An Instructional Design/Development Model for the Creation of Game-like Learning Environments: The FIDGE Model

Göknur KAPLAN AKILLI [a, 1] and Kürşat ÇAĞILTAY [b]
[a, b] *Department of Computer Education and Instructional Technology, Middle East Technical University, Turkey*

Abstract. Computer games are considered as powerful tools to learning and they have a potential for educational use. However, the lack of available comprehensive design paradigms and well-designed research studies about the question of "how to" incorporate games into learning environments is still a question, despite more than thirty years' existence of computer games and simulations in the instructional design movement. Setting off from these issues, a formative research study is designed to propose an instructional design/development model, which may be used for creation of game-like learning environments. Depending on the results and with the inspiration from fuzzy logic, an instructional design/development model for creating game-like environments, which is called as "FIDGE model" is proposed.

Keywords. Games, simulations, game-like learning environments, instructional design/development (IDD), instructional design/development model (IDDM), formative research, fuzzy logic.

Introduction

One of the possible novelties regarding the methods of education, which should be discussed, is the use of games. As a matter of fact, games are not so much a novelty in this field, as young human beings, by nature, begin to learn through games and playing from their early childhood [1]. At the older ages, games are replaced by formal education. Nevertheless, the transition from informal games to formal education environment does not always, and especially nowadays, seem to be a sharp one as it is known that games are being used also in some educational environments, yet their success is questionable. When one looks deeper into the subject, it is understood that the use of games in education is not so much a novelty too, because its history may be traced back a few thousand years [2]. It is now known that even in times before history, games and dramatic performances as representations of real life were more effective as teaching tools than the presentations of life itself. In our modern day, with the new technological advancement of societies, traditional games of old times have been replaced by electronic games and in similar manner, dramatic representations of old have been transformed into role-playing in simulation environments. Hence, electronic games and simulations have been parts of contemporary formal education. However, such transformation cannot be expected to take place quite smoothly and without its problems.

1. Problem Statement

Traditional instructional design/development models have been criticized on the grounds that they hardly represent a variety of structure, although they are abundant in number. The procedural stratifications and time-consuming practices have constituted the main rationale of these criticisms. On the other hand, although computer games and

[1] Corresponding Author: Göknur Kaplan Akıllı, Department of Computer Education and Instructional Technologies, Middle East Technical University, İnönü Bulvarı 06531, Ankara, Turkey; E-mail: akilli@metu.edu.tr.

simulations have a history of more than three decades in the instructional design movement and computer games are considered as powerful tools to increase learning [2, 3]; there are two major problems that are encountered. One is that there are no available comprehensive design paradigms and the other is the lack of well-designed research studies [4]. While the literature is growing as time passes, by the carbon copy researches that report perceived student reactions preceded by vague description of games and simulations or comparative studies of simulations versus regular classroom instruction [4], the question of how to incorporate games into learning environments rather than, simply, to master the material, is much more frequently asked to the educational researchers [2, 5].

2. Significance of the Study

Computer games and simulations have appeared on the scene of instructional design/development (IDD) activities more than three decades ago; yet, the literature still lacks available comprehensive design paradigms and well-designed research studies [4]. Although there is vast number of instructional design/development models (IDDMs), which reveal answers of "how to" questions for various learning environments and situations and an accumulating mass of research about the perceptions of the students and their reactions, effects of games on learning and various skills, and even about the illustrations of such environments, the question of how to incorporate games into learning environments stays unresolved. Reigeluth and Frick mention that although the existing design theories have not reached perfection; there is need for more theories and models that will guide us through human development and related additional kinds of learning, where for different kinds of situations those utilize new information technologies as tools, via telling us "how to do"[6]. For this "how to do" question, the three studies within researchers' reach were proposing basic design guidelines and principles for creating game-like learning environments rather than a model [7, 8, 9].

In conclusion, there is the apparent and urgent need for the introduction of an IDDM that will help and guide instructional designers and/or game designers for the efficient use of games and simulations in educational environments, more precisely to create game-like learning environments.

3. General Overview and Current State of Knowledge

Education has always been considered as one of the most productive breeding-grounds for technology where it would find its finest resonances and thus would have revolutionary effects. However, the use of technology in educational environments does not presently seem to have contributed significantly to the realization of these expectations [10, 11]. The most important reason may be the insufficiency of current models and methods to meet the consequences of the paradigm shift from Industrial Age to Information Age [12, 13]. The latter statement is also valid for the use of games and simulations in education.

Games and simulations are often referred to as experiential exercises [4], in which there is 'learning how to learn' [14]. However, they have hardly become a part of IDD movement until early 1970s, despite their entrance to educational scene in the late 1950s [4]. There are two major problems that we faced with, when educational use of games and simulations is of concern, non-existence of available comprehensive design paradigms and the lack of well-designed research studies [4]. Despite existence of many IDDMs, which reveal answers of "how to" questions for various learning environments and situations, there is no trace about the presence of a such model with the exception of the model that the current study proposes, which can be used for creating game-like learning environments.

3.1. Instructional Design/Development

During the review of the relevant literature, we faced with the interchangeable use of instructional design; instructional systems design (ISD); instructional development; and even instructional technology, which was also asserted by many researchers [15, 16, 17, 18]. Even though several attempts have been made to derive standardized definitions and terms [17, 16, 19], the results have not been adopted and used in the literature. Thus, a unified term of "instructional design/ development (IDD)" will be used throughout the study. However, it would be better to assert that we considered the definition of instructional development given by Reigeluth, which is "concerned with understanding, improving and applying methods of *creating* [italics added] instruction" [18, p.8], optimizes the process of developing the instruction and encompasses analysis, design, development, implementation, and formative and summative evaluation activities [18, 17].

Winn and Jonassen et al. put criticisms about the positivist basis of ID models [20, 21]. Both disapproved the linear design process assumes the predictability of human behavior, the closure and isolatedness of learning situations, responsibility of instructor than the learner for learning and ignores the dynamic, complex and non-linear nature of the design processes, contextualness of learning environments, differences among learners, metacognitive abilities of learners, unstable, elusive and complex nature of human consciousness.

As alternative approaches that can be employed for the improvement of IDD process, various researchers offer various suggestions. Jonassen et al. suggest adapting new sciences, such as hermeneutics, fuzzy logic and chaos theory [21]. Reigeluth suggests customized, learner-centered and social-contextual design conducted by user-designers [22, 13], which is also articulated by Winn's matched timing of design and use of instructional material [20] and Winn's statement of necessity to get help from Human Computer Interaction discipline [24]. Lastly, Hoffman offers plasticity and modularity [23], as a result of linking Reigeluth 's Elaboration Theory and hypermedia [18]. There are further suggestions, however, among these issues only fuzzy logic which is first suggested by Jonassen et al. will be explained within the scope of the current study [21].

3.2. 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 implies for IDD that behavior could only be understood probabilistically, using continua, rather than binary measures and integration of problematic areas such as student perceptions of the efficacy of the educational program into the design. More specifically, set-theoretic facet of fuzzy logic also implies the non-linear, dynamic IDD phases, which has "fuzzy" rather than strict boundaries. Moreover, since the sequence of events within a project depends on human decisions, which are based on approximate reasoning of human beings, fuzzy logic can be well-applied to IDD process. 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. 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 in "real-life" issues, where things are not black-and-white, but rather any number of different shades of color across the spectrum [21]. Jonassen et al. further state that it is impossible to predict, let alone describe, what will happen in learning situations due to elusive and complex nature of human consciousness [21], which is also consistent with Winn's opinion that although instructional designers would like them to do otherwise, people think 'irrationally,' and reason 'implausibly'[24]. Both of these statements support the main definition of fuzzy logic. However, both researchers' studies lack more specific facets of fuzzy logic, which had been coined first by Lotfi A. Zadeh in 1960s, but remained concealed until it was discovered in the late 1980s [25]. For the current study, the researchers were especially interested in the set-theoretic facet of fuzzy logic, which is concerned with fuzzy sets, whose boundaries are not sharply defined [26; 27, ¶5]. The set-theoretic facet of fuzzy logic is also the initial focus of the development of fuzzy logic, which gave birth to applications such as fuzzy arithmetic (also known as "computing with words" [26, p.1]) fuzzy topology, etc. Moreover, by fuzzification, which is the process of replacing the concept of a set with that of a fuzzy set, it becomes possible to provide a way of constructing models or theories that are more general and more reflective of the imprecision of the real world than the models or theories in which the sets are assumed to be sharply bounded and definitely limited. Briefly, any concept, method or theory can be generalized to a reflection of the real world via fuzzification. This was exactly what the researchers wanted, i.e. the proposal of an alternatively structured instructional design/development model against the traditional instructional development models that have been criticized for their linear structures, procedural stratifications and time-consuming practices.

3.3. Games and Simulations

Games and simulations are often referred to as experiential exercises [4], in which there is 'learning how to learn' [14]. Turkle further contended that it provides more than thinking; beyond thinking [14]. Specifically, Prensky defines games as "organized play." [8, p. 119]. Heinich, Molenda, Russell, and Smaldino define game as "an activity, in which participants follow prescribed rules that differ from those of real life as striving to attain a challenging goal" [28, p.10]. Dempsey, Rasmussen and Lucassen define gaming in a basic sense as "any overt instructional or learning format that involves competition and is rule-guided" [3, p. 4].

According to Prensky simulations and games differ in that, "simulations are not, in and of themselves games. They need all the additional structural elements - fun, play, rules, a goal, winning, competition, etc." [8, p. 212]. Depending on these definitions and characteristics, as an attempt to derive a general term, the researchers will use *game-like learning environments*, which is defined as 'authentic or simulated places, where learning is fostered and supported especially by seamless integration of motivating game elements.

As for theories that inspired the game design, "Flow Theory of Optimal Experience" developed by Mihaly Csikszentmihalyi [29] and "Activity Theory" developed by Alexey Leontiev, a student of Lev Vygotsky could be recognized [30]. Moreover, there are some principles to be taken into consideration proposed by Cerny and John [31]. Yet, there seems 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 [32].

3.3.1. Effects of Games and Simulations on Learning

Although the literature about 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 state that among problem solving and integrated learning systems, games and simulations were the least used technology applications in education [10]. However, there exist studies that put forth effects of games and simulations on discovery learning strategies, problem solving skills and computer using skills; their effects on students' intellectual, visual, motor skills and about the engagement and interactivity which are important for learning environments.

3.3.2. Educational Use of Games and Simulations

There is evidence that the use of games as instructional tools dates back to 3000 B.C. in China [2]. Nevertheless, games and simulations have hardly become a part of instructional design movement until early 1970s, despite their entrance to educational scene in the late 1950s [4]. Seels and Richie report that in those times audio-visual specialist saw the potential of games and simulations but not of video (or likewise electronic) games [16].

Rieber argues that growing technological innovations provide opportunities of interactive learning environments that can be integrated with the theories of learning [1]. However, Prensky further claims that, instruction through neither CAI, nor web based technologies contributes to learning, rather they subtract. People do not want to be included in such learning "opportunities" offered via innovative technologies, but they have to, since these learning "opportunities" possess still the same boring content and same old fashioned strategy as traditional education [8, p. 92-93]. Prensky 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" [8, 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 works [8].

3.3.3. Design Models for Educational Use of Games and Simulations

The literature is reviewed to search for design models that will help and guide instructional designers especially 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." [33, ¶ 15]. However, it seems there is lack of IDD models, in turn there are various design principles and lessons learned from commercial game designs. For instance, Amory, et al. 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 [7]. Furthermore, Prensky presents various principles for good computer game design and other important digital game design elements [8]. The other recent study on the subject that the design and research team currently works on is the "Games-to-Teach" project carried by Massachusetts Institute of Technology (MIT). This study also proposes design principles for successful games design [9].

4. Methodology

This study is designed as a special methodology that is similar to that of a case study method of qualitative research [34], which is referred as "formative research" by Reigeluth and Frick [6, p. 633]. Formative research methodology fits best, while the researchers were interested in the design and development process rather than the product or outcomes, in contextual structure rather than specific variables and in discovery of the underlying elements rather than conformation [35]. Moreover, the reason that the case, which is selected by the researchers, is not especially and intentionally designed according to a specific model, but fulfils the same goals and provides the same context as researchers intention, leads the design of the study towards *naturalistic case* of formative research.

Participants of the study were selected by using convenience and purposive sampling and consisted of 18 out of 56 senior undergraduate students of the Computer Education and Instructional Technologies (CEIT) Department of the Middle East Technical University in Turkey, with the age range of 20 to 24. Participants, who were fourth year students, enrolled in an educational game design course in their department, were invited to participate in a study that was designed to suggest a new IDDM that might be used for creation of game-like learning environments, utilizing a 3D virtual world tool on the Internet. The researchers collected data during this IDD process, duration of which was three months.

As for the data collection and analysis techniques, observations, documents (such as weekly reports, peer evaluations, e-mail logs and reflective papers about the specific aspects of the selected case written by the participants), and semi-structured interviews with the participants (students), instructors (of the selected case); and content analysis were used. These data sources are the ones that formative research implies.

5. Findings

The findings of the research is summarized under three groups, which are completely invented and were determined by the researchers themselves, depending upon the data, to scrutinize the phenomena much more easily and comprehensively. In reality, the collected data showed an inter-relational and fuzzily-bounded nature.

The findings were grouped as the soft issues, process-related issues, and hard issues related to creation of game-like learning environments. Soft issues are the peopleware part, or in other words, the human relations and social/organizational issues of an instructional design/development (IDD) process. The findings related with these soft issues can be summarized as the following:

1. IDD requires teamwork.
2. Team members' characteristics and qualifications are important (i.e. field knowledgeableness, proficiency in technology, strategic, holistic and especially creative thinking abilities, project management skills, leader qualifications, communication skills, responsibility, honesty, empathy, professionality, high-level programming knowledge and advanced coding skills are essentially required).
3. Quality and qualifications of the team members affect the quality of an instructional system.
4. Beforehand determined cautions and ways for resolutions to possible conflicts are essential.

As its name suggests, process-related issues are the findings related to analysis, design, development and evaluation steps of an IDD process, i.e. the findings that formed the core of the model. These can be summarized as:

1. It is impossible to omit or ignore any of the ID phases.
2. Do not isolate ID phases from each other strictly.
3. Do not conduct ID phases in a linear sequence.
4. Conduct ID phases parallel to and within each other.
5. Transitions between phases should be flexible.
6. Turning back to a phase should be possible.
7. Tendency to think of and create a utopia in the design phase.
8. Flexibility and modularity of the product is important.
9. Progressing via prototypes is very effective.
10. Evaluation should be fused into the whole ID process.
11. Formative evaluations are of great importance.
12. Guidance is needed in each step.

Lastly, hard issues are the technical aspects of this IDD process, which can be summarized as the following:

1. Technical problems, which are mostly originated from the tool
    a. usability (hard-to-use, hard-to-adapt)
    b. manipulation (even the administrator of tool has limited permission, log on option for one of the group members at a time)
    c. limitations/restrictions (mostly related to 3D component of the tool)
    d. location (difficulty of carrying the program to another location other than the computer labs in the department)
    e. interaction features of the tool (difficulty of finding putting or exporting appropriate objects or animations to 3D area)
    f. server-related problems (difficulty of uploading their works to the server via FTP)
    g. speed
    h. similarity (possibility to find out the corresponding features and similar sides among the tools that were previously used)
2. Location and communication problems in reaching target audience
    a. lack of permission from the school administration
    b. difficulties to conduct evaluations
    c. difficulty in describing the project to the other people

3. Time limitations

6. The FIDGE Model

6.1 General Overview of the FIDGE Model

In the current study, the researchers suggest an appropriate and evolving IDDM for the creation of game-like learning environments based on the findings. In accordance with many of the traditional models, this model also consists of four parts, which are analysis, design, development and evaluation. Additionally, it possesses an additional phase; the “pre-analysis” phase. However, the components of these parts and the way they are structured are different from the traditional models. It consists of dynamic phases, which have fuzzy boundaries and through which the instructional designers progressed in a non-linear manner. Indeed, the reason of these characteristics is the basis of the model that is cultivated on the fuzzy logic concept, which also leads to a different visualization of the model rather than the traditional “boxes-and-arrows” approach (see Figure 1). Another reason is that the model is proposed depending directly on actual and concrete data collected from real-life practices. What is more, the researchers also coined the below presented model’s name regarding these attributes, especially the non-linearity and fuzziness emerged from the findings. It is called as “FIDGE” model, which is the acronym that stands for “**F**uzzified **I**nstructional **D**esign **D**evelopment of **G**ame-like **E**nvironments” for learning. According to the Oxford English Dictionary [36], “fidge” as a verb means “to be eager and restless; to express pleasurable eagerness by restless movements,” which is also consistent with the impatience that anybody shows when playing a game is of concern.

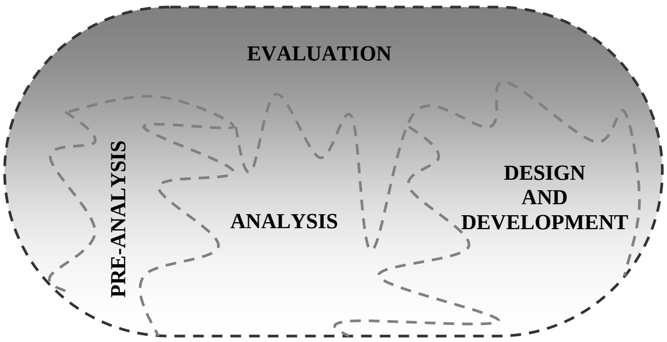

Figure 1. General structure of the FIDGE model.

Before scrutinizing the details of the proposed model, it would be better to emphasize the two general patterns that were dominant within the findings. First one is the contexts, in which IDD takes place, and, in which the product attained at the end of IDD process will be used. The second one is the attributes of this IDD process.

The first pattern is both a contributor and the by-product of the IDD process. It seriously affects the quality of the product and IDD process itself, and is in turn affected by the socio-organizational needs and cultural issues, which appeared during the IDD process, such as the need for a leader who will lead the rest of the team throughout the process, and the necessity to avoid acting with their emotions and feelings. As for the context, in which the product attained at the end of IDD process will be used, the findings revealed the importance of the appropriateness of the product regarding the socio-economic status and the abilities of the learner with consideration of the cultural issues.

For the second general pattern, the “must-be” non-linearity and dynamism throughout the IDD process; the fuzziness among each step of IDD process; and lastly, features originated and inherited from games and simulations were asserted by the participants. Throughout the entire process, all the participants had to make modifications and revisions in their plans and actions that they took to overcome the problems and obstacles, by means of continuous evaluation. Findings have indicated that it is impossible to omit or ignore any of the analysis, design, and development phases and instead of isolating these phases from each other strictly and conducting them in a linear sequence, it would be better to conduct them parallel to each other and in an intertwined manner.

Lastly, findings of study revealed that all of the participants used some features peculiar to games and simulations. For instance, findings of the study provided traces of unique features peculiar to simulations, such as non-linear event sequence, intertwined consequences of action-reaction chains, and dynamic set(s) of relationships changing with respect to the actions that the user took.

As for the games, findings of the study indicated the use of game characteristics, especially in the design phase of IDD process, such as challenge, fantasy, curiosity and control given to the learners that contribute specifically to motivation and thus eager learning. Moreover the findings also pointed out other features of games and simulations, such as engagement, interactivity and active participation. The use of popular culture elements with the above mentioned elements was another issue revealed by the findings of the study.

There are two sets of principles that underlie the model, which are related to some socio-organizational issues for the design team and to the instructional design/development process itself. The first set of principles, which is related to peopleware (soft) and technical (hard) issues, is as follows:

1. Form a multidisciplinary and multi-skilled team including an experienced game-player
2. Provide common standards about the work done
3. Identify and develop awareness and need for an instructional system, and create mechanisms for motivation.
4. Meet the need for a leader and a guide.
5. Establish good communication strategies and create active involvement.
6. Manage, plan and schedule time.

The second set of principles, which is related to the whole instructional design/development process itself, is as follows:

1. Dynamic, non-linear and fuzzy phases.
2. Early decisions about the utilities and restraints of the technology, which will be used throughout the project.
3. Analogous, participatory design and prototypes.
4. Support from the literature.
5. Continuous and iterative evaluation and synthesis.
6. Focus on the modularity and flexibility of the product.
7. Creativity.

Lastly, before moving on the details of the model, it would be better to emphasize that the components of the model are intertwined through each other and sometimes conducted in parallel among the phases, despite their exhibition as a listing.

6.2 Pre-analysis Phase of the FIDGE Model

The reason for the existence of this phase is to provide a starting point for the instructional designers (see Figure 2). However, if there is no need for such a warm-up period, this phase could be skipped.

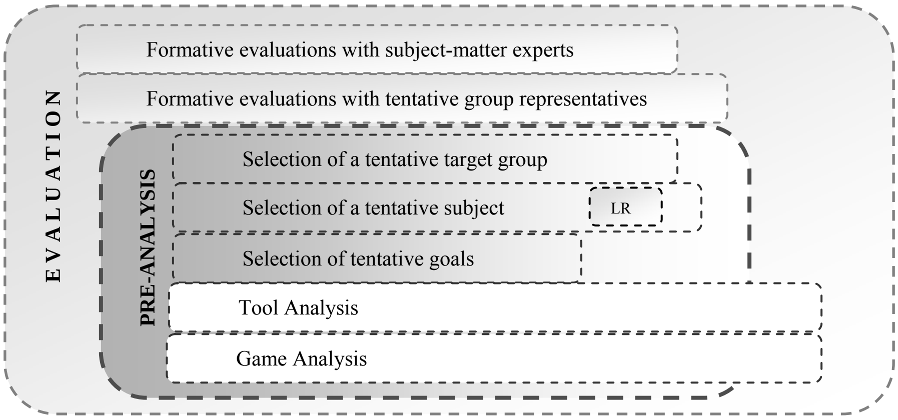

Figure 2. The visualization of pre-analysis phase of the FIDGE model.

All of the following issues are tentative and could be easily changed when the instructional designers begin to conduct analysis phase:

1. Determine and specify a tentative target group.
2. Select a tentative subject regarding your target group and depending on your previous experiences.
3. Conduct a small literature review (LR) to find evidence, whether your tentative subject fits or is likely to be fit for creation of game-like learning environment, or not.
4. Specify the tentative goals of your design according to the selected subject and regarding your target group.
5. Take the opinions and recommendations of the subject-matter experts, and a representative group of the tentative target group via interviews.
6. Begin to explore and analyze the development tool /software.
7. Begin to analyze different games to:
    a. Differentiate different game genres such as strategy, adventure, sports, etc.
    b. Find out game utilities such as multiplayer, collaboration, communities etc.
    c. Find out which game genre is appropriate for which subject matter e.g. strategy games are appropriate for social sciences.
    d. Find out game elements such as the use of pirates, magic, history, etc.
    e. Find out the appropriateness of the instructional approach in relation to game genre, game utilities, and game elements.

6.3. Analysis Phase of the FIDGE Model

In this phase, needs analysis, learner analysis, context analysis, content (or task) analysis, cost analysis (if needed), risk analysis, an analysis to adjust the duration and the frequency of the system for effective use, and a self-analysis should be conducted, while the tool and game analyses which began in the previous phase will continue (see Figure 3). Moreover, instructional approach and its implications should be specified and a time planning activity should be done.

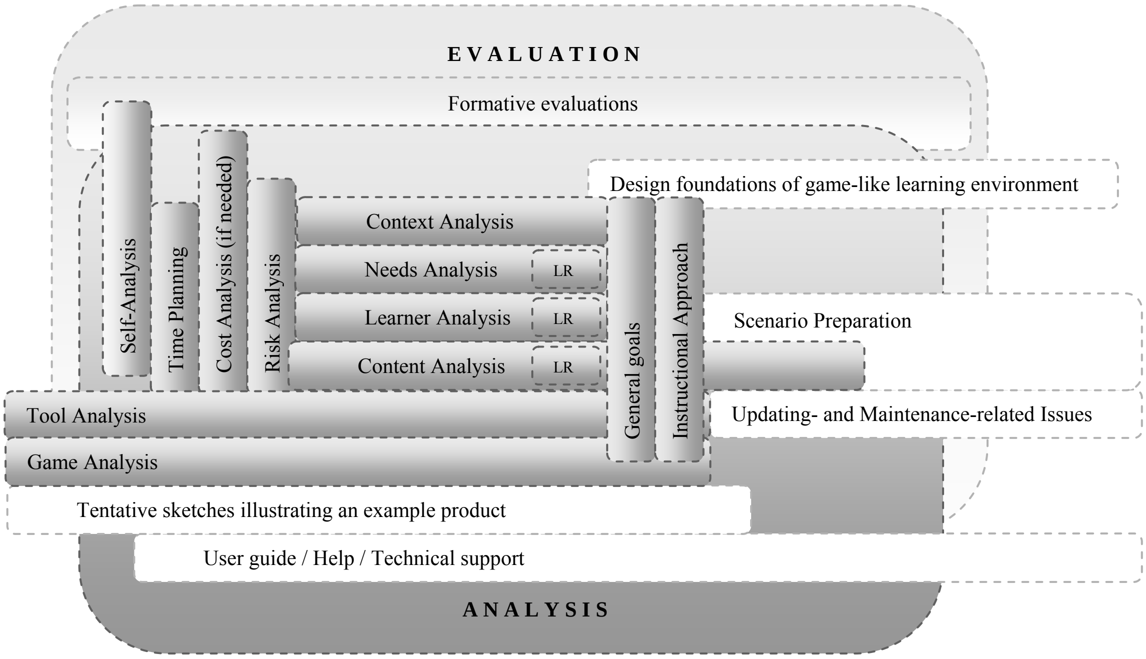

Figure 3. The visualization of analysis phase of the FIDGE model.

The components are as follows:

1. Needs analysis:
    a. potential stakeholders' (e.g. teachers', students', parents', etc.) attitudes toward computers
    b. potential stakeholders' opinions about computer use
    c. potential stakeholders' expectations from simulations and games
    d. why the target group should use simulations and games
    e. the insufficiencies and gaps in the topic/ subject stated by the target group (continued in content analysis)
    f. support from literature
    g. obtain or create sketches illustrating a completed product should to be shown to the target group or experts as an example, in order to be able to transform an abstract concept into a tangible one for them.
2. According to the conducted needs analysis, the general goals of the project will be constituted; more precisely, the needs will be transformed into the general goals of the project.
3. Learner analysis (conducted parallel to needs analysis and includes real observations, surveys, structured or semi-structured interviews with the actual target group and time schedule for all these):
    a. Actual target group's background information, i.e. characteristics, attributes, skills, prior knowledge, and specific entry competencies
    b. Support and help from the literature
4. Context analysis (conducted parallel to needs and learner analyses):
    a. Actual learners' perspectives about the attributes of a game-like learning environment, in which they would learn the designated content.
    b. The role of the teacher or instructor.
    c. The amount of the learner control.
    d. Examination of the computer infrastructure (fulfillment of the necessary and sufficient conditions, specification of minimum system requirements to work out the prepared program, identification of the hardware-related issues).
    e. Specification of the socio-economic status of the learners (in relation with their computer literacy, in order to determine at which grade the program will be used).

    f. Begin to lay design foundations.
5. Content (task) analysis (conducted parallel to needs, learner and context analyses; and affected by tool analysis):
    a. Efficiency assessment that stood for the optimum amount of content in a limited amount of time.
    b. Checking the accuracy of the content (formative evaluation with experts and learners).
    c. Verifying the topics included in the content through various resources (literature review).
    d. Taking students', subject matter experts' and experienced instructional designers' opinions (formative evaluation).
    e. Carrying out step-by-step reduction (regarding the limitations and boundaries of the tool and the structure (or nature) of the tool) (iterative cycles of formative evaluation).
    f. Setting the structure of the content (regarding the limitations and boundaries of the tool and the structure/nature of the tool).
    g. Creating the main elements of the scenario.
    h. Synthesis of the collected opinions of the students and the experts; the elements included in the content; and the instructional designers' own opinions (to provide intact objectivity).
6. Tool analysis (began in the pre-analysis and will be continued in analysis).
    a. The tool's structure/nature:
    b. What its uses are.
    c. How it is used.
    d. What its limitations and utilities are.
    e. Students' or learners' viewpoints and reactions to the tool.
    f. Investigation for alternatives to the selected tool/ technology.
    g. Thinking of suggestions about updating and maintenance of the system regarding tool analysis.
    h. Thinking of the issues concerning the guidance for and support to the user, such as 'help,' or 'technical support.'
7. Game analysis (began in the pre-analysis and will be continued in analysis. it is conducted parallel to tool analysis and in relation to learner, content, context analyses and instructional approach):
    a. Think of game utilities such as multiplayer options, collaboration, online virtual communities.
    b. Think of which game genre is appropriate for your instructional design/development.
    c. Think of the game elements for your instructional design/development.
    d. Specify the appropriateness of the instructional approach in relation to game genre, game utilities, and game elements of your instructional design/development.
8. Instructional approach (selected regarding the structure of the content, tool's nature/structure):
    a. Selection of instructional approach (e.g. discovery learning, scenario-based learning, problem-based learning or a hybrid approaches, which are offspring of two or more different approaches).
    b. The implications of the selected instructional approach to the design.
    c. Assurance of the selected instructional approach's capacity and aptitude for the application of game-elements.
    d. Adjustment of the instruction's duration and frequency for effective use.
    e. Formative evaluation to take the opinions of the learners and the experts.
9. Self-analysis for each instructional designer in the design team:
    a. Find out the needs, characteristics and skills that are lacking, but should be possessed by the members in the design team.
    b. Specify strategies to gain them.
10. Risk analysis:
    a. Envision of potential risks.
    b. Outline of a "panic room" plan against these foreseen risks.
    c. Cautions both to avoid and to solve possible problems.

11. Time schedule:
    a. Time arrangement for group meetings.
    b. Time arrangement for meetings with the designated experts.
    c. Time arrangement for meetings with learners from the target group.
12. Preparation for design:
    a. Specifying design foundations of game-like learning environment
    b. Writing down the tentative design decisions as the design team envisions them at the moment, i.e. a very general overview of design.
    c. Writing down the ‘scenario bits,’ such as the main theme of the scenario, the characters, etc.
    d. Drawing or providing tentative sketches illustrating an example product (The design team could find an example or create one to be used in formative evaluations mainly to give an idea to the interviewees about how the completed product would look like).

6.4. Design-Development Phase of the FIDGE Model

In this phase, scenario preparation; content clear-cuts; specification of motivation, attention, feedback, and learning assessment elements; preparation of user-help; creation of prototypes; preparation of rating scales, checklists and interview guides for formative evaluations; design of orientations; and insurance of usability issues, product’s modularity and flexibility will be conducted (see Figure 4).

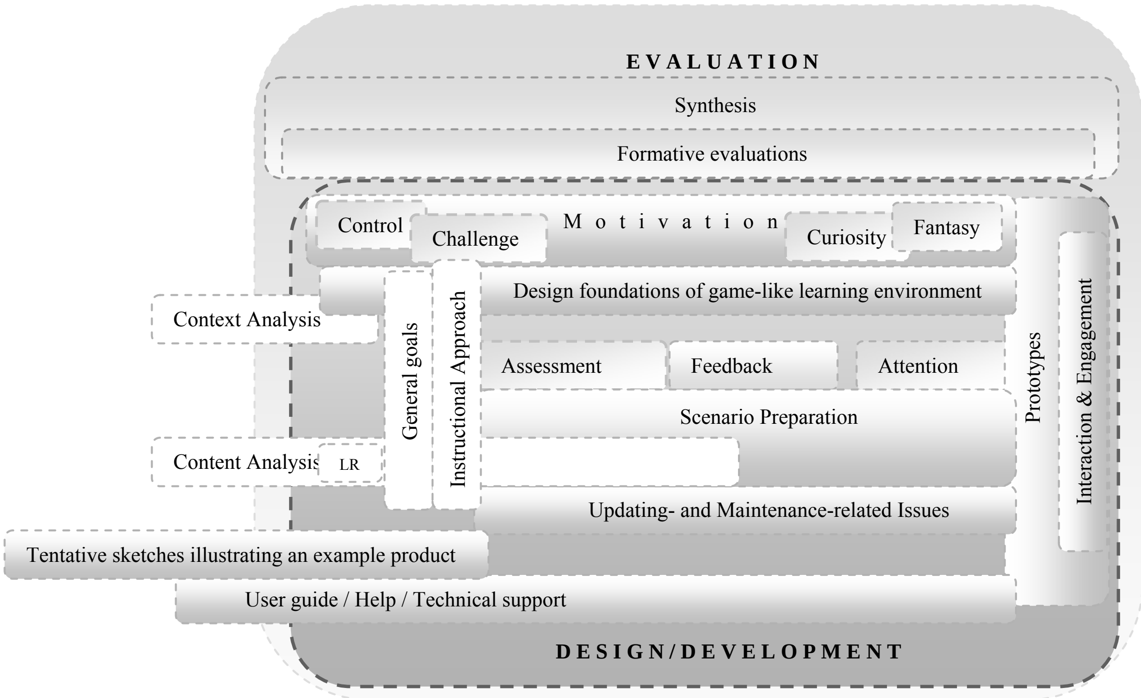

Figure 4. The visualization of design-development phase of the FIDGE model.

It would be better to emphasize that the *implementation* phase of the traditional models is contained in the intertwined design and development phase of the FIDGE model. This phase encompasses:

1. Preparation of more than one scenario, namely alternative scenarios for the game-like learning environment and selection of the most appropriate one:
    a. Regarding the content analysis.
    b. Regarding the selected instructional approach.

c. Regarding the boundaries of the tool.
d. Utilizing the team member's wide experiences as a game player.

This gives an opportunity to switch to another scenario, in case the scenario prepared at the beginning failed to be implemented.

2. Preparation of the scenario-related components:
   a. Setting of the scenario (prototypes should be prepared, to be used to take feedback from the learners and ID experts continuously (formative evaluation)).
   b. Plot structure of the scenario (a typical use case should be written, which also provides guidance for the usage of the prepared program).
   c. A flowchart regarding the scenario (the flowchart should inherit the content's structure and should be framed by the tool's limitations).
3. Content clear-cuts (as an extension of the content analysis in the analysis phase):
   a. Clarify the content in its brief, intertwined and clear-cut form using the continuing step-by-step reductions and modifications via iterations and feedbacks from the team members; subject matter experts, ID experts; and learners (formative evaluation).
   b. Make necessary changes in the goals, content analysis and the flowchart according to these modifications and reductions.
4. Specification of motivation, attention, feedback, and learning assessment elements for creation of game-like learning environments:
   a. Utilize the essential elements of many commercial games possess, such as curiosity, challenge, fantasy and control given to the learner to give his/her own decisions.
   b. Utilize elements from popular culture.
   c. Pay attention to the relatedness of motivation elements with the feedback and attention components.
   d. Feel free to combine feedback and the learning assessment elements.
   e. Pay attention to interaction and engagement elements, which are also peculiar to games, related to the feedback, motivation and content.
   f. Include activities to provide learners' active engagement.
   g. Enrich the social aspect of the interaction provided via the program you are designing, to help your learners to establish a virtual community, or to give the feeling of togetherness.
   h. Specify collaboration utility and climate of your game-like learning environment by describing how the users will collaborate, what utilities they will have when collaborating each other (e.g. will they share the tasks, complete only their own part of the task and merge each completed part at the end or each of them will complete the task on their own and use collaboration utility of your program to get help from each other?).

   The employment of formative evaluations to specify the details and components of the above is also important and helpful.
5. Preparation of user-help which should be conducted parallel to tool analysis including:
   a. The issues concerning guidance for user such as 'help.'
   b. The issues concerning support for user, such as 'technical support.'
6. Creation of prototypes (in relation to the above mentioned analyses and scenario)
   a. Paper-based prototypes preparation.
   b. Computer-based prototypes preparation.

   These prototypes are used to take feedback from the learners, experts and team members, about both the user-interface design and the overall design itself. They are also likely to reveal the above-given issues about the motivation, attention, feedback and the learning assessment elements of the design. All the way through these feedbacks, it is likely that the details of the 'user-help,' or 'technical support will also emerge.
7. Preparation of rating scales, checklists and interview guides for formative evaluations by:

    a. Including items about the arrangement, presentation, appropriateness, consistency of the content.
    b. Including items about the general appearance, appropriateness and consistency of the user-interface.
    c. Including items about the extent to which the program appeals to the user.
8. Design of orientations, such as:
    a. An orientation about the program to avoid misunderstandings.
    b. A more general orientation to acquire target audience with the basic computer literacy and game-related skills (such as adjustment of an environment, in which the learners could play a simple game to acquire the game-logic and gain basic eye-hand coordination).
9. Insurance of usability issues throughout the whole phase by:
    a. Keeping in mind that everything should be user-centered and check the program's status accordingly, since users would be the ones who would use the product.
    b. Being aware of usability issues and employing them in the first place.
10. Assurance of product's modularity and flexibility by providing as much flexibility and modularity as possible for the final product, so that the need of a radical change, which might emerge following the formative evaluations, could easily be conducted.

Lastly, each of the above-mentioned elements should be supported by the literature. It should also be emphasized that final user interface could not even bear a resemblance to the initial one envisioned at the beginning. What is more, it is a possibility to be confronted with a very different version of the program, compared to the previously visualized design at the beginning.

6.5. Evaluation Phase of the FIDGE Model

Although the related elements of the evaluation phase were presented in the above phases, it would be better to give the general structure and main elements of the evaluation phase. Evaluation phase has three main elements, which are formative evaluation; summative evaluation and the synthesis (see Figure 5).

Instructional designers should never forget that evaluations and feedback taken from the learners should be continuous and should begin as soon as they started with the pre-analysis (or alternatively, analysis) phase.

Before conducting evaluations, the instructional designers should clarify the issues, such as, by whom the product would be evaluated, how they would be reached, where the evaluations would be conducted. For data collection, instructional designers should employ rating scales, checklists and the interview guides that would be already prepared in the design/development phase.

Instructional designers should conduct the formative evaluations frequently and with shorter intervals throughout the instructional design/development process and should employ them while determining the foundation stones of the instructional design/development process.

Instructional designers should conduct formative evaluations with the team members, their peers, learners in their target group and various experts of various professions; however, as stated in the previous parts, the learners representing the variance of the target group should be in the first place. This also puts forth the usability test that should be conducted within the evaluation phase.

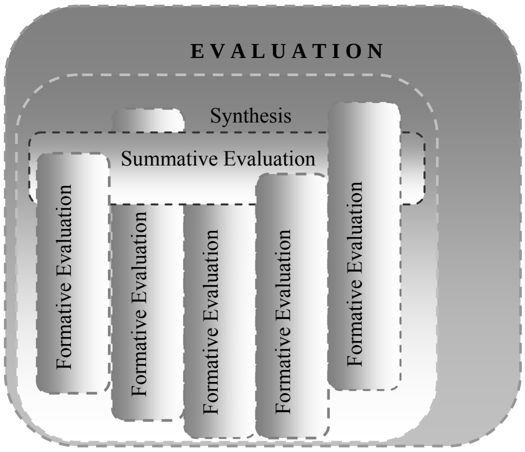

Figure 5. The visualization of evaluation phase of the FIDGE model.

In the synthesis part, as its name implies, instructional designers should make a synthesis and interpretation of all the data collected from the evaluations, related literature and their own comments, when making the final decisions about the project. For these purposes, after each evaluation, collected data should be analyzed; common points should be noted and discussed with the other instructional designers in the team.

As for the summative evaluation, it will be used to evaluate the instructional system as a whole. However, summative evaluation is not as critical as it was for the traditional model, since there will not be much left, due to the continual formative evaluations conducted throughout the design-development phase.

6.6. Summary of the FIDGE Model

To summarize, the FIDGE model is a real-life originated model that has a dynamic, non-linear and fuzzy structure and is enriched by unique features of games and simulation, which combines the context with peopleware throughout the instructional design-development process.

The proposed model might be used in creation of educational games as well as in creation of game-like learning environments. The researchers think that the proposed model might be appropriate to be used by both novice and expert users. The existence of the "pre-analysis" phase of the model is the most apparent evidence that this model addresses the novice instructional designers' needs. Other evidence is that they are the affiliates of the so called "game generation," who are different from many of us in various aspects and possess differentiating characteristics and skills resulting from different experiences and the "new media society" [8, p.65; 37]. However, they also lack sufficient instructional design experience, which would have impact on their use of this model, both positively and negatively. The probable positive effects are their untouched creativity and ingenious design habits. The probable negative effects would be the difficulty in understanding the model or misinterpretations, which would result in void and ineffective design practices.

As for the expert instructional designers, the researchers believe that this model might widen their visions and help them catch up with the current trends and changes of the coming generation.

Lastly, among the limitations of the model, the probable inheritance from the selected case and the complex and complicated nature of the model could be asserted. The elements that constituted the model seemed to be affected by the IDD model used in the case. For instance, the use of prototypes was inherited from the "rapid prototyping" model [38]. However, it would be meaningless to strive naming this concept in another way or to eliminate it, since it was found to be very useful. As for the complex and complicated nature of the model, it could be said that this is the first impression and it would be much easier to use this model due to its more flexible structure and fitting nature to human reasoning than other traditional models.

In conclusion, it should be kept in mind that all these issues should be further verified by the follow-up studies. It would be hardly possible to clarify the uses, users and the limitations of the model, earlier than the conduction of such follow-up studies.

Table 1. Summary of the FIDGE Model

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

References

[1] Rieber, L. P. (1996). Seriously considering play: Designing interactive learning environments based on the blending of microworlds, simulations, and games. *Educational Technology Research and Development 44*(2) pp. 43-58.

[2] Dempsey, J. V., Lucassen, B.A., Haynes, L.L., & Casey, M. S. (1996). Instructional applications of computer games. In J.J. Hirschbuhl & D. Bishop (Eds.), *Computer Studies: Computers in education* (8th ed., pp. 85-91). Guilford: Annual Editions.

[3] Dempsey, J. V., Rasmussen, K. & Lucassen, B. (1996). *The Instructional Gaming Literature: Implications and 99 Sources* (Tech. Rep. No: 96-1). USA, Alabama: University of South Alabama, College of Education. Retrieved May 30, 2002, from http://www.coe.usouthal.edu/TechReports/TR96_1.PDF

[4] Gredler, M. E. (1996). Educational games and simulations: a technology in search of a (research) paradigm. In D. H. Jonassen (Ed.) *Handbook of Research for Educational Communications and Technology*. Missouri: Simon and Schuster.

[5] Dede, C. (1996). The evolution of constructivist learning environments: immersion in distributed, virtual worlds. In B.G. Wilson (Ed.), *Constructivist learning environments: Case studies in instructional design* (pp. 165-175). New Jersey: Educational Technology Publications.

[6] Reigeluth, C. M. & Frick, T. W. (1999). Formative research: methodology for creating and improving design theories. In C. M. Reigeluth (Ed.) *Instructional-design theories and models (Volume II) A new paradigm of instructional theory* (pp. 633 – 652). Mahwah, NJ: Lawrence Erlbaum Associates.

[7] Amory, A., Naicker, K., Vincent, J. & Adams, C. (1999). The use of computer games as an educational tool: Identification of appropriate game types and game elements. *BJET, 30*(4), 311-321.

[8] Prensky, M. (2001). *Digital game-based learning.* New York: McGraw-Hill.

[9] Massachusetts Institute of Technology (MIT), (2003). Design principles of next-generation digital gaming for education. *Educational Technology*, September-October 2003, 17-22.

[10] Molenda, M. & Sullivan, M. (2003). Issues and trends in instructional technology: Treading water. In Fitzgerald, M.A., Orey, M., and Branch, R.M. (Eds.) *Educational Media and Technology Yearbook 2003*. Englewood, CO: Libraries Unlimited.

[11] Russell, T. (2003). *The "No Significant Difference Phenomenon".* Available at: http://teleeducation.nb.ca/nosignificantdifference (Retrieved on January 10, 2003).

[12] Bates, A. W. (2000). *Managing technological change. Strategies for college and university leaders.* San Francisco: Jossey-Bass.

[13] Reigeluth, C. M. (1999). What is instructional-design theory and how is it changing?. In C. M. Reigeluth (Ed.) *Instructional-design theories and models (Volume II) A new paradigm of instructional theory* (pp.5-29). Mahwah, NJ: Lawrence Erlbaum Associates.

[14] Turkle, S. (1984). Video Games and Computer Holding Power. In *The Second Self: Computers and the Human Spirit*. New York: Simon & Schuster, Inc.

[15] Shrock, S. A. (1995). A brief history of instructional development. In G. Anglin (Ed.), *Instructional technology: Past, present, and future* (2nd ed. pp. 11-19). Engelwood, CO: Libraries Unlimited.

[16] Seels, B & Richie, R. (1994) *Instructional technology: The definitions and domains of the field*. Washington: AECT.

[17] Gustafson, K. L., & Branch, R. M. (1997). *Survey of instructional development models* (3rd Ed.). Syracuse, NY: ERIC Clearinghouse on Information Resources. (ED 411 780).

[18] Reigeluth, C. M. (1983). Instructional design: What is it and why is it? In C. M. Reigeluth, (Ed.) *Instructional-design theories and models: An overview of their current status* (pp. 3-36). New Jersey: Lawrence Erlbaum Associates.

[19] Schiffman (1995). Instructional systems design: Five views of the field. In G. Anglin (Ed.), *Instructional Technology: Past, present, and future* (2nd ed. pp. 131-144). Engelwood, CO: Libraries Unlimited.

[20] Winn, W. (1997). Advantages of a Theory-based Curriculum in Instructional Technology. *Educational Technology, (37)*1, 34-41.

[21] Jonassen, D.H., Hennon, R.J., Ondrusek, A., Samouilova, M., Spaulding, K.L., Yueh, H.P., et al. (1997). Certainty, determinism, and predictability in theories of instructional design: Lessons from science. Educational Technology, 37(1), 27-33.

[22] Reigeluth, C.M. (1996). A new paradigm of ISD? *Educational Technology, (36)*3, 13-20.

[23] Hoffman, S. (1997). Elaboration theory and hypermedia: Is there a link? *Educational Technology, 37*(1), 57-64.

[24] Winn, W. (1996). Cognitive perspectives in psychology. In D. H. Jonassen (Ed.) *Handbook of research for educational communications and technology: A project of the Association for Educational Communications and Technology* (pp. 79-112). New York: Macmillan Library Reference.

[25] Dubois, D., Foulloy, L., Galichet, S. & Prade, H. (1999). Performing approximate reasoning with words?. In L.A. Zadeh & J. Kacprzyk (Eds.), *Computing with words and information/intelligent systems 1* (pp. 24-49). Heidelberg: Physica-Verlag.

[26] Zadeh, L. A.. (1999). Fuzzy logic = Computing with words. In L.A. Zadeh & J. Kacprzyk (Eds.), *Computing with words and information/intelligent systems 1* (pp. 1-23). Heidelberg: Physica-Verlag.

[27] MIT Encyclopedia of Cognitive Science. (2003). Fuzzy Logic. Retrieved June 25, 2003, from http://cognet.mit.edu/MITECS/Entry/zadeh.html.

[28] Heinich, R., Molenda, M., Russell, J.D. & Smaldino, S.E. (2002). Instructional media and technologies for learning (7th ed.). New Jersey: Merrill Prentice Hall.

[29] Csikszentmihalyi, M. (1990). *Flow: The psychology of optimal experience.* New York: Harper Perennial.

[30] Kaptelinin, V. & Nardi, B.A. (1997). *Activity theory: Basic concepts and applications.* Retrieved October 11, 2003, from http://www.acm.org/sigchi/chi97/proceedings/tutorial/bn.htm/

[31] Cerny, M. & John, M. (2002, June). Game development. Myth vs. method. *Game Developer*.

[32] Akilli, G. K. (2004). *A proposal of instructional design/development model for game-like learning environments: The FID^{2}GE model.* Unpublished master's thesis, Middle East Technical University, Ankara.

[33] Morrison, J., L. & Aldrich, C. (2003, September/October). Simulations and the learning revolution: An interview with Clark Aldrich. *The Technology Source.* Retrieved from August 11, 2003, from http://64.124.14.173/default.asp?show=article&id=2032 on

[34] Yin, R. K. (1996). *Case study research: design and methods.* (2nd ed.) Thousand Oaks, CA: Sage Publications.

[35] Merriam, S. B. (1998). *Qualitative research and case study applications in education.* (2nd ed.) San Francisco: Jossey-Bass.

[36] Oxford English Dictionary (2nd edition) [Online version] (1989). Retrieved January 9, 2003 from http://dictionary.oed.com/cgi/entry/00084385/

[37] Calvert, S. L. & Jordan, A. B. (2001). Children in the digital age. *Applied Developmental Psychology, 22,* 3-5.

[38] Tripp, S., & Bichelmeyer, B. (1990). Rapid prototyping: An alternative instructional design strategy. *Educational Technology Research and Development, 38* (1), 31-44.