (2001) admits that especially with the non-stop speedy games, the opportunity to stop and think critically about the experience is lessened (Prensky, 2001; Provenzo, 1992). Csikszentmihalyi (1990) also supports the belief that during an enjoyable activity, insufficient amount of time is devoted for thinking and reflection.

Games are claimed to have cognitive development effects on visual skills including "spatial representation," "iconic skills," and "visual attention" (Greenfield, 1984, cited in Prensky, 2001, p 45; Subrahmanyan et al., 2001, p 13). Greenfield, deWinstanley, Kilpatrick, and Kaye (1994) claim that as players become more skilled in games, their visual attention becomes proportionally better.

Critical thinking and problem-solving skills (Rieber, 1996), drawing meaningful conclusions (Price, 1990), some inductive discovery skills like observation, trial, and error and hypothesis testing (Gorriz & Medina, 2000; Greenfield, 1984, cited in Prensky, 2001; Price, 1990), and several other strategies of exploration (Prensky, 2001; Provenzo, 1992) were other positive effects of games on learning.

Subrahmanyan et al. (2001) articulate that playing computer games can provide training opportunities for gaining computer literacy, which is consistent with Prensky's (2001)...
statement that games can be used in order to help people gain some familiarity with the computer hardware.

Games motivate learners to take responsibility for their own learning, which leads to intrinsic motivation contained by the method itself (Rieber, 1996) Malone (1980) and Malone and Lepper (1987) define four characteristics of games that contribute to increases in motivation and eagerness for learning. These are challenge, fantasy, curiosity, and control. Challenges in a game tend to fight students’ boredom and keep them engaged with the activity by means of adjusted levels of difficulty. Fantasy in a game increases enthusiasm by providing an appealing imaginary context, whereas curiosity offers interesting, surprising, and novel contexts that stimulate students’ needs to explore the unknown. Finally, the control characteristic gives learners the feeling of self-determination.

According to Rieber (1996), gaming elements have a relationship with enjoyable activities that enable the “flow” stage, a term coined by Csikszentmihalyi (1990). Thus, gaming activities have the potential to engross the learner into a state of flow and consequently cause better learning through focus and pleasant rewards (Prensky, 2001), while increasing their motivation and attainment (Rosas, Nussbaum, Cumsille, Martanov, Correa, Flores, et al., 2003).

Other characteristics that ensure the effectiveness of game-based learning are their engagement and interactivity, and active participation (Gredler, 1996; Prensky, 2001; Price, 1990; Provenzo, 1992). Games provide a great deal of highly interactive feedback, which is crucial to learning (Gredler, 1994; Malone, 1980; Prensky, 2001; Rieber, 1996). “Practice and feedback, learning by doing, learning from mistakes, goal-oriented learning, discovery learning, task-based learning, question-based learning, situated learning, role playing, coaching, constructivist learning, multi-sensory learning” are applicable interactive learning techniques, when learning through games (Prensky, 2001, p. 157).

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### Educational Use of Games and Simulations

There is evidence that the use of games as instructional tools dates back to 3000 BC in China (Dempsey, Lucassen, Haynes, & Casey, 1998). Nevertheless, games and simulations did not become a part of the formal field of instructional design until the early 1970s, despite their entrance into the educational scene in the late 1950s (Gredler, 1996). Seels and Richie (1994) report that in those times audio-visual specialists saw the potential of games and simulations but not of video or electronic games.

Although computer games can be considered powerful tools for increasing learning (Dempsey, Lucassen, et al., 1998; Dempsey, Rasmussen, & Lucassen, 1996), there are two major problems that instructional designers encounter. One is that there are no available comprehensive design paradigms and the other is the lack of well-designed research studies (Gredler, 1996). Since the first problem will be handled in the following sections, at this point, it is proper to proceed with a discussion on the second problem.

While the literature on games and simulations is growing, a majority of the research studies report on perceived student reactions preceded by vague descriptions of games and simulations or on computer-mediated learning. The more recent trends (Dempsey, 1996; Rieber, 1996; Prensky, 2001) indicate that the instructional design field of the future technologies does not include such interactive technologies, such as games. Rieber (1996) argues that “serious games” are necessary “high-level, interactive learning environments that are working on defining new roles for education, enabling students to achieve learning goals in new ways.”

---

### Instructional Technology

The need for the development of learning theory and educational technology is widely acknowledged (Rieber, 1983, 1996). It is seen that the first decade of the 21st century will be a period of growth in the field of educational technology. Rieber (1996) argues that “serious games” are necessary “high-level, interactive learning environments that are working on defining new roles for education, enabling students to achieve learning goals in new ways.”
lations or on comparisons of simulations versus regular classroom instruction (Gredler, 1996). The more important questions that need further research remain unanswered (Dede, 1996; Dempsey, Lucassen, et al., 1998): How to incorporate games into learning environments? How do students learn best through games and simulations? What are the significant impacts of games and simulations on learning that differentiate them from other forms of online teaching?

Rieber (1996) argues that technological innovations provide new opportunities for interactive learning environments that can be integrated with and validated by theories of learning. Prensky (2001) underscores the need for change in instructional design by claiming that much of the instruction currently provided through computer-assisted instruction and Web-based technologies does not contribute to learning, rather it subtracts. People do not want to be included in such learning “opportunities” offered via “new wine into old bottles” innovative technologies, unless they have to, since these learning “opportunities” possess still the same boring content and same old fashioned strategy as traditional education (pp. 92-93).

Prensky (2001) puts forth that learning can best take place when there is high engagement, and he proposes “digital-game-based learning,” which has potential for achievement of the necessary “high learning” through “high engagement” (p. 149). He states that high engagement, interactive learning process, and the way the two are put together will guarantee the sound working of digital game-based learning (Prensky, 2001).

Rieber (1996) states, “Research from education, psychology, and anthropology suggests that play is a powerful mediator for learning throughout a person’s life” (p. 43). In line with this statement, Prensky (2001) further claims that, “Play has a deep biological, evolutionarily important, function, which has to do specifically with learning” (p. 112). However, despite some important psychological and cultural relationships to games, the education profession has long been hesitant about the value of games as an instructional tool or strategy (Rieber, 1996). For instance, as the prevailing philosophy in education has changed over time, the attitude toward play changed accordingly, too. “In one era, play can be viewed as a productive and natural means of engaging children in problem-solving and knowledge construction, but in another era it can be viewed as wasteful diversion from a child’s studies” (Rieber, 1996, p. 44).

The seamless integration of beneficial elements of games and simulations into learning, in an endeavor to create “game-like learning environments” seems promising and worth trying. Before discussing the instructional designer’s concerns and reviewing instructional design/development models, I will first provide a brief look into the “instructional design/development” field to catch a glimpse of what is going on there.

**Instructional (Systems) Design/Development (IDD)**

The need for the development of a linking science and the need for a “middleman” between learning theory and educational practice was first asserted by John Dewey in 1900 (as cited in Reigeluth, 1983), yet, when the origins of instructional design procedures are traced, it is seen that the first research efforts date back only to the time of World War II (Dick, 1987). Moreover, the need for a “middleman” was also put forth by Glaser (1971), who
stated that an instructional designer must perform the interplay between theory, research, and application.

As the title seems to imply (i.e., is it "design" or "development," and is it "instruction" or an "instructional system"?), there is no consensus about the name and the definition of what I choose to call "instructional design/development (IDD)." Basically, my concern here is "instructional design" as an activity rather than the most accurate name that refers to this activity. However, the term IDD is used here as a term of convenience, since it encompasses the width and the depth of these activities in a fairly acceptable manner. The literature shows an interchangeable use of instructional design, instructional systems design (ISD), instructional development (ID), and even instructional technology (IT) (Gustafson & Branch, 1997; Reigeluth, 1983; Schrock, 1995; Seels & Richie, 1994). Even though several attempts have been made to derive standardized definitions and terms (Gustafson & Branch, 1997; Schifman, 1995; Seels & Richie, 1994), the results have not been widely adopted and used in the literature.

Reigeluth (1983) characterizes his views on instructional design as "concerned with understanding, improving and applying methods of instruction." (p. 7), contrasted with instructional development as being "concerned with understanding, improving and applying methods of creating" [italics added] instruction" (p. 8). Furthermore, he states that instructional design produces knowledge of optimal blueprints about methods of instruction, whereas instructional development optimizes the process of developing the instruction and encompasses design, implementation, and formative evaluation activities. He also emphasizes that design theories are different from descriptive theories due to their prescriptive nature, in the sense that they offer guidelines, without attempting to spell out every detail and allow no variation (Reigeluth, 1983, 1997, 1999). On the other hand, Gustafson and Branch (1997) accept the Seels and Richie (1994) definition, which is "an organized procedure that includes steps of analyzing, designing, developing, implementing, and evaluating instruction" (p. 31). However, they declare that Seels and Richie (1994) have coined this definition for ISD, instead of instructional development. Shrock (1995) has also made a definition similar to that of Seels and Richie's (1994), yet for instructional development. Gustafson and Branch (1997) further characterize instructional development as "a complex, yet purposeful process that promotes creativity, interactivity and cyberneticity [communication and control processes]" (p. 18)

**What is an Instructional Design/Development Model (IDDM)?**

Gustafson and Branch (1997) define model as "simple representation of more complex forms, processes, and functions of physical phenomena or ideas" (p. 17). It provides a visual representation of an abstract concept (Schindelka, 2003), helps people to "conceptualize representations of reality" (Gustafson & Branch, 1997, p. 17), and "explains ways of doing" (Gustafson & Branch, 1998, p. 3).

In line with Reigeluth’s (1983) opinions about instructional development, Gustafson and Branch (1997) have gone a step further and stated that instructional development models have at least four components of specifications for an individual learner and many, both formatively and summatively, be the distribution and an extended period of time as "conceptual and cognitive" (Spector, 1997, p. 48) stoking a link between learning.

The origins of instructional design models can be traced back to World War II development models from the first instructional design mentalistically linear theory, which theories of today were have impacted instruction. Microcomputers in the classroom and Internet access, discussion, to accommodate the cap (1990) and content, have proved, degree of line of feedback is the accompanying computer used. It has contributed to the increased static; it has evolved in terms of interactive and uncreative limitations.

Since the 1990s, six factors (Reiser, 2001). These are

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at least four components, which are “analysis of the setting and learner needs; design of a set of specifications for an effective, efficient and relevant learner environment; development of all learner and management materials; and evaluation of the results of the development both formatively and summatively” (p. 12) They have also added that a fifth activity could be the distribution and monitoring of the learning environment across various settings, over an extended period of time. These components help instructional development models serve as “conceptual and communications tool” (p. 13). Gros, Elen, Kerres, Merriënboer, and Spector (1997, p 48) state that, “instructional design models have the ambition to provide a link between learning theories and the practice of building instructional systems.”

The origins of instructional design procedures can be traced to the first research efforts dating back to World War II (Dick, 1987). Gustafson and Branch (1997) state that instructional development models first appeared in 1960s and since then an increasing number of models have been published in the literature. Seels and Richie (1994) highlight the simplicity of the first instructional design models, which had only to master a few techniques and a fundamentally linear theory, since instructional science was an infant and many of the tools and theories of today were not conceivable. Since then, a variety of developments and trends have impacted instructional design practices (Reiser, 2001). However, the introduction of microcomputers in the 1980s has exerted the most significant effect on instructional design practices. With the advent of desktop digital media and the subsequent arrival of worldwide Internet access, discussions began for the need to develop new models of instructional design to accommodate the capability and interactivity of this technology (Merrill, Li, & Jones, 1990). Wide variations have emerged in models in terms of their purposes, amount of detail provided, degree of linearity in which they are applied, and quantity, quality, and relevance of the accompanying operational tools (Gustafson & Branch, 1997). This paradigmatic change has contributed to the instability of the terminology and shows that the field of IDD is not static; it has evolved in time and is still evolving. This is good, since a field that becomes static and uncreative is likely to become less prominent (Seels & Richie, 1994).

Since the 1990s, six factors have had significant impact on instructional design practices (Reiser, 2001). These are performance technology movement, constructivism, Electronic Performance Support Systems (EPSSs), rapid prototyping, increasing use of Internet for distance education/distance learning, and knowledge management endeavors. However, to provide an account of these factors is out of the scope of this chapter, and Reiser’s work should be consulted for a comprehensive discussion.

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**Criticisms About the Current State of IDD and IDDMs**

Gustafson and Branch (1997) assert that there has been a cumulative increase in the number of published instructional development models since the 1960s. However, there seems to be little uniqueness in the structure of these models, although they are abundant in number. In other words, as time passes, models are enhanced in quantity, but not in quality (Gustafson & Branch, 1997, 1998).
Some writers have argued that the traditional instructional design models are resistant against substantial changes (Rowland, 1992) and are only fit to narrow, well-defined, and static scenarios, because they are process-oriented rather than people-oriented, and use clumsy, bureaucratic, and linear approaches (Gordon & Zemke, 2000; Jonassen, 1990; McComb, 1986; Tripp & Bichelmeyer, 1990; You, 1993; Zemke & Rossett, 2002). Contrasting with these criticisms, others contend that over time, problems become apparent in the traditional ISD model and important and permanent modifications and additions are performed (Clark, 2002; Schiffman, 1995; Shrock, 1995).

The procedural stratifications and time-consuming practices of traditional ISD models have drawn much of the criticism. As an alternative, thinking of instructional development as a set of concurrent, overlapping procedures might help both to speed up the process and to overcome many limitations of the traditional instructional design models. One of the most well-known examples is “prototyping” or “rapid prototyping,” which is a design approach borrowed from the discipline of software engineering (Tripp & Bichelmeyer, 1990).

Both Prensky (2001) and Rowland, Parra, and Basnet (1994) assert that often instructional design is done by the book, or by using an overly rationalistic view, which in turn produces “boring cookie-cutter outcomes” (Prensky, 2001, p. 83). These writers emphasize that a move toward more creative methodologies is necessary, in order to lead to flexible, creative solutions to unique situations.

Since the existing design theories have not reached perfection, there is need for new theories and models that will guide instructional designers in the use of ideas about learning founded in human development and cognitive science, and in taking advantage of new information technologies as tools for feedback and assessment or for instruction in general (Reigeluth & Frick, 1999).

Table 1: Key alterations with the shift from Industrial Age to Information Age

<table>
<thead>
<tr>
<th>Industrial Age</th>
<th>Information Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial Society</td>
<td>Information Society</td>
</tr>
<tr>
<td>Bureaucratic organization</td>
<td>Team-based organization</td>
</tr>
<tr>
<td>Centralized control</td>
<td>Autonomy with accountability</td>
</tr>
<tr>
<td>Adversarial relationships</td>
<td>Cooperative relationships</td>
</tr>
<tr>
<td>Autocratic decision making</td>
<td>Shared decision making</td>
</tr>
<tr>
<td>Compliance</td>
<td>Initiative</td>
</tr>
<tr>
<td>Conformity</td>
<td>Diversity</td>
</tr>
<tr>
<td>One-way communications</td>
<td>Networking</td>
</tr>
<tr>
<td>Compartmentalization</td>
<td>Holism</td>
</tr>
<tr>
<td>Parts-oriented</td>
<td>Process-oriented</td>
</tr>
<tr>
<td>Planned obsolescence</td>
<td>Total quality</td>
</tr>
<tr>
<td>CEO or boss “King”</td>
<td>Customer (learner) as ‘King’</td>
</tr>
</tbody>
</table>

This section explores the improvement of models, such as hergests customized, i.e, which is also articial material and Winn: Interaction disciplin as a result of linkin are further suggeste depend on multi-pe Joucloux’ (1995), a need to be further e: Hermeneutics emph meanings of individ introduce gaps of in (Jonassen et al., 1995) multiplayer online b: social constructivist Chaos theory finds on and self-organization structure, for example IDDMs that adjust titions, consideratio skills and self aware The last alternative t on the idea that reali
Apart from technological changes, Reigeluth (1999) discusses a paradigm shift in education and training, a major shift from Industrial Age to Information Age thinking, which implies shifts in various attributes for instruction (see Table 1).

The change in paradigms, according to Reigeluth (1996), requires a shift from standardization to customization. New models of IDD need to make possible a unique learning experience for each learner, rather than trying to produce a single, clearly defined outcome for all learners. The need for customization is also consistent with Winn’s (1997) and Jonassen, Hennon, Ondrus, Samouilova, Spaulding, Yueh et al.’s (1997) criticisms about the positivist basis of ID models. Both disapproved the way that a linear design process assumes the predictability of human behavior, the closed and isolated nature of learning situations, the responsibility for learning belonging to the instructor rather than the learner. New IDD models need to reflect the dynamic, complex, and non-linear nature of the design process, the changing contexts of learning in digital game-based environments, and the many and varied cognitive, emotional, and social differences in abilities among learners.

### New Trends in IDD and IDDMs

This section explores a number of new alternative approaches that have been suggested for the improvement of the IDD process. Jonassen et al. (1997) suggest adapting new scientific models, such as hermeneutics, fuzzy logic, and chaos theory. Reigeluth (1996, 1999) suggests customized, learner-centered and social-contextual design conducted by user-designers, which is also articulated by Winn’s (1997) matched timing of design and use of instructional material and Winn’s (1996) statement of necessity to get help from the Human Computer Interaction discipline. Lastly, Hoffman (1997) offers the ideas of plasticity and modularity as a result of linking Reigeluth’s (1983) Elaboration Theory (ET) and hypermedia. There are further suggestions, such as Gros et al.’s (1997) multimedia-facilitated IDD models that depend on multi-perspectival presentation of knowledge or Wilson, Teslow, and Osman-Jouchoux’s (1995), and Wilson’s (1997) adaptation of postmodernism to IDD field, which need to be further explored.

Hermeneutics emphasizes the importance of the socio-historical context in mediating the meanings of individuals creating and decoding texts; this implies that IDD must strive to introduce gaps of understanding, which allow the learner to create his/her own meanings (Jonassen et al., 1997). Other chapters in this book introduce the idea that new massively multiplayer online learning environments entail new social processes that align well with social constructivist, hermeneutic philosophy, and methods.

Chaos theory finds order in the chaos of natural structures through looking for self-similarity and self-organization, patterns that are repeated at different levels of complexity through a structure, for example, a fractal. It can offer two alternatives to IDD: first complex, dynamic IDDMs that adjust to learners on the fly, and secondly due to its sensitiveness to initial conditions, consideration of learners’ emotions, and related self-awareness, besides cognitive skills and self-awareness (Cagiltay, 2001; Jonassen et al., 1997).

The last alternative that Jonassen et al. (1997) suggest is fuzzy logic. Fuzzy logic is based on the idea that reality can rarely be represented accurately in a bivalent manner. Rather, it...
is multivalent, having many in-between values, which do not have to belong to mutually exclusive sets. It is a departure from classical two-valued sets and logic, that uses “soft” linguistic (e.g., large, hot, tall) system variables and a continuous range of truth values in the closed interval [0, 1], rather than strict binary (True or False) decisions and assignments. Since the sequence of events within a project depends on human decisions, which is based on approximate reasoning of human beings, fuzzy logic can be well applied to IDD process.

The fuzzy logic perspective implies for IDD that behavior can be better understood probabilistically, using continua, rather than binary measures. Instead of having strictly bounded and sequenced phases, having intertwined phases, which have flexible and fuzzy boundaries, would be more advantageous in that it would allow designers to move freely in between phases throughout the entire IDD process. Jonassen et al. (1997) state that the more one moves away from deterministic approaches to thinking and designing toward more probabilistic ways of thinking, the more useful it becomes in providing methods for assessing “real-life” issues, where things are not black-and-white, but rather any number of different shades of color across the spectrum. Jonassen et al. (1997) further state that it is impossible to predict, let alone describe, what will happen in learning situations due to the elusive and complex nature of human consciousness, which is also consistent with Winn’s (1996) opinion that although instructional designers would like them to do otherwise, people think “irrationally,” and reason “implausibly.” Both of these statements support the main definition of fuzzy logic. However, both researchers’ studies lack more specific facets of fuzzy logic. More specifically, the set-theoretic facet of fuzzy logic implies the non-linear, dynamic IDDM phases, which have “fuzzy” rather than strict boundaries. This provides freedom for instructional designers to move back and forth throughout the design process and even conduct more than one activity at a time.

Depending on the previously mentioned shift to Information Age, Reigeluth (1999) also suggests an alternative to the linear stages of the ID process. The entire process cannot be known in advance, so designers are required to do “just-in-time analysis” (p. 15), synthesis, evaluation, and change at every stage in the ID process. However, this is not a newcomer to the field, since learner-centeredness and parallel process have been articulated by Heinich (1973) a long time ago (cited in Winn, 1996). Reigeluth (1999) further states that to be capable to meet the demands of the Information Age, the instructional designer should become more aware of the broader social context, within which the instruction takes place, and a point that is also made by various researchers as well (Dede, 1996; Jonassen et al., 1997; Kember & Murphy, 1995; Richey, 1995; Tessmer & Richey, 1997). For example, the instructional designer might consult more broadly with stakeholder groups to reach a common vision of the final instructional and the means to develop it. The social context can expand to include the learners, consistent with Kember and Murphy’s (1995) suggestion that linking the learners to designers supports iterative improvement.

Lastly, Hoffman (1997) offered plasticity and modularity as a result of linking Reigeluth’s (1983) Elaboration Theory (ET) and hypermedia. He states that the Web-like linking of ideas that characterizes hypermedia is more alike to the functioning of human cognition than is the traditional linear structure found in most educational programming. He further asserted that this kind of model for IDD could lead to the possibility of modularity and plasticity, which would bring along the ease to make changes in response to learner needs without changing the overall structure of the product and rapid development. It could also allow the custom manner to that of

To sum up the work with the changing mentioned alternatives, IDD field against also begins to evolve statement summar

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itors to design game of a traditional, line
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important digital gar balanced in terms of
has character in term
the player playing, an
lements, he further a
ive, easy to learn bu
allow the customization from the user end to allow a more feasible learner control in like manner to that of a Web structure.

To sum up the whole discussion, IDD and IDDM should find alternative ways to catch up with the changing world of education due to changes in the world itself. The previously mentioned alternatives are thought to be useful and helpful to renew and strengthen the IDD field against the criticisms. It also reveals the fact that like the other disciplines, IDD also begins to evolve into a multidisciplinary discipline. Indeed, Jonassen et al.'s (1997) statement summarizes the main idea:

*Like the chiropractor who realigns your spine, we might become healthier from a realignment of our theories. If we admit to and attempt to accommodate some of the uncertainty, indeterminism and unpredictability that pervade our complex world, we will develop stronger theories and practices that will have more powerful (if not predictable) effects on human learning* (p 33)

# Design Models for Educational Use of Games and Simulations

Theories that inspire game design include “Flow Theory of Optimal Experience” developed by Mihaly Csikszentmihalyi (1990) and “Activity Theory” developed by Alexey Leontiev, a student of Lev Vygotsky (Kaptelinin & Nardi, 1997). Moreover, there are some myths and principles to be taken into consideration during preproduction and production stages of game design proposed by Cerny and John (2002). Yet, there seem to be hardly any design models except for the instructional design/development model tailored for the creation of game-like learning environments, which is called the FIDGE model (Akili & Cagiltay, 2006). Hence it is clear that there is a need for IDD models that will help and guide educators to design game-like learning environments, “which requires the ability to step outside of a traditional, linear approach to content creation—a process that is counter-intuitive to many teachers” (Morrison & Aldrich, 2003).

This section offers a brief review of different design principles and lessons learned from game design processes before briefly reviewing the FIDGE model. For instance, Amory, Naicker, Vincent, and Adams (1999) identified game elements that students found interesting or useful within different game types, which were the most suitable for their teaching environment and presented a model that links pedagogical issues with these identified game elements.

Prensky (2001) presents various principles for good computer game design and other important digital game design elements. For instance, he claims that good game design is balanced in terms of challenge, creative in terms of originality, focused in terms of fun, and has character in terms of richness and depth that make you remember it, tension that keeps the player playing, and energy that keeps you up all night (pp. 133-134). In addition to these elements, he further asserts that a game should have a clear overall vision with highly adaptive, easy to learn but hard to master structure offered via a very user-friendly interface. It
Table 2 Summary of the FIDGE model (Source: Akilli & Cagiltay 2006, p 110, reprinted with permission from IOS Press)

<table>
<thead>
<tr>
<th>Issue</th>
<th>Its Property</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participants</td>
<td>All of actively participating learners and experts</td>
</tr>
<tr>
<td>Team</td>
<td>Multidisciplinary multi-skilled game-player experience</td>
</tr>
<tr>
<td>Environment</td>
<td>Socio-organizational, cultural</td>
</tr>
<tr>
<td>Process</td>
<td>Dynamic, non-linear, fuzzy, creative, enriched by games' and simulations' elements (fantasy, challenge, etc.)</td>
</tr>
<tr>
<td>Change</td>
<td>Continuous, evaluation-based</td>
</tr>
<tr>
<td>Evaluation</td>
<td>Continuous, iterative, formative, and summative, fused into each phase</td>
</tr>
<tr>
<td>Management</td>
<td>Need for a leader in the team and a well-planned and scheduled time management</td>
</tr>
<tr>
<td>Technology</td>
<td>Suitable compatible</td>
</tr>
<tr>
<td>Use</td>
<td>By (novice/expert) instructional designers and educational game designers for game-like learning environments and educational games</td>
</tr>
</tbody>
</table>

should have a constant focus on the player experience that keeps the player within the flow state providing exploration, discovery, and frequent rewards, not penalties. It should provide mutual assistance, which means achieving one thing in the game helps to solve another, and the ability to save this progress (pp. 134-136). Lastly, as for digital game-based learning, he provides five questions to be asked during the process of designing, again with his emphasis for fun followed by learning. These five questions can be summarized as the appeal of games in terms of fun for other people too, who are not targeted as audience; the self-perceptions of users as “players of the game among level of encouragement.”

The “Games-to-Text” design principles for action games by using “power-ups [adjust player speed, height identifying contests players to experience]” using informed choices and consent expertise in multiple.

The most recent study shows the “FIDGE model” (AI fuzzy boundaries, the model’s foundation is unlike traditional “box sets of principles that for the design team articulates the model in an all of these studies are “boring” by students and mass are being to provide a medium to the same game the digitally-based educational practice.

This chapter has provided an overview of the issues and design of the FIDGE model and, domain, and design guidelines, and the design through this existent but newly developed. New IDD models are new can armor students for they.

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of users as “players” not as “students” or “trainees;” the level of addiction and prominence of the game among the players; the level and rate of improvement at player’s skills; and the level of encouragement and enactment for players’ reflection on their learning (p. 179).

The “Games-to-Teach” project carried by Massachusetts Institute of Technology proposes design principles for successful games design (MIT, 2003). These are designing educational action games by turning simulations into simulation games; moving from parameters to “power-ups” (adjustments made on some traits of the character in the game, such as shifts in player speed, height, and so forth to enhance their attributes); designing game contexts by identifying contested spaces, identifying opportunities for transgressive play (that enables players to experience new roles via “temporarily letting go of social/cultural rules and mores”); using information to solve complex problems in simulated environments; providing choices and consequences in simulated worlds; and differentiating roles and distributing expertise in multiplayer games.

The most recent study on the subject with a promising design/development model is the “FIDGE model” (Akilli & Cagiltay, 2005). The model consists of dynamic phases with fuzzy boundaries, through which instructional designers move in a non-linear manner. The model’s foundation in the fuzzy logic concept leads to a visualization of the model that is unlike traditional “boxes-and-arrows” representations (see Figure 2). There are two other sets of principles that underlie the model, which are related to socio-organizational issues for the design team and to the instructional design/development process itself. Table 2 summarizes the model in its essence.

All of these studies deserve appreciation, since educational games are mostly classified as “boring” by students. Moreover, they also show that endeavors are being suffered for and steps are being taken toward what Kirriemuir (2002) emphasized: “Computer games provide a medium that engages people for long periods of time, and gamers usually return to the same game many times over. There are obvious lessons here for the developers of digitally-based educational, learning and training materials.”

Conclusion

This chapter has provided a brief theoretical framework for the educational use of games and simulations and their effect on learning. It reviewed and addressed some of the main criticisms and new trends in the IDD and IDDM fields.

The characteristics of the “game generation,” the importance of games for education, and criticisms about IDDMs’ failure to meet these changing needs lead to the conclusion that instructional designers should strive to seamlessly integrate game elements into their designs and to create game-like learning environments, so that they can arm our students for the future and build powerful learning into their designs. However, there seems to be a little number of design guidelines, and only one IDD model exists in the literature, to guide instructional designers through this painstaking process, which at the same time provides an already existent but newly discovered playground for the practitioners in the field.

New IDD models are needed to help designers create game-like learning environments that can arm our students for the future and build powerful learning into their designs.

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